Wendy Collard

From: Wendy Collard
Sent: Wednesday, 12 April 2023 04:25 p.m.
To: [redacted]
Subject: Local Government Official Information and Meetings Act 1987 - DCC Municipal Stormwater Discharge Consents or Certificate of Compliance

Kia ora

I refer to your Local Government Official Information and Meetings Act 1987 for the following:

Please provide the application/s, decision/s, and consent/s for current Dunedin City Council stormwater discharge/s, if any. I understand that a permitted activity rule may also apply to many stormwater discharges (Rule 12.8.1.8 of the Otago Regional Plan; Water for Otago). If that is the case, any certificates of compliance-related documentation or information would also assist.

Dunedin City Council (DCC) holds 11 consent for stormwater discharges from its stormwater network to the environment. There are 10 Coastal Discharge Consents (for discharge into the Otago Harbour; and the Pacific Ocean at St Clair/Second Beach). There is also one consent for stormwater discharge to land in circumstances where it may enter the Tomahawk Lagoon.

Any other stormwater discharges from its stormwater network are permitted activities under the Otago Regional Council's Regional Plan: Water. The DCC does not hold certificates of compliance in relation to this permitted activity.

Please find attached the following documentation:

Marine Stormwater

2012 Marine Stormwater Discharge Consent Application

Hearing Panel Decision RM11.313 Narrative

Tomahawk Lagoon

2019 Tomahawk Lagoon Stormwater Consent

RM10.261.01 Tomahawk Lagoon Stormwater consent;

Otago Regional Council staff Recommending Report RM19.261.01

Stormwater Discharges to Coast

Council has 10 Coastal Discharge Consents – RM11.313.01 – RM11.313.10) which are available on the Dunedin City Council website https://www.dunedin.govt.nz/services/stormwater/stormwater-monitoring

Kā mihi

Wendy Collard



Assessment of Environmental Effects

Dunedin City Council Marine Stormwater Discharges

28 MAY 2012

Prepared for

Dunedin City Council

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Appendix B ICMP Summary Report
Appendix C Cultural Impact Assessment
Appendix D DCC Monitoring Framework
Appendix E Action Plan

Appendix F Stormwater Compliance Monitoring Reports

Appendix G Additional Monitoring Reports

1

Introduction

1.1 Brief Description of the Proposal

The Dunedin City Council (DCC) manages the stormwater network for Dunedin. Stormwater is the runoff from roofs, roads, car parks and other hardstand areas generated from rain events. Dunedin City's stormwater network consists of a series of underground pipes and some open channels that convey the stormwater generated by the city to the point where it discharges to the coastal marine area (either the Otago Harbour or St Clair and Second Beach).

Resource consents from the Otago Regional Council (ORC) are currently held by DCC for these discharges (refer to Appendix A), however they are due to expire in 2012. Consequently, DCC is applying for resource consents to replace those that are due to expire.

1.2 Purpose of this Report

Section 88 of the Resource Management Act 1991 (RMA) requires that an application for resource consent(s) include, in accordance with Schedule 4, an assessment of effects on the environment (AEE) in such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

This document provides this assessment and supports the resource consent applications made to the ORC.

1.3 Summary of Resource Consents Sought

DCC is seeking resource consent from the ORC for the discharge of stormwater to the coastal marine area (CMA) from 10 stormwater catchments in Dunedin City. These discharges are classified by the Regional Plan for Otago: Coast (the coastal plan) as a **controlled activity** requiring resource consent. DCC is proposing to group the 10 stormwater catchments into four receiving environments with common environmental characteristics: St Clair / Second Beach; Andersons Bay Inlet; Upper Harbour Basin; and Port Chalmers. The DCC is applying for four discharge permits (resource consents); one for each receiving environment.

2

Background

2.1 Current Resource Consents

DCC currently holds 29 resource consents for stormwater discharges to the CMA. Each consent relates to a known stormwater outfall and there is no grouping of consents in relation to stormwater catchment or the receiving environment of the discharge. These consents were granted by the ORC on 29 November 2007 and expire on 29 November 2012.

The current resource consents require the implementation of a monitoring regime and the preparation of an Integrated Catchment Management plan (ICMP) for each catchment, conditions which have been met by DCC. The current consent documents are contained in **Appendix A**.

2.2 Section 124 of the Resource Management Act

Section 124 of the RMA provides a mechanism for an applicant to continue to exercise its existing consent while applying for a replacement. This can occur provided an application is made with the relevant consent authority at least 6 months prior to the expiry of the existing consent. As stated above, the current discharge permits are due to expire on 29 November 2012. DCC can therefore continue to discharge stormwater under the conditions of the existing consents until the new applications have commenced in accordance with section 116 of the RMA.

2.3 Three Waters Vision and Strategy

Over the past four years DCC's Water and Waste Services Business Unit (WWSBU) has made significant changes to its approach to the planning and delivery of water, wastewater and stormwater services; as well as the team and staffing structure required to enable such changes.

As part of these changes the DCC developed the Three Waters Strategic Direction Statement, which outlines a set of priorities and approaches for the management of the "three waters" (wastewater, stormwater and drinking water supply).

The key strategic priorities relating to the discharge of stormwater are:

- *'We will Improve the quality of our discharges to minimise the impact on the environment;*
- *We will limit cost increases to current affordability where practical; and*
- *We will adopt an integrated approach to the management of the three waters and embrace the concept of kaitiakitaka.'*

The sustainable and integrated nature of this statement has provided the focus necessary for the WWSBU to change the way it manages and delivers water services. This integrated focus provides unique opportunities to optimise decision making processes, funds allocation and issue identification. For example identifying and addressing cross connections between stormwater and wastewater networks.

The Three Waters Strategy Project was developed to meet the priorities outlined in the Three Waters Direction Statement and has led to detailed investigations into the performance of the three waters networks. In relation to stormwater, this included investigations into the quality and quantity of stormwater discharges and investigations into potential associated environmental effects.

A significant component of the Three Waters Project was the development of 10 ICMPs which was also a requirement of the DCC's current stormwater discharge consents.

2.4 Integrated Catchment Management Plans

The current resource consents require the implementation of a monitoring regime and the preparation of an ICMP for each catchment. The ICMPs have been developed for 10 stormwater catchments in Dunedin and were completed and submitted to the ORC in November 2011. The ICMPs are a requirement of the current stormwater resource consent conditions and provide:

- a description of each catchment;
- a description of the stormwater network;
- the stormwater management objectives for each catchment;
- the identification of stormwater management problems and issues for each catchment;
- a description of the long (35 years) and short term programme of works and priorities to implement each management plan;
- monitoring procedures to assess each plan's effectiveness; and
- procedures for revising each plan.

Through the development of these ICMPs the DCC have developed a greater understanding of the potential effects of Dunedin's stormwater discharge and has developed a robust mechanism for managing these effects. The actions contained within the ICMPs are categorised under the headings: further study; operation and maintenance tasks; planning and regulatory changes; and capital works. The action plan for the first three years of the consent term is included with the consent application as **Appendix E**. Where actions listed in this plan are referred to within this AEE, the action plan reference number associated with this action will be noted.

Where practicable the studies undertaken, mitigation recommendations made, and the holistic management approach contained within the individual ICMP documents, are referenced in the assessment of effects on the environment. The issues identification and prioritisation sections of the ICMPs form an integral part of the method of managing any actual or potential effects arising from the proposed discharges. A report providing a summary of all 10 ICMPs is contained in **Appendix B**. It should be noted that the ICMPs were completed over a period from 2009 to 2011. Some of the early recommendations have already been implemented. Where appropriate, this report uses the most recent available information.

As outlined in Section 4.2 of this report, the DCC intend to continue with an ongoing monitoring programme (the monitoring framework). The programme has been modified and extended from the current monitoring programme (results of this monitoring are included in **Appendix F and G**) to allow the effectiveness of measures implemented through the current action plan to be assessed with regards to meeting DCC's objective of improving the quality of stormwater discharges. The incorporation of environmental trigger values into the monitoring framework will also ensure that the ICMP's and associated action plans can be modified and actions reprioritised as a result of any changes to the assessed environmental effects.

3

Description of the Environment

3.1 Overview

The parts of the Dunedin stormwater network discharging into the coastal environment are divided up into 10 distinct stormwater catchments, each of which has a number of associated stormwater outfalls. Where there were previously thought to be 29 stormwater outfalls (this is the reason for the 29 stormwater discharge consents currently held by the DCC), recent investigation by the DCC has identified additional outfalls, bringing the total to 33.

The 10 stormwater catchments discharge into four receiving environments, shown in Figure 3-1:

- St Clair / Second Beach;
- Andersons Bay Inlet;
- the Upper Otago Harbour Basin; and
- Port Chalmers.

All these receiving environments are considered modified due to reclamation, historic industrial land use and historical discharges. Consequently, any assessment of effects associated with the current stormwater discharges needs to be undertaken against this baseline.

This section of the report provides a description of the 10 stormwater catchments, grouped based on the receiving environment into which each catchment discharges. Also described are a number of more general environmental factors such as topography, land use, recreation values, the stormwater drainage network and a description of the ecology of the stormwater receiving environments. Stormwater quality monitoring is also reported.

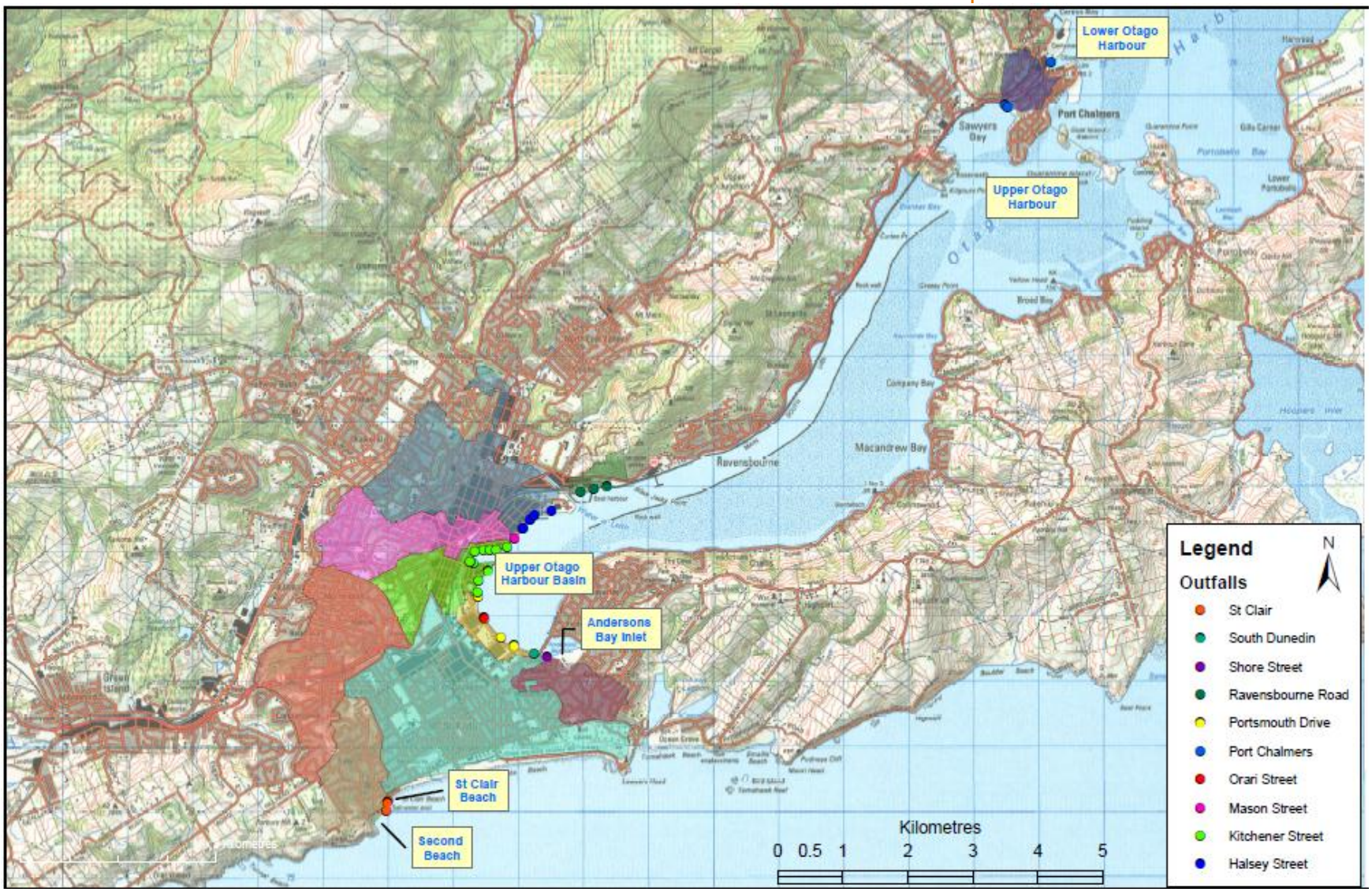


Figure 3-1 Receiving Environments

3.2 Upper Otago Harbour Basin

The South Dunedin, Portsmouth Drive, Orari Street, Kitchener Street, Mason Street, Halsey Street and Ravensborne Road stormwater catchments discharge to the Upper Otago Harbour Basin. The following section describes these stormwater catchments and the Upper Otago Harbour Basin receiving environment.

3.2.1 Catchment Descriptions

South Dunedin

The South Dunedin catchment is generally flat, and covers approximately 10-15 % of the central urban area of Dunedin. The stormwater network in the catchment is comprised chiefly of shallow pipes laid at flat gradients, all of which discharge to the Upper Otago Harbour Basin via the Portobello pump station.

Contamination of harbour sediments adjacent to the South Dunedin catchment discharge point has occurred historically, due to industrial land uses in the catchment. Because the catchment is now predominantly residential, with fewer significant industries in the area, the quality of stormwater discharged is improving, however PAH and potentially heavy metal contamination has been detected in some stormwater samples, and will be the subject of further investigation (Action Plan Reference: 0013).

Portsmouth Drive

The Portsmouth Drive catchment is a small, flat catchment adjacent to the Upper Harbour Basin. The catchment land use is entirely industrial and located on reclaimed land.

The stormwater network is piped, and discharges via four outfalls into the Upper Otago Harbour Basin. While the level of service of the pipe network is generally low, predicted flooding is expected to be primarily 'nuisance' flooding. Tidal influence is significant, however, and Portsmouth Drive is known to be flooded during high tides and storm events. During climate change scenarios, flood risk is likely to be related to sea level and storm surge, rather than the reticulation.

The catchment is adjacent to a historically contaminated part of the harbour, however information in relation to the stormwater quality or current discharges does not draw strong conclusions regarding the role of current contaminant inputs.

Orari Street

The Orari Street catchment is a large, relatively steep catchment that includes three main stream gullies surrounding Caversham Valley Road, Corstorphine Road and Glen Road. The stormwater network is characterised by a mixture of piped and open watercourses, with a single large outfall pipe that is sealed for approximately 1.3 km, from Wilkie Road to the outfall in the Upper Otago Harbour Basin. The Glen Valley discharges to a large intake structure at the base of Glen Road.

Kitchener Street

The Kitchener Street catchment is located near the centre of the Dunedin City urban area. The residential area lies on the hilly upper part of the catchment to the west, whereas the industrial, commercial and port areas span the flat, low-lying portion of the catchment, most of which is situated on reclaimed land. The town belt runs along the western boundary, while the Otago Harbour bounds the catchment to the east.

3 Description of the Environment

The stormwater network in the catchment is characterised by ageing pipes, laid at steep grades in the upper catchment, and flat grades east of Princes Street. Flooding occurs at a few locations in the catchment, due mainly to insufficient pipe capacity and localised depressions in the topography. Stormwater quality in the catchment is typical of discharges from catchments with similar land use when compared to published stormwater quality monitoring results and guidelines (CCC, 2003; Williamson, 1993; Zollhoefer, 2008; Wendelborn et al, 2005; U.S. Department of Transportation Federal Highway Administration, 1990).

Mason Street

The topography of the Mason Street catchment is characterised by low lying relatively flat areas in the eastern areas which are occupied by industrial and urban land uses, with the topography increasing in steepness towards the residential-zoned west of the catchment. The catchment includes part of the central business district in Dunedin.

High microbial readings in the limited stormwater quality samples taken indicate possible wastewater contamination, and further monitoring and investigation of the likely source is included in the current action plan for stormwater works over the next three years (Action plan reference: 0012).

Halsey Street

The Halsey Street stormwater catchment is approximately 390 ha and is one of the larger stormwater catchments in Dunedin.

The catchment includes a large part of the central commercial and industrial area in Dunedin, north and east of the Octagon, as well as the residential suburbs of Littlebourne and Maori Hill. The Town Belt runs through the catchment in the west. The catchment is generally bounded by the waterfront to the south-east, Stuart Street, York Place and Kilgour Street to the south-west, Highgate Street to the north-west and Drivers Road and St David Street to the north-east. There is also an area to the north-east of the main catchment encompassing a section of the Bullock Track and Malvern Street, draining to the main catchment via a piped network along Great King Street North.

Ravensborne Road

The Ravensbourne Road catchment is a small, primarily industrial, catchment to the east of the Dunedin CBD. The industrial area of the catchment is located on flat, reclaimed land adjacent to the harbour, with steep bush covered hillside to the north.

A single small gully drains the bushy hillside, and natural flow is intercepted at Ravensbourne Road and diverted via pipework and an open channel to an outfall discharging to the Otago Harbour. The flat industrial area and roads are drained via two stormwater pipe networks, which discharge to the harbour via two further harbour outfalls.

The stormwater monitoring information gathered to date indicates that the stormwater quality discharged from this catchment has a low level of contaminants when compared to the typical contaminant range of expected stormwater quality for the catchment's industrial land use. Similarly, harbour sediment contaminant levels adjacent to the catchment were found to be low.

3 Description of the Environment

3.2.2 Receiving Environment Description

The Upper Otago Harbour Basin

The majority of the Dunedin urban area stormwater discharges into the Upper Otago Harbour Basin. In addition to these discharges, a number of freshwater inputs have an effect on the Harbour – in particular the Water of Leith, which discharges water from a 9,416 ha catchment to the north-west of the Dunedin urban area.

The Upper Otago Harbour Basin is a highly modified environment as a result of reclamation, road works and dredging activities (Smith, 2007). Historical activities in the Dunedin urban area (particularly industrial activities) have also contaminated the marine environment. Because of this, it has been difficult to establish a 'baseline' in terms of the Upper Harbour ecology, in order to assess the ongoing effects of current discharges. However, the monitoring undertaken to date provides the best information available against which to assess on-going ecological health.

The tidal range in the Otago Harbour is approximately 2.2 m. Tidal current water velocities range from zero to 0.25 m/s (Ryder Consulting, 2005), and estimates for harbour flushing times range from 2 to 15 days (Grove and Probert, 1999; Smith and Croot, 1993, 1994).

A study by Smith and Croot (1993), describes the circulation of water in the Otago Harbour as being dominated by the tide and inputs of heavy rainfall. Smith and Croot (1993) report that flushing times in the harbour are hard to establish because heavy rainfall has a dramatic effect on dilution displacement of the water in the upper harbour. Harbour flushing times, therefore, may vary and be greatly reduced during rainfall events.

Figure 3-2 below shows depths and water circulation patterns in the Upper Harbour Basin.

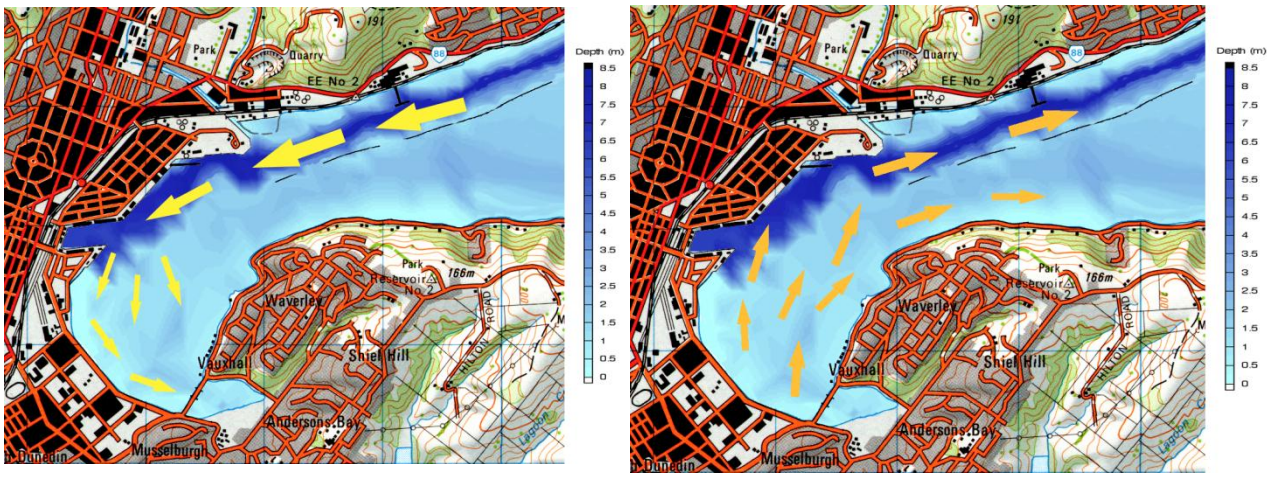


Figure 3-2 Flood Tide (left) and Ebb Tide (right), Upper Harbour Basin

3.3 Andersons Bay Inlet

The Shore Street stormwater catchment is the only catchment that discharges to Andersons Bay Inlet. The following section describes the Andersons Bay Inlet receiving environment and the Shore Street stormwater catchment.

3.3.1 Catchment Description

Shore Street

The Shore Street catchment is characterised by steep gullies at the head of the catchment in the east and the Musselburgh Rise in the west of the catchment. There is a large area of reclaimed land adjacent to the Andersons Bay Inlet, some of which is included in the Shore Street catchment.

The stormwater network has two main branches running south to north; one along Tainui Road, picking up flow from the Musselburgh Rise area, with the second following along Bayfield Road draining the balance of the catchment. These branches meet at Shore Street before discharging into the Andersons Bay Inlet. The network is predominantly piped, but includes several lengths of open channel in the upper reaches.

The Andersons Bay Inlet has evidence of historical contamination. This has been reported in Ryder (2005) and is based on historical studies, and sediment sampling between 2007 and 2012 near the outfall that has shown that lead, zinc and PAH have been elevated in some samples. The enclosed nature of the inlet means that contaminants discharged with stormwater are more likely to remain in the inlet. While the stormwater quality is thought to be typical of the residential land use, because only one ecological survey has been undertaken (in 2010), more information is required in order to determine whether current stormwater discharges are having an effect on the receiving environment, or whether sediment sampling is capturing historic sediments.

3.3.2 Receiving Environment Description

Andersons Bay Inlet

The Andersons Bay Inlet causeway was completed in 1872. Dredging of the Inlet occurred as early as 1890, and there is a large area of reclaimed land adjacent to the inlet (Bayfield Park) which is identified as a contaminated site (Figure 3-4). Recently, a ‘bird island’ has been constructed in the Inlet.

Flushing times in the Andersons Bay Inlet are long compared to the Upper Harbour; Smith and Croot (1993) estimate that between 4 and 10 tidal cycles are necessary for 99% flushing.

There is evidence of historical sediment contamination in the Andersons Bay inlet (Ryder, 2005). As well as stormwater inputs, Somerville Stream discharges into the Inlet, and there is an emergency overflow facility from the Marne Street wastewater pumping station during times of high rainfall.

3.4 Port Chalmers

The Port Chalmers stormwater catchment discharges into both the Upper and Lower Harbour. These receiving environments have been grouped together as Port Chalmers. The following section describes the Port Chalmers stormwater catchment and receiving environment.

3.4.1 Catchment Description

Port Chalmers

The Port Chalmers catchment is relatively small, covering an area of approximately 58 ha, bounded by coastline to the south-west, a rural area of significant bush cover to the north, and the Otago port to the north-east. Land use within the catchment is predominantly residential and rural with areas of commercial, industrial and port land uses.

The stormwater system in the catchment is entirely piped and discharges via three main outfalls; one to the east into the Lower Otago Harbour, and two to the west, into the Upper Otago Harbour (via Sawyers Bay).

Wastewater overflows have been constructed from two pump stations in the catchment into the stormwater system. These are not predicted to occur during frequent rainfall events.

3.4.2 Receiving Environment Description

Port Chalmers (The Upper and Lower Harbour)

The Upper Harbour extends from Goat and Quarantine Islands to the mouth of the Water of Leith. The long narrow shape of the Upper Harbour creates strong tidal flows with the residence time of the water being variable depending on location (Stevenson, 1998).

The Lower Harbour extends from Goat Island to the head of the Otago Harbour. As with much of the Otago Harbour, the Lower Harbour has also been substantially modified by human activity through reclamation, dredging and channel stabilisation (Single, 2011).

3.5 St Clair / Second Beach

The St Clair stormwater catchment is the sole catchment that discharges to the St Clair/Second Beach receiving environment. This section describes both the stormwater catchment and receiving environment.

3.5.1 Catchment Description

St Clair

The St Clair catchment is characterised by steep gullies along the head of the catchment in the west, with the low lying areas of South Dunedin and St Kilda in the east.

The stormwater network consists of both open channel (streams) and piped sections, and is based on the catchment's natural watercourses, with ten branches converging in three main gullies before discharging to a large 'interceptor' pipeline running north to south, along Forbury Road. Outfalls discharge stormwater to Second Beach via the Bell Chamber Outfall, and directly to St. Clair Beach.

The stormwater discharges into a high-energy environment, and as such, the quality of the stormwater (typical of the residential land use) is not considered to be having an adverse effect on the receiving environment. However, wastewater has been detected in the stormwater, and investigations are

underway to identify the source and remove this contamination. This is particularly important as St Clair Beach is a popular bathing and surfing beach.

3.5.2 Receiving Environment Description

St Clair / Second Beach

The main stormwater line conveying all stormwater from the St Clair stormwater catchment splits into two at the base of the catchment, with one pipe discharging stormwater via the Bell Chamber Outfall to Second Beach, and a second diverting approximately half of the stormwater to an outfall through the St Clair Beach sea wall. There is also a watercourse discharging to St Clair Beach, however discharges to water courses are permitted by the current Regional Plan: Water and do not require resource consent.

Because the marine environment at both Second Beach and St Clair Beach is a high energy environment; the stony/sandy substrates in these locations are frequently re-worked by the tides. The opportunity for the deposition of sediments and build-up of contaminants is therefore limited at these locations.

3.6 Land Use

3.6.1 Historical Land Use

For the majority of the stormwater catchments, land use has not changed significantly in the last 100 years. The Portsmouth Drive, Ravensborne Road, and Kitchener Street catchments have historically had a high proportion of industrial land use. The Shore Street, St Clair, Halsey Street, Mason Street, Orari Street and Port Chalmers catchments have historically had a relatively high proportion of residential land use.

Port Chalmers also has a significant portion of port-related land use due to it being Dunedin's main port. The Mason Street and Kitchener Street catchments have historically contained the central business district of Dunedin, with the financial heart of the city originally being located in the Mason Street catchment approximately 400 metres from the Octagon.

Reclaimed land is a feature of the Portsmouth Drive, Ravensborne Road, Shore Street, St Clair, Halsey Street and Kitchener Street catchments.

3.6.2 Current Land Use

Land use in Dunedin is classified by the Dunedin City District Plan into six residential zones; rural; rural residential; industrial; port; campus; and a number of 'activity zones' which include light industry, recreation and commercial areas. The areas of the city covered by the ICMPs are predominantly made up of four main land use zones: residential (zoned residential 1 and to a lesser extent residential 2); large scale commercial / retail zoning; and an area of industrial land use adjacent to the harbour.

The current pattern of land use is shown in Figure 3-3.

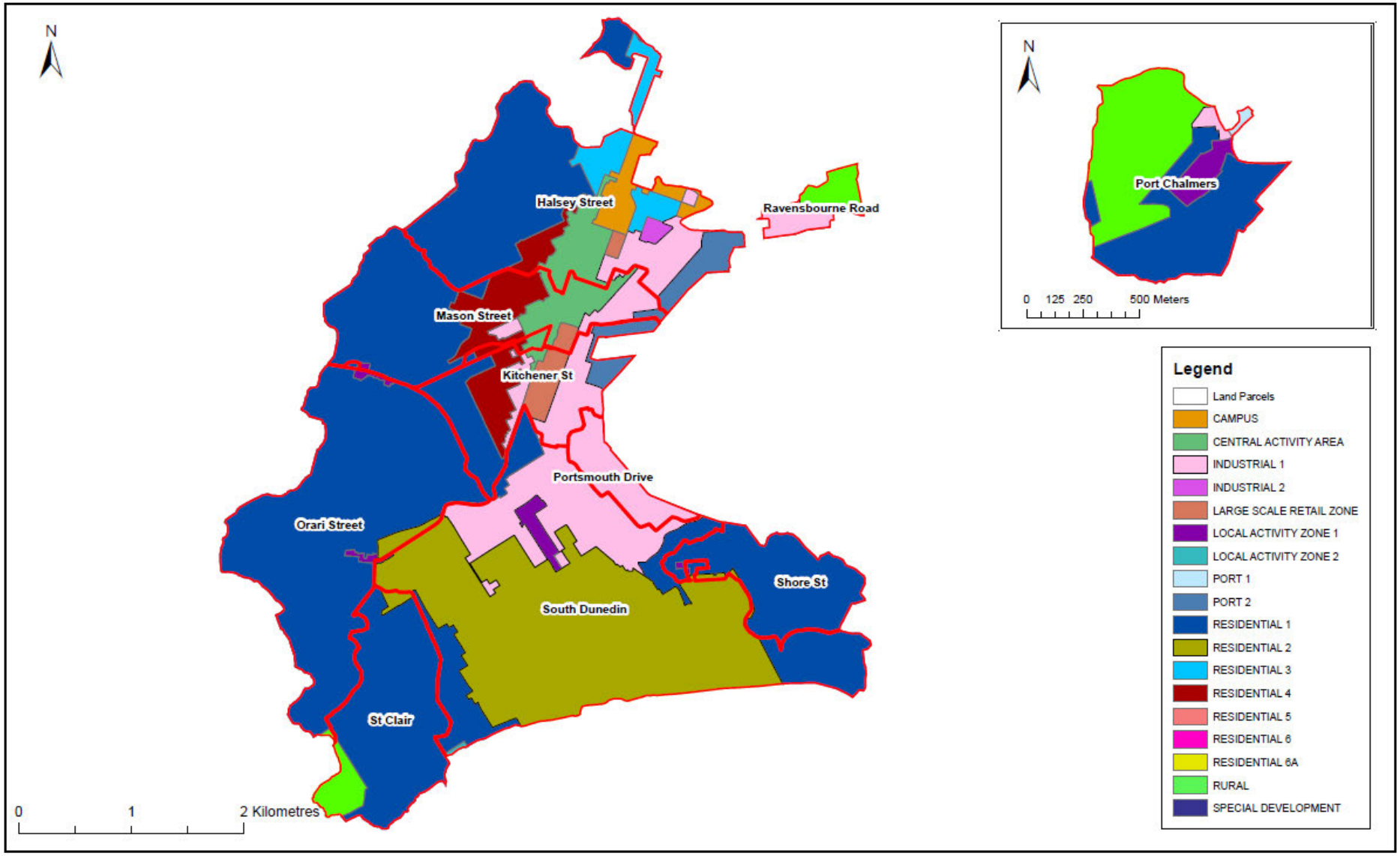


Figure 3-3 Land use types in Dunedin City stormwater catchments (from the Dunedin City Plan).

3.6.3 Contaminated Land

Various types of fill may have been used during the extensive land reclamation undertaken in the Upper Harbour Basin, so the fill material may contain contaminants. The entire Portsmouth Drive catchment is within an area of reclaimed land adjacent to the harbour, and other catchments also contain areas of reclaimed land (the Ravensborne Road, Shore Street, St Clair, Halsey Street and Kitchener Street catchments).

A number of landfills exist in the Kitchener Street and Ravensborne Road catchments which have a variety of waste contained in them, some of which is potentially contaminated. Other contaminated sites in the city include petroleum storage sites (Halsey Street catchment), a saw mill and timber storage area, a tanning and wool scouring site (Ravensborne Road), service station (Orari Street catchment), and historic gasworks (Port Chalmers and South Dunedin catchments).

The contaminated sites within the city are shown in Figure 3-3.

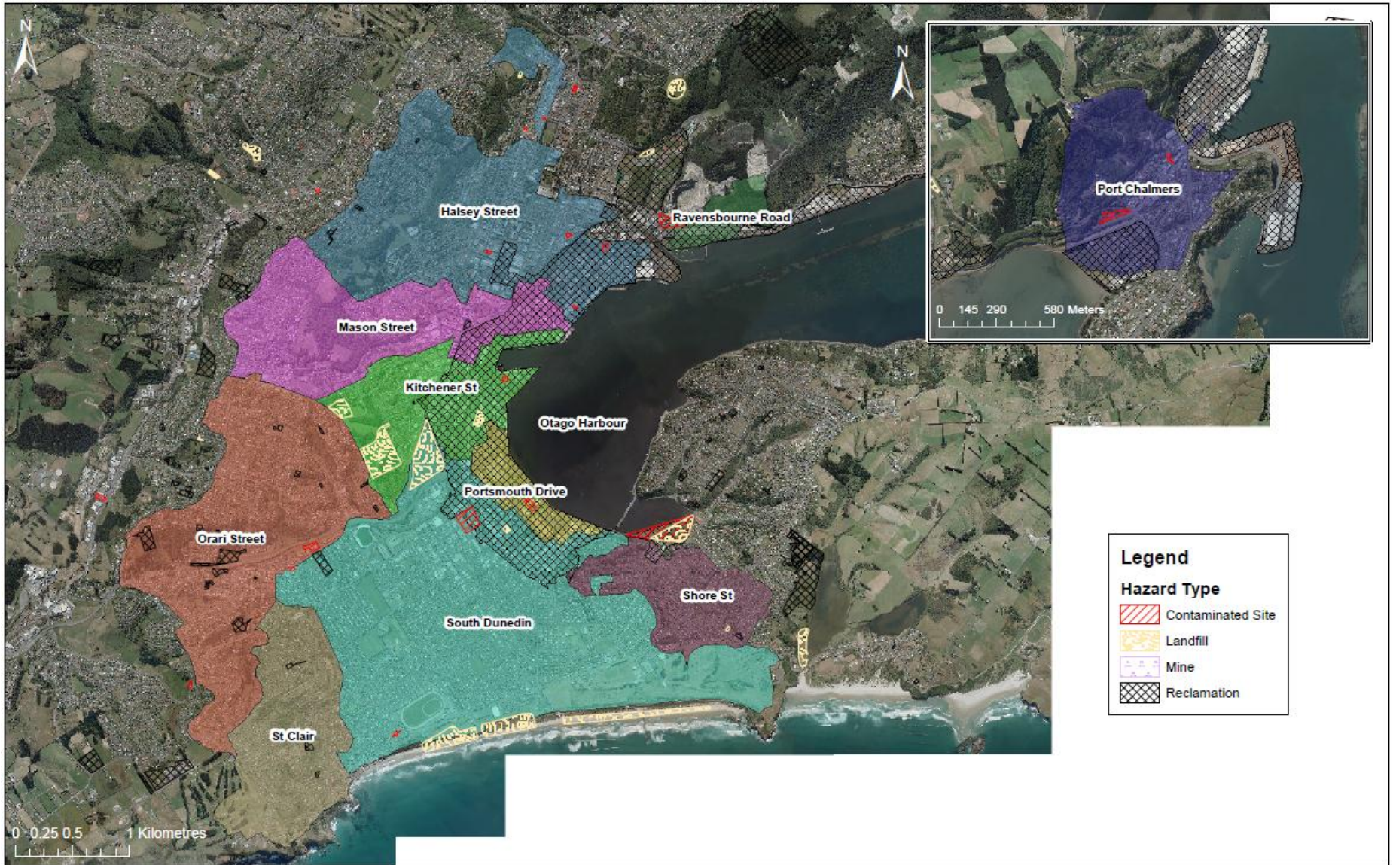


Figure 3-4 Contaminated land.

As the urban area is mostly impervious, contaminated sites identified are assumed to be capped. Therefore, there is no interaction between contaminated material and stormwater runoff, making contamination of overland flow at these sites extremely unlikely. Aging and cracked pipes in the city may be allowing groundwater to infiltrate the stormwater network. There is a remote possibility that this may cause contaminants from contaminated sites to infiltrate the stormwater network and discharge to the Otago Harbour. While most known contaminated sites currently have a groundwater monitoring programme designed to detect leaching of contaminants, targeted stormwater and/or groundwater monitoring (as recommended in South Dunedin, action plan reference: 0013) would be required to identify whether this is occurring.

3.7 Stormwater Drainage Network

3.7.1 Network Description

A schematic of the Dunedin City stormwater network is shown in Figure 3-6.

The stormwater network in the steeper parts of the catchments consists of a network of pipes and some open channels and natural streams. The inlets to the piped network from these open channels and streams are key features as they determine the flow entering the network from these open channels.

The remainder of the network consists of pipes with some connecting open channels or box drains. Some parts of the network contain sealed manholes that allow the system to become pressurised in high flow events (Halsey Street, Shore Street). However, a majority of manholes are not pressurised and provide points for stormwater overflows to reach the surface.

Throughout the stormwater network a majority of the pipes are less than 600 millimetres diameter. However, some catchments have much smaller pipes, such as the Ravensborne Road catchment with diameters of between 225 mm and 450 mm. The pipe diameter frequency distribution for the ICMP catchments is shown in Figure 3-5.

This piped network discharges via a number of outfalls into the Otago Harbour or the Pacific Ocean at the locations shown in 3-1. A significant number of these outfalls are located below the high tide level and do not have flap valves to seal them against tidal inundation.

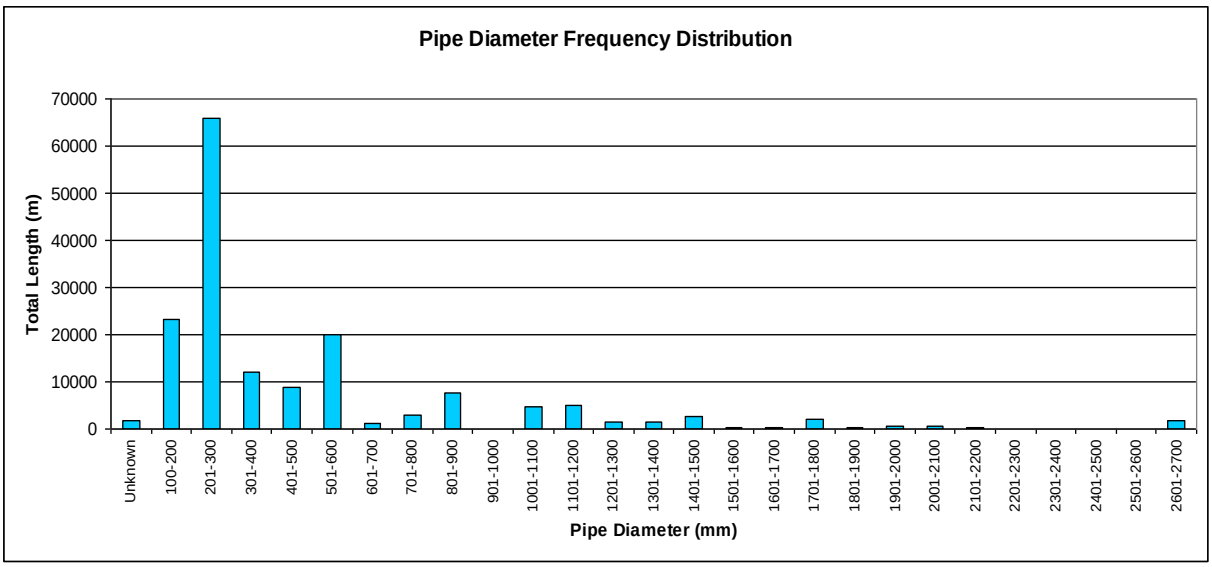


Figure 3-5 Pipe diameter frequency distribution

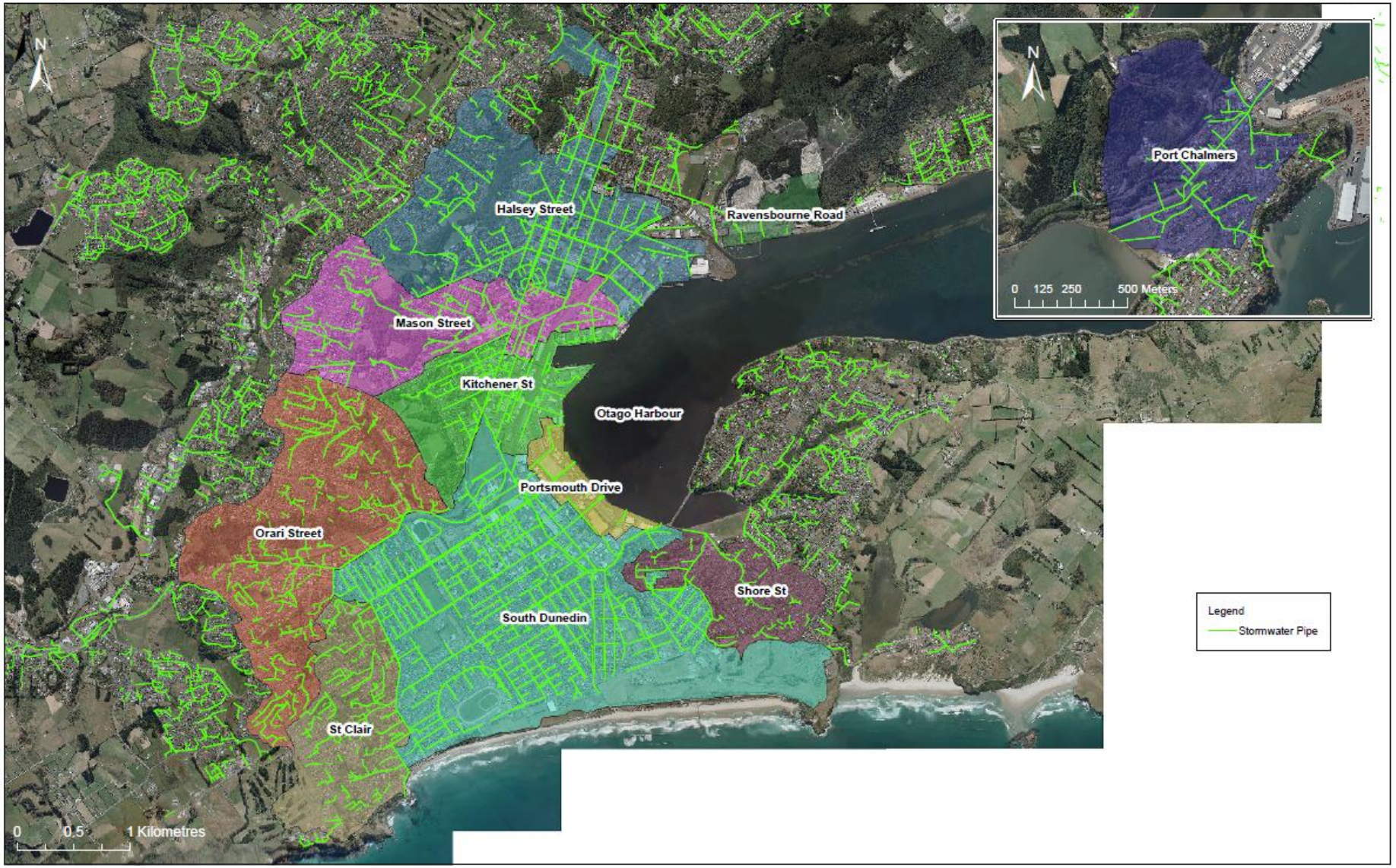


Figure 3-6 Dunedin City stormwater drainage network.

3.7.2 Network Age

The age of the stormwater network is a consideration when undertaking maintenance planning and may be helpful to identify where infiltration from contaminated groundwater may be occurring. Figure 3-7 below shows the spatial distribution of the pipe network age across Dunedin City.

Table 3-1 Summary of stormwater pipe age and length

Installation Date	Approximate Age	Number of Pipelines	Length of Pipe (m)	% of Pipe Length
Installed before 1900	90-145 years	456	17920	11
Installed 1901 to 1920	90-110 years	473	20459	12
Installed 1921 to 1940	70-90 years	1128	50949	31
Installed 1941 to 1960	50-70 years	473	18849	11
Installed 1961 to 1980	30-50 years	995	36904	22
Installed 1981 to 2000	10-30 years	618	16964	10
Installed 2001 to 2009	<10 years	101	2513	2

The theoretical life of most stormwater infrastructure is approximately 100 years. This would suggest approximately 20% of the system could be currently due for renewal. Experience in Dunedin and elsewhere demonstrates that the actual number of pipes that require renewal after this period is significantly lower, and renewals are being targeted where performance problems are being experienced or where there is potential for infiltration of contaminated groundwater.

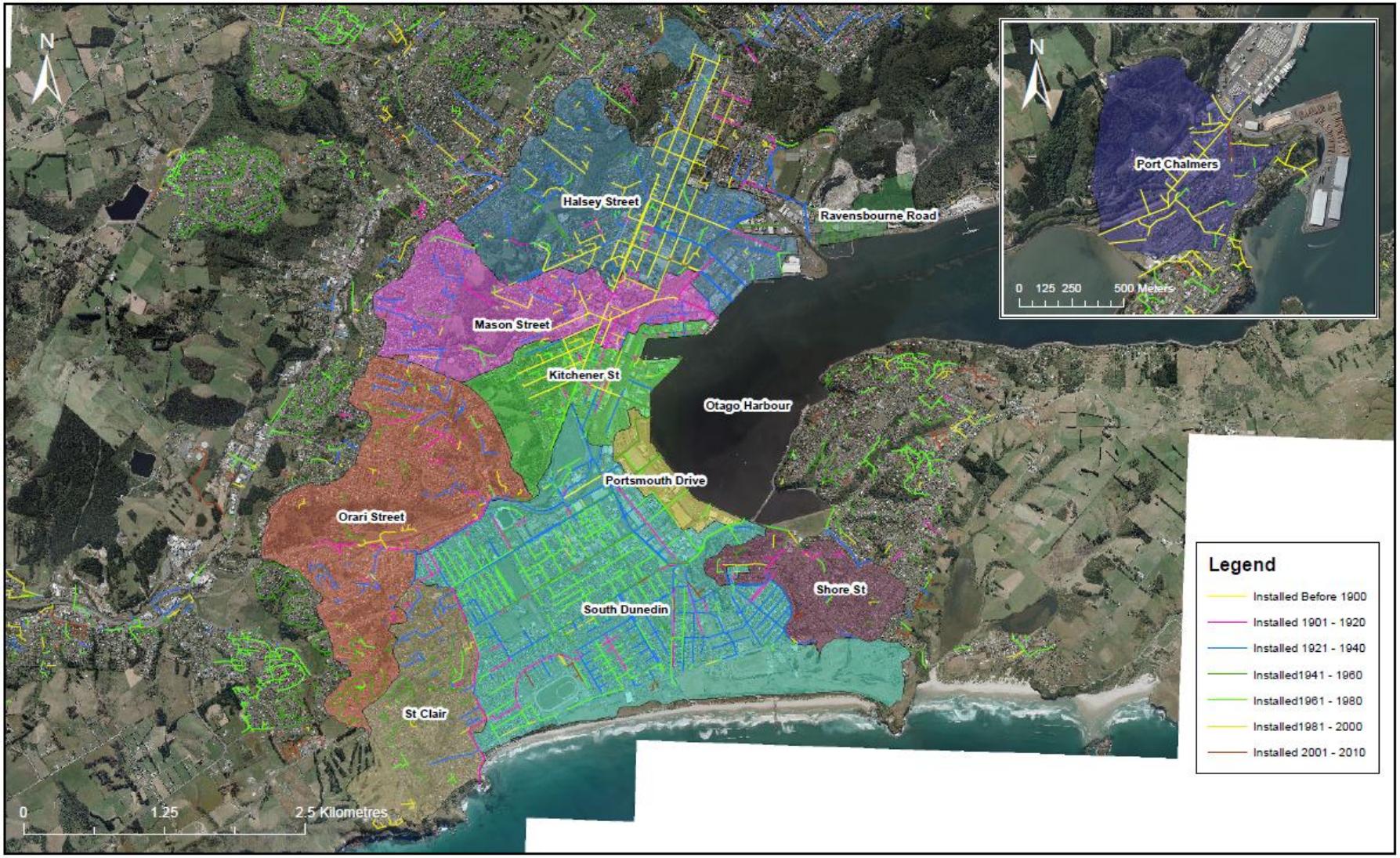


Figure 3-7 Pipe network age.

3.8 Recreational and Cultural Significance

The harbour is considered an important area for recreation. It is frequently used by wind surfers, kite boarders, by people fishing, sea kayakers and hobby sailors. There are a number of boat clubs and tourism operators in the area that make use of the harbour including sea kayaking tours. The coastal plan specifically identifies the Otago Harbour as a coastal recreation area and lists fishing, boating and walking as specific activities that are undertaken in the area. St Clair and second beach are widely used for surfing, other contact recreation pursuits and passive recreation (i.e. walking along the beach) and are similarly identified in the coastal plan. Activities identified include swimming, walking and surfing.

Coastal and freshwater environments hold particularly high values for Käi Tahu, therefore any discharge into the coastal environment has the potential to impact a cultural site. This is especially the case in relation to discharges to the Otago coastal marine area / Te Tai O Arai Te Uru - this area is identified as a statutory acknowledgement area in Schedule 103 of the Ngai Tahu Claims Settlement Act 1998.

A historic Māori settlement was located in the area close to the St Clair Esplanade in pre-European times, and artefacts have been discovered close to the western end of the Esplanade. Artefacts have also occasionally been uncovered in the dunes which lie to the east.

A full description of the cultural values associated with the Otago coastal marine area is outlined in the Cultural Impact Assessment (CIA) completed for the 2005 discharge consent applications and updated for these applications. Both assessments are contained in **Appendix C.**

The CIA describes the strong relationship that Käi Tahu ki Otago have with the coastal environment. Evidence of Mäori use of the harbour extends back to the Mäori's earliest tribal history when the harbour was a valued food resource and used for transport. The report states that the increasing degradation of the harbour environment has affected the Mäori people in many ways and while still utilised its place as a mahika kai has been dramatically altered. Further consultation with Käi Tahu is discussed in Section 6 of this report. The 2005 CIA is reproduced in full in **Appendix C**.

Dunedin is the oldest city in New Zealand and therefore is of wider cultural significance. Dunedin was founded in that late 1840's and experienced considerable growth from the early 1860's after gold was discovered in the Otago region. The location of Dunedin played an important role in the subsequent gold boom particularly through the use of its port as the entry point for prospectors and traders to the region.

The Otago Harbour contains internationally significant wildlife habitats, including colonies of the Hoiho (yellow eyed penguin) the world's rarest penguins, and the world's only mainland colony of Royal Albatross. These species among others make Dunedin a popular centre for eco-tourism.

3.9 Ecology

3.9.1 Description

For the purposes of describing the ecology found in the stormwater discharge receiving environments, the four areas identified above have been consolidated into two. These are the Otago Harbour (Upper Harbour Basin, Andersons Bay Inlet and Port Chalmers) and St Clair / Second Beach.

Otago Harbour

The Upper Otago Harbour shows relatively sparse flora and fauna in the intertidal zone. This is largely due to the artificial nature of the shores and the sheltered aspect of embayments (Probert and

3 Description of the Environment

Jillett 1998, Ryder Consulting 2005a). Some animals usually found in rocky shore high tide zones (e.g. the periwinkles *Nodilittorina cincta* and *N. unifasciata*, and the barnacle *Chamaesipho columna*) are notably absent from rocky shore areas, likely because of the lack of a splash zone (Clayton 1982). Other possible contributing factors to the lack of plant and animal life in this area are historic anthropogenic inputs to the upper harbour (Ryder Consulting 2005) and freshwater inputs from the Water of Leith, Somerville Stream, and a variety of other smaller watercourses. There is also a reduction in biodiversity with shore height, as found by Probert and Jillett (1998). This is typical of all shores and reflects increasing aerial exposure and stress (Raffaelli and Hawkins 1996, Ricketts *et al* 1997). The organisms existing in the high tide zone are neither particularly rare nor extremely slow reproducers and are generally common on rocky shores throughout sheltered New Zealand shorelines (Batham 1956, Morton & Miller 1973, Ricketts *et al* 1997).

Below the tidal zone there is a general lack of macroflora within the upper harbour, with the majority of algae being drift *Ulva* and *Lenormandia*. On intertidal soft substrate further down harbour are quite extensive patches of *Zostera novazealandica* and *Ulva lactuca* (Norhardi 2001, Ryder Consulting 2008). Such beds are recognized as important nursery and feeding areas for a wide variety of fish, waterfowl and invertebrates (Schwarz *et al.* 2004).

Infaunal communities on soft substrate are reasonably diverse and show a high abundance of some animals, such as the clam *Austrovenus stutchburyi,* polychaete worms and some amphipods (Grove 1995, Stewart 2008, 2010, 2011a). The communities are much as expected for sheltered soft shores around New Zealand (Morton and Miller 1973). Crabs, mantis shrimps (*Squilla armata*), ghost shrimps (*Callianassa filholi*), wedge shells (*Macomona liliana*) and a variety of gastropod snails are all present in lesser numbers, but are neither rare nor significant in the wider New Zealand context.

As the main outfall for the Port Chalmers catchment is not in a location with a suitable environment to adequately assess the ecology (due to a lack of intertidal zone), data relating to the Port Chalmers catchment is more limited (Ryder Consulting 2005c).

An environmental impact assessment was carried out as part of Port Otago's reclamation programme, a component of which included an analysis of the marine ecology in the area (Probert 1990a, 1990b). The relevant findings can be summarised as follows:

- Benthic communities in and around Port Chalmers are generally similar to those of mud bottoms throughout the Otago Harbour.
- The intertidal zone around Port Chalmers appears to harbour organisms similar to other rocky shore communities within Otago Harbour.
- Rocky shore communities around Port Chalmers are more diverse than in the Upper Harbour Basin but less diverse than those further out in the harbour and on naturally occurring rocky shores.
- Shores either side of Port Chalmers and soft substrates in Sawyers Bay display similar communities to those found closer to the head of the harbour despite historically high levels of some metals (Grove 1995, Ryder Consulting 2005b). Once again, organisms are neither rare nor nationally significant.

St Clair / Second Beach

Second Beach and St Clair Beach are both high-energy environments into which stormwater is discharged. Mixing in such environments is rapid and thorough. The major difference in the sites is

that St Clair is a largely soft shore environment comprising generally fine sand while Second Beach is a rocky shore comprising large cobbles and small boulders.

High energy soft shores in New Zealand have generally low diversity and an abundance of infauna (Ryder Consulting 2011c). St Clair is no different in this respect (Ryder Consulting 2005c). Ecological monitoring of the intertidal habitat at Second Beach has been carried out annually since 1996 as part of the Green Island Waste Water Treatment Plant monitoring programme (Ryder Consulting, 2011b). The results of this monitoring show that algal communities at Second Beach display a moderate diversity of mainly red algae, but with none of the species present being rare or significant.

Barnacles, *Chamaesipho columna,* dominate the rocky shore animal community at Second Beach, with numbers reaching the tens of thousands per square metre (Ryder Consulting, 2011b). Gastropod snails such as *Austrolottorina cincta* are also abundant and reasonably widely distributed. The small black mussel, *Xenostrobus pulex,* is extremely common in patches, with larger mussels (*Mytilus galloprovincialis* and *Perna canaliculus*) also quite common. Once again, the communities along this stretch of coastline are neither ecologically significant nor rare.

3.9.2 Ecological Monitoring

The current stormwater discharge consents do not all require biological monitoring of marine ecology. However the resource consents associated with the Mason Street, Kitchener Street, Orari Street, Portsmouth Drive, Ravensborne Road and St Clair catchments require that samples are taken from cockles and octopus or fish. The Port Chalmers and Portsmouth Drive catchment have historical biological data that has also contributed to the knowledge of the effects of stormwater discharges on marine ecology.

The biological monitoring results to date do not indicate significantly high levels of contaminants within the samples taken. Where applicable, lead and cadmium concentrations have been consistently below the maximum levels as outlined in Australia New Zealand Food Standards Code (2004). The results indicate that the fish and cockle communities at the sampling locations are not being exposed to significantly high levels of contaminants.

Historical data and the results of biological monitoring carried out harbour-wide for DCC stormwater consent compliance indicate that, a reasonably low diversity amongst the benthic and infaunal communities is typical of the Upper Harbour Basin. The general lack of diversity may be attributable to a range of anthropogenic influences, including stormwater quality. Other factors such as freshwater inputs and exposure at low tide are likely to contribute to the ecological health observed. Therefore, it is not possible to clearly link ecological health with stormwater quality.

It should be noted that fish sampled are likely to travel throughout the harbour and will be influenced by contaminants in the harbour marine environment outside of the sampled catchment. The biological communities generally will also be influenced by contamination from sources other than stormwater including freshwater inputs such as the Waters of Leith and other discharges to the CMA such as from industry and shipping. Therefore, whilst generally the health of the species sampled was not found to be poor, it is difficult to draw any parallels between ecology and stormwater-derived contaminants.

Determining with precision the ecological effects of contamination in the harbour environment from a particular source is difficult. Unless contamination levels are very high within the sediments it is difficult to distinguish between the potential adverse effects of contamination from stormwater, contamination from other sources, and the effects of other environmental variables.

The biological monitoring results to date, harbour-wide, show that, whilst not pristine, the upper harbour and the communities associated with the intertidal areas adjacent to the major stormwater outfalls appear not to be undergoing any significant further degradation as a result of the stormwater inputs during the monitoring period (2007-2012).

3.10 Harbour Sediments

Harbour sediments can provide information about the quality of discharges to the harbour including stormwater discharges. Contaminant concentrations within harbour sediments can be compared to sediment quality guidelines to provide an indication of whether there is potential for sediment to adversely affect aquatic ecology.

ANZECC (2000) sediment quality guidelines provide low and high trigger values. The low values are indicative of contaminant concentrations where the onset of adverse biological effects may occur, thus providing early warning and the potential for adverse environmental effects to be prevented or minimised. The high values are indicative of contaminant concentrations where significant adverse biological effects may be observed. Exceedence of these values could therefore indicate that adverse environmental effects may already be occurring.

3.10.1 Harbour Wide Trends

Harbour-wide, trends in the levels of contaminants in the sediment remain unclear with six years of monitoring data revealing high variability among contaminant levels and sites. Many contaminants are present in the sediments at various sites within the harbour at levels exceeding the ANZECC sediment guideline low trigger values, with some also exceeding the high trigger values.

Levels of metals and PAHs were generally found to be lower in 2010 than in previous years, however concentrations increased again in 2011 and 2012. It may be that the deposition of ‘cleaner’ sediments is occurring. However, deposition rates in the harbour are thought to be reasonably slow, approximately 2 mm per year, and significant re-suspension occurs in the shallow harbour during wind and rain events. Any trend, therefore, may take some time to be observed.

Further monitoring of the sediments harbour-wide is required to better understand the levels of contamination and establish whether any long term trends exist (Action plan reference: 0002).

4

Detailed Description of the Proposal

4.1 Overview

The DCC are applying for four resource consents to discharge stormwater to the CMA. This stormwater is generated from a range of land uses including; industrial, residential, commercial, and local roads and state highways. The decision to apply for four resource consents (the DCC currently have one resource consent per stormwater outfall) stems from there being four main receiving environments for this discharge. These receiving environments are shown in 3-1 and are as follows:

- St Clair;
- Andersons Bay Inlet;
- Upper Otago Harbour Basin; and
- Port Chalmers.

The DCC has developed ICMPs for each stormwater catchment discharging via the piped network into the CMA. These ICMPs and implementation of the associated action plan, along with a comprehensive monitoring framework will drive the management of stormwater in Dunedin to achieve the DCC's strategic objectives. The monitoring framework includes targeted monitoring of the stormwater to measure stormwater quality improvement and assess the effectiveness of the stormwater management actions that have been undertaken.

As will be discussed further in Section 8, the coastal plan places strong emphasis on protecting the values of the receiving environment. The central focus of the consent application and the resource consent conditions that are proposed is therefore to ensure that, as a minimum, there is no degradation of the receiving environment that is attributable to the public stormwater network. This process runs in parallel with actions identified in the ICMPs already being implemented and involves:

- Setting trigger values for receiving environment water quality– after reasonable mixing;
- Monitoring to measure performance against these trigger values;
- The inclusion of any stormwater quality issues as a priority in the relevant ICMP; and
- The identification of a management option and the allocation of resources to address the issue; and
- Undertake further monitoring to ascertain the performance of the management option chosen.

The DCC are applying for a 35 year resource consent duration. This long term consent duration provides a level of certainty that will help funding be directed toward stormwater management measures where required as opposed to further resource consent processes.

4.2 Stormwater Management Process

4.2.1 Introduction

As described above the DCC has adopted a new approach to managing stormwater in the past 5 years. The Three Waters Strategic Direction Statement is the overarching document relating to this approach and outlines a set of priorities and actions for the management of the "three waters" including the following key priorities relating to stormwater:

- Improving the quality of discharges to minimise the impact on the environment;

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- Limiting cost increases to current affordability where practical;
- Adopting an integrated approach to the management of the 3 waters and embrace the concept of kaitiakitaka.

These key priorities are supported by the following statements in the Direction Statement:

- *'We will resolve all known cross connections between the foul and stormwater networks by 2015, and have an ongoing programme to disconnect the systems as new issues are identified';*
- *'We will reduce the contaminant load in our stormwater. We will use source control where practical, or otherwise consider effective stormwater treatment'; and*
- *'We will prioritise our investment based on the community's willingness to pay for improvements and what they are willing to sacrifice as a result'.*

These priorities and actions have driven the objectives, approach and content of the ICMPs for Dunedin City's stormwater catchments. Each ICMP is a 'living' document which identifies and prioritises stormwater issues for appropriate management action. The Three Waters Strategic Direction Statement and ICMPs are non-statutory documents however have been developed in consultation with the public and outline and detail the direction the DCC will head with stormwater management.

Managing stormwater through an integrated catchment management approach is not unique and is fast becoming best practice across New Zealand. For example both the Auckland Council and the Christchurch City Council, the local authorities for New Zealand's two largest cities, are utilising or proposing to utilise ICMPs to manage their stormwater. Auckland is currently in the process of applying for resource consents for stormwater discharges and Christchurch City Council has recently been granted resource consents for stormwater discharges from the south-western stormwater area. Both of these applications have ICMPs at their core.

While this report focuses on the stormwater management approach proposed for resource consenting purposes, it is important to note that obtaining resource consents and complying with any associated conditions is only a small part of how the DCC propose to manage stormwater discharges into the future. As is evident from reviewing the Three Waters Strategic Direction Statement and the ICMP for each stormwater catchment, the DCC has made a strong commitment to improving stormwater quality.

As part of a wider commitment to the community to effectively manage stormwater and reduce environmental impacts, the DCC will use the ICMP recommendations to systematically ensure that best practice stormwater management methods are implemented across the city (including, for example, source control practices). The associated action plan includes a commitment to ensuring that stormwater management objectives are given effect through the second generation district plan, as well as the strengthening, implementation and enforcement of existing statutory source control regulations that sit outside the RMA such as the Dunedin City Council Wastewater Bylaw and Code of Subdivision and Development. Consideration is also being given as to the need for a dedicated stormwater bylaw and it is anticipated that work on this will commence in 2012/2013. (Action plan reference: 0011).

The RMA provides an effects based framework for the assessment of activities such as stormwater discharges. On this basis the stormwater management process outlined in this report focuses on the

actual or potential effects of the proposed activity as opposed to the DCCs wider aspirations for stormwater management. The issues prioritisation sections of the ICMPs provide the ideal mechanism to combine the wider stormwater management process that seeks to realise the key three waters priorities, with the resource consent process of avoiding, remedying and mitigating adverse effects as required by the RMA.

Since the DCC has adopted the ICMP's, it has committed to spend $2.6m over 3 years (excluding the upgrade of the Tahuna Wastewater Treatment plant) to improve the quality of discharges.

4.2.2 Effects Monitoring Process

The proposed ongoing stormwater management process stems from the central focus improving the quality of stormwater discharges to minimise the impact on the environment. This will ensure that as a minimum, the receiving environment (Upper Harbour Basin, Andersons Bay Inlet, Port Chalmers and St Clair / Second Beach) is not further degraded as the result of stormwater discharges from Dunedin City.

Annual monitoring of the water quality of the Otago Harbour and sediment within the Otago Harbour will be undertaken in accordance with the revised monitoring framework. Ecological monitoring will also be undertaken to identify whether contaminants are adversely affecting marine life within the harbour. All monitoring will be undertaken in accordance with the monitoring framework attached as **Appendix D**. The results of the sediment and water quality monitoring will be compared to water and sediment quality trigger values as outlined in the monitoring framework.

If an exceedence of the water quality trigger values is identified, further monitoring will be undertaken within the next 24 hour period to confirm whether or not contaminants are present in the environment in elevated quantities.

If an exceedence of the sediment quality trigger values is identified, a comparison will be made with the ecological samples taken to identify whether the contamination identified is potentially having an adverse effect on marine ecosystems. Due to the predicted low sedimentation rates within the harbour, sediment samples, and associated ecological samples taken the following year will be analysed to determine whether an effect is actually occurring.

If an exceedence of either the water or sediment quality trigger value is confirmed through this repeat sampling process, investigations will be undertaken to determine whether the contaminant is attributed to the Dunedin City stormwater discharges. If this is the case, then the stormwater quality issue will be managed via the ICMP process which involves the prioritisation of the stormwater issue and the identification of a management option if appropriate. Once a management option is implemented the monitoring framework will be adjusted to assess the effectiveness of the option.

The DCC will produce and annual report that will be supplied to the ORC. This will contain details of any exceedences, management/mitigation options implemented and the effectiveness of any mitigation measures. Importantly, this report will also contain an 'action plan'. The action plan will outline stormwater management actions (including recommendations from the ICMPs) to be implemented over a three year period. The action plan for the next three years is included as **Appendix E**.

The way in which receiving environment results will be assessed within the context of the ICMP stormwater management process is summarised in Figure 4-1 and Figure 4-2.

4 Detailed Description of the Proposal

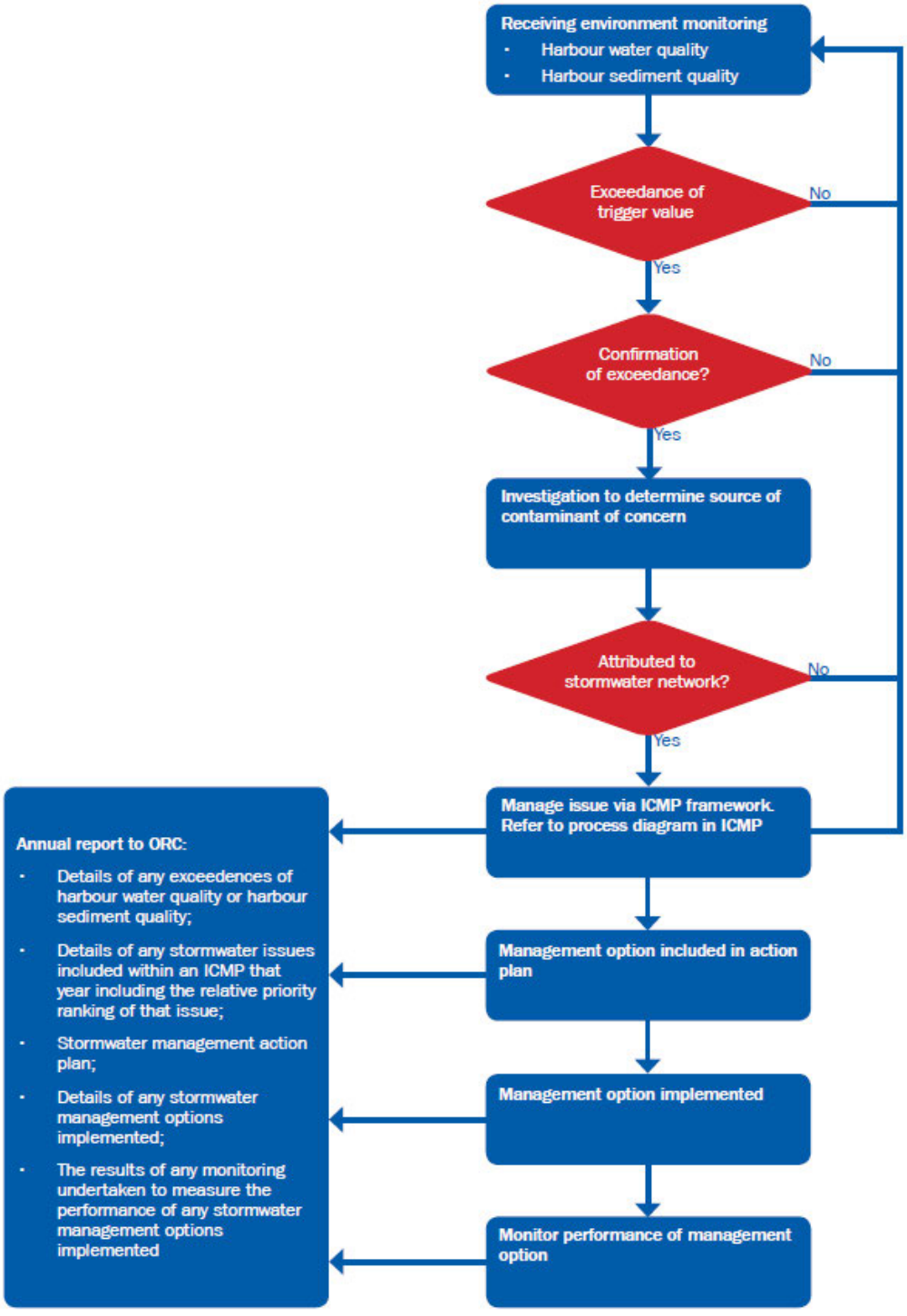


Figure 4-1 Receiving environment monitoring results analysis and response process



Figure 4-2 Issue management within the Integrated Catchment Management Plan process.

4.3 Stormwater Quality

This section of the report provides a description of the stormwater characteristics and overall stormwater quality from monitoring undertaken to date in and around the catchments.

4.3.1 Stormwater Quality Monitoring

Annual monitoring of the quality of the stormwater discharged from all 10 stormwater catchments has been undertaken as specified in the current resource consent conditions (between 2007 and 2012). Sampling has not occurred from every stormwater outfall, however a representative spread has been achieved and all four stormwater receiving environments are represented.

Monitoring Associated with Current Resource Consents

The current stormwater discharge consents contain a condition requiring annual stormwater quality monitoring. The condition requires that a sample be taken within the first hour of a storm event that is preceded by a 72 hour period of dry weather. This is to ensure that the maximum concentration of pollutant is sampled. Targeted sampling of any 'slicks' observed is also a requirement of this resource consent condition. The stormwater monitoring undertaken for consent compliance purposes and the associated reporting has been undertaken by Ryder Consulting Ltd. The compliance reports for this monitoring are contained in **Appendix F**.

4 Detailed Description of the Proposal

The following observations have been made from the consent compliance monitoring. However, these observations should be viewed in the context of a small dataset and limitations associated with the sampling method (discussed below):

- The levels of all contaminants in the stormwater from the outfalls in each catchment are generally typical of stormwater quality from the land use undertaken in the catchment;
- The results show variability between years and to date, due to both the sampling method, and an insufficient number of samples to establish trends;
- Microbial contamination has been detected in some samples from the Halsey Street, Mason Street, Kitchener Street, Shore Street, St Clair and Port Chalmers catchments;
- Point source PAH discharge is suspected from within the South Dunedin Catchment; and
- High zinc concentrations have been measured in the discharge from South Dunedin and Mason Street catchments, although this would need to be confirmed via more comprehensive monitoring.

The variability in the stormwater quality results is likely influenced by time since the previous rainfall event within the catchment, and the intensity and distribution of rainfall. A long period between rainfall events allows contaminants to build up within the catchment and as such the contaminant concentrations in the stormwater following the first rainfall event for a significant period of time may be higher than for a period with a shorter time between rainfall events.

However, the key contributing factor to the data variability is likely to be the use of grab samples to monitor the stormwater. Grab sample results give a 'snapshot' of the stormwater quality at one point in time only. Throughout a storm event, the concentration of contaminants within the stormwater varies depending on the time since the start of the event.

The point in time, during the storm event, that grab samples are taken can significantly affect the results. While stormwater samples taken were targeted at sampling the 'first flush', and consent conditions detailed required storm size and antecedent conditions, it is not known when, during a rainfall event, the stormwater monitoring grab samples were taken for each monitoring year. While the resource consent conditions prescribe that the sample be taken within the first hour of an event, it is likely that they were taken at differing times during this first hour. One consequence of this may be the data variability and lack of clear trends.

Other Monitoring

In 2010 the DCC commissioned Ryder Consulting to undertake an assessment of stormwater and marine sediments, in addition to previous monitoring and ongoing consent monitoring. This assessment involved sampling for possible anthropogenic contamination and to assess the health of benthic communities in the vicinity of 14 major Dunedin stormwater outfalls that were not monitored as part of resource consent compliance (Ryder Consulting, 2010).

This monitoring indicated that while not pristine, the Upper Harbour and the communities associated with the intertidal areas adjacent to major stormwater outfalls appear not to be undergoing any significant further degradation as a result of stormwater inputs. The results of this monitoring are attached as **Appendix G**.

4.3.2 Stormwater Characteristics

As discussed above, it is difficult to determine the relative concentrations of particular stormwater contaminants from the sampling undertaken to date. The sampling does however give a snapshot of

4 Detailed Description of the Proposal

the likely contaminants present in the stormwater discharge. The types of contaminants present are typical of a stormwater discharge originating from a catchment containing a mix of land uses including industrial and trade activities. These are described in Table 4-1. However, due to the sampling techniques utilised for the majority of the sampling, the stormwater quality data is not able to provide a conclusive picture of the discharge quality.

Table 4-1 Types of contaminants present in Dunedin's stormwater.

Contaminant	Potential Anthropogenic Sources
Total Suspended Solids (TSS)	Erosion, including stream-bank erosion. Can be intensified by vegetation stripping and construction activities. Road dust.
Arsenic (As)	Combustion of fossil fuels; industrial activities, including primary production of iron, steel, copper, nickel, and zinc.
Cadmium (Cd)	Zinc products (Cd occurs as a contaminant), soldering for aluminium, ink, batteries, paints, oils spills, and industrial activities.
Chromium (Cr)	Pigments for paints & dyes; vehicle brake-lining wear; corrosion of welded metal plating; wear of moving parts in engines; pesticides; fertilisers; industrial activities.
Copper (Cu)	Vehicle brake-linings; plumbing (including gutters and downpipes); pesticides and fungicides; industrial activities.
Nickel (Ni)	Corrosion of welded metal plating; wear of moving parts in engines; electroplating and alloy manufacture.
Lead (Pb)	Residues from historic paint and petrol (exhaust emissions), pipes, guttering & roof flashing; industrial activities.
Zinc (Zn)	Vehicle tyre wear and exhausts, galvanised building materials (e.g. roofs), paints, and industrial activities.
PAHs	Vehicle / engine oil; vehicle exhaust emissions; erosion of road surfaces; pesticides.
Faecal coliforms / E.coli	Animal faeces (birds, rodents, domestic pets, livestock), wastewater.
Fluorescent Whitening Agents (FWAs)	Constituent of domestic cleaning products.
References: ARC (2005); ROU (2002); Williamson (1993).	

4.3.3 Current Stormwater Management Measures

The DCC has developed a Strategic Direction Statement to manage the three waters that makes clear commitments to improve stormwater quality. The development of the 3 Waters Strategy and the associated ICMP's represents a turning point in Dunedin's stormwater management. Although, historically, the DCC has not actively managed stormwater quality, significant improvements have been made in the past 2-3 years as issues have become apparent through the development of the ICMPs.

The DCC has previously undertaken an extensive programme of sewer separation, and continues to have a programme to remove any connections between the wastewater and the stormwater system as a priority when they are identified and located.

The stormwater network incorporates structures such as catch pits and intake screens to capture debris and some oils and grease, and reduce coarse sediment loads within the final discharge. The flat nature of the pipe network in the lower catchment also results in silt and sediment removal from the discharge.

The DCC requires sediment and erosion control on development sites and has recently organised a course for DCC and ORC staff, consultants and contractors on sediment control principles and practices to raise awareness and expertise.

The DCC undertakes a street cleaning regime and also has a contract for maintenance of catchpits, including requirements for sediment removal. Increased focus on contract management over the past 1-2 years has led to significant improvements in this area.

The DCC's Code of Subdivision and Development encourages the enables low impact design options for management of both quality and quantity of stormwater. Recent developments such as the Caversham Bypass and recent subdivisions incorporate stormwater pre-treatment prior to discharge into the reticulated stormwater network.

In 2008, the DCC adopted a new trade waste bylaw which ensures that trade and industrial discharges are appropriately managed and discharged to the foul sewer network for treatment. It also includes requirements for stormwater management. Both the development of the trade waste bylaw and review of the code of subdivision and development took place before the ICMPs were completed. Therefore it is intended that these be reviewed, alongside the development of the second generation district plan and potential development of a dedicated stormwater bylaw. This will ensure that the DCC has a comprehensive and complimentary regime of regulatory and planning documents to give effect to and support the ICMPs.

The beginnings of this regime are evident in the recently completed its draft spatial plan which supports the 3 Waters Strategic Direction Statement and references the need for sustainable urban design as a mechanism to ensure that stormwater is managed effectively.

Through the long term planning process, the DCC has made a significant financial commitment to stormwater management and stormwater quality improvements. The action plan attached as **Appendix E** reflects a financial commitment of $2.6 million to support the strategic objective of improving the quality of discharges to the environment. Similar levels of funding are committed for the duration of the long term plan. This is in addition to significant capital programmes to target stormwater flooding issues.

4.4 Stormwater Quantity

Through the ICMP development process stormwater flows and volumes have been estimated for specific rainfall events. This has been done by modelling the stormwater runoff, utilising imperviousness data, and information about the stormwater network such as pipe size, ground levels, and pipe gradient. The modelled stormwater volumes generated by each of the 10 catchments during a 1 in 10 year annual recurrence interval (ARI) rainfall event lasting 60 minutes are outlined in Table 4-2.

Table 4-2 Modelled stormwater discharge volumes for a 1 in 10 year ARI of 60 minutes duration.

Receiving Environment	Catchment	Volume (m^3)
Upper Harbour Basin	Halsey Street	30,656
	Kitchener Street	11,716
	Mason Street	18,929
	Orari Street	28,630
	South Dunedin	38,492
	Portsmouth Drive	4,558
	Ravensborne Road	832
Andersons Bay Inlet	Shore Street	4,123
Port Chalmers	Port Chalmers	3,569
St Clair	St Clair	7,274

5

Alternatives Considered

5.1 Schedule Four, 1(f) of the RMA

Alternatives have been considered in accordance with Section 105 and the Fourth Schedule of the RMA.

5.2 Discharge Points / Environments

5.2.1 Discharge Points

St Clair / Second Beach are high energy environments that have the potential to provide faster mixing and dilution of stormwater related contaminants. An option would be to pump all of Dunedin's stormwater to St Clair for discharge. However, this option would require an upgrade of much of the existing infrastructure, as well as considerable investment in new infrastructure including pumping stations, pipes and outfall structures. To meet current design standards, 133,813 m^3 of stormwater from the upper harbour basin catchments would need to be stored and discharged to St Clair during a 60 minute 1 in 10 yr ARI rainfall event.

A second option would be to direct all stormwater flows to the Tahuna wastewater treatment facility and discharge via the ocean outfall. This option would also require considerable investment in infrastructure including an increase in the capacity of the wastewater treatment facility.

Environmental outcomes are likely to be improved under these scenarios. However, the cost of both these options have not been determined but are likely to be considerable and outside the realms of possibility for the DCC.

5.2.2 Discharge Environments

While developing the ICMPs, consideration was given to discharging stormwater to land within each stormwater catchment. Groundwater levels in a majority of the catchments are relatively high with flooding being problematic in a number of catchments. The infiltration capacity of the soils was also investigated as part of the ICMP process and is generally considered to be low or variable. Discharging to land would therefore have a number of issues associated with it, including an increase in flooding risk, availability of land, and a lack of storage capacity during extended periods of wet weather.

There would be considerable costs of developing the infrastructure to enable a land discharge to occur, including the development of soakage basins or wetlands to provide some treatment of the discharge. A good proportion of this cost would be the purchase price of the land required to construct the infrastructure to enable land discharge to occur. This is discussed further below in relation to treatment wetlands.

5.3 Treatment Options

5.3.1 Introduction

While the ICMPs promote targeted stormwater treatment, a number of alternative catchment-based treatment options have been investigated during the development of this AEE, in order to consider treating the 'first flush' of all catchment-generated stormwater. These include the creation of treatment

5 Alternatives Considered

wetlands, the diversion of all stormwater to the Tahuna wastewater treatment plant, the installation of filter cartridges, and gross pollutant traps such as catchpit filters and vortex accelerators.

Stormwater treatment is best approached via a 'treatment train', which incorporates at-source control of contaminants with a number of further stormwater treatment steps designed to remove contaminants of concern in a progressive manner.

Key contaminants of concern in the Dunedin city stormwater and receiving environment sediments have been identified as the heavy metals copper (Cu), zinc (Zn) and lead (Pb), along with polycyclic aromatic hydrocarbons (PAHs). Heavy metals such as Cu, Zn and Pb are either dissolved or adsorbed to or within sediment particles (usually less than 2 mm, and often less than 63 µm in diameter).

Many stormwater treatment systems are designed to treat the 'first flush' of stormwater, which is assumed to contain the majority of contaminants. Limited stormwater sampling in Dunedin has indicated that the first flush of stormwater has a higher level of contaminants, as indicated by Figure 5-1 below, based on data collected from the South Dunedin catchment. The rainfall event charted had a total depth of 6 mm with a peak intensity occurring at approximately 7:40am.

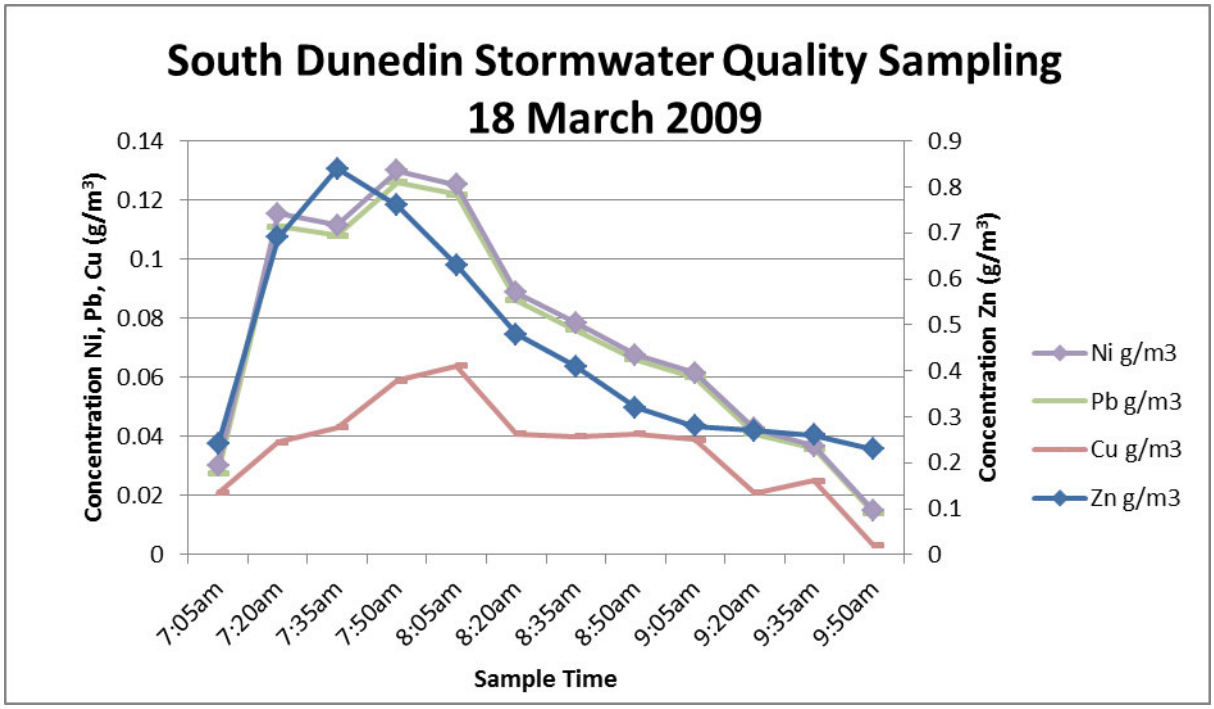


Figure 5-1 Variation in contaminant concentration throughout a rainfall event, South Dunedin.

In terms of quantity, the first flush is assumed by the Auckland Council (TP10) (ARC, 2003) to be equivalent to approximately 1/3 of the 24 hour 1 in 2 yr ARI rainfall event rainfall depth. For Dunedin, this would equate to a rainfall depth of approximately 18 mm (URS, 2011b). In Christchurch, the Christchurch City Council (CCC, 2003) recommends that between 15 and 25 mm rainfall depth is appropriate for determining first flush volume for the design of treatment devices.

5 Alternatives Considered

An analysis has been undertaken to consider catchment based treatment, as an alternative to the proposed ICMP approach. This analysis includes source control and targeted treatment as an option in response to issues identified via investigations. This analysis does not include all methods of stormwater treatment, or at-source control but presents an overview of a number of options for end-of pipe or catchment based stormwater treatment.

The area being considered for treatment in this analysis is the area of catchment discharging into the upper harbour basin and Andersons Bay Inlet. Table 5-1 below provides an overview of the catchment characteristics.

Table 5-1 Upper Otago Basin catchment characteristics

Catchment	Area (ha)	Current Imperviousness (%)	Land Use
South Dunedin	590	60	Mixed
Orari	341	47	Residential
St Clair	164	41	Residential
Kitchener	137	69	Mixed
Portsmouth Dr	40	98	Industrial/Commercial
Shore St	101	49	Residential
Mason St	209	56	Mixed
Halsey Street	334	60	Mixed
Ravensbourne Rd	31	48	Industrial
Total	1947		

While stormwater treatment in Dunedin would best be targeted to high contaminant generating land uses, this analysis presents the use of stormwater treatment on a 'whole of catchment' first flush basis, for comparative purposes. Calculations are based on the treatment of first flush on a volumetric basis, rather than targeted stormwater contaminant removal. Stormwater treatment device costs are to be considered indicative, and for the purposes of assessing alternatives only. Further design would be necessary to provide accurate cost estimates.

5.3.2 Status Quo

The option to continue only with the stormwater management practices outlined in section 4.3.3 has been assessed. Financially this offers an attractive solution as it would involve little increase in expenditure. However, the DCC has made a clear strategic commitment to "improve the quality of our discharges to minimise the impact on the environment". The status quo would not achieve this objective and community and stakeholder consultation has demonstrated strong support for a more active and robust approach to stormwater management. This had led to the comprehensive ICMP driven management approach.

5 Alternatives Considered

5.3.3 Treatment Wetlands

Wetlands are often used as 'end of pipe' treatment methods, or as the final step in a treatment train. Using a simplified design methodology provided in CCC (2003), the following required wetland sizes (Table 5-2) have been calculated for the stormwater catchments discharging into the upper harbour basin, calculated for both 18 mm and 25 mm water quality storm depths (df), and an average wetland depth of 0.5 m. The residence time in the wetland is assumed to be 2 days (the recommended minimum in CCC (2003)).

Table 5-2 Preliminary wetland design

		Wetland Area (ha)		Wetland Area (%) of catchment	
Catchment	**Area (ha)**	**df=18mm**	**df=25mm**	**df=18mm**	**df=25mm**
South Dunedin	590	17.0	23.6	2.9%	4.0%
Orari	341	7.7	10.7	2.3%	3.1%
St Clair	164	3.2	4.5	2.0%	2.7%
Kitchener	137	4.5	6.3	3.3%	4.6%
Portsmouth Dr	40	1.9	2.6	4.7%	6.5%
Shore St	101	2.4	3.3	2.4%	3.3%
Mason St	209	5.6	7.8	2.7%	3.7%
Halsey Street	334	9.6	13.4	2.9%	4.0%
Ravensbourne Rd	31	0.7	1.0	2.3%	3.2%

CCC (2003) guidance indicates that a combined detention basin/ wetland area with buffers, will typically require 4 to 5 % of the urban catchment. From the data presented in Table 5-2 above, it would appear that for Dunedin, an area of 4 % would be appropriate for cost estimate purposes.

Considering the total catchment area of 1,947 ha, total wetland area required (at 4 % of catchment) would be approximately 78 ha. Based on recent sales in the area, Colliers International Dunedin office (pers comm. Bill Brown) indicates that commercial / industrial property in Dunedin ranges from approximately \$95/m^2 to \$300/m^2. Using the minimum values for estimate purposes, this indicates that the cost of land acquisition alone (not including wetland construction costs) would be in the region of \$74,000,000 for first flush treatment via wetland/detention ponds.

In terms of wetland construction costs, the excavation cost alone (assuming excavation to 0.5m depth, and 20 km cartage of excavated material) would be a further \$13,000,000 (Rates from Rawlinsons, 2011). Further costs for control structures, additional reticulation and wetland plants would be anticipated. Maintenance costs have not been estimated. Based on these cost estimates, it is apparent that wetlands would be an extremely expensive option, and should only be considered as a final step in stormwater treatment, following the employment of at-source stormwater treatment where necessary.

5.3.4 Treatment plant

As discussed above, the option to direct all stormwater to the Tahuna wastewater treatment plant was investigated. The current treatment capacity of the Tahuna wastewater treatment plant is 5 m^3 per second (Opus 2011).

5 Alternatives Considered

For Dunedin, the 10 year ARI, 40 minute rainfall event has a depth of 16.78 mm – this rainfall depth is almost equivalent to the water quality / first flush event depth of 18 mm. This equates to a discharge volume of 113,680 m^3 from the upper harbour basin catchments; approximately six times the treatment capacity of the Tahuna wastewater treatment plant. This alternative is not considered practical, as it would require a major upgrade of the plant, along with the provision of considerable storage and additional pumping and treatment costs.

Wastewater treatment costs are currently estimated by DCC to be \$1.02/m^3. This equates to approximately \$116,000 for treatment of just one event via a treatment plant. It should be noted, however, that the contaminants of concern present in stormwater are not necessarily directly targeted via wastewater treatment processes. At the current rate of processing at Tahuna, 6 -7 hours would be required to process the stormwater from this event (assuming full capacity is available). Assuming full capacity is not available during rainfall events, costs to store this quantity of water, assuming multiple storage tanks were located throughout the network, would be in the order of \$17,500,000 (Rates from Rawlinsons, 2011, based on the use of 40 m^3 storage tanks). It is considered that the infrastructure costs of implementing this option would make it unfeasible.

5.3.5 Filter Cartridge

Proprietary stormwater filters designed for heavy metals can be used to filter stormwater at the base of the catchment, or in a number of locations throughout the catchment.

A water quality storm event was modelled for the Mason Street catchment, resulting in a water quality discharge rate of approximately 1.2 m^3/s. Based on discussions with a supplier, it is estimated that approximately 915 cartridges would be required to target heavy metals from the Mason Street catchment based on removal of approximately 75 % of suspended solids from the stormwater (a level of removal required currently in Auckland). A custom stormfilter of this size would cost approximately \$1,600,000.

This equates to a cost of approximately \$8,000 per hectare for supply and installation. Maintenance costs are approximately \$150/cartridge/year (pers. comm, Stormwater 360 Limited).

Based on an area of 1,947 ha, the use of stormfilters for first flush treatment of the whole catchment area discharging to the Upper Otago Harbour would amount to a capital cost of approximately \$15,000,000. Annual maintenance would be approximately \$900,000.

Consequently on a catchment basis, these devices are uneconomical, however may be useful for on-site stormwater treatment for some high risk land uses/areas. While applying this method to all catchments is not an economically viable option. This method may be utilised to target problem catchments or land uses if identified.

5.3.6 Gross Pollutant Traps

Gross pollutant traps such as catchpit filters and vortex separators are effective as a pre-treatment device for stormwater management – they remove oils, debris and some of the larger sediment particles from stormwater (with catchpit filters generally removing smaller particles than vortex separators). As identified above, target contaminants for Dunedin are metals and PAHs – if attached to sediments, these would typically be in the size fraction of 2 mm or less. Gross pollutant traps and oil separators may be considered on a site-specific basis – i.e., as part of source control stormwater management, or where particular issues with gross pollutants are present. In general, the use of

these devices as stand-alone treatment for stormwater would not remove a large proportion of the sediments that contain metals, nor would they remove dissolved contaminants from solution.

Catchpit filters

Catchpit filters are commonly used on busy roads to remove gross pollutants and the larger particles of sediment. They sit within a catchpit, and require regular cleaning and maintenance (frequency depending on rate of debris capture). Where gross pollutants are an issue (i.e., near bathing beaches), catchpit filters can effectively remove rubbish and a proportion of sediment from the stormwater.

Enviropods (a brand of catchpit filter) cost approximately $750 per unit (plus installation costs), with an annual maintenance fee of between $30 and $60 per unit (depending on frequency of cleaning).

There are currently approximately 8,000 catchpits in the Dunedin urban area (1,147 in South Dunedin catchment alone). Capital costs for the installation of catchpit filters city-wide would be in the order of $7,000,000 (allowing for installation costs), with an ongoing minimum annual maintenance cost of at least $240,000.

Catchpit filters may be appropriate for installation in areas of Dunedin where gross pollutants are an issue (i.e. for visual amenity purposes or to reduce blocking of screens on watercourses or at pump station intakes), or as a first step in a treatment train.

Vortex Separators

During pre-application discussions the ORC expressed a clear desire for the DCC to commit to installation of devices such as Vortex Separators as part of programmed renewals. As a result of these discussions, the DCC has undertaken additional investigations to assess the appropriateness of these devices in the Dunedin context.

Vortex Separators are larger proprietary in-line stormwater treatment devices. They primarily remove gross pollutants, oil, and large sediments (larger than approximately 5 mm in diameter).

A water quality storm event was modelled for the Mason Street catchment, resulting in a water quality discharge rate of approximately 1.2 m^3/s. Due to the size of the catchment, treatment of sub-catchments would be necessary; a supplier of Vortex separators has indicated that for a catchment of this size, 3 devices would be necessary, at a cost of approximately $100,000 each.

On an area basis, this indicates that one Vortex separator would be required to treat approximately 100 ha; for the entire area, 20 devices would have a capital cost of approximately $2,000,000.

Vortex separators require a cleaning frequency of between 1.5 and 4 years, with a cost of $2,000 to $6,000 per clean (based on $200 - $250 per tonne removed). City-wide, this would cost up to $60,000 per year, assuming cleaning of each device every two years.

High head losses occur across vortex separators, therefore installation may be unsuitable in flatter areas of Dunedin subject to flooding – the effectiveness of installing these devices further up-catchment in Dunedin would be minimal, as in general, the high contaminant generating land uses (commercial and industrial land uses) are in the flatter parts of the catchments. This inability to treat stormwater from the lower parts of the catchment, combined with an inability to remove key contaminants from the stormwater adhered to small particles, makes Vortex separators unsuitable for these catchments.

5 Alternatives Considered

5.3.7 Comparison

Table 5-3 below provides a comparison of the catchment-based stormwater treatment methods investigated for Dunedin.

Table 5-3 Comparison of catchment based stormwater treatment devices – Dunedin Upper Harbour Basin catchments.

Device	Target Pollutants	Treatment Efficiency		Capital Cost (1,947 Ha)	Annual Maintenance cost	Comment
		Zinc[1]	Copper[1]			
Wetlands	Sediments, nutrients, heavy metals (dissolved and particulate).	20% (roofs) - 54% (roads and paving)	25% (roofs) – 69% (roads and paving)	$87M	Not calculated[4]	Excessive land requirement at catchment base; uneconomical.
Treatment Plant	Nutrients	Not comparable[3]		$17.5M[5]	$116K	Stormwater may disturb biological processes at the wastewater treatment plant. Efficiencies unknown in terms of contaminant removal. Large reticulation costs (not included).
Filter Cartridge (Stormfilter[2])	Heavy metals	30% (roofs) – 55% (roads and paving)	40% (roofs) – 65% (roads and paving)	$15M	$900K	More suitable on-site than at end of pipe. Most targeted treatment removal.
Catchpit Filters	Gross pollutants	15% (roads and paving)	25% (roads and paving)	$7M	$240K	Low removal efficiency for key contaminants. Most appropriate as part of treatment train.

5 Alternatives Considered

Vortex Separators[2]	Gross pollutants	<15%[3]	<25%[3]	$2M	$60K	Large headloss, inappropriate for base of catchments in Dunedin. low removal efficiency for key contaminants. Most appropriate as part of treatment train.

1. Removal efficiencies from ARC Contaminant Load Model, ARC 2006. Ranges are provided, as treatment efficiency is dependent on contaminant source (ie roofs, roads, paved surfaces).
2. Proprietary devices supplied by Stormwater 360 Limited.
3. No comparable treatment efficiencies available – assumption based on catchpit filter efficiencies (catchpit filters remove smaller particles than vortex separators, therefore more metal contaminants).
4. Not calculated; based on amount of sediment captured and landfill/transport costs.
5. Costs do not include transport of stored stormwater to treatment plant; likely to be considerable.

6

Consultation

During the application for coastal discharge consents in 2005, through Annual Plan consultation, and through specific consultation in relation to the 3 Waters Strategy, a number of stakeholders have been identified as affected by, or interested in stormwater management in Dunedin. The following provides a summary of values identified through the consultative processes mentioned. These values have been considered throughout the development of the 3 Waters Direction Statement and the ICMPs, particularly when developing objectives and options for the management of identified stormwater-related issues.

6.1 3 Waters Strategy Consultation- Stakeholder Workshops and Community Survey

6.1.1 Overview

During consultation workshops relating to the 3 Waters Strategy, stakeholders were divided into three groups; environmental, economic/business, and social/cultural. The outcomes of these workshops were used to inform a community telephone survey to gauge the views of the wider community, including catchment residents. Specific groups were also consulted directly, including Käi Tahu Ki Otago, ORC, and East Otago Taiapure Management Committee. From all consultation relating to the 3 Waters Strategy there was a general recognition that stormwater requirements and standards will need to increase, in terms of both quality and volume management.

In general a coordinated approach to stormwater management between the ORC and DCC is desired, with the responsibilities for each organisation being clarified. Also, increasing the sustainability and efficiency of the stormwater network is desired.

The following sections summarise the views expressed during the 3 Waters consultative process.

6.1.2 Views Relating to Stormwater Quality

- A high awareness that stormwater contains many contaminants, and thus its management is not just a matter of transportation to the coast.
- That quality involves household drains and farm run-off as well as road run-off and sewage contamination.
- Recognition that recreational areas form integral parts of the stormwater system, underlining the need for better quality stormwater
- Improving quality of disposed stormwater is a key issue – the higher the quality, the better.

6.1.3 Views Relating to Stormwater Volume

- Recognition that climate change may result in more frequent storm events, thus putting a greater episodic demand on the system; and thus likely to require increased capacity. This may be compounded by decreases in permeable land resulting from increased property development in certain areas.
- That managing volumes (which is partially related to quality) requires a holistic view of the system and its management.

6.1.4 Summary

In summary, the consultation identified that the key points in relation to stormwater management were:

- Legislative changes, e.g. changing planning or building consents standards to further reduce the impact of new developments on stormwater;
- Passive changes, e.g. increasing the use of swales and soakholes to better manage storm events, using landscaping to reduce the visual impact of outfalls;
- Active changes, e.g. increasing outfall pipe numbers to reduce the impact in any given area; increasing treatment standards; installing low-flow regulators;
- Doing more than simply increasing pipe capacity – i.e. review requirements for new property developments in order to reduce run-off volumes and minimise the loss of permeable land; and
- Consideration of sustainable options e.g. stormwater captured and used by households; implementing alternative energy sources for pump stations (such as wind turbines or micro hydro-electricity generators). In rural areas, also capture stormwater in detention ponds, both to slow flows and prevent flooding but also to balance with demand for other water-use activities e.g. irrigation.

During the development of the 3 Waters Strategic Direction Statement, objective setting took the results of the community consultation into account, for example, by incorporating statements relating to the use of source control for stormwater management. The ICMP approach to stormwater management also considers a range of management options for stormwater, described as 'legislative, passive, and active' changes above.

6.2 Resource Consent Submissions from Existing Discharge Permits

The 2005 resource consent process for the coastal discharge permits identified the residents within the affected catchments as interested parties. Matters raised by submitters in relation to the coastal stormwater discharge permit applications are also a valuable source of stakeholder opinion. A majority of the submissions echo the views outlined above, however the Käi Tahu cultural impact assessment outlined below goes into more detail.

6.2.1 Käi Tahu Cultural Impact Assessment

In October 2005, Dunedin City Council commissioned Käi Tahu ki Otago Limited (KTKO) to undertake a cultural impact assessment (CIA) (KTKO, 2005) on the discharge of stormwater into Otago Harbour and at Second Beach. This report was commissioned as part of the consent application process for the existing discharge consents. The CIA report is contained in **Appendix C**.

KTKO was approached regarding whether the CIA needed revision and Chris Rosenbrock confirmed that *"the values in the CIA are still relevant and should be considered as part of the Catchment Management Plans or consent conditions moving forward."*

The 2005 CIA details historical use of the Otago Harbour by Käi Tahu and their descendants, particularly for transport and as a food resource (mahika kai).

The report studies the reported levels of contaminants in the stormwater discharged to the harbour, and also in sediments within the harbour, and states that Runanga are concerned about the lack of information on biological impacts, on effects further afield than the immediate area of discharge, and of the possibility of wastewater discharges into the harbour.

6 Consultation

The discharge of stormwater and associated contaminants has the potential to significantly impact Käi Tahu values and beliefs. These adverse impacts are associated with effects on the spiritual value of water, mahika kai, aquatic biota and water quality.

The traditional resource management methods of Käi Tahu require coordinated and holistic management of the interrelated elements of a catchment, from the air to the water, the land and the coast. The CIA notes that it is accepted by Käi Tahu that removal of all contaminants from stormwater is not possible. However, it is also considered that more could be done to reduce the level of contaminants discharged. Recommended management measures for consideration are as follows:

- Reducing the area of impervious land;
- Use of grass swales to filter stormwater;
- Covering car-parking areas and other areas where increased contaminants may be found;
- Sediment/grease traps to be installed at all industrial premises, petrol stations and car parks;
- Management plans for industrial and commercial facilities to minimise the contaminant loading into stormwater, including the management of spills;
- Ensuring industrial waste is not discharged to the stormwater system;
- Ensuring there is no discharge of human sewage to the stormwater system; and
- Ongoing awareness of best management practices and technological improvements that will reduce contaminant levels and a willingness to implement these as appropriate.

As with the wider community consultation results, it is considered that the proposed stormwater management approach incorporating the ICMPs and associated action plans encompasses much of what was desired by Käi Tahu in the 2005 CIA. This is achieved through identifying catchment specific issues and problems and supporting the use of source control and low impact design options for stormwater management. This will be achieved by improving and enforcing development controls such as a stormwater by-law, the Code of Subdivision and Development and the second generation district plan. The current and planned work to investigate and reduce the incidence of wastewater discharge into the receiving environment will also help to mitigate these concerns.

6.3 Annual Plan Submissions

A number of submissions were made with respect to stormwater issues through the 2009 Annual Plan consultation process. These submissions mainly centred on the maintenance and upgrade of the existing system so to ensure adequate treatment and filtration of the stormwater prior to it being discharged. The issue of infrastructure capacity was also raised. Public support for stormwater quality improvement initiatives was also evident through the 2012 long term planning process.

6.4 Consultation Undertaken for the Current Resource Consent Applications

6.4.1 Introduction

The DCC undertook further consultation as part of the process leading up to the lodgement of these stormwater discharge applications. This included meetings with the ORC to discuss the stormwater management approach and with stakeholders identified through the previous resource consent process.

6 Consultation

6.4.2 Meetings with Otago Regional Council

The DCC has been in consultation with the ORC from the inception of the Three Waters project in 2007. The DCC attended meetings with the ORC in relation to these resource consent applications on 1 December 2010 and 19 October 2011. The first of these meetings discussed the content of the ICMPs. The DCC presented the ORC with a draft of the South Dunedin ICMP and a general discussion about the likely resource consent process was had. Feedback from the ORC in relation to the ICMP was generally positive. The finalised ICMPs were presented to the ORC on the 29 November 2012and comment to date has also been positive.

The purpose of the meeting held on October 19 was for the DCC to present the philosophy and intended approach for the resource consent applications. The DCC provided the meeting attendees with a flow diagram that outlined the stormwater management process and a one page summary of the consent philosophy. This material described the focus on managing the effects on the receiving environment.

At this meeting it was agreed that the 31 existing resource consents should be condensed into a fewer number although what this number should be was not confirmed. The DCC also outlined that it would be seeking a 35 year consent term.

The DCC also met with the ORC on the 6 March 2012 to discuss a draft of the AEE which had been provided to the ORC previously. The ORC described the meeting as “productive” however they raised some concerns in a follow-up letter to the DCC. These included: the use of mixing zones; a reactive approach dealing with contamination hot-spots rather than a pro-active approach; a lack of a clear indication in the AEE that methods such as the implementation of bylaws and proactive surveillance will be utilised; and the lack of a staged contaminant concentration based approach to stormwater management.

DCC met with the ORC on 22 March 2012 to present solutions to the issues raised in the earlier meeting. These solutions included: amendments to the AEE to describe the wider stormwater management process being undertaken by the DCC as per the Strategic Direction Statement and 3 Waters Project (resource consent condition compliance only one link in a longer stormwater management chain), the inclusion of an action plan that links management actions prioritised in the ICMPs to funding allocated through the long term planning process to provide confidence that the DCC are and will continue to act to improve stormwater discharge quality; and a proposal for a further meeting in the form of a technical workshop to collaboratively develop the details of where receiving environment monitoring should take place and to develop appropriate contamination trigger values. These changes were met with general approval from the ORC and following this meeting a date was set for the technical workshop.

The DCC and the ORC held a technical workshop on May 12, 2012. The aim of this workshop was to come to an agreement as to the stormwater contaminants of concern and where possible to agree on monitoring locations and contaminant trigger levels within the receiving environment. While key contaminants were agreed (Cu, Zn, Pb, PAH and bacterial contamination), rather than discussing receiving environment monitoring locations, methods and trigger values, the ORC advocated for a percentage reduction in contaminant load at the end of the stormwater pipe. The DCC are of the opinion that applying end of pipe standards is not an appropriate method for avoiding, remedying or mitigating the effects that may be associated with stormwater discharges and is inconsistent with the RMA, New Zealand Coastal Policy Statement and the coastal plan. Consequently no further progress was made at this meeting.

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The concerns identified at the meetings with the ORC, and the DCC's responses are summarised in

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Table 6-1 below.

6.4.3 Stakeholder Meetings

The DCC held a meeting with the Department of Conservation (DoC), Public Health South (PHS) and Save the Otago Peninsula Inc. Soc. (STOP) on 14 December 2011. The purpose of this meeting was to provide attendees with information about the monitoring that has been undertaken and the development of the ICMPs. The purpose was also to present the proposed resource consent approach and philosophy and seek feedback in relation to this. Feedback has been received from PHS and STOP but at the time this report was written no feedback had been received from DoC.

PHS applauded the stormwater management approach proposed by the DCC (focus on the effects of the discharge) and described it as responsible and logical. PHS was very supportive and recommended that priorities should include:

- Eliminating cross connections;
- Notification to PHS where monitoring indicates a public health risk; and
- Investigations into the removal of a direct discharge at St Clair.

STOP provided comments and items they would like to see covered as consent conditions. Overall STOP has some misgivings about the shift to a management focus based on monitoring the receiving environment. They were concerned that contaminants entering the harbour would be diluted to such an extent that they would not be detectable and that contaminant levels may build up over time to become an issue. They were of the opinion that ecological monitoring should continue to provide a picture of the effects of pollutants on ecosystem health and abundance.

STOP was also concerned that by having four consents to authorise all discharges it may be impossible to identify individual contaminant sources. They would like to see monitoring requirements included as consent conditions and require the monitoring of the stormwater discharge. STOP wished to be involved in an annual meeting for stakeholders such as themselves and DoC to discuss the implementation of the ICMPs and to review the annual monitoring results.

6.4.4 Addressing Stakeholder Concerns

The consultation summarised above has raised some very important issues. The stormwater management regime proposed by the DCC addresses many of the concerns or issues that stakeholders have raised.

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Table 6-1 addresses the points raised by STOP, PHS and Kai Tahu by highlighting how the management regime will deal with the issue or explaining why it is not considered necessary.

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Table 6-1 Stakeholder Issues Summary

Stakeholder	Issue/Concern	DCC Response
Public Health South (PHS)	DCC should eliminate cross connections.	Further investigations of this issue are prioritised in the ICMPs for all catchments where cross connections have been identified. Removal of cross connections will systematically occur as they are discovered and funding allows (Action plan reference: 0001, 0004, 0005, 0010 and 0012).
	Notify PHS when monitoring indicates public health risk.	DCC have proposed a condition that requires notice to be provided to PHS when monitoring confirms there is a public health risk arising from its discharge.
	Investigate removal of direct stormwater discharge to St Clair.	Alternatives to discharging to current receiving environments have been assessed. The considerable cost of discharging to land or through the Tahuna Wastewater Treatment facility means these options have been disregarded.
Save the Otago Peninsula (STOP)	STOP has misgivings about management focus based on monitoring the receiving environment.	This approach is consistent with the ORC planning framework and the effects based approach prescribed by the RMA. This is also in line with other Councils that have recently consented stormwater discharges i.e. Christchurch City Council. The DCC have an ongoing programme to improve the quality of stormwater discharge, and will be undertaking targeted direct monitoring of the stormwater to ensure that its own strategic objectives are being met.
	Contaminants may not be	A combination of harbour water

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	detected and will build up in the environment over time.	quality, sediment and ecological health monitoring will ensure that any cumulative effects are identified and addressed where associated with urban stormwater discharges.
	Ecological monitoring should continue.	DCC are proposing to continue with ecological monitoring
	Identifying individual contaminant sources may be difficult with four consents authorising all discharges.	If issues are identified within any one of the four receiving environments, more focused catchment specific investigations will be undertaken. Limiting the number of consents will have no influence on how the DCC will respond to any issues identified.
	Monitoring requirements included as consent conditions.	Monitoring will be required by the proposed conditions of consent. The detail of what monitoring will be undertaken, when and how will be specified in the monitoring framework that will sit outside the consent conditions to enable adaptive management to progress. The consent conditions will require a monitoring framework to be in place at all times ensuring monitoring is always being undertaken.
	Wish the stormwater discharge to be monitored.	Monitoring of the discharge as opposed to the receiving environment may occur to pin-point a contaminant source. Targeted monitoring of stormwater will be used to assess effectiveness of management actions to achieve the strategic objectives. However, regular stormwater monitoring at 'the end of pipe' is not being proposed because there is not always a direct

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		correlation between end of pipe stormwater quality and effects on the environment.
	Wish to be involved in an annual meeting for stakeholders.	Annual stakeholder meetings will be held with STOP. This is proposed as a condition of consent.
Kai Tahu ki Otago	Reducing the area of impervious land.	The DCC propose to develop and review new and existing site controls (stormwater bylaw, Code of Subdivision and Development). These controls may include reductions in impervious land where appropriate (Action plan reference: 0011).
	Use of grass swales to filter stormwater.	The DCC propose to develop and review new and existing site controls (stormwater bylaw, Code of Subdivision and Development). These controls may include low impact design specifications for stormwater treatment where appropriate (Action plan reference: 0011). The DCC is also involved in a pilot project to install and monitor the effectiveness of a grass swale for managing stormwater quality from a new subdivision.
	Covering car-parking areas and other areas where increased contaminants may be found.	The DCC propose to develop and review new and existing site controls (stormwater bylaw, Code of Subdivision and Development). These controls may include specifications for source control of stormwater where appropriate (Action plan reference: 0011).
	Sediment/grease traps to be installed at all industrial premises, petrol stations and	These are already a requirement for some types of premises. The DCC propose to

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	car parks.	develop and review new and existing site controls (stormwater bylaw, Code of Subdivision and Development). These controls may include an increase in the specifications for stormwater treatment where appropriate (Action plan reference: 0011).
	Management plans for industrial and commercial facilities to minimise the contaminant loading into stormwater, including the management of spills.	The DCC propose to develop and review new and existing site controls (stormwater bylaw, Code of Subdivision and Development) and to provide improved education for industrial property owners. These controls may include requiring commercial or industrial sites to produce and adhere to site specific stormwater management plans where appropriate (Action plan reference: 0011).
	Ensuring industrial waste is not discharged to the stormwater system.	This is already incorporated into the Trade Waste Bylaw. However, the proposed review of regulatory controls for stormwater management will ensure that this is controlled in the most effective way practicable (Action plan reference: 0011). Enhanced education of industrial land owners will also facilitated better waste management on site (Action plan reference: 1005 and 1006).
	Ensuring there is no discharge of human sewage to the stormwater system.	Further investigations of this issue are prioritised in the ICMPs for all catchments where cross connections have been identified. Removal of cross connections will systematically occur as they are discovered. A

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		programme to reduce the frequency and duration of sewage overflows to the stormwater system during storm events is also in place (Action plan reference: 0001, 0004, 0005, 0010 and 0012).
	Ongoing awareness of best management practices and technological improvements that will reduce contaminant levels and a willingness to implement these as appropriate.	Through taking an integrated catchment management approach, the DCC are demonstrating its commitment to best practice. The DCC are aware of technological improvements in stormwater treatment methods and will implement these where they are seen to be cost effective and fit for purpose.
	35 year consent term is not appropriate. 15-20 years to be sought by Kai Tahu.	The DCC are applying for a 35 year resource consent duration. This long term consent duration provides a level of certainty that will help funding be directed toward stormwater management measures where required as opposed to further resource consent processes. The adaptive ICMP process will allow a 35 year consent to adapt to changing effects and receiving environment values therefore fulfilling the role of a shorter term consent duration.
	A regular programme for cleaning of street corner sumps should be implemented.	A regular programme of cleaning is already in place and improved contract management has improved the performance in this area over the past 1-2 years. The existing contract expires in 2013 and the contract requirements will be fully reviewed to ensure that they effectively support stormwater management objectives (Action

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		plan reference: 0007).
Otago Regional Council	Reliance on mixing zones.	Setting trigger values for contaminants outside a zone of reasonable mixing is consistent with the RMA, the NZ Coastal Policy Statement and the Regional Plan for Otago: Coast. It allows the DCC to avoid, remedy or mitigate adverse effects on the environment in a manner that allows the efficient allocation of resources to the catchments with stormwater quality issues.
	Proposal appears to be reactive rather than proactive.	This resource consent application is one part of a wider stormwater management approach. The purpose of the proposed stormwater management approach outlined in the proposed resource consent conditions is to avoid, remedy or mitigate adverse effects on the environment. The wider management approach promoted by the 3 Waters Project moves beyond this by proactively prioritising and addressing stormwater quality issues regardless of whether effects have been observed.
	Lack of evidence in AEE of a proposal to review and further develop site controls.	The DCC propose to develop and review new and existing site controls (stormwater bylaw, Code of Subdivision and Development) (Action plan reference: 0011). This has been reflected in the AEE and funds have already been allocated to this task within the action plan attached as

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		Appendix E.
	ORC would like to set a percentage reduction of contaminants in stormwater at the point of discharge as a consent condition.	Setting trigger values for contaminants outside a zone of reasonable mixing is consistent with the RMA, the New Zealand Coastal Policy Statement and the Regional Plan for Otago: Coast. It allows the DCC to avoid, remedy or mitigate adverse effects on the environment in a manner that allows the most efficient allocation of resources to the catchments with stormwater quality issues. It is difficult to predict a percentage reduction of contaminants with any degree of confidence. Consequently limits could be set as consent conditions without any clear understanding of whether they could reasonably be met. This produces a high level of uncertainty for the DCC, the ORC and stakeholders and may require high levels of investment that is not necessarily required to avoid remedy or mitigate adverse environmental effects placing a burden on ratepayers.

7

Assessment of Environmental Effects

7.1 Summary of Positive Effects

The most obvious positive effect associated with a stormwater discharge to the CMA is that it allows stormwater to be conveyed to a location where it does not cause a flooding hazard. The high level of impermeable surfaces in urban areas reduces the capacity for infiltration. Runoff is concentrated in low lying areas potentially causing damage to property and a safety risk. By discharging stormwater to the CMA this hazard can be reduced which provides a level of certainty that allows the inhabitants of Dunedin City to invest in and provide for their economic and social wellbeing and their health and safety. Conveying stormwater away from these low lying areas and discharging it to the CMA also reduces the potential health risks associated with bodies of standing water that may contain contaminants.

Managing Dunedin's stormwater through a robust monitoring programme and the implementation of the ICMPs provides a management method that ensures funding will be prioritised based on need. This ensures any management measures implemented are cost effective and addressing real rather than perceived issues making it affordable to the Dunedin community.

7.2 Effects on Water Quality

7.2.1 Introduction

The quality of the receiving environment water has the potential to be affected by numerous contaminant sources including, but not limited to: stormwater discharges; marine vessels; freshwater inputs; and other marine users. When making an assessment of the potential adverse effects of stormwater discharges on water quality, the Resource Management Act, the New Zealand Coastal Policy Statement and the coastal plan describe how it is appropriate to consider the dilution that the receiving water body provides through identifying a reasonable mixing zone.

Throughout this section of the report the Australian and New Zealand Environment and Conservation Council (2000) (ANZECC) guidelines have been used to inform any assessments. It is worth noting that these are just guidelines and do not form a standard set of trigger values for activities that may impact on water quality (or sediment quality) and should not be read as such. The guidelines aim to protect ambient waters from sustained exposures to toxicants, i.e. from chronic toxicity. Stormwater discharges occur periodically, and concentrations of chemicals in the water column are reduced significantly within a small number of tidal cycles.

Water quality in relation to contact recreation is addressed in Section 7.5 below.

7.2.2 Otago Harbour

Currently, harbour water quality is not regularly monitored by DCC and there is no clear link between the quality of stormwater leaving the outfall and the quality of the water in the harbour. DCC has recently undertaken some harbour water quality monitoring during dry and wet conditions on both the ebb and flood tide. Near-shore harbour water quality has been measured during dry weather and during two recent storm events (82.8 mm and 2.2 mm rainfall depth respectively).The first monitored storm was extreme with 82.8 mm of rain in a 24 hour period– equating to an ARI (Average Recurrence Interval) of approximately 1 in 5 years, however storms similar to the smaller storm are likely to occur more frequently. This sampling shows there is potential for contaminants in the harbour to regularly exceed the ANZECC guidelines for the protection of 95% of marine species, even during dry weather

when no stormwater is being discharged. This is shown in Tables 7-1, 7-2 and 7-3 below. The consequences of this exceedence for Otago Harbour ecology is discussed in Section 7.4.

Table 7-1 Harbour water quality during dry weather (2011). Exceedences of ANZECC guidelines for the protection of 95% of marine species shaded.

	Ravensbourne dry ebb	Ravensbourne dry flood	Causeway dry ebb	Causeway dry flood	Glenfalloch dry ebb	Glenfalloch dry flood
Enterococci MPN/100ml	BDL[1]	BDL	BDL	BDL	BDL	BDL
Cadmium g/m^3	BDL	BDL	BDL	BDL	BDL	BDL
Chromium g/m^3	BDL	0.0011	BDL	BDL	0.0016	0.0023
Copper g/m^3	0.0028	0.0058	0.0018	0.0018	BDL	0.0042
Lead g/m^3	0.0033	0.0092	0.0025	0.0027	0.0017	0.0076
Nickel g/m^3	BDL	BDL	BDL	BDL	BDL	BDL
Zinc g/m^3	0.0097	0.026	0.0078	0.0137	0.008	0.025

Table 7-2 Harbour water quality during an extreme rain event (82.8mm) (2011). Exceedences of ANZECC guidelines for the protection of 95% of marine species shaded.

	Ravensbourne wet ebb	Ravensbourne wet flood	Causeway wet ebb	Causeway wet flood	Glenfalloch wet ebb	Glenfalloch wet flood
Enterococci MPN/100ml	1200	2500	340	1300	41	400
Cadmium g/m^3	BDL	BDL	BDL	0.00025	BDL	BDL
Chromium g/m^3	BDL	0.0024	BDL	0.0018	BDL	0.0015
Copper g/m^3	0.0027	0.033	0.0025	0.013	BDL	0.007
Lead g/m^3	0.0065	0.054	0.0166	0.024	0.0043	0.0159
Nickel g/m^3	BDL	0.008	BDL	BDL	BDL	BDL
Zinc g/m^3	0.026	0.122	0.027	0.06	0.0099	0.026
Salinity	29	21	32	24	34	32

[1] BDL = below detection limit

7 Assessment of Environmental Effects

Table 7-3 Harbour water quality during a moderate rain event (2.2mm) (2011). Exceedences of ANZECC guidelines for the protection of 95% of marine species shaded.

	Ravensbourne wet ebb	Ravensbourne wet flood	Causeway wet ebb	Causeway wet flood	Glenfalloch wet ebb	Glenfalloch wet flood
Enterococci MPN/100ml	<10	31	10	<10	63	20
Cadmium g/m^3	BDL	BDL	BDL	BDL	BDL	BDL
Chromium g/m^3	BDL	BDL	0.0012	BDL	BDL	BDL
Copper g/m^3	0.003	0.0012	0.0033	0.0038	0.0029	BDL
Lead g/m^3	0.0032	0.0014	0.0017	0.0031	0.0013	BDL
Nickel g/m^3	BDL	BDL	BDL	BDL	BDL	BDL
Zinc g/m^3	0.009	0.0057	0.012	0.021	0.0058	BDL
Salinity (ppt)	33	35	35	35	35	34

	ANZECC 80% trigger values.	ANZECC 95% trigger values.
Cadmium	0.036	0.0055
Chromium	0.085	0.0044
Copper	0.008	0.0013
Lead	0.012	0.0044
Nickel	0.56	0.07
Zinc	0.043	0.015

The DCC acknowledge that the understanding of the existing quality of water in the Otago Harbour is limited. The stormwater management process proposed as part of this application (described in Section 4.2) seeks to improve this by prescribing an annual monitoring regime that includes harbour water quality monitoring. This will inform the management approach taken by the DCC and will also provide a long term record of harbour water quality.

To account for the dilution provided by the receiving environment and to be consistent with the approaches set out in the RMA, NZCPS and the coastal plan, the DCC propose that sampling take place outside a zone of reasonable mixing for each outfall. These are depicted in the monitoring framework attached as **Appendix D**.

7.2.3 St Clair / Second Beach

St Clair and Second Beach are dynamic environments that are influenced considerably by wave and tide action and long-shore currents. No receiving water quality sampling has been undertaken as part of the DCC's resource consent compliance monitoring or as part of a study undertaken by Ryder Consulting in 2010 because it was not required by the consent conditions and the high energy environment means contaminants are mixed and dispersed very quickly.

Beach water quality is monitored as part of the resource consent condition compliance for the Tahuna wastewater treatment plant outfall, and as part of the MfE beach bathing, monitoring programme. Prior to the commissioning of improvements to this facility there was some evidence of increased microbial levels at Second Beach. Post commissioning of the new extended outfall from the Tahuna treatment plant there has been a decrease in bacterial levels to below maximum acceptable levels for recreational contact at both St Clair and Second Beach as determined by the Ministry for the Environment recreational water quality guidelines.

The St Clair stormwater catchment consists of largely residential land use with approximately 10% of the catchment zoned rural (a golf course). The discharge of stormwater from this catchment would be classified as a permitted activity if there were no wastewater cross connections within the catchment. Monitoring of stormwater quality undertaken in relation to resource consent compliance has indicated that there may be a cross connection issue in the catchment, and this was also considered possible based on modelling results from the 3 Waters Strategy Project wastewater studies. Consequently resource consent is required and the main stormwater contamination issues to be investigated and possibly subsequently addressed at St Clair are microbial.

Because monitoring associated with the Tahuna outfall shows the receiving water quality to be of a contact recreation standard, microbial contamination in the area from all sources including stormwater, is not a significant issue at St Clair / Second Beach. However, potential cross connections between the wastewater and the stormwater network have been prioritised in the St Clair ICMP and will be managed actively. Work is underway to identify the extent of the issue and to identify the potential sources.

7.2.4 Conclusion

DCC have a commitment to improving the quality of stormwater discharging to the marine environment. However, in terms of the ongoing effects on the marine environment, water quality and ecological surveying to date indicate that in general, stormwater discharges are unlikely to be having a more than minor adverse effect on water-related values in the Otago Harbour environment. However, it is not easy to isolate stormwater influences from other influences on marine water quality, sediment contaminant levels, and species richness and abundance in ecological sampling based on available data.

To provide additional information and to seek assurance that better stormwater management will result in reduced adverse effects on water quality related values (contact recreation and marine ecosystem health) in the future, DCC proposes to monitor harbour water quality for contaminants outside of the proposed reasonable mixing zones. If the water quality triggers set in the DCC Stormwater Monitoring Framework (attached as **Appendix D**) are exceeded and confirmed through the process described in Section 4.2 of this report, actions will be taken to ensure any contamination issues attributable to stormwater discharge identified via this monitoring are addressed via the process set out in the relevant ICMP. This adaptive approach provides some flexibility for the DCC to enable funding to be appropriately allocated to stormwater quality management through the annual planning process having regard to the broader 3 Waters Strategy. It will also ensure that any adverse effects on water quality that are identified are remedied or mitigated in a timely manner.

Recent monitoring has shown that in the St Clair catchment, coastal water quality is of an acceptable standard for contact recreation and to preserve marine ecosystems. However, further investigations of potential cross connections have been prioritised in the St Clair ICMP and identified in the action plan (Action plan reference: 0005).

7.3 Effects on Sediment Quality

7.3.1 Overview

Contaminants in urban stormwater entering the marine environment potentially pose a risk to the health of marine organisms, primarily through the accumulation of the contaminants in marine sediments. Contaminants in the stormwater adhere to suspended particles and sediments in the marine environment and accumulate in the marine bed. High levels of contaminants within the sediments may result in an adverse impact on marine flora and fauna which come into contact with those sediments.

For the purposes of this assessment of sediment quality, the Upper Harbour Basin and Andersons Bay Inlet, Port Chalmers, and St Clair / Second Beach have each been assessed separately.

An assessment of the contaminant concentrations within the sediments can be compared to sediment quality guidelines to give an indication of whether potential adverse effects on marine ecology may be observed. These guidelines provide indicative rather than conclusive evidence of adverse effect with any exceedence of the guidelines only indicating a potential for adverse effects.

Australian and New Zealand Environment and Conservation Council (2000) (ANZECC) sediment quality guidelines provide low and high trigger values. The low values are indicative of contaminant concentrations where the onset of adverse biological effects may occur after chronic exposure, thus providing an early warning of potential adverse environmental effects. The high trigger values are indicative of contaminant concentrations where significant adverse biological effects may be observed. Exceedence of the high values could therefore indicate that adverse environmental effects may already be occurring. Contaminant concentrations below the ANZECC (2000) low trigger values therefore, are unlikely to result in the onset of adverse biological effects.

A summary of results from monitoring undertaken for consent condition compliance purposes and a separate study commissioned by the DCC are presented in Table 7-4 below. These results indicate that there are sediment contamination issues in the sediments adjacent to the South Dunedin and

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Halsey Street stormwater catchments. Sampling of sediments adjacent to the Portsmouth Drive, Kitchener Street and Orari Street catchments also indicates elevated contaminant levels are present. Sediment samples adjacent to the Shore Street outfall indicate some lead, zinc and Polycyclic Aromatic Hydrocarbons (PAH) contamination. Overall, this monitoring indicates that the contamination is largely heavy metals and PAH.

Elevated contaminant levels in sediments does not necessarily result in an adverse effect on the environment. This will be discussed further in Sections 7.4 and 7.5.

Table 7-4 Summary of sediment quality monitoring

Contaminant	Shore Street	South Dunedin	Portsmouth Drive	Orari Street	Kitchener Street	Halsey Street	Ravensbourne Road	Port Chalmers (2010 only)	St Clair (2010 only)
	Andersons Bay Inlet	Upper Harbour Basin						Upper Harbour	St Clair Beach
Arsenic (As)									
Cadmium (Cd)									
Chromium (Cr)									
Copper (Cu)									
Nickel (Ni)									
Lead (Pb)									
Zinc (Zn)									
PAH**									

All samples at or below ANZECC low trigger values.	Some samples exceed ANZECC low trigger value	All samples exceed ANZECC low trigger value	Some samples exceed ANZECC high trigger value	All samples above ANZECC high trigger value.

*Mason Street catchment sediments not monitored

** PAH – Polycyclic Aromatic Hydrocarbons

7.3.2 Upper Harbour Basin / Andersons Bay Inlet

The upper harbour bed has been classified as muddy sands/sandy muds, with varying proportions of fine gravels (Ryder Consulting, 2005b). The sediment analysis results for monitoring between 2007-2010 associated with DCC's current discharge consents, and a 2010 sediment study, are presented in Table 7-2, for each Upper Harbour catchment alongside ANZECC sediment quality guidelines.

In summary, trends in the levels of contaminants in the sediment remain unclear with monitoring data revealing high variability among contaminant levels and sites. Many contaminants are present in the sediments at various sites within the harbour at levels exceeding the ANZECC sediment guideline low trigger values.

Levels of metals and PAHs were generally found to be lower in 2010 than in previous years, however concentrations increased again in 2011 and 2012. It may be that the deposition of 'cleaner' sediments is occurring. However, deposition rates in the harbour are thought to be reasonably slow, approximately 2 mm per year, and significant re-suspension occurs in the shallow harbour during wind and rain events. Any trend, therefore, may take some time to be observed. Further monitoring of the sediments harbour-wide is required to better understand the levels of contamination and establish whether any long term trends exist.

7.3.3 Port Chalmers

The majority of studies carried out in the Otago Harbour have concentrated on the Upper Harbour Basin area, and as such information relating to the Upper and Lower Harbour environments in the vicinity of the Port Chalmers outfalls is limited. However, sediment samples were taken in 2010 from the Upper Harbour outfall location in Sawyers Bay. A majority of the contaminants found were in levels unlikely to cause concern, when using the low ANZECC trigger value as an indicator. Concentrations of Lead (Pb) in all these samples exceeded the ANZECC guidelines low trigger value. However, stormwater quality monitoring undertaken shows that concentrations of Lead in current stormwater discharges are relatively low. This suggests that Lead contamination in sediments at this location may be related to historical discharges prior to the removal of Lead from paint and fuel.

7.3.4 St Clair / Second Beach

The marine environment at St Clair Beach is a high energy environment. Consequently the substrate in this location will be frequently re-worked by the tides and the opportunity for the deposition of sediments and build-up of contaminants is therefore limited. The resource consent associated with the outfalls from the St Clair catchment does not have any sediment monitoring requirements. However, samples were taken from within 20 m and greater than 20 m from the outfall at St Clair Beach as part of a study undertaken in 2010. The substrate at Second Beach was unsuitable for sampling due to its coarse nature.

The study results for sediment analysis are presented in Table 7-2.

To summarise, the levels of contaminants in the marine sediments sampled in 2010 were found to be low, with all contaminants measured well below ANZECC low trigger values. These results are not surprising because the high energy environment is likely to quickly disperse any sediment and adsorbed contaminants. Sediments at Second Beach were unable to be sampled due to the rocky substrate.

7.3.5 Conclusion

Sediment sampling undertaken to date does provide some indication of anthropogenic contamination within the Otago Harbour. However, it is difficult to attribute the contamination observed to current stormwater discharges, and it is likely that contamination is largely the result of historic land use activities and their associated discharges occurring prior to the DCC implementing stormwater controls. However, ongoing monitoring is required to confirm that this is and remains the case. The contaminants that have been observed are largely at levels that are unlikely to cause adverse effects to marine ecosystems when using ANZECC high trigger values as an indicator with the exception of samples taken near the South Dunedin and Halsey Street catchment outfalls. The coastal plan prioritises recreational values, specifically water quality suitable for contact recreation and marine ecosystems, and particularly in relation to gathering shellfish when addressing the effects of contaminant discharges to the CMA. While some contamination has been identified in specific locations the important point is whether these values are adversely impacted as a result. This will be discussed further in Sections 7.4 and 7.5.

The contamination of sediment at St Clair and Second Beach is low which is likely due to the high energy environment and mainly residential land use within the St Clair catchment. Monitoring indicates that contamination levels are well below the ANZECC low trigger values and consequently adverse effect of the current stormwater discharges to St Clair / Second Beach on sediment quality are nil to less than minor.

Regardless of these outcomes, DCC has made a commitment to improving the quality of the stormwater discharged to the marine environment. It is hoped that monitoring will show an improvement in sediment quality over time as a result of improved stormwater management. This will, however, depend on the extent and rate at which stormwater discharges are influencing the quality of the deposited sediment.

7.4 Effects on Marine Ecosystems

7.4.1 Introduction

The contaminants that may be present in stormwater discharges have the potential to adversely affect marine ecosystems. The current stormwater discharge consents do not require marine biological monitoring for all catchments. However, the resource consents associated with the Mason Street, Kitchener Street, Orari Street, Portsmouth Drive, Ravensbourne Road and St Clair catchments require that samples are taken from cockles and octopus or fish. The Port Chalmers and Portsmouth Drive catchment have historical biological data that has also contributed to the knowledge of effects of stormwater discharges on marine ecology.

It should be noted that determining the ecological effects of contamination in the marine environment is difficult. Unless contamination levels are very high within the sediments it is difficult to distinguish between the potential adverse effects of contamination from stormwater, contamination from other sources, and the effects of other environmental variables. It should also be noted that the fish sampled are likely to travel throughout the area and will be influenced by contaminants in the marine environment outside of the sampled catchment or from non-stormwater sources from within the catchment.

7 Assessment of Environmental Effects

Ecological monitoring associated with the current resource consents was undertaken within the Otago Harbour, and at St Clair and Second Beach the results of which are described below.

7.4.2 Otago Harbour

The Upper Otago Harbour is a highly modified environment heavily influenced by historic land uses, harbour reclamation, historic discharges including stormwater, the use of the harbour as a deep water port and harbour dredging activities.

The biological monitoring results to date do not indicate significantly high levels of contaminants within the samples taken. Monitoring of cockles and fish has indicated that concentrations of heavy metals have been consistently below accepted food standards (Australia New Zealand Food Standards Code (2004), New Zealand Department of Health Food Regulations, United States Food and Drug Administration Guidelines [shown in Table 7-6]) and in three out of four years at least two orders of magnitude lower. A summary of results from cockle flesh sampling is shown in Table 7-5.

Table 7-5 Summary of heavy metal contamination in cockle flesh.

Contaminant	Unit	Year	Portobello Road	Orari Street	Kitchener Street
As	mg/kg	2007	2.5	2.5	3.5
		2008	4.0	2.8	3.3
		2009	2.9	4.9	3.8
		2010	2.0	2.3	2.2
		2011	2.5	2.5	2.8
		2012	8.0	8.8	5.3
Cd	mg/kg	2007	0.014	0.011	0.016
		2008	0.023	0.015	0.010
		2009	0.021	0.024	0.017
		2010	0.014	0.013	0.010
		2011	0.015	0.014	0.015
		2012	0.053	0.027	0.025
Cr	mg/kg	2007	0.32	0.32	0.34
		2008	0.65	0.15	0.27
		2009	0.22	0.30	0.31
		2010	BDL	0.18	0.13
		2011	0.02	0.17	0.22
		2012	0.33	0.41	0.33
Cu	mg/kg	2007	0.64	0.70	0.81

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Contaminant	Unit	Year	Portobello Road	Orari Street	Kitchener Street
		2008	1.20	0.85	0.67
		2009	0.82	1.10	0.89
		2010	0.43	0.46	0.66
		2011	0.77	0.65	0.71
		2012	1.29	1.24	1.29
Ni	mg/kg	2007	0.71	1.00	0.64
		2008	1.30	1.10	1.30
		2009	0.89	0.93	1.00
		2010	0.72	1.24	1.30
		2011	0.69	1.02	1.10
		2012	0.46	0.55	0.51
Pb	mg/kg	2007	0.17	0.11	0.08
		2008	0.42	0.07	0.08
		2009	0.099	0.110	0.082
		2010	0.151	0.082	0.089
		2011	0.130	0.094	0.082
		2012	0.35	0.11	0.20
Zn	mg/kg	2007	6.3	6.4	8.0
		2008	11.0	7.7	8.6
		2009	7.4	10.0	9.0
		2010	5.5	5.3	6.7
		2011	6.8	5.8	7.1
		2012	12.8	10.6	12.1

Table 7-6 Accepted standards for heavy metal contamination in food (expressed as mg/kg dry weight).

	Cu	Zn	Pb	Cd	Cr	Ni
New Zealand Department of Health Food Regulations	150.0	2000.0	10.0	5.0	-	-

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1984						
United States Food and Drug Administration Guidelines	-	-	4.2	-	11.0	80.0
Australia New Zealand Food Standards Code (2004)	-	-	2.0	2.0	-	-

While sampling also indicates limited heavy metal contamination in fin fish caught in traps near the Mason Street catchment, it is difficult to use these results to draw conclusions about the effects of stormwater discharges to the harbour due to their transient nature. There is potential for sampled fish to have been contaminated by sources other than municipal stormwater, from discharges in other locations or to have been largely living in areas not subject to stormwater discharges at all. Fish flesh monitoring results are presented in Table 7-7.

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Table 7-7 Monitoring results of fish flesh sampling undertaken in Otago Harbour.

Contaminant	Unit	Year	Mason Street
As	mg/kg	2007	1.9
		2008	1.6
		2009	1.9
		2010	1.6
		2011	1.24
		2012	1.09
Cd	mg/kg	2007	0.0047
		2008	0.0047
		2009	0.0110
		2010	0.0091
		2011	0.0060
		2012	0.0020
Cr	mg/kg	2007	0.05
		2008	BDL
		2009	0.14
		2010	BDL
		2011	BDL
		2012	BDL
Cu	mg/kg	2007	0.54
		2008	0.52
		2009	1.20
		2010	0.38
		2011	0.49
		2012	0.57
Ni	mg/kg	2007	BDL
		2008	BDL
		2009	<0.095
		2010	BDL

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Contaminant	Unit	Year	Mason Street
		2011	0.13
		2012	BDL
Pb	mg/kg	2007	0.140
		2008	0.120
		2009	0.43
		2010	0.14
		2011	0.14
		2012	0.29
Zn	mg/kg	2007	21
		2008	20
		2009	21
		2010	18
		2011	19.70
		2012	25.00
PAH	mg/kg	2007	0.0056
		2008	0.0023
		2009	0.0060
		2010	0.0150
		2011	0.0015
		2012	0.0052

Levels of PAH in cockles (using benzo[a]pyrene as an indicator) have been compared to the food standards for British Columbia (there are no specific guidelines for PAH in shellfish flesh for New Zealand). Levels of benzo[a]pyrene at Portobello Road are presented in Table 7-8.

Table 7-8 Results of benzo[a]pyrene monitoring in cockle flesh assessed against the relevant food standard for British Columbia.

	Location		
Year	B[a]P Portobello Road cockles (µg B[a]P/kg wet weight)	B[a]P Orari Street cockles (µg B[a]P/kg wet weight)	B[a]P Kitchener Street cockles (µg B[a]P/kg wet weight)
2007	249	2.2	-
2008	34	2.3	1.3

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2009	37	<0.20	<0.20
2010	95	1.28	1.14
2011			
2012			

B[a]P concentration in the edible portion of fish/shellfish (µg B[a]P/kg wet weight)	**Safe quantity for weekly consumption* on a regular basis (g wet weight)**
4	50
2	100
1	200

*low and moderate consumption levels, according to the State of Washington, are 45 g/wk (or 6.5 g/d) and 140 g/wk (or 20 g/d).

These monitoring results indicate that the fish and cockle communities at a majority of the sampling locations are not being exposed to significantly high levels of heavy metals and PAH and consequently there is little associated risk to human health. Table 7-8 indicates that there is PAH contamination in the vicinity of the Portobello Road outfalls that exceeds relevant food standards. Further monitoring and pipe surveys have been allocated funding in the current action plan to address this issue (Action plan reference: 0013).

Sampling indicates that faecal coliform levels have fluctuated wildly through the 2007-2010 sampling period. Few conclusions can therefore be drawn about adverse effects other than to say that the potential for adverse effects on human health exist from consuming cockles from the areas sampled due to microbial contamination. This issue has been given a high priority in the ICMPs due to it being a core strategic goal identified in the Strategic Direction Statement. Corresponding actions and funds have been included in the action plan to address wastewater contamination of stormwater (Action plan reference: 0001, 0005, 0010 and 0012). A summary of monitoring is shown in Table 7-9.

Table 7-9 Results of faecal coliform monitoring in cockle flesh

Contaminant	**Unit**	**Year**	**Portobello Road**	**Orari Street**	**Kitchener Street**
Faecal coliforms	MPN/100g	2007	<18	<18	<18
		2008	1300	230	78
		2009	78	<18	<18
		2010	68	68	220
		2011	45	<18	<18
		2012	<18	<18	<18

Historical data and the results of biological monitoring carried out harbour wide for DCC stormwater consent compliance indicate reasonably low diversity amongst the benthic and infaunal communities. The general lack of diversity is likely attributable to historical anthropogenic influences, including historic stormwater quality. However, other factors such as freshwater inputs, exposure at low tide and the loss of habitat from historic reclamation may also be contributing to the ecological health observed. It is not therefore possible to clearly link ecological health with the quality of current stormwater discharges.

The biological monitoring results to date, harbour-wide, show that, whilst not pristine, the upper harbour and the communities associated within the intertidal areas adjacent to the major stormwater outfalls appear not to be undergoing any significant further degradation as a result of the stormwater inputs during the monitoring period (2007-2010).

7.4.3 St Clair / Second Beach

The current resource consents for the stormwater discharges from the St Clair catchment require that the sampling and analysis of mussel flesh is undertaken from Second Beach. In addition, macroalgae and epifauna were investigated as part of a study in 2010.

The 2010 study concludes that the ecological communities at St Clair Beach and Second Beach were typical of intertidal communities in high energy environments.

All contaminants analysed in the sampled mussel flesh at Second Beach for consent requirements (2007 to 2010) were measured in low levels. Also the concentration of heavy metals measured in mussel flesh (2007-2010), have remained well below the New Zealand accepted food guidelines levels for shellfish flesh (Australia New Zealand Food Standards Code 2002; NZ Food Regulations 1984). The 2010 monitoring report concludes that there is little evidence of contamination of shellfish by stormwater at Second Beach. Monitoring results from mussel sampling are reproduced in Table 7-7.

Table 7-10 Results of contaminant monitoring in mussel flesh at Second Beach

Contaminant	Unit	Year	Second Beach
As	mg/kg	2007	1.6
		2008	1.9
		2009	1.9
		2010	1.5
		2011	1.7
		2012	1.65
Cd	mg/kg	2007	0.078
		2008	0.083
		2009	0.084
		2010	0.094

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Contaminant	Unit	Year	Second Beach
		2011	0.014
		2012	0.105
Cr	mg/kg	2007	0.33
		2008	0.20
		2009	0.11
		2010	0.19
		2011	0.21
		2012	BDL
Cu	mg/kg	2007	1.00
		2008	0.65
		2009	1.50
		2010	0.94
		2011	1.03
		2012	0.89
Ni	mg/kg	2007	0.4
		2008	0.3
		2009	0.3
		2010	0.5
		2011	0.4
		2012	0.31
Pb	mg/kg	2007	0.14
		2008	0.11
		2009	0.20
		2010	0.18
		2011	0.16
		2012	0.103
Zn	mg/kg	2007	12.0
		2008	9.4
		2009	14.0
		2010	9.8

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Contaminant	Unit	Year	Second Beach
		2011	11.3
		2012	12.2
Faecal coliforms	cfu/100ml	2007	<18
		2008	20
		2009	45
		2010	<18
		2011	170
		2012	1300

The 2010 study also found that Macroalgal cover was sparse with low diversity at both the St Clair Beach and Second Beach outfalls. Epifauna at both the St Clair Beach and Second Beach outfalls was restricted to hard substrate. Epifauna found at this location are typical of intertidal areas high energy environments, dominated by small barnacles, snails, limpets and chitons. Diversity and abundance was not found to change significantly with distance from the outfalls.

The biological monitoring results to date do not provide any evidence that there is heavy metal or PAH contamination of shellfish by stormwater from this catchment. Faecal coliform counts within the mussel flesh were found to be low between 2007 and 2010 but rose over the last two years of monitoring. Removing wastewater contamination from stormwater has been prioritised in the St Clair ICMP and funding has been allocated to this issue in the action plan (Action plan reference: 0005).

The annual monitoring for the current resource consents to date indicates that the ecology at St Clair and Second Beach is not being adversely affected by stormwater quality in this catchment.

7.4.4 Conclusion

The Upper Otago Harbour is a highly modified environment. Influences on the ecology include historic land uses, harbour reclamation, historic discharges to the CMA including stormwater, the use of the harbour as a deep water port and harbour dredging activities. Monitoring undertaken in recent years indicates that there does not appear to be any further degradation of harbour ecosystems as a result of contaminants in the current stormwater discharges.

Levels of all contaminants apart from PAH in cockles near the Portobello Road catchment and faecal coliforms and have been found to be low in ecological samples. Levels of all contaminants, apart from faecal coliforms in the last two years, were low in samples taken from Second Beach. The high energy environment and consequential rapid dispersal of contaminants is a likely contributor to the reasonable ecological quality observed.

Regardless of these findings, the DCC have made a commitment to improve the quality of discharges to the environment, and have committed to a programme of actions to support this objective. The DCC also intend to continue to monitor water and sediment quality and undertake biological sampling in the Otago Harbour. The results of this monitoring will help to quantify the positive effects of current stormwater management initiatives, and determine whether further action needs to be taken to ensure

that there is no decline in the quality of this environment that can be attributed to Dunedin City's stormwater discharge. Given the results of existing ecological monitoring, and the measures in place to ensure that that the quality of the ecological habitat remains at the status quo or better will ensure that any adverse effect on marine ecology will be minimal.

7.5 Effects on Recreational Values

7.5.1 Introduction

Recreational activities such as swimming and boating can be compromised if water quality is below specific standards. Schedule 2.3 of the coastal plan specifically identifies the Otago Harbour as a coastal recreation area and lists fishing, boating and walking as specific activities that are undertaken in the area. The harbour is frequently used by wind surfers, by people fishing, sea kayakers and hobby sailors. There are also a number of boat clubs and tourism operators in the area that make use of the harbour for recreational activities, including sea kayaking tours. The recreational values identified in the coastal plan suggest that contact recreation standards are an appropriate measure to assess water quality against.

7.5.2 Otago Harbour

Recent sampling has shown that during dry weather microbial levels have been low and below the ANZECC guidelines. There is potential for microbial contamination during extreme storm events however contact recreation is less likely to occur during these periods. The results for this recent DCC monitoring are outlined in Table 7-1. The results in this table are reinforced by monitoring undertaken by the Ministry for the Environment (MfE) for their Regional Water Quality Environmental Snapshot. Results published on MfE's website indicate that there is generally a low risk of microbiological contamination of water in Macandrew Bay where the measurements are taken (MfE, 2011).

The viability of recreational fishing requires marine ecosystems to be in a state that support a healthy fish population. Effects on marine ecosystems have been assessed in Section 7.4. In summary, contaminant levels in shellfish and fish are low and below relevant food standards aside from microbial contamination in cockles. Faecal coliform levels in cockles have fluctuated over the sampling period between levels below detectable limits to 1300 per 100g. Likely cross connections to the wastewater network have been identified in several stormwater catchments (Port Chalmers, Halsey Street and Mason Street) catchments through the ICMP process. The issues have been prioritised for investigation in the action plan with a view to eliminating any confirmed cross connections. Consequently microbial contamination of stormwater will be systematically reduced which will contribute to reducing the potential for the contamination of fish and shellfish.

As discussed in Section 7.4, diversity amongst the benthic and infaunal communities of the Otago Harbour is reasonably low which will contribute to the value of the harbour as a recreational fishery. The general lack of diversity is likely attributable to historical anthropogenic influences, including historical stormwater quality, historic land use and harbour reclamation. However, other factors such as freshwater inputs, exposure at low tide and the loss and modification of habitat from historic reclamation may also be contributing to the ecological health observed. It is not therefore possible to clearly link ecological health and consequently effects on recreational fishing values with the quality of current stormwater discharges.

7.5.3 St Clair / Second Beach

St Clair and Second Beach are also listed as Coastal Recreation Areas. Schedule 2.3 lists swimming, walking and surfing as the recreational activities undertaken at these locations. Swimming and surfing require the water quality to be suitable for contact recreation.

Both St Clair beach and Second Beach are high-energy environments; stormwater contaminants discharged at these locations will be quickly diluted and dispersed. While there has been some evidence of increased microbial levels at Second Beach in the past, the commissioning of the new extended outfall from the Tahuna wastewater treatment plant has led to a decrease in bacterial levels to below maximum acceptable levels for recreational contact at both St Clair and Second Beach. This is demonstrated at St Clair in MfEs Regional Water Quality Environmental Snapshot. Water quality monitoring results published on their website show that there is almost always a low risk of microbiological contamination of water at St Clair (MfE, 2011).

7.5.4 Conclusion

While limited, microbial contaminant monitoring to date shows that during dry weather, water quality in Otago Harbour is of a quality that is suitable for contact recreation. Possibly due to the high energy environment water quality at St Clair / Second Beach almost always has a low risk of microbial contamination. This will only improve, as DCC continue to implement their strategic direction statement objective of disconnecting all known cross connections between the wastewater and stormwater networks and undertake initiatives to reduce wastewater overflows.

Historic influences on the Otago Harbour have limited the diversity of species present. Monitoring of fish and cockle flesh generally shows relatively low levels of contaminants in the species that are present. However, PAH contamination in cockle flesh in the vicinity of the Portobello Road catchment has been observed above relevant food standards. Due to cockle habitat being within the marine sediments which include sediment contaminated as the result of historic land use, it is unlikely that the situation would change significantly in the absence of current stormwater inputs. Faecal coliform contamination levels in cockles have also been observed in levels above accepted food standards. A small number of samples taken of harbour water quality have indicated that there may be exceedences of ANZECC guidelines for protection of 95% of species, even during dry weather (i.e. without any stormwater discharge occurring).

As well as the range of stormwater management improvements that are being put in place by DCC, DCC proposes to monitor the water quality of the Otago Harbour on an annual basis and this will provide a better picture of the long term suitability of the harbour as a recreation resource. This monitoring will also provide additional information and be used to provide assurance that better stormwater management will result in reduced adverse effects on water quality. This monitoring will feed into the stormwater management regime outlined in Section 4 and Figure 4-1 of this AEE. The monitoring undertaken by the DCC and MfE suggests that recreation values are not currently being compromised by stormwater discharges. The proposed stormwater monitoring and management regime will ensure that this continues to be the case into the future.

7.6 Effects on Takata Whenua Values

Kai Tahu ki Otago have a strong relationship with the coastal environment. Evidence of Maori use of the harbour extends back to the Mäori's earliest tribal history when the harbour was a valued food resource and was used for transport.

Significant modifications to the Otago Harbour including reclamation and dredging and surrounding land uses have degraded the harbour as a resource for Maori. For example the opportunities for gathering mahika kai have been reduced. Stormwater contamination of the coastal marine area has the potential to further reduce takata whenua values or reduce the ability for values associated with the coastal marine area to recover.

Local iwi have been involved in the wider Three Waters Project from its inception. In developing the Three Waters Direction Statement the DCC engaged with with Kāi Tahu ki Otago to gain an understanding of the key cultural concerns regarding the future management of the three waters. This involvement resulted in the development of a key strategic priority of the 3 Waters Strategic Direction Statement:

> '*We will adopt an integrated approach to the management of the three waters and embrace the concept of kaitiakitaka.'*

The values identified in these discussions, the cultural impact assessment undertaken by Kai Tahu ki Otago as part of the application for the current resource consents held by the DCC, and guidance provided in the Kai Tahu ki Otago Resource Management Plan 2005 have all influenced the ICMPs developed as part of the Three Waters Project and the final approach that has been adopted by the DCC for applying for these new stormwater discharge permits.

The key values takata whenua attribute to the Otago Harbour and St Clair/Second Beach are the mauri or life supporting capacity of the ocean, mahika kai and biodiversity values. The monitoring that has been undertaken to date suggests that the Otago Harbour and St Clair/Second Beach are suitable for contact recreation but that there is some wastewater contamination occurring. Also, the biological monitoring results to date generally do not indicate significantly high levels of contaminants within the samples taken. Where applicable, lead and cadmium concentrations have been consistently below the maximum levels as outlined in Australia New Zealand Food Standards Code (2004). As discussed in Section 7.4.2, PAH levels above relevant food standards have been recorded in cockles adjacent to the Portobello Road catchment. However, generally the sampling results indicate that the fish and cockle communities in the Otago Harbour and at St Clair are not being exposed to significantly high levels of contaminants originating from stormwater discharges.

The DCC have prioritised eliminating wastewater discharges through the stormwater system within the ICMPs. Funding has been allocated to further investigations of microbial contamination in the Port Chalmers, St Clair, Halsey Street and Mason Street catchments.

The DCC is proposing to closely monitor the quality of the receiving environment including the Otago Harbour sediment. This will allow any future degradation of the environment attributable to the DCC stormwater discharge to be avoided by identifying the likely source of any contamination and applying measures priorities within the relevant ICMP and action plan to reduce that contaminant in the discharge. This approach is in line with policy in Kai Tahu ki Otago Resource Management Plan 2005.

7 Assessment of Environmental Effects

Monitoring the receiving environment including ecological health and implementing stormwater management options specific to any issues that may arise provides a practical method to ensure that takata whenua values are not further degraded as the result of stormwater discharges.

8

Statutory Assessment

8.1 Overview

The RMA provides the planning and decision framework under which the resource consents applied for will be assessed by the Otago Regional Council. This framework is discussed in Section 8.2.

The resource consents required from the Otago Regional Council, including the relevant rules in the regional plan, and the activity status of the proposal, are detailed in Section 8.3.

Section 8.4 provides an assessment of the proposal against the objectives and policies of the relevant statutory documents, including the relevant national and regional policies.

Section 8.5.4 concludes by providing an assessment of the proposal against the purpose and principles of the RMA.

8.2 Planning Framework

8.2.1 Part 2 of the Resource Management Act

In New Zealand, the RMA is the principal statutory document governing the use of land, air and water. Part II of the RMA, contained in sections 5-8, sets out the purpose and principles of the Act.

The purpose of the RMA, as set out in section 5, is to "*promote the sustainable management of natural and physical resources*". The method of applying section 5 involves an overall broad judgement, which allows for the comparison of conflicting considerations, the scale of them and their relative significance or proportion in the final outcome.

Sections 6, 7 and 8 of the RMA set out the principles to be applied in achieving the purpose of the Act. These sections respectively outline the matters of national importance that must be recognised and provided for; other matters to which particular regard must be had; and the requirement to take into account the principles of the Treaty of Waitangi.

It is important to note that the principles contained in sections 6, 7 and 8 of the RMA are subordinate to the overall purpose of the Act. Each plays a part in the overall consideration of whether the purpose of the Act has been achieved in a particular situation. These matters are not an end in themselves and are but an accessory to the principal purpose.

Assessment of the proposal against Part 2 of the Act is contained in Section 8.5 of this AEE.

8.2.2 Part 3 of the RMA

Part 3 contains the sections of the RMA which require resource consents for the proposal, namely; Section 15 that relates to discharge permits.

The resource consents applied for are detailed in Section 8.3.2.

8.2.1 Section 104 of the Resource Management Act

Section 104 of the RMA identifies the matters that the consent authorities have to consider in determining whether the applications should be granted.

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Section 104 Consideration of applications

(1) When considering an application for a resource consent and any submissions received, the consent authority must, subject to Part 2, have regard to–

(a) any actual and potential effects on the environment of allowing the activity; and

(b) any relevant provisions of—

(i) a national environmental standard:

(ii) other regulations:

(iii) a national policy statement:

(iv) a New Zealand coastal policy statement:

(v) a regional policy statement or proposed regional policy statement:

(vi) a plan or proposed plan; and

(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application.

Section 104 does not give any particular matter primacy over any other. All the matters are to be given such weight as the consent authority sees fit in the circumstances and all provisions are subject to Part 2.

The actual and potential effects on the environment of the proposal have been set out in Section 7 of this AEE.

Section 104 (2A) addresses applications for resource consent affected by Section 124 of the RMA (exercise of current resource consent while applying for new consent) and states:

Section 104 (2A)

When considering an application affected by section 124, the consent authority must have regard to the value of the investment of the existing consent holder.

A 2011 valuation report has estimated that the DCC's three-waters assets are valued at $268 million. This indicates the level of investment in the Dunedin City stormwater network. This current investment and the likely significant capital cost of implementing many alternatives to the proposed solution will need to be considered when assessing the merits of these applications.

8.2.2 Section 105 of the Resource Management Act

Section 105 of the RMA outlines matters relevant to certain applications for resource consent including discharges and coastal permits. Section 105(1) states:

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Section 105(1)

If an application is for a discharge permit or coastal permit to do something that would contravene section 15 or section 15B, the consent authority must, in addition to the matters in section 104(1), have regard to—

(a) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and

(b) the applicant's reasons for the proposed choice; and

(c) any possible alternative methods of discharge, including discharge into any other receiving environment.

The sensitivity of the receiving environment has been discussed at length in Section 3 of this report. Alternatives to the coastal discharge and reasons why they have not been adopted have been discussed in Section 5.

8.2.3 Section 107 of the Resource Management Act

Section 107 of the RMA places restrictions of the grant of certain discharge permits and states:

Section 107(1)

Except as provided in subsection (2), a consent authority shall not grant a discharge permit or a coastal permit to do something that would otherwise contravene section 15 or section 15A allowing—

(a) the discharge of a contaminant or water into water; or

[…]

if, after reasonable mixing, the contaminant or water discharged (either by itself or in combination with the same, similar, or other contaminants or water), is likely to give rise to all or any of the following effects in the receiving waters:

(c) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials:

(d) any conspicuous change in the colour or visual clarity:

(e) any emission of objectionable odour:

(f) the rendering of fresh water unsuitable for consumption by farm animals:

(g) any significant adverse effects on aquatic life.

The ecological monitoring undertaken to date indicates that there are no significant adverse effects on aquatic life arising from the current stormwater discharges. The proposed stormwater management process will ensure this remains the case and will also ensure that after reasonable mixing the other effects outlined in Section 107(1) are avoided. Proposed monitoring will seek to pinpoint any suspected areas of issue, in order to develop mitigation solutions as soon as practicable.

8.3 Resource Consent Requirements

8.3.1 Relevant Planning Documents and Document Status

The Regional Plan for Otago: Coast (coastal plan) has been operative since September 2001. Plan change 1 (harbour side) to the coastal plan was made operative in December 2009. The coastal plan is due for full review, however, this was put on hold pending the outcome of the review of the New Zealand Coastal Policy Statement (NZCPS). The review of the NZCPS has been completed however the review of the coastal plan has not commenced. The current coastal plan therefore remains the operative regional coastal planning document.

8.3.2 Resource Consents Required

Four resource consents to discharge stormwater to the coastal environments are being sought to cover each of the 10 Dunedin stormwater catchments covered by the Dunedin ICMPs. Not all of the stormwater receiving environments have the same characteristics, and stormwater catchments have been grouped to account for this.

8.3.3 Rule Assessment

Chapter 10.5.3 addresses the discharge of stormwater to the coastal environment. This activity is classified by Rules 10.5.3.1 and 10.5.3.2. Rule 10.5.3.1 states that discharges can be considered a permitted activity provided certain conditions are met. Clause (a) of this rule is relevant to the proposed activity and states:

> **Rule 10.5.3.1**
>
> The discharge of water into the coastal marine area is a *permitted* activity provided:
>
> (a) The discharge does not include stormwater from any industrial or trade premises or any human sewage …

A majority of the stormwater catchments subject to these consent applications contain industrial or trade premises. There is also the possibility of cross connection between the stormwater and wastewater systems in some catchments. The proposed activity therefore fails to comply with this condition.

Rule 10.5.3.2 states:

> Rule 10.5.3.2
>
> Except as provided for by Rule 10.5.3.1, the discharge of stormwater into the coastal marine area is a *controlled* activity.

The proposed activity is not provided for by Rule 10.5.3.1 due to the non-compliance with Clause (a) as described above. The proposed discharges to the coastal marine area are therefore classified as **controlled activities** requiring resource consent.

8.3.4 Permitted Baseline

When making an assessment of the effects of a proposal it is important to keep in mind how the proposed activity has been anticipated by the relevant planning documents. As stated above the discharge of stormwater to the CMA is addressed by the coastal plan.

Rule 10.5.3.1 provides for stormwater from any land use that is not an industrial or trade premises or does not contain wastewater as a permitted activity provided discharge occurs to an area that is 'well flushed' and complies with the criteria listed in s107(1) (c)-(e) and (f).

'Well flushed' is not defined in the coastal plan but it is probable that parts of Otago Harbour could be defined as well flushed. It is also highly likely that the St Clair area would meet criteria to be defined as well flushed. By including these criteria in this rule a strong focus is placed on the receiving environment as being important to whether restrictions are placed on this activity.

The coastal plan clearly anticipates that stormwater that does not contain wastewater from any source other than industrial or trade premise can occur with limited control. This includes discharges from residential roofs, roads and areas of car parking which may contain a number of contaminants including heavy metals, PAH and potentially low levels of microbial contamination. Rule 10.5.3.1 therefore sets a reasonably high baseline of what contaminants can be expected to be discharged to the CMA in stormwater without control or treatment. This baseline provides a starting point for any assessment that needs to be undertaken when identifying environmental effects associated with discharges from industrial or trade premises.

8.3.5 Implications of Controlled Activity Status

Section 104A outlines the role of the consent authority in relation to making a determination on controlled activities. Section 104A states:

Section 104A

After considering an application for a resource consent for a controlled activity, a consent authority—

(a) must grant the resource consent, unless it has insufficient information to determine whether or not the activity is a controlled activity; and

(b) may impose conditions on the consent under section 108 only for those matters—

(i) over which control is reserved in national environmental standards or other regulations; or

(ii) over which it has reserved its control in its plan or proposed plan.

These applications are for stormwater discharges to the CMA from catchments that include industrial or trade premises. As outlined in Section 8.3.3 above these are the key determinants as to whether the activity is controlled. Consequently the ORC must grant the applications in accordance with Section 104A(a).

Section 104A(b) provides a mechanism in which the consent authority may impose conditions of consent. A discussion of the extent of the consent authority's powers to modify an application for a controlled activity through conditions is contained within paragraphs 34-36 of *Aqua King Ltd v Marlborough District Council* W038/98. The key point of this discussion in relation to the current application is that conditions are not to be of such a nature as to effectively prevent the activity taking

place. Consequently conditions imposed by the consent authority must not modify the activity from that which has been applied for.

Section 104A(b)(ii) limits the matters that conditions can cover to those over which the Council has reserved control. These are outlined in Rule 10.5.3.2 and are:

- The location of the discharge point.
- The volume, rate and nature of the discharge.
- The treatment, if any, required prior to discharge.
- The duration of the resource consent.
- The information and monitoring requirements.
- The administrative charges payable.
- The review of conditions of the resource consent.

8.4 Objective and Policy Assessment

8.4.1 Overview

The objectives and policies of the following documents are reviewed in this section:

- New Zealand Coastal Policy Statement
- Otago Regional Policy Statement
- Regional Plan for Otago: Coast

8.4.2 New Zealand Coastal Policy Statement

The New Zealand Coastal Policy Statement (NZCPS) is a national policy statement under the RMA. The purpose of the NZCPS is to state policies in order to achieve the purpose of the RMA in relation to the coastal environment of New Zealand. The NZCPS was issued by notice in the New Zealand Gazette on 4 November 2010 and took effect on 3 December 2010. The NZCPS contains a number of objectives and policies and those most relevant to this proposal will be discussed below.

Objective 1 states:

Objective 1

To safeguard the integrity, form, functioning and resilience of the coastal environment and sustain its ecosystems, including marine and intertidal areas, estuaries, dunes and land, by:

- maintaining or enhancing natural biological and physical processes in the coastal environment and recognising their dynamic, complex and interdependent nature;
- protecting representative or significant natural ecosystems and sites of biological importance and maintaining the diversity of New Zealand's indigenous coastal flora and fauna; and
- maintaining coastal water quality, and enhancing it where it has deteriorated from what would otherwise be its natural condition, with significant adverse effects on ecology and habitat, because of discharges associated with human activity.

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The first and third bullet points of this objective are the most relevant to the proposed discharges. Current recommendations seek to improve land management within the harbourside catchments, which will result in improved stormwater quality. The proposed method of monitoring the coastal receiving environment and implementing stormwater management options based on this monitoring will ensure that the dynamic nature of the coastal environment is taken into account. The proposed method allows stormwater management to adapt more quickly to the changing environment. The implementation of management options where appropriate will ensure that the receiving environment is not further degraded and where possible enhanced.

Policies 3, 21, 22 and 23 seek to achieve Objective 1. Policy 3 is to apply a precautionary approach to the use of the coastal marine area. This policy states:

Policy 3 Precautionary approach

(1) Adopt a precautionary approach towards proposed activities whose effects on the coastal environment are uncertain, unknown, or little understood, but potentially significantly adverse.

(2) In particular, adopt a precautionary approach to use and management of coastal resources potentially vulnerable to effects from climate change, so that:

(a) avoidable social and economic loss and harm to communities does not occur;

(b) natural adjustments for coastal processes, natural defences, ecosystems, habitat and species are allowed to occur; and

(c) the natural character, public access, amenity and other values of the coastal environment meet the needs of future generations.

The discharge of stormwater to the Otago Harbour cannot be avoided due to the prohibitive cost of any alternative solutions. The results of monitoring undertaken to date provide a useful insight to the likely effects of current stormwater discharges on specific marine values. For the most part these effects have been assessed as relatively minor. However, the implementation of mitigation options and further investigation of potential issues have been recommended where a potential for adverse effects due to the stormwater discharges has been identified, and as a result of DCC's strategic commitment to improve stormwater discharge quality. By undertaking long term monitoring and more focused investigations where required, DCC will fill in any gaps in information about the potential effects of stormwater discharges and adapt the management regime accordingly.

Regardless of monitoring undertaken to identify potential effects and any associated mitigation, the wider strategic stormwater management priorities and the actions stated in the ICMPs provide a precautionary mechanism to drive the long term improvements in the quality of stormwater entering the CMA. Due to the level of knowledge about potential effects and the fact that to date, it is considered that the prohibitively expensive cost of implementing a highly precautionary ('avoid') approach such as directing all stormwater flows to the Tahuna wastewater treatment facility cannot be justified at this point in time.

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Policy 21 seeks to enhance water quality in the coastal environment where it has been degraded by use and states:

Policy 21 Enhancement of water quality

Where the quality of water in the coastal environment has deteriorated so that it is having a significant adverse effect on ecosystems, natural habitats, or water based recreational activities, or is restricting existing uses, such as aquaculture, shellfish gathering, and cultural activities, give priority to improving that quality by:

[…]

(c) where practicable, restoring water quality to at least a state that can support such activities and ecosystems and natural habitats;

[…]

(e) engaging with tangata whenua to identify areas of coastal waters where they have particular interest, for example in cultural sites, wāhi tapu, other taonga, and values such as mauri, and remedying, or, where remediation is not practicable, mitigating adverse effects on these areas and values.

The results of monitoring to date show that overall adverse effects on ecosystems and recreational values are not significant. However, proposed stormwater management options have and will continue to be outlined in the ICMPs for each stormwater catchment as issues are identified – for example, ensuring that stormwater management requirements in the DCC Code of Subdivision and Development are complied with. These actions will help to improve the water quality in the Otago Harbour and at St Clair/Second Beach.

Takata whenua have been engaged through this resource consent application process and through the commissioning of a cultural impact assessment that was utilised for the past resource consent applications.

Policy 22 of the NZCPS seeks to address the issue of sedimentation of the CMA from land use activities including stormwater discharges and states:

Policy 22 Sedimentation

[…]

(4) Reduce sediment loadings in runoff and in stormwater systems through controls on land use activities.

The DCC has in place a Code of Subdivision and Development that provides guidance on matters related to the development of land which includes stormwater. The largest reduction in sediment loadings is most likely to occur through controlling erosion and sediment runoff during construction activity within the city. Controls on sediment discharges from this type of activity are controlled by the ORC. However, the DCC have run a course on erosion and sediment control techniques that was attended by ORC staff, contractors and DCC staff. This has led to a number of outcomes that will help

to help reduce the level of sediment runoff in the future including plans to produce a Dunedin specific erosion and sediment control guide (Action plan reference: 0006).

Policy 23 specifically relates to the discharge of contaminants to the CMA and states:

Policy 23 Discharge of contaminants

(1) In managing discharges to water in the coastal environment, have particular regard to:

(a) the sensitivity of the receiving environment;

(b) the nature of the contaminants to be discharged, the particular concentration of contaminants needed to achieve the required water quality in the receiving environment, and the risks if that concentration of contaminants is exceeded; and

(c) the capacity of the receiving environment to assimilate the contaminants; and:

(d) avoid significant adverse effects on ecosystems and habitats after reasonable mixing;

(e) use the smallest mixing zone necessary to achieve the required water quality in the receiving environment; and

(f) minimise adverse effects on the life-supporting capacity of water within a mixing zone.

(2) In managing discharge of human sewage, do not allow:

(a) discharge of human sewage directly to water in the coastal environment without treatment; and

(b) the discharge of treated human sewage to water in the coastal environment, unless:

(i) there has been adequate consideration of alternative methods, sites and routes for undertaking the discharge; and

(ii) informed by an understanding of tangata whenua values and the effects on them.

[…]

(4) In managing discharges of stormwater take steps to avoid adverse effects of stormwater discharge to water in the coastal environment, on a catchment by catchment basis, by:

(a) avoiding where practicable and otherwise remedying cross contamination of sewage and stormwater systems;

(b) reducing contaminant and sediment loadings in stormwater at source, through contaminant treatment and by controls on land use activities;

(c) promoting integrated management of catchments and stormwater networks; and

(d) promoting design options that reduce flows to stormwater reticulation systems at source.

[…]

The development of DCC's 3 Waters Direction Statement objectives, and the extensive effort put into developing and implementing ICMPs to manage the harbour side stormwater catchments is considered to be fully in keeping with this policy.

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Studies indicate that the Otago Harbour ecosystems are relatively impoverished and the monitoring undertaken to date suggests that contaminants present in sediment and in harbour water are not having a significant effect on ecosystem values.

The proposal to monitor the receiving environment and manage stormwater based on this monitoring has been developed based on information about the sensitivity of the receiving environment. A majority of this information has been gained from monitoring undertaken in relation to the current resource consents. Applying stormwater management options through the ICMPs for each catchment which may include measures to remedy cross connections promotes an integrated approach which is especially important in an area such as Dunedin that has a series of common receiving environments. An important point to note is that the reasonable mixing of contaminants is provided for. This echoes the restrictions on the grant of coastal discharge permits stated in s107 of the RMA.

The action plan attached as **Appendix E** includes actions to investigate and remedy wastewater/stormwater cross connections where identified; minimise the incident of wet weather overflows from the wastewater system; further improve the regulatory regime relating to source control of stormwater; improve erosion and sediment control practices during subdivision and development; ensure that the second generation district plan provides controls on land use activities to support stormwater management objectives and promote sustainable urban design as a tool for effective stormwater management via the spatial plan; and review of the code of subdivision and development.

Objective 3 of the NZCPS is to ensure that the role of takata whenua is recognised and involved in the management of the CMA. This objective states:

Objective 3

To take account of the principles of the Treaty of Waitangi, recognise the role of tangata whenua as kaitiaki and provide for tangata whenua involvement in management of the coastal environment by:

- recognising the ongoing and enduring relationship of tangata whenua over their lands, rohe and resources;
- promoting meaningful relationships and interactions between tangata whenua and persons exercising functions and powers under the Act;
- incorporating mātauranga Māori into sustainable management practices; and
- recognising and protecting characteristics of the coastal environment that are of special value to tangata whenua.

Policy 2 provides the main direction in relation to his objective. However, in relation to stormwater discharges a number of other policies including Policy 21 discussed above are relevant. Policy 2 states:

Policy 2 The Treaty of Waitangi, tangata whenua and Māori heritage

In taking account of the principles of the Treaty of Waitangi (Te Tiriti o Waitangi), and kaitiakitanga, in relation to the coastal environment:

(a) recognise that tangata whenua have traditional and continuing cultural relationships with areas of the coastal environment, including places where they have lived and fished for generations;

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[…]

(c) with the consent of tangata whenua and as far as practicable in accordance with tikanga Māori, incorporate mātauranga Māori in regional policy statements, in plans, and in the consideration of applications for resource consents, notices of requirement for designation and private plan changes;

[…]

(e) take into account any relevant iwi resource management plan and any other relevant planning document recognised by the appropriate iwi authority or hapū and lodged with the council, to the extent that its content has a bearing on resource management issues in the region or district; and

(i) where appropriate incorporate references to, or material from, iwi resource management plans in regional policy statements and in plans; and

(ii) consider providing practical assistance to iwi or hapū who have indicated a wish to develop iwi resource management plans;

(f) provide for opportunities for tangata whenua to exercise kaitiakitanga over waters, forests, lands, and fisheries in the coastal environment through such measures as:

(i) bringing cultural understanding to monitoring of natural resources;

(ii) providing appropriate methods for the management, maintenance and protection of the taonga of tangata whenua;

(iii) having regard to regulations, rules or bylaws relating to ensuring sustainability of fisheries resources such as taiāpure, mahinga mātaitai or other non-commercial Māori customary fishing; and

(g) in consultation and collaboration with tangata whenua, working as far as practicable in accordance with tikanga Māori, and recognising that tangata whenua have the right to choose not to identify places or values of historic, cultural or spiritual significance or special value:

(i) recognise the importance of Māori cultural and heritage values through such methods as historic heritage, landscape and cultural impact assessments; and

(ii) provide for the identification, assessment, protection and management of areas or sites of significance or special value to Māori, including by historic analysis and archaeological survey and the development of methods such as alert layers and predictive methodologies for identifying areas of high potential for undiscovered Māori heritage, for example coastal pā or fishing villages.

Takata whenua were involved in the previous application through consultation and through undertaking a cultural impact assessment. This involvement, the Kai Tahu ki Otago Natural Resource Management Plan, and discussions held with takata whenua through the development of the 3 Waters Direction Statement have provided a valuable insight into the values held by local Maori, and has ensured that the core values outlined by Kai Tahu have been incorporated into the overarching objectives for stormwater management. Takata whenua have been consulted as part of this application as well and the outcomes of all these processes have helped develop and refine the proposed stormwater management methodology.

Objective 4 is to recognise the CMA as a public resource and states:

Objective 4

To maintain and enhance the public open space qualities and recreation opportunities of the coastal environment by:

- recognising that the coastal marine area is an extensive area of public space for the public to use and enjoy;

  …

Policy 18 seeks to achieve this objective by:

Policy 18 Public open space

Recognise the need for public open space within and adjacent to the coastal marine area, for public use and appreciation including active and passive recreation, and provide for such public open space, including by:

(a) ensuring that the location and treatment of public open space is compatible with the natural character, natural features and landscapes, and amenity values of the coastal environment;

(b) taking account of future need for public open space within and adjacent to the coastal marine area, including in and close to cities, towns and other settlements;

[…]

The assessment of coastal water quality shows that it is largely suitable for contact recreation. Current stormwater discharges are therefore not for the most part reducing the potential for the CMA to be utilised as a public space. The proposed management regime will help ensure that this continues to occur.

8.4.3 Otago Regional Policy Statement

The Otago Regional Policy Statement (ORPS) is an operative policy statement the purpose of which is to give effect to the RMA. The ORPS discusses issues, objectives and policies relating to managing the use, development and protection of the natural and physical resources of the region. It identifies regional issues and provides a policy framework for managing environmental effects associated with urban and rural development including issues relating to stormwater discharges and coastal water quality. The ORPS was due for full review in October 2008 however at the time this report was written the review process had not been initiated. Relevant Objectives and policies are outlined below.

Objective 8.4.2 relates to coastal ecology and is:

Objective 8.4.2

To maintain and enhance the health and diversity of Otago's existing coastal ecology.

Objective 8.4.4 relates to the water quality within the coastal environment:

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Objective 8.4.4

To seek to maintain existing water quality within Otago's coastal waters and where water quality is degraded, to seek to achieve water quality suitable for contact recreation and the eating of shellfish.

The water quality of the harbour and at St Clair / Second Beach is of a quality suitable for contact recreation. Testing of shellfish indicates that contaminant levels are below those required to meet relevant food standards for heavy metal contamination in a majority of cases with some contamination issues observed in samples taken near the Portobello Road catchment outfall. Samples of cockle flesh indicate that microbial contamination may be an issue at some locations in Otago Harbour but not at St Clair / Second Beach. The DCC has prioritised removing wastewater discharges through the stormwater system in the relevant ICMPs and has allocated funding to the task in the action plan (Action plan reference: 0001, 0004, 0005, 0010 and 0012).

Policy 8.5.2

To recognise uses within the coastal environment through:

(a) Accepting the continuation of lawfully existing uses;

(b) Allowing for the maintenance and where practicable enhancement of existing infrastructure; and

(c) Allowing for activities requiring a coastal location; subject to avoiding, remedying or mitigating the adverse effects of any activity.

This policy gives some weight to the continuation of stormwater discharges to the CMA. This is also reflected in the controlled activity status of this stormwater discharge application.

Policy 8.5.5

To maintain and where practicable enhance the physical and ecological quality of the coastal environment through:

(a) Protecting the life-supporting capacity of coastal ecosystems; and

(b) Avoiding as far as practicable, or remedying or mitigating the adverse effects, including cumulative effects, of land and water based activities on the coastal marine area through appropriate methods.

Policy 8.5.6

To promote a reduction in the adverse effects of contaminant discharges into Otago's coastal waters through:

(a) Adopting the existing water quality of Otago's coastal waters as a minimum acceptable standard;

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and

(b) Investigating and where appropriate, enhancing water quality so that as a minimum standard it is suitable for contact recreation and shellfish gathering where

(i) There is a high public interest in, or use of the water; or

(ii) There is a particular Kai Tahu interest in the water; or

(iii) There is a particular value to be maintained or enhanced; or

(iv) There is a direct discharge containing human sewage or wastes from commercial or industrial activities; and

(c) Requiring that all discharges into Otago's coastal waters maintain the standard for the receiving waters after reasonable mixing; and

(d) Promoting discharges to land where practicable and where there are no significant adverse effects on groundwater or surface water resources, or soil; and

(e) Preparing contingency responses for accidental pollution spills; and

(f) Investigating and addressing the effects of diffuse source discharges on coastal water quality; while considering financial and technical constraints.

Policies 8.5.5 and 8.5.6 relate to ensuring the water quality of the marine environment is not further degraded and where possible enhanced to protect the life supporting capacity of the CMA. The stormwater management regime proposed will achieve this aim by implementing recommendations made in the ICMPs to date, and by monitoring the existing water quality and identify any adverse effect on this. Policy 8.5.6(c) also provides for a reasonable mixing zone to allow the assimilation qualities of the coastal environment to be utilised. Mixing zones have been proposed as part of this application and an exceedence of water quality trigger values set beyond these zones will initiate a management response.

Policy 8.5.1 is relevant to all the objectives addressing coastal management and is:

Policy 8.5.1

To recognise and provide for the relationship Kai Tahu have with Otago's coast through:

(a) Identifying in conjunction with Kai Tahu priority areas and mechanisms for upgrading mahika kai and for protecting waahi tapu, waahi taoka and places of cultural importance;

(b) Facilitating, where practicable, the maintenance and enhancement of access for Kai Tahu to waahi tapu, waahi taoka and mahika kai and places of cultural importance; and

(c) Protecting the characteristics of the coastal environment of special value to tangata whenua.

As discussed above, takata whenua were involved in the previous application through consultation and through the cultural impact assessment. Takata whenua have been consulted as part of this application as well and the outcomes of all these processes have helped develop and refine the proposed management methodology.

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8.4.4 Regional Plan for Otago: Coast

The purpose of the Regional Plan for Otago: Coast (coastal plan) is to provide a framework to promote the integrated and sustainable management of Otago's coastal environment. The coastal plan recognises that the coastal environment is one of the integral features of the Otago Region, and that it is dynamic, diverse and maintained by a complex combination of physical and ecological processes.

The following objectives seek to ensure that the water quality in Otago's coastal marine area is not degraded and that associated ecosystem, community and cultural values are taken into account when discharges to the CMA are being considered. Objectives 10.3.1, 10.3.2 and 10.3.3 are outlined below.

Objective 10.3.1

To seek to maintain existing water quality within Otago's coastal marine area and to seek to achieve water quality within the coastal marine area that is, at a minimum, suitable for contact recreation and the eating of shellfish within 10 years of the date of approval of this plan.

Objective 10.3.2

To take into account community, cultural and biological values associated with Otago's coastal marine area when considering the discharge of contaminants into Otago's coastal waters.

Objective 10.3.3

To safeguard the life-supporting capacity of Otago's coastal marine area.

DCC's new stormwater management approach supports ORC's objectives to safeguard the life supporting capacity of the CMA. The Strategic Direction Statement objectives were developed in line with the values listed in Objective 10.3.2, and therefore influence all aspects of stormwater management decision making. Water quality in all receiving environments is currently suitable for contact recreation during dry weather when contact recreation is most likely to occur, and the management regime will ensure that stormwater discharges do not adversely affect this.

Monitoring to date shows relatively low contaminant levels in shellfish in the harbour with the exception of faecal coliforms, The last part of Objective 10.3.1 may be difficult to achieve, however, if influenced by stormwater discharges, the levels of faecal coliforms in shellfish should reduce in response to prioritised initiatives already underway by DCC to resolve cross connection and wastewater system capacity issues (Action plan reference: 0001, 0004, 0005, 0010 and 0012).

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Policy 10.4.1

In order that any proposed discharge, into the coastal marine area that will, or is likely to, have an adverse effect on cultural values, can be identified by kaitiaki runanga, Kai Tahu will be:

(a) Treated as an affected party for non-notified resource consent applications to discharge water or contaminants into areas, or adjacent to such areas, identified in Schedules 2 and 3 of this Plan as having cultural or spiritual values to Kai Tahu; and be

(b) Notified about notified resource consent applications to discharge water or contaminants into the coastal marine area.

Kai Tahu have been consulted in the preparation of this application and will be formally notified by the ORC.

Policy 10.4.3

To restrict the discharge of contaminants into Otago's coastal marine area where that discharge would result in a lowering of the existing water quality in the receiving waters:

(a) After reasonable mixing; and

(b) After disregarding any natural processes that may affect the receiving waters.

The existing water quality will be monitored outside of a reasonable mixing zone to ensure any adverse changes to water quality attributable to DCC stormwater discharges are identified and addressed through the proposed management regime.

Policy 10.4.4

To require an effective mixing zone for discharges of water or contaminants into the coastal marine area which takes account of:

(a) The sensitivity of the receiving environment; and

(b) The particular discharge, including contaminant type, concentration, and volume; and

(c) The physical processes acting on the area of discharge; and

(d) The community uses and values associated with the area affected by the discharge; and

(e) The ecological values associated with the area.

Mixing zones have been developed taking into account the values outlined in Policy 10.4.4. This has involved modelling the stormwater plumes entering the harbour, discussions with stakeholders regarding the values of the harbour, investigations of stormwater quality and quantity and ecological monitoring. The mixing zones are contained in the monitoring framework attached as **Appendix D** of this report.

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Policy 10.4.7

The discharge of a contaminant (either by itself or in combination with other discharges) into the coastal marine area will only be allowed where:

(a) It can be shown that the adverse effects of the discharge to any area, other than the coastal marine area, would create greater adverse effect than the discharge to the coastal marine area; or

(b) There are no practicable alternatives to the discharge occurring to the coastal marine area; and

(c) The discharge is of a standard which will achieve a water quality suitable for contact recreation and shellfish gathering within ten years of approving this Plan.

The collection and conveyance of stormwater away from built up areas is essential to prevent flooding and to allow the city to function as a place of residence, commerce, culture and recreation. The discharge of Dunedin's stormwater to any other receiving environment is impractical due to the lack of available land and the prohibitive expense of pumping it away from the city to an area where land may be available. This policy contradicts the controlled activity status of stormwater discharges to the CMA by stating that discharges will only be allowed if certain criteria are met. No such restrictions are placed on the relevant rule that classifies the activity.

Objective 10.3.4 identifies specific coastal areas where water quality is to be enhanced.

Objective 10.3.4

To enhance water quality in:

(a) Coastal protection areas; and

(b) Coastal recreation areas; and

(c) Areas adjacent to marine mammal or bird sites; and

(d) Areas where there is a direct discharge containing human sewage; and

(e) Areas where there is a direct discharge of wastes from commercial, industrial or production activities.

The proposed discharges will occur to a coastal recreation area (Otago Harbour depicted as CRA9 on the coastal plan planning maps). The Otago Harbour is listed as being utilised for boating fishing and walking. Water quality in these areas will be monitored and stormwater management measures will be implemented should water quality trigger values be exceeded. Provided this occurs and the DCC continues to implement the actions required to meet their strategic stormwater objectives, coastal water quality within Otago Harbour will be enhanced.

Policy 10.4.2

For activities involving the discharge of water or contaminants, priority will be given to avoiding adverse effects on values associated with any area identified in Schedules 2 and 3 of this Plan as being a coastal protection area, a coastal recreation area, an area of outstanding natural features and landscapes or an area important to marine mammals or birds.

As a consequence of Policy 10.4.2, priority has been given to boating and fishing values (walking values being of little consequence to these stormwater discharge applications) when assessing the potential effects of the proposed discharges. As discussed above water quality in Otago Harbour is of suitable quality for contact recreation. Fishery values in the inner harbour are limited however, contaminants present in ecological samples taken indicate that contaminant levels in shellfish are relatively low in a majority of cases.

8.5 Part 2 of the RMA

Please refer to Section 8.2.1 for an overview of the Part 2 framework under the RMA.

8.5.1 Section 6

Firstly addressing matters of national importance contained within Section 6. The most relevant matters are considered to be:

Section 6

(a) the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development:

[…]

(e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga.:

[…]

The Otago Harbour is a highly modified environment. However, natural character values do need to be considered when assessing the potential or actual effects of Dunedin's stormwater discharges.

The proposed monitoring and management regime provides a method that identifies any potential stormwater contamination issues by assessing the state of the receiving environment against a set of trigger values. These issues will then be prioritised within the relevant ICMP and an appropriate management response will be implemented if required (this is already occurring as evident from the ICMP documents and associated action plan [attached as **Appendix E**]). Natural character values associated with the quality of the harbour water or sediment quality will be preserved by closely monitoring the receiving environment and the effectiveness of any management response. Any management response will be modified if required to ensure the desired outcomes are achieved.

This regime is integrated into the wider strategic approach the DCC have taken to stormwater management to achieve their strategic stormwater objectives. This approach means stormwater

issues are prioritised within the ICMPs and included in an action plan where appropriate, regardless of whether effects in the stormwater receiving environment are observed. This integrated approach ensures that the natural character of the coastal environment is protected from inappropriate use.

The relationship of Maori with the Dunedin coastal environment has been recognised throughout the process of this assessment and through the process of obtaining previous resource consents. This has occurred through consultation with takata whenua and the commissioning of a cultural impact assessment. These activities have helped shape the proposed monitoring and management regime for Dunedin's stormwater discharges.

8.5.2 Section 7

Section 7 of the RMA outlines other matters. Those of particular relevance to this application include:

Section 7
[…]
(d) intrinsic values of ecosystems:
[…]
(f) maintenance and enhancement of the quality of the environment:
(g) any finite characteristics of natural and physical resources:

As discussed, the monitoring and management regime proposed will ensure that any adverse effects associated with stormwater discharges will be identified and addressed to ensure that stormwater will not significantly degrade the quality of the environment. This management approach will also contribute to maintaining the intrinsic values of ecosystems by monitoring ecosystem health and implementing specific management options if issues attributable to stormwater are identified.

The DCC recognises that the CMA and especially the Otago Harbour has a limit to its ability to assimilate contaminants. By closely monitoring the receiving environment the DCC can ensure that these limits are not exceeded as the result of stormwater discharges.

This management regime sits alongside the pro-active measures the DCC are undertaking to improve the quality of discharges to the CMA. As issues are prioritised in the ICMPs, stormwater management actions are included in the action plan and funds are allocated. While independent of any consent condition compliance, these actions contribute to preserving the intrinsic values of ecosystems and the enhancement the quality of the environment while recognising the limitations of the coast to assimilate contaminants.

8.5.3 Section 8

Section 8 of the RMA states that the principles of the Treaty of Waitangi must be taken into account when addressing matters under the RMA. As discussed above, takata whenua have been involved in this consent application process and have provided input in the form of a cultural impact assessment for the previous application to discharge stormwater and through consultation undertaken for this application.

8.5.4 Section 5

Section 5 contains the purpose and principles of the RMA which are:

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> 5 Purpose
>
> (1) The purpose of this Act is to promote the sustainable management of natural and physical resources.
>
> (2) In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while—
>
> (a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
>
> (b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
>
> (c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.

An effective stormwater network including appropriate discharge locations is essential to any urban area. By discharging stormwater to the CMA, the DCC is providing a safer, healthier environment for the people of Dunedin to live, work, socialise and undertake recreation activities at a reasonable cost.

The development of ICMPs for stormwater management has provided DCC with the opportunity to manage stormwater quantity and quality in parallel – the resulting recommendations in each ICMP include actions to better manage the effects of flooding, as well as prioritised studies and management actions to improve the quality of the stormwater discharged to the harbour. These recommendations become commitments via the annual planning and Long Term Planning process that the council follows.

In this way, the proposed stormwater monitoring and catchment based management regime will ensure that through providing for the wellbeing, health and safety of the current population of Dunedin, the city is also working to avoid, remedy or mitigate any adverse effects associated with discharges from the Dunedin City stormwater network,

Therefore, in line with strategic objectives embraced by DCC, successful outcomes from the stormwater management process will help to ensure that the coastal environment will not be compromised for future generations.

9

Proposed Resource Consent Conditions

9.1 Discharge of stormwater into the coastal marine area.

9.1.1 Upper Harbour Basin

General

The discharge will be stormwater from the Ravensborne Road; Halsey Street; Mason Street; Kitchener Street; Orari Street; Portsmouth Drive; and South Dunedin catchments to the Upper Otago Harbour Basin and will include stormwater from sites that have industrial land uses.

As far as is practicable the consent holder will ensure that the stormwater system, including outlet structures, are maintained in a safe and effective operating condition.

Trigger Values

HARBOUR WATER QUALITY

Harbour water quality trigger values outside of a reasonable mixing zone shall be set within the Monitoring Framework.

HARBOUR SEDIMENT QUALITY

Harbour sediment quality trigger values shall be set within the Monitoring Framework.

Sampling and Monitoring

HARBOUR WATER QUALITY MONITORING (ONGOING)

Annual harbour water quality monitoring shall be undertaken for the purposes of determining the effect if any, that the authorised stormwater discharge has on the water quality of the Otago Harbour and to determine whether the trigger values outlined in the Monitoring Framework are exceeded. Harbour water quality sampling shall be undertaken in accordance with Section [7.1] of the Monitoring Framework.

Samples shall be analysed by a qualified laboratory using IANZ accredited or other comparable accredited methods.

If harbour water quality sampling identifies [contaminants listed in Monitoring Framework] at a level exceeding the trigger values outlined in the Monitoring Framework, the level of contamination shall be confirmed by [insert trigger value exceedence confirmation method from Monitoring Framework].

If the harbour water quality is confirmed as exceeding the trigger values outlined in the Monitoring Framework, the protocol outlined in Condition [stormwater management protocol] shall be implemented.

HARBOUR SEDIMENT QUALITY MONITORING

Annual harbour sediment monitoring shall be undertaken for the purposes of determining the characteristics and rate of deposition of the suspended sediment settling on the bed of the Otago Harbour and to determine compliance with the trigger value set in the Monitoring Framework. Harbour

sediment quality monitoring shall be undertaken in accordance with Section [Discharge consent monitoring] of the Monitoring Framework.

Sediment samples shall be analysed by a qualified laboratory using IANZ accredited or other comparable accredited methods.

If harbour sediment sampling in two consecutive annual sampling cycles identifies [contaminants listed in Monitoring Framework] at a level exceeding the trigger values outlined in the Monitoring Framework, then the protocol outlined in Condition [stormwater management protocol] shall be implemented.

ECOLOGICAL HEALTH MONITORING

Annual ecological health monitoring will be undertaken in accordance with Section [Discharge consent monitoring] of the Monitoring Framework for the purposes of quantifying long term trends in ecological health.

Stormwater Management

STORMWATER MANAGEMENT PROTOCOL

This protocol is to be implemented should the harbour water quality or sediment quality trigger values identified in the Monitoring Framework be confirmed as exceeded utilising the method described in Section [??] of the Monitoring Framework. The stormwater management protocol is as follows:

a) An investigation will be undertaken by the consent holder as to the likely source of the contaminant(s) that caused the exceedence of the harbour water quality or sediment quality trigger values identified in the Monitoring Framework. A report will be prepared by the consent holder and provided to the Otago Regional Council outlining the likely source of the contaminants and describing the stormwater contamination issue.
b) If the report referred to in Condition [stormwater management protocol a)] concludes that contaminants present in the samples are attributable to the stormwater discharge authorised by this consent, then the consent holder shall implement clauses c) through h) of this protocol. If the report referred to in Condition [stormwater management protocol a)] concludes that contaminants identified in the samples are not attributable to the stormwater discharge authorised by this consent then no further action is required by the consent holder in relation to the identified exceedence of the trigger values outlined in the Monitoring Framework.
c) The stormwater contamination issue identified in accordance with Condition [stormwater management protocol a)] shall be given a priority rating and included within the relevant ICMP under the section titled ‘Issues Prioritisation’;
d) The relevant ICMP will be revised to prioritise the stormwater issue and include stormwater management options relevant to the contaminant(s) present. Management option(s) will be implemented as prioritised within the ICMP and may include but not be limited to: the installation of stormwater treatment measures;
e) Stormwater monitoring will be undertaken in the relevant catchment or catchments once management option(s) have been applied for the purposes of determining the performance of the management option(s);
f) The monitoring undertaken in accordance with Condition [stormwater management protocol e)] shall be analysed by a qualified laboratory using IANZ accredited or other comparable accredited

methods to determine whether the contaminant levels identified as exceeding the trigger values outlined in the Monitoring Framework are reducing within the stormwater discharge as the result of the stormwater management option(s) employed. The results of this analysis will be presented in a report and provided to the ORC within [XX] working days of the samples being taken;

g) If the monitoring undertaken in accordance with Condition [stormwater management protocol e)] shows no reduction in the level of contaminant(s) that exceeded the trigger values outlined in the Monitoring Framework, the ICMP will be reviewed to describe further management options. The consent holder shall then undertake the actions described in Condition [stormwater management protocol c) through h)].

h) If the monitoring undertaken in accordance with Condition [stormwater management protocol e)] shows a reduction in the level of contaminant(s) that exceeded the trigger values outlined in the Monitoring Framework, no further action is required to be undertaken by the consent holder.

MONITORING FRAMEWORK

a) The consent holder shall have a Monitoring Framework in place at all times that is certified by the Otago Regional Council as containing appropriate harbour water quality and sediment quality trigger values and is appropriate as a method of monitoring the receiving environment to identify any potential effects associated with the stormwater discharges authorised by this consent.

b) The consent holder may revise the Monitoring Framework at any time. These revisions may include but are not limited to: changes in water quality trigger values and changes in water quality and sediment quality sampling locations.

c) Prior to the implementation of any revised Monitoring Framework by the consent holder, the revised Monitoring Framework shall be certified by the Otago Regional Council as containing appropriate harbour water quality and sediment quality trigger values and is appropriate as a method of monitoring the receiving environment to identify any potential effects associated with the stormwater discharges authorised by this consent.

d) The Otago Regional Council shall provide written certification, or if certification is not being provided written communication to the consent holder listing and explaining the reasons why certification has not been provided, within 20 working days from submission of the revised Monitoring Framework.

DISPUTE RESOLUTION

a) If a dispute arises between the consent holder and the Otago Regional Council in relation to the conclusions drawn in the reports required by Condition [Stormwater management protocol a) and f)], a third party determined by both the consent holder and the Otago Regional Council as being independent, appropriately qualified and experienced, will undertake a review of the report. This third party will make a determination on the appropriateness of the conclusions drawn in the report within a timeframe as agreed by the consent holder and the Otago Regional Council.

b) If a dispute arises between the consent holder and the Otago Regional Council in relation to revisions to the Monitoring Framework, a third party determined by both the consent holder and the Otago Regional Council as being independent, appropriately qualified and

experienced, will undertake a review of the revised Monitoring Framework. This third party will make a determination on the appropriateness of the revised Monitoring Framework within a timeframe as agreed by the consent holder and the Otago Regional Council.

CHANGES TO MONITORING REGIME

Water quality

If sampling and subsequent analysis undertaken in accordance with Condition [harbour water quality (ongoing)] show no exceedence of the trigger value outlined in the Monitoring Framework for a sequential three year period, the sampling frequency may be reduced to one sampling round every two years. If no exceedence of the trigger value occurs within the subsequent four year period (two sampling rounds) the harbour water quality sampling may be reduced to one sampling round every three years.

Sediment quality

If sampling and subsequent analysis undertaken in accordance with Condition [harbour sediment quality] show no exceedence of the trigger value outlined in the Monitoring Framework for a sequential three year period, the sampling frequency may be reduced to one sampling round every two years. If no exceedence of the trigger value occurs within the subsequent four year period (two sampling rounds) the harbour sediment quality sampling may be reduced to one sampling round every three years.

Emergency Procedures

In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the DCC Water and Waste Services Business Unit Pollution Emergency Procedures.

Integrated Catchment Management Plans

The consent holder shall, at all times, have in place and maintain an integrated catchment management plan (ICMP) for the following stormwater catchments:

- Ravensborne Road;
- Halsey Street;
- Mason Street;
- Kitchener Street;
- Orari Street;
- Portsmouth Drive; and
- South Dunedin.

Reporting

The consent holder shall produce an annual report and submit this to the Otago Regional Council by [insert date] each year. This report shall include but not be limited to:

a) The results of harbour sediment, harbour water quality and ecological health monitoring;

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b) Details of any exceedences of harbour water quality or harbour sediment quality trigger values;
c) Details of any stormwater issues included within an ICMP that year including the relative priority ranking of that issue;
d) Details of any stormwater management options implemented;
e) The results of any monitoring undertaken to measure the performance of any stormwater management options implemented;
f) Minutes of meetings held with [stakeholders];

Stakeholder meeting

The consent holder shall hold an annual meeting with [stakeholders] and shall report and comment on any monitoring results.

Review

The consent authority may, in accordance with sections 128 and 129 of the Resource Management Act 1991 serve notice of its intention to review the conditions of this resource consent within two months of the anniversary of the granting of this consent:

a) to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage; or
b) to adopt the best practicable option to remove or reduce any adverse effect on the environment; or
c) when a regional plan has been made operative which sets rules relating to minimum standards of water quality and it is appropriate to review the conditions of the permit in order to enable the standards set by the rule to be met; or
d) when relevant national environmental standards have been made.

9.1.2 Andersons Bay Inlet

General

The discharge will be stormwater from the Shore Street catchment to Andersons Bay Inlet and will include stormwater from sites that have industrial land uses.

As far as is practicable the consent holder will ensure that the stormwater system, including outlet structures, are maintained in a safe and effective operating condition.

Trigger Values

HARBOUR WATER QUALITY

Harbour water quality trigger values outside of a reasonable mixing zone shall be set within the Monitoring Framework .

HARBOUR SEDIMENT QUALITY

Harbour sediment quality trigger values shall be set within the Monitoring Framework.

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Sampling and Monitoring

HARBOUR WATER QUALITY MONITORING (ONGOING)

Annual harbour water quality monitoring shall be undertaken for the purposes of determining the effect, if any, that the authorised stormwater discharge has on the water quality of the Otago Harbour and to determine whether the trigger values outlined in the Monitoring Framework are exceeded. Harbour water quality sampling shall be undertaken in accordance with Section [7.1] of the Monitoring Framework.

Samples shall be analysed by a qualified laboratory using IANZ accredited or other comparable accredited methods.

If harbour water quality sampling identifies [contaminants listed in Monitoring Framework] at a level exceeding the trigger values outlined in the Monitoring Framework, the level of contamination shall be confirmed by [insert trigger value exceedence confirmation method from Monitoring Framework].

If the harbour water quality is confirmed as exceeding the trigger values outlined in the Monitoring Framework, the protocol outlined in Condition [stormwater management protocol] shall be implemented.

HARBOUR SEDIMENT QUALITY MONITORING

Annual harbour sediment monitoring shall be undertaken for the purposes of determining the characteristics and rate of deposition of the suspended sediment settling on the bed of the Otago Harbour and to determine compliance with the trigger value set in the Monitoring Framework. Harbour sediment quality monitoring shall be undertaken in accordance with Section [Discharge consent monitoring] of the Monitoring Framework.

Sediment samples shall be analysed by a qualified laboratory using IANZ accredited or other comparable accredited methods.

If harbour sediment sampling in two consecutive annual sampling cycles identifies [contaminants listed in Monitoring Framework] at a level exceeding the trigger values outlined in the Monitoring Framework, then the protocol outlined in Condition [stormwater management protocol] shall be implemented.

ECOLOGICAL HEALTH MONITORING

Annual ecological health monitoring will be undertaken in accordance with Section [Discharge consent monitoring] of the Monitoring Framework for the purposes of quantifying long term trends in ecological health.

Stormwater Management

STORMWATER MANAGEMENT PROTOCOL

This protocol is to be implemented should the harbour water quality or sediment quality trigger values identified in the Monitoring Framework be confirmed as exceeded utilising the method described in Section [??] of the Monitoring Framework. The stormwater management protocol is as follows:

9 Proposed Resource Consent Conditions

a) An investigation will be undertaken by the consent holder as to the likely source of the contaminant(s) that caused the exceedence of the harbour water quality or sediment quality trigger values identified in the Monitoring Framework. A report will be prepared by the consent holder and provided to the Otago Regional Council outlining the likely source of the contaminants and describing the stormwater contamination issue.
b) If the report referred to in Condition [stormwater management protocol a)] concludes that contaminants present in the samples are attributable to the stormwater discharge authorised by this consent, then the consent holder shall implement clauses c) through h) of this protocol. If the report referred to in Condition [stormwater management protocol a)] concludes that contaminants identified in the samples are not attributable to the stormwater discharge authorised by this consent then no further action is required by the consent holder in relation to the identified exceedence of the trigger values outlined in the Monitoring Framework.
c) The stormwater contamination issue identified in accordance with Condition [stormwater management protocol a)] shall be given a priority rating and included within the relevant ICMP under the section titled 'Issues Prioritisation';
d) The relevant ICMP will be revised to prioritise the stormwater issue and include stormwater management options relevant to the contaminant(s) present. Management option(s) will be implemented as prioritised within the ICMP and may include but not be limited to: the installation of stormwater treatment measures;
e) Stormwater monitoring will be undertaken in the relevant catchment or catchments once management option(s) have been applied for the purposes of determining the performance of the management option(s);
f) The monitoring undertaken in accordance with Condition [stormwater management protocol e)] shall be analysed by a qualified laboratory using IANZ accredited or other comparable accredited methods to determine whether the contaminant levels identified as exceeding the trigger values outlined in the Monitoring Framework are reducing within the stormwater discharge as the result of the stormwater management option(s) employed. The results of this analysis will be presented in a report and provided to the ORC within [XX] working days of the samples being taken;
g) If the monitoring undertaken in accordance with Condition [stormwater management protocol e)] shows no reduction in the level of contaminant(s) that exceeded the trigger values outlined in the Monitoring Framework, the ICMP will be reviewed to describe further management options. The consent holder shall then undertake the actions described in Condition [stormwater management protocol c) through h)].
h) If the monitoring undertaken in accordance with Condition [stormwater management protocol e)] shows a reduction in the level of contaminant(s) that exceeded the trigger values outlined in the Monitoring Framework, no further action is required to be undertaken by the consent holder.

MONITORING FRAMEWORK

a) The consent holder shall have a Monitoring Framework in place at all times that is certified by the Otago Regional Council as containing appropriate harbour water quality and sediment quality trigger values and is appropriate as a method of monitoring the receiving environment to identify any potential effects associated with the stormwater discharges authorised by this consent.

b) The consent holder may revise the Monitoring Framework at any time. These revisions may include but are not limited to: changes in water quality trigger values and changes in water quality and sediment quality sampling locations.

c) Prior to the implementation of any revised Monitoring Framework by the consent holder, the revised Monitoring Framework shall be certified by the Otago Regional Council as containing appropriate harbour water quality and sediment quality trigger values and is appropriate as a method of monitoring the receiving environment to identify any potential effects associated with the stormwater discharges authorised by this consent.

d) The Otago Regional Council shall provide written certification, or if certification is not being provided written communication to the consent holder listing and explaining the reasons why certification has not been provided, within 20 working days from submission of the revised Monitoring Framework.

DISPUTE RESOLUTION

a) If a dispute arises between the consent holder and the Otago Regional Council in relation to the conclusions drawn in the reports required by Condition [Stormwater management protocol a) and f)], a third party determined by both the consent holder and the Otago Regional Council as being independent, appropriately qualified and experienced, will undertake a review of the report. This third party will make a determination on the appropriateness of the conclusions drawn in the report within a timeframe as agreed by the consent holder and the Otago Regional Council.

b) If a dispute arises between the consent holder and the Otago Regional Council in relation to revisions to the Monitoring Framework, a third party determined by both the consent holder and the Otago Regional Council as being independent, appropriately qualified and experienced, will undertake a review of the revised Monitoring Framework. This third party will make a determination on the appropriateness of the revised Monitoring Framework within a timeframe as agreed by the consent holder and the Otago Regional Council.

CHANGES TO MONITORING REGIME

Water quality

If sampling and subsequent analysis undertaken in accordance with Condition [harbour water quality (ongoing)] show no exceedence of the trigger value outlined in the Monitoring Framework for a sequential three year period, the sampling frequency may be reduced to one sampling round every two years. If no exceedence of the trigger value occurs within the subsequent four year period (two sampling rounds) the harbour water quality sampling may be reduced to one sampling round every three years.

Sediment quality

If sampling and subsequent analysis undertaken in accordance with Condition [harbour sediment quality] show no exceedence of the trigger value outlined in the Monitoring Framework for a sequential three year period, the sampling frequency may be reduced to one sampling round every two years. If no exceedence of the trigger value occurs within the subsequent four year period (two sampling rounds) the harbour sediment quality sampling may be reduced to one sampling round every three years.

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Emergency Procedures

In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the DCC Water and Waste Services Business Unit Pollution Emergency Procedures.

Integrated Catchment Management Plans

The consent holder shall, at all times, have in place and maintain an integrated catchment management plan (ICMP) for the Shore Street catchment.

Reporting

The consent holder shall produce an annual report and submit this to the Otago Regional Council by [insert date] each year. This report shall include but not be limited to:

a) The results of harbour sediment, harbour water quality and ecological health monitoring;
b) Details of any exceedences of harbour water quality or harbour sediment quality trigger values;
c) Details of any stormwater issues included within an ICMP that year including the relative priority ranking of that issue;
d) Details of any stormwater management options implemented;
e) The results of any monitoring undertaken to measure the performance of any stormwater management options implemented;
f) Minutes of meetings held with [stakeholders];

Stakeholder meeting

The consent holder shall hold an annual meeting with [Stakeholders] and shall report and comment on any monitoring results.

Review

The consent authority may, in accordance with sections 128 and 129 of the Resource Management Act 1991 serve notice of its intention to review the conditions of this resource consent within two months of the anniversary of the granting of this consent:

a) to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage; or
b) to adopt the best practicable option to remove or reduce any adverse effect on the environment; or
c) when a regional plan has been made operative which sets rules relating to minimum standards of water quality and it is appropriate to review the conditions of the permit in order to enable the standards set by the rule to be met; or
d) when relevant national environmental standards have been made.

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9.1.3 Port Chalmers

General

The discharge will be stormwater from the Port Chalmers catchment to the Otago Harbour at Port Chalmers and will include stormwater from sites that have industrial land uses.

As far as is practicable the consent holder will ensure that the stormwater system, including outlet structures, are maintained in a safe and effective operating condition.

Trigger Values

HARBOUR WATER QUALITY

Harbour water quality trigger values outside of a reasonable mixing zone shall be set within the Monitoring Framework .

HARBOUR SEDIMENT QUALITY

Harbour sediment quality trigger values shall be set within the Monitoring Framework.

Sampling and Monitoring

HARBOUR WATER QUALITY MONITORING (ONGOING)

Annual harbour water quality monitoring shall be undertaken for the purposes of determining the effect, if any, that the authorised stormwater discharge has on the water quality of the Otago Harbour and to determine whether the trigger values outlined in the Monitoring Framework are exceeded. Harbour water quality sampling shall be undertaken in accordance with Section [7.1] of the Monitoring Framework.

Samples shall be analysed by a qualified laboratory using IANZ accredited or other comparable accredited methods.

If harbour water quality sampling identifies [contaminants listed in Monitoring Framework] at a level exceeding the trigger values outlined in the Monitoring Framework, the level of contamination shall be confirmed by [insert trigger value exceedence confirmation method from Monitoring Framework].

If the harbour water quality is confirmed as exceeding the trigger values outlined in the Monitoring Framework, the protocol outlined in Condition [stormwater management protocol] shall be implemented.

HARBOUR SEDIMENT QUALITY MONITORING

Annual harbour sediment monitoring shall be undertaken for the purposes of determining the characteristics and rate of deposition of the suspended sediment settling on the bed of the Otago Harbour and to determine compliance with the trigger value set in the Monitoring Framework. Harbour sediment quality monitoring shall be undertaken in accordance with Section [Discharge consent monitoring] of the Monitoring Framework.

Sediment samples shall be analysed by a qualified laboratory using IANZ accredited or other comparable accredited methods.

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If harbour sediment sampling in two consecutive annual sampling cycles identifies [contaminants listed in Monitoring Framework] at a level exceeding the trigger values outlined in the Monitoring Framework, then the protocol outlined in Condition [stormwater management protocol] shall be implemented.

ECOLOGICAL HEALTH MONITORING

Annual ecological health monitoring will be undertaken in accordance with Section [Discharge consent monitoring] of the Monitoring Framework for the purposes of quantifying long term trends in ecological health.

Stormwater Management

STORMWATER MANAGEMENT PROTOCOL

This protocol is to be implemented should the harbour water quality or sediment quality trigger values identified in the Monitoring Framework be confirmed as exceeded utilising the method described in Section [??] of the Monitoring Framework. The stormwater management protocol is as follows:

a) An investigation will be undertaken by the consent holder as to the likely source of the contaminant(s) that caused the exceedence of the harbour water quality or sediment quality trigger values identified in the Monitoring Framework. A report will be prepared by the consent holder and provided to the Otago Regional Council outlining the likely source of the contaminants and describing the stormwater contamination issue.
b) If the report referred to in Condition [stormwater management protocol a)] concludes that contaminants present in the samples are attributable to the stormwater discharge authorised by this consent, then the consent holder shall implement clauses c) through h) of this protocol. If the report referred to in Condition [stormwater management protocol a)] concludes that contaminants identified in the samples are not attributable to the stormwater discharge authorised by this consent then no further action is required by the consent holder in relation to the identified exceedence of the trigger values outlined in the Monitoring Framework.
c) The stormwater contamination issue identified in accordance with Condition [stormwater management protocol a)] shall be given a priority rating and included within the relevant ICMP under the section titled 'Issues Prioritisation';
d) The relevant ICMP will be revised to prioritise the stormwater issue and include stormwater management options relevant to the contaminant(s) present. Management option(s) will be implemented as prioritised within the ICMP and may include but not be limited to: the installation of stormwater treatment measures;
e) Stormwater monitoring will be undertaken in the relevant catchment or catchments once management option(s) have been applied for the purposes of determining the performance of the management option(s);
f) The monitoring undertaken in accordance with Condition [stormwater management protocol e)] shall be analysed by a qualified laboratory using IANZ accredited or other comparable accredited methods to determine whether the contaminant levels identified as exceeding the trigger values outlined in the Monitoring Framework are reducing within the stormwater discharge as the result of the stormwater management option(s) employed. The results of this analysis will be presented in a report and provided to the ORC within [XX] working days of the samples being taken;

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g) If the monitoring undertaken in accordance with Condition [stormwater management protocol e)] shows no reduction in the level of contaminant(s) that exceeded the trigger values outlined in the Monitoring Framework, the ICMP will be reviewed to describe further management options. The consent holder shall then undertake the actions described in Condition [stormwater management protocol c) through h)].

h) If the monitoring undertaken in accordance with Condition [stormwater management protocol e)] shows a reduction in the level of contaminant(s) that exceeded the trigger values outlined in the Monitoring Framework, no further action is required to be undertaken by the consent holder.

MONITORING FRAMEWORK

a) The consent holder shall have a Monitoring Framework in place at all times that is certified by the Otago Regional Council as containing appropriate harbour water quality and sediment quality trigger values and is appropriate as a method of monitoring the receiving environment to identify any potential effects associated with the stormwater discharges authorised by this consent.

b) The consent holder may revise the Monitoring Framework at any time. These revisions may include but are not limited to: changes in water quality trigger values and changes in water quality and sediment quality sampling locations.

c) Prior to the implementation of any revised Monitoring Framework by the consent holder, the revised Monitoring Framework shall be certified by the Otago Regional Council as containing appropriate harbour water quality and sediment quality trigger values and is appropriate as a method of monitoring the receiving environment to identify any potential effects associated with the stormwater discharges authorised by this consent.

d) The Otago Regional Council shall provide written certification, or if certification is not being provided written communication to the consent holder listing and explaining the reasons why certification has not been provided, within 20 working days from submission of the revised Monitoring Framework.

DISPUTE RESOLUTION

a) If a dispute arises between the consent holder and the Otago Regional Council in relation to the conclusions drawn in the reports required by Condition [Stormwater management protocol a) and f)], a third party determined by both the consent holder and the Otago Regional Council as being independent, appropriately qualified and experienced, will undertake a review of the report. This third party will make a determination on the appropriateness of the conclusions drawn in the report within a timeframe as agreed by the consent holder and the Otago Regional Council.

b) If a dispute arises between the consent holder and the Otago Regional Council in relation to revisions to the Monitoring Framework, a third party determined by both the consent holder and the Otago Regional Council as being independent, appropriately qualified and experienced, will undertake a review of the revised Monitoring Framework. This third party will make a determination on the appropriateness of the revised Monitoring Framework within a timeframe as agreed by the consent holder and the Otago Regional Council.

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CHANGES TO MONITORING REGIME

Water quality

If sampling and subsequent analysis undertaken in accordance with Condition [harbour water quality (ongoing)] show no exceedence of the trigger value outlined in the Monitoring Framework for a sequential three year period, the sampling frequency may be reduced to one sampling round every two years. If no exceedence of the trigger value occurs within the subsequent four year period (two sampling rounds) the harbour water quality sampling may be reduced to one sampling round every three years.

Sediment quality

If sampling and subsequent analysis undertaken in accordance with Condition [harbour sediment quality] show no exceedence of the trigger value outlined in the Monitoring Framework for a sequential three year period, the sampling frequency may be reduced to one sampling round every two years. If no exceedence of the trigger value occurs within the subsequent four year period (two sampling rounds) the harbour sediment quality sampling may be reduced to one sampling round every three years.

Emergency Procedures

In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the DCC Water and Waste Services Business Unit Pollution Emergency Procedures.

Integrated Catchment Management Plans

The consent holder shall, at all times, have in place and maintain an integrated catchment management plan (ICMP) for the Port Chalmers stormwater catchment.

Reporting

The consent holder shall produce an annual report and submit this to the Otago Regional Council by [insert date] each year. This report shall include but not be limited to:

a) The results of harbour sediment, harbour water quality and ecological health monitoring;
b) Details of any exceedences of harbour water quality or harbour sediment quality trigger values;
c) Details of any stormwater issues included within an ICMP that year including the relative priority ranking of that issue;
d) Details of any stormwater management options implemented;
e) The results of any monitoring undertaken to measure the performance of any stormwater management options implemented;
f) Minutes of meetings held with [stakeholders];

Stakeholder meeting

The consent holder shall hold an annual meeting with [Stakeholders] and shall report and comment on any monitoring results.

9 Proposed Resource Consent Conditions

Review

The consent authority may, in accordance with sections 128 and 129 of the Resource Management Act 1991 serve notice of its intention to review the conditions of this resource consent within two months of the anniversary of the granting of this consent:

a) to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage; or
b) to adopt the best practicable option to remove or reduce any adverse effect on the environment; or
c) when a regional plan has been made operative which sets rules relating to minimum standards of water quality and it is appropriate to review the conditions of the permit in order to enable the standards set by the rule to be met; or
d) when relevant national environmental standards have been made.

9.1.4 St Clair / Second Beach

General

The discharge will be stormwater from the St Clair catchment to the Pacific Ocean at St Clair and Second Beach.

As far as is practicable the consent holder will ensure that the stormwater system, including outlet structures, are maintained in a safe and effective operating condition.

Stormwater Management

Stormwater contamination issues will be managed in general accordance with the St Clair stormwater catchment ICMP. Should any stormwater quality issues be identified the St Clair stormwater catchment ICMP will be revised to prioritise the issue and include stormwater management options relevant to the contaminant(s) present. Management option(s) will be implemented as prioritised within the ICMP and may include but not be limited to: the installation of stormwater treatment measures.

Stormwater monitoring may be undertaken in the relevant catchment or catchments once management option(s) have been applied for the purposes of determining the performance of the management option(s).

Emergency Procedures

In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the DCC Water and Waste Services Business Unit Pollution Emergency Procedures.

Integrated Catchment Management Plans

The consent holder shall, at all times, have in place and maintain an integrated catchment management plan (ICMP) for the St Clair stormwater catchment.

Reporting

The consent holder shall produce an annual report and submit this to the Otago Regional Council by [insert date] each year. This report shall include but not be limited to:

9 Proposed Resource Consent Conditions

a) Details of any stormwater issues included within an ICMP that year including the relative priority ranking of that issue;
b) Details of any stormwater management options implemented;
c) The results of any monitoring undertaken to measure the performance of any stormwater management options implemented;
d) Minutes of meetings held with [stakeholders];

Stakeholder meeting

The consent holder shall hold an annual meeting with [Stakeholders] and shall report and comment on any monitoring results.

Review

The consent authority may, in accordance with sections 128 and 129 of the Resource Management Act 1991 serve notice of its intention to review the conditions of this resource consent within two months of the anniversary of the granting of this consent:

a) to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage; or
b) to adopt the best practicable option to remove or reduce any adverse effect on the environment; or
c) when a regional plan has been made operative which sets rules relating to minimum standards of water quality and it is appropriate to review the conditions of the permit in order to enable the standards set by the rule to be met; or
d) when relevant national environmental standards have been made.

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Conclusion

Dunedin City's stormwater system is vital for the effective operation of the city and the on-going social and economic wellbeing and health of its residents. The DCC has taken bold steps to actively manage stormwater in a way that places a strong focus on ensuring the values associated with the stormwater receiving environment are maintained. This approach will ensure that the level of information about the quality of water and habitat in the Otago Harbour increases, any adverse effects attributable to stormwater discharges are identified, and management actions are prioritised so as to address these effects.

This stormwater management process provides a practical solution to a complex issue through providing a method to ensure environmental, cultural and recreational values are maintained while ensuring that scarce rate-payer funds are allocated in the most cost effective manner. On this basis the current population of Dunedin will be able to provide for their wellbeing, health and safety while ensuring the coastal environment will not be compromised for future generations.

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Limitations

URS New Zealand Limited (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of the Dunedin City Council and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 15 December 2010.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between January 2011 and 28 May 2012 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

A

Appendix A Current Stormwater Discharge Consents

Consent No: 2002.080

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 330 metres northwest of the Intersection of Shore Street and Musselburgh Rise, Dunedin

Legal description of consent location: Crown Land Seabed pursuant to Foreshore and Seabed Act 2004, currently described as Sec 12 Blk II Andersons Bay SD

Grid reference: NZMS 260 I44:174-763

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

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ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and 2(b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive).

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

verification
ISO9001
Certified

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Shore Street catchment that shall contribute to the efficient and effective management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term Stormwater Catchment Management Plan shall include as a minimum:

   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
   (b) A description of the stormwater network system, and the capacity of the system to meet current and future needs;
   (c) The stormwater management objectives for the catchment including the level of service for the network;
   (d) Identification of stormwater management problems and issues for the catchment;
   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
      (i) Maintenance of the network; and
      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
   (f) Monitoring procedures to assess the plan's effectiveness; and
   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;
   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

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Certified

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

Manager Consents

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Consent No: 2002.081

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Portobello Road, approximately 70 metres west of the Southern end of the Andersons Bay Causeway, Dunedin

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:172-764

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

   (i) pH

   (ii) suspended solids

   (iii) faecal coliforms and *Escherichia coli*

verification
ISO9001
Certified

(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease
(xiii) polycyclic aromatic hydrocarbons

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 14(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xiii) in condition 2(b).

3. (a) The consent holder shall undertake to determine the source and extent of the high levels of polycyclic aromatic hydrocarbons in the historic sediment deposits associated with discharge from the Portobello Road stormwater outlet.

(b) Updates on the progress of the investigation in condition 3(a) shall be provided in writing to the Consent Authority by 1 September each year.

(c) No later than six months prior to the expiry of this consent, the consent holder shall provide a report to the Consent Authority stating the outcomes of the investigation in condition 3(a) and outlining the best practicable option(s) to mitigate the effects of these contaminated sediments.

4. (a) The consent holder shall undertake biological monitoring annually between the months of January to June inclusive. The monitoring shall be undertaken at four sites at the waters edge at low tide; two within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide, and two a minimum of 50 metres of the confluence of the stormwater outlet and the waters edge at low tide.

(b) From the top 20 millimetres at each site, three randomly spaced 5 square metre quadrats shall be sampled at two sites; one within 20 metres of each outfall and one at least 50 metres distant from each outfall. For epifauna within each 5 square metre quadrat, the number of each species shall be recorded in five 0.1 square metre quadrats. For infauna a sediment core shall be taken in three 0.1 square metre quadrats and the number of each species shall be recorded. For macroflora, the percentage cover of each species shall be estimated in three 1.0 square metre quadrats.

(c) Results shall be reported to the Consent Authority in accordance with condition 14(e).

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5. The consent holder shall undertake three replicate samples of the flesh of cockles *(Austrovenus stutchburyi)* annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide. Analysis shall be from a composite sample of at least 200 grams of cockle flesh, and the number and size of cockles used shall be recorded.

   The cockle flesh samples shall be analysed for:

   (a) total copper
   (b) total lead
   (c) total zinc
   (d) total arsenic
   (e) total nickel
   (f) total cadmium
   (g) total chromium
   (h) polycyclic aromatic hydrocarbons
   (i) faecal coliforms

   Dry weight results shall be reported to the Consent Authority in accordance with condition 14(e).

6. The consent holder shall undertake sampling of deceased octopus annually, between the months of January to June inclusive (to align with the autumn die-off of octopus). Where practicable, the digestive gland of the octopus shall be sampled along with the mantle and arm. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The total arm span and weight of each octopus sampled shall be recorded.

   The samples shall be analysed for:

   (a) total copper
   (b) total lead
   (c) total zinc
   (d) total arsenic
   (e) total nickel
   (f) total cadmium
   (g) total chromium
   (h) polycyclic aromatic hydrocarbons

   Dry weight results shall be reported to the Consent Authority in accordance with condition 14(e). Should no deceased octopus be present, the consent holder shall notify the Consent Authority that sampling is unable to be undertaken.

7. The consent holder shall undertake sediment quality sampling using three replicate sediment samples from the top 20 millimetres of sediment that shall be

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Certified

collected at each site as marked on the plans attached as Appendix 1 to this consent. Sampling shall be undertaken:

(a) Annually between January and June at the locations marked by large orange stars; and

(b) Between January and June 2007, and between January and June 2011, at the locations marked by large pink stars. Analysis shall be of all sediment fractions.

The samples shall be analysed for:

(i) total copper
(ii) total lead
(iii) total zinc
(iv) total arsenic
(v) total nickel
(vi) total cadmium
(vii) total chromium
(viii) faecal coliforms and enterococci
(ix) polycyclic aromatic hydrocarbons

Dry weight results shall be reported to the Consent Authority in accordance with condition 14(e).

8. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

9. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

10. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

11. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

12. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the DCC Water and Waste Services Business Unit Pollution Emergency Procedures.

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Management Plans

13. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Portobello Road catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
    (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
    (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
    (c) The stormwater management objectives for the catchment including the level of service for the network;
    (d) Identification of stormwater management problems and issues for the catchment;
    (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
        (i) Maintenance of the network; and
        (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
    (f) Monitoring procedures to assess the plan's effectiveness; and
    (g) A procedure for revising the plan.

Reporting

14. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
    (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
    (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 13(a) above;
    (c) The methods used by the new connections reported in condition 13(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

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(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in conditions 2 to 7 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

15. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

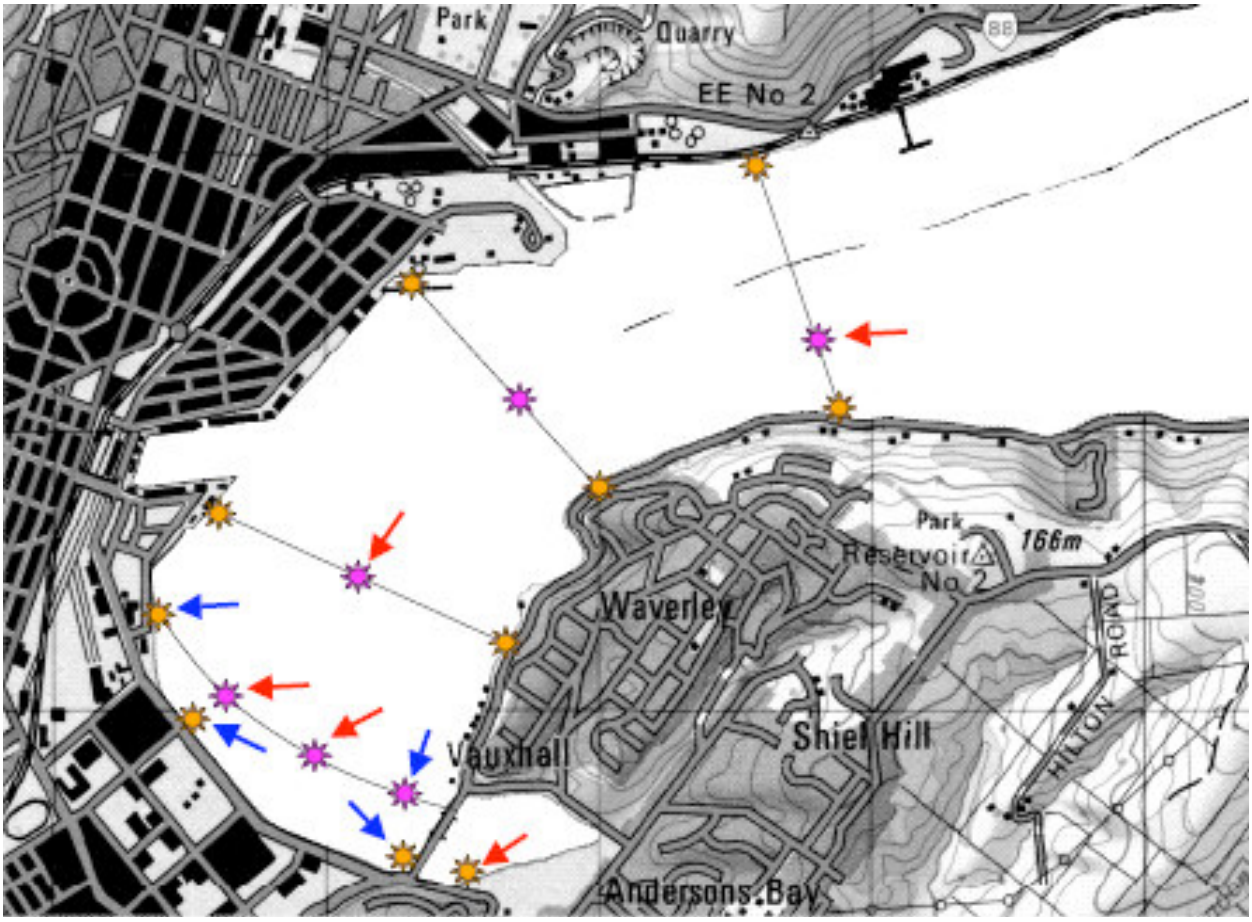
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APPENDIX 1

Upper Otago Harbour Sediment Sampling Sites



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Consent No: 2002.082

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Teviot Street, at its intersection with Portsmouth Drive, Dunedin

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:169-765

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

   (i) pH

   (ii) suspended solids

   (iii) faecal coliforms and *Escherichia coli*

verification
ISO9001
Certified

(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive).

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the DCC Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the foreshore catchment (including Teviot Street) that shall contribute to the effective and efficient management of stormwater in that catchment to minimise

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contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The

Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

(a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

(b) A description of the stormwater network system, capacity of the system to meet current and future needs;

(c) The stormwater management objectives for the catchment including the level of service for the network;

(d) Identification of stormwater management problems and issues for the catchment;

(e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

  (i) Maintenance of the network; and

  (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

  (a) The location and nature of any new subdivisions or industries situated in a greenfields location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

  (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;

  (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

  (d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

  (e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

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ISO9001
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(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.083

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Midland Street, at its intersection with Portsmouth Drive, Dunedin

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:167-767

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

   (i) pH

   (ii) suspended solids

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Certified

(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive).

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the DCC Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the

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foreshore catchment (including Midland Street) that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

(a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

(b) A description of the stormwater network system, capacity of the system to meet current and future needs;

(c) The stormwater management objectives for the catchment including the level of service for the network;

(d) Identification of stormwater management problems and issues for the catchment;

(e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

  (i) Maintenance of the network; and

  (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

(a) The location and nature of any new subdivisions or industries situated in a greenfields location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

(b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;

(c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

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(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.084

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 90 metres northeast of the intersection of Orari Street and Portsmouth Drive, Dunedin

Legal description of consent location: Pt Sec 100 Blk VII Town SD

Grid reference: NZMS 260 I44:165-769

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

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Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease
(xiii) polycyclic aromatic hydrocarbons

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 13(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xiii) in condition 2(b).

3. (a) The consent holder shall undertake biological monitoring annually between the months of January to June inclusive. The monitoring shall be undertaken at four sites at the waters edge at low tide; two within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide and two a minimum of 50 metres of the confluence of the stormwater outlet and the waters edge at low tide.

(b) From the top 20 millimetres at each site, three randomly spaced 5 square metre quadrats shall be sampled at two sites; one within 20 metres of each outfall and one at least 50 metres distant from each outfall. For epifauna within each 5 square metre quadrat, the number of each species shall be recorded in five 0.1 square metre quadrats. For infauna a sediment core shall be taken in three 0.1 square metre quadrats and the number of each species shall be recorded. For macroflora, the percentage cover of each species shall be estimated in three 1.0 square metre quadrats.

(c) Results shall be reported to the Consent Authority in accordance with condition 13(e).

4. The consent holder shall undertake three replicate samples of the flesh of cockles *(Austrovenus stutchburyi)* annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide. Analysis shall be from a composite sample of at least 200 grams of cockle flesh, and the number and size of cockles used shall be recorded.

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The cockle flesh samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
(i) faecal coliforms

Dry weight results shall be reported to the Consent Authority in accordance with condition 13(e).

5. The consent holder shall undertake sampling of deceased octopus annually, between the months of January to June inclusive (to align with the autumn die-off of octopus). Where practicable, the digestive gland of the octopus shall be sampled along with the mantle and arm. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The total arm span and weight of each octopus sampled shall be recorded.

The samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons

Dry weight results shall be reported to the Consent Authority in accordance with condition 14(e). Should no deceased octopus be present, the consent holder shall notify the Consent Authority that sampling is unable to be undertaken.

6. The consent holder shall undertake sediment quality sampling using three replicate sediment samples from the top 20 millimetres of sediment that shall be collected at each site as marked on the plans attached as Appendix 1 to this consent. Sampling shall be undertaken:

(a) Annually between January and June at the locations marked by large orange stars; and

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(b) Between January and June 2007, and between January and June 2011, at the locations marked by large pink stars. Analysis shall be of all sediment fractions.

The samples shall be analysed for:

(i) total copper
(ii) total lead
(iii) total zinc
(iv) total arsenic
(v) total nickel
(vi) total cadmium
(vii) total chromium
(viii) faecal coliforms and enterococci
(ix) polycyclic aromatic hydrocarbons

Dry weight results shall be reported to the Consent Authority in accordance with condition 14(e).

7. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

8. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

9. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

10. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

11. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the DCC Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

12. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this

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ISO9001
Certified

consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Orari Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

(a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

(b) A description of the stormwater network system, capacity of the system to meet current and future needs;

(c) The stormwater management objectives for the catchment including the level of service for the network;

(d) Identification of stormwater management problems and issues for the catchment;

(e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

  (i) Maintenance of the network; and

  (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

13. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

(a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

(b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 12(a) above;

(c) The methods used by the new connections reported in condition 12(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in conditions 2 to 6 of this consent. At minimum this shall include:

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Certified

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

14. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

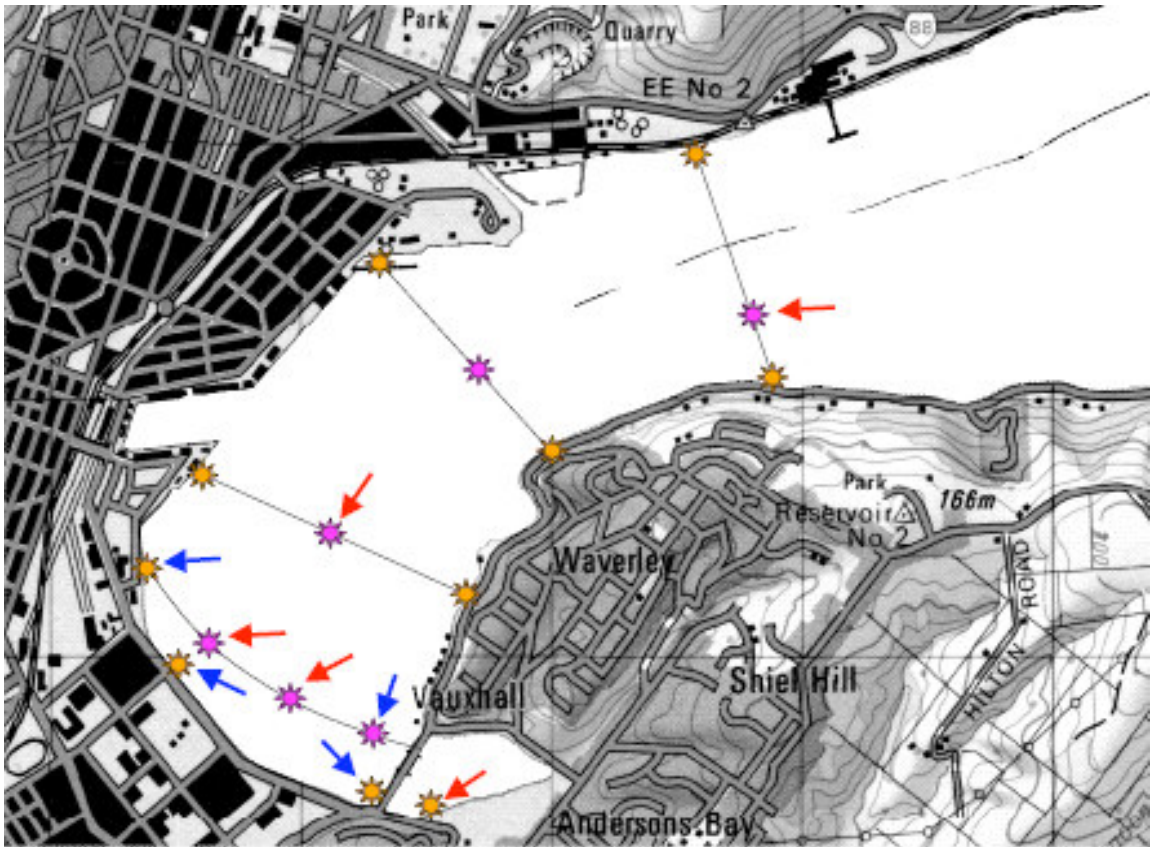
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APPENDIX 1

Upper Otago Harbour Sediment Sampling Sites



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Certified

Consent No: 2002.085

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of consent activity: Approximately 75 metres northeast of the intersection of Orari Street and Portsmouth Drive, Dunedin

Legal description of consent location: Pt Sec 100 Blk VII Town SD

Grid reference: NZMS 260 I44:165-770

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

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(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease
(xiii) polycyclic aromatic hydrocarbons

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 13(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xiii) in condition 2(b).

3. (a) The consent holder shall undertake biological monitoring annually between the months of January to June inclusive. The monitoring shall be undertaken at four sites at the waters edge at low tide; two within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide and two a minimum of 50 metres of the confluence of the stormwater outlet and the waters edge at low tide.

(b) From the top 20 millimetres at each site, three randomly spaced 5 square metre quadrats shall be sampled at two site; one within 20 metres of each outfall and one at least 50 metres distant from each outfall. For epifauna within each 5 square metre quadrat, the number of each species shall be recorded in five 0.1 square metre quadrats. For infauna a sediment core shall be taken in three 0.1 square metre quadrats and the number of each species shall be recorded. For macroflora, the percentage cover of each species shall be estimated in three 1.0 square metre quadrats.

(c) Results shall be reported to the Consent Authority in accordance with condition 13(e).

4. The consent holder shall undertake three replicate samples of the flesh of cockles *(Austrovenus stutchburyi)* annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide. Analysis shall be from a composite sample of at least 200 grams of cockle flesh, and the number and size of cockles used shall be recorded.

verification
ISO9001
Certified

The cockle flesh samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
(i) faecal coliforms

Dry weight results shall be reported to the Consent Authority in accordance with condition 13(e).

5. The consent holder shall undertake sampling of deceased octopus annually, between the months of January to June inclusive (to align with the autumn die-off of octopus). Where practicable, the digestive gland of the octopus shall be sampled along with the mantle and arm. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The total arm span and weight of each octopus sampled shall be recorded.

The samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons

Dry weight results shall be reported to the Consent Authority in accordance with condition 14(e). Should no deceased octopus be present, the consent holder shall notify the Consent Authority that sampling is unable to be undertaken.

6. The consent holder shall undertake sediment quality sampling using three replicate sediment samples from the top 20 millimetres of sediment that shall be collected at each site as marked on the plans attached as Appendix 1 to this consent. Sampling shall be undertaken:

(a) Annually between January and June at the locations marked by large orange stars; and

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ISO9001
Certified

(b) Between January and June 2007, and between January and June 2011, at the locations marked by large pink stars. Analysis shall be of all sediment fractions.

The samples shall be analysed for:

(i) total copper
(ii) total lead
(iii) total zinc
(iv) total arsenic
(v) total nickel
(vi) total cadmium
(vii) total chromium
(viii) faecal coliforms and enterococci
(ix) polycyclic aromatic hydrocarbons

Dry weight results shall be reported to the Consent Authority in accordance with condition 14(e).

7. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

8. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

9. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

10. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

11. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the DCC Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

12. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this

verification
ISO9001
Certified

consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Orari Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

(a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

(b) A description of the stormwater network system, capacity of the system to meet current and future needs;

(c) The stormwater management objectives for the catchment including the level of service for the network;

(d) Identification of stormwater management problems and issues for the catchment;

(e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

  (i) Maintenance of the network; and

  (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

13. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

(a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

(b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 12(a) above;

(c) The methods used by the new connections reported in condition 12(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in conditions 2 to 6 of this consent. At minimum this shall include:

verification
ISO9001
Certified

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

14. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

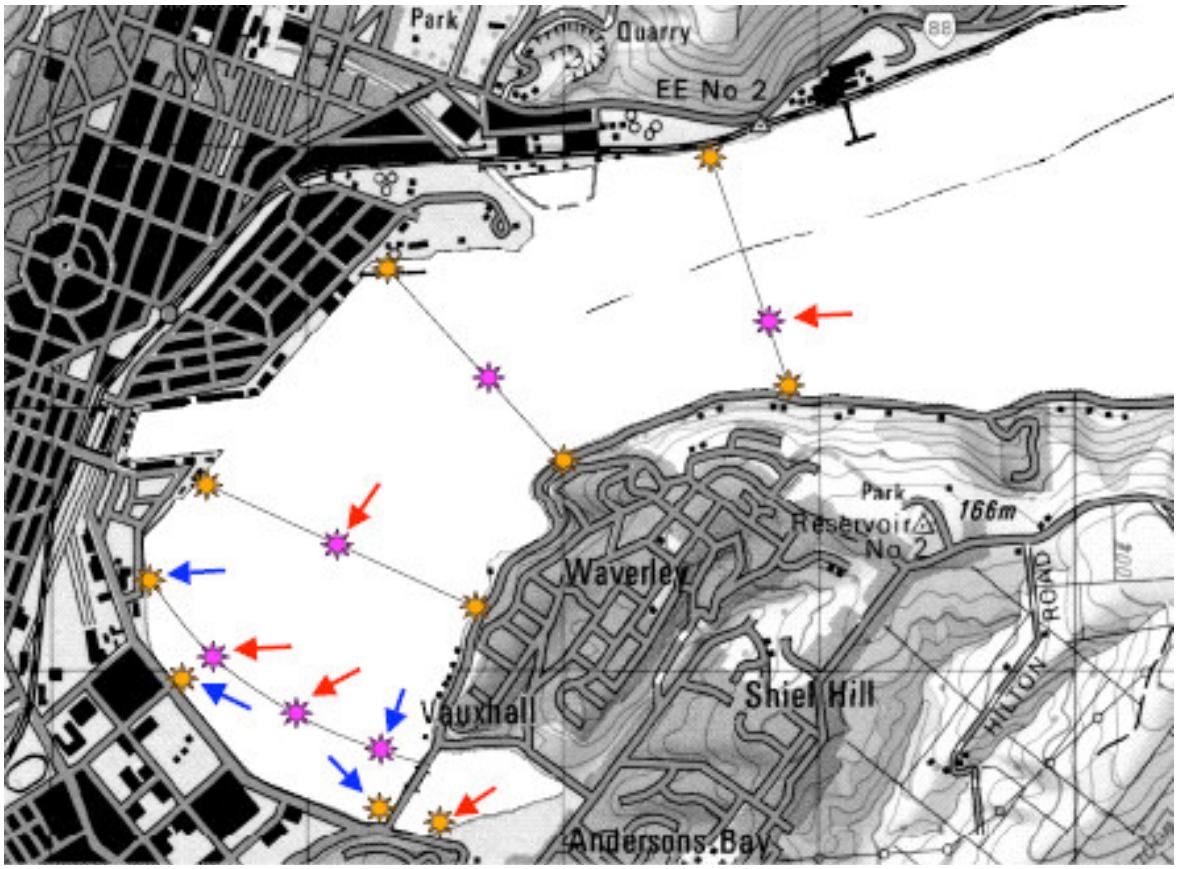
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ISO9001
Certified

APPENDIX 1

Upper Otago Harbour Sediment Sampling Sites



verification
ISO9001
Certified

Consent No: 2002.086

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 170 metres east of the intersection of Kitchener Street and Wharf Street, Dunedin

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:164-773

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

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(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease
(xiii) polycyclic aromatic hydrocarbons

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 12(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xiii) in condition 2(b).

3. (a) The consent holder shall undertake biological monitoring annually between the months of January to June inclusive. The monitoring shall be undertaken at four sites at the waters edge at low tide; two within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide and two a minimum of 50 metres of the confluence of the stormwater outlet and the waters edge at low tide.

(b) From the top 20 millimetres at each site, three randomly spaced 5 square metre quadrats shall be sampled at two sites; one within 20 metres of each outfall and one at least 50 metres distant from each outfall. For epifauna within each 5 square metre quadrat, the number of each species shall be recorded in five 0.1 square metre quadrats. For infauna a sediment core shall be taken in three 0.1 square metre quadrats and the number of each species shall be recorded. For macroflora, the percentage cover of each species shall be estimated in three 1.0 square metre quadrats.

(c) Results shall be reported to the Consent Authority in accordance with condition 12(e).

4. The consent holder shall undertake three replicate samples of the flesh of cockles *(Austrovenus stutchburyi)* annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide. Analysis shall be from a composite sample of at least 200 grams of cockle flesh, and the number and size of cockles used shall be recorded.

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The cockle flesh samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
(i) faecal coliforms

Dry weight results shall be reported to the Consent Authority in accordance with condition 12(e).

5. The consent holder shall undertake sediment quality sampling using three replicate sediment samples from the top 20 millimetres of sediment that shall be collected at each site as marked on the plans attached as Appendix 1 to this consent. Sampling shall be undertaken:

(a) Annually between January and June at the locations marked by large orange stars; and
(b) Between January and June 2007, and between January and June 2011, at the locations marked by large pink stars. Analysis shall be of all sediment fractions.

The samples shall be analysed for:

(i) total copper
(ii) total lead
(iii) total zinc
(iv) total arsenic
(v) total nickel
(vi) total cadmium
(vii) total chromium
(viii) faecal coliforms and enterococci
(ix) polycyclic aromatic hydrocarbons

Dry weight results shall be reported to the Consent Authority in accordance with condition 12(e).

6. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

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ISO9001
Certified

7. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

8. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

9. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

10. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the DCC Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

11. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Kitchener Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
    (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
    (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
    (c) The stormwater management objectives for the catchment including the level of service for the network;
    (d) Identification of stormwater management problems and issues for the catchment;
    (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
        (i) Maintenance of the network; and
        (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant

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control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

12. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

(a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

(b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 11(a) above;

(c) The methods used by the new connections reported in condition 11(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in conditions 2 to 5 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

13. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal

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with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

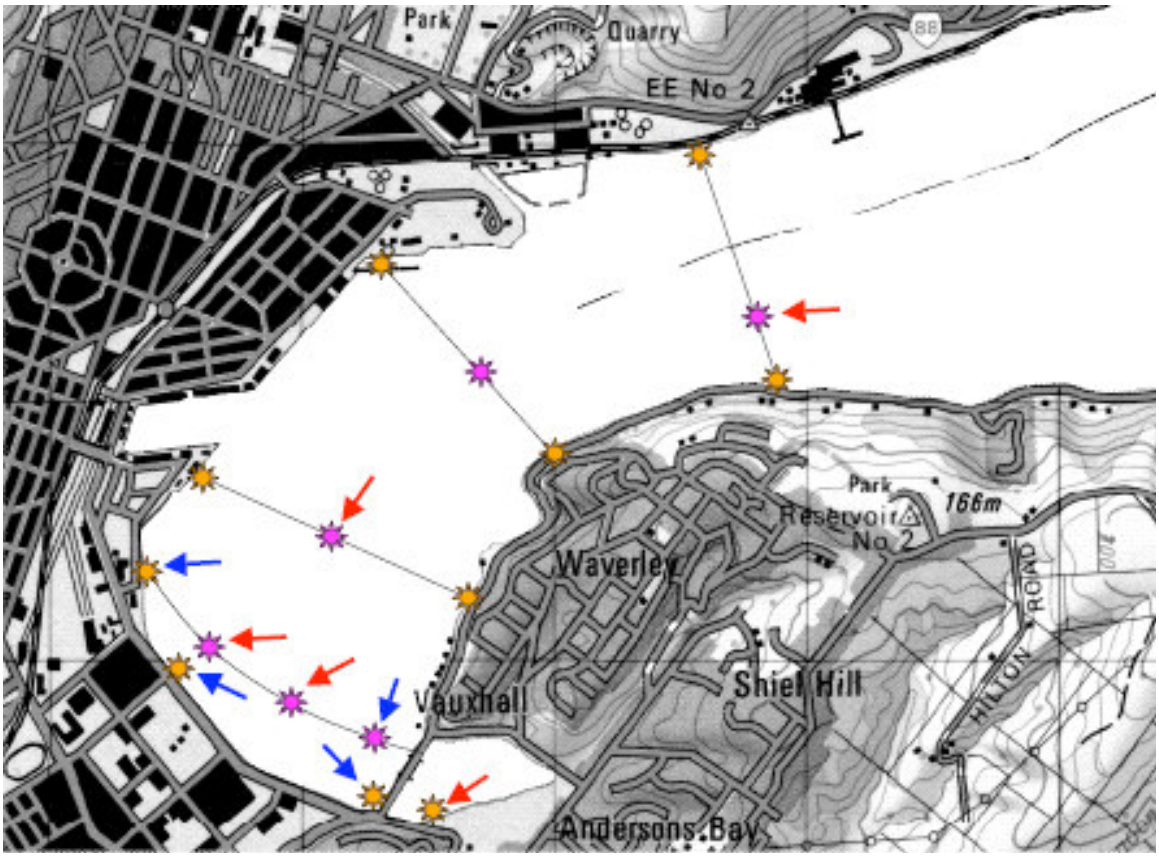
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APPENDIX 1

Upper Otago Harbour Sediment Sampling Sites



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Consent No: 2002.087

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 225 metres northeast of the intersection of Kitchener Street and Wharf Street, Dunedin

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:164-774

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

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(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease
(xiii) polycyclic aromatic hydrocarbons

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 12(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xiii) in condition 2(b).

3. (a) The consent holder shall undertake biological monitoring annually between the months of January to June inclusive. The monitoring shall be undertaken at four sites at the waters edge at low tide; two within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide and two a minimum of 50 metres of the confluence of the stormwater outlet and the waters edge at low tide.

(b) From the top 20 millimetres at each site, three randomly spaced 5 square metre quadrats shall be sampled at two sites; one within 20 metres of each outfall and one at least 50 metres distant from each outfall. For epifauna within each 5 square metre quadrat, the number of each species shall be recorded in five 0.1 square metre quadrats. For infauna a sediment core shall be taken in three 0.1 square metre quadrats and the number of each species shall be recorded. For macroflora, the percentage cover of each species shall be estimated in three 1.0 square metre quadrats.

(c) Results shall be reported to the Consent Authority in accordance with condition 12(e).

4. The consent holder shall undertake three replicate samples of the flesh of cockles *(Austrovenus stutchburyi)* annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide. Analysis shall be from a composite sample of at least 200 grams of cockle flesh, and the number and size of cockles used shall be recorded.

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The cockle flesh samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
(i) faecal coliforms

Dry weight results shall be reported to the Consent Authority in accordance with condition 12(e).

5. The consent holder shall undertake sediment quality sampling using three replicate sediment samples from the top 20 millimetres of sediment that shall be collected at each site as marked on the plans attached as Appendix 1 to this consent. Sampling shall be undertaken:

(a) Annually between January and June at the locations marked by large orange stars; and
(b) Between January and June 2007, and between January and June 2011, at the locations marked by large pink stars. Analysis shall be of all sediment fractions.

The samples shall be analysed for:

(i) total copper
(ii) total lead
(iii) total zinc
(iv) total arsenic
(v) total nickel
(vi) total cadmium
(vii) total chromium
(viii) faecal coliforms and enterococci
(ix) polycyclic aromatic hydrocarbons

Dry weight results shall be reported to the Consent Authority in accordance with condition 12(e).

6. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

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7. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

8. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

9. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

10. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the DCC Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

11. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Kitchener Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
    (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
    (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
    (c) The stormwater management objectives for the catchment including the level of service for the network;
    (d) Identification of stormwater management problems and issues for the catchment;
    (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
        (i) Maintenance of the network; and
        (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant

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control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

12. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

(a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

(b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 11(a) above;

(c) The methods used by the new connections reported in condition 11(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in conditions 2 to 5 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

13. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal

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with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

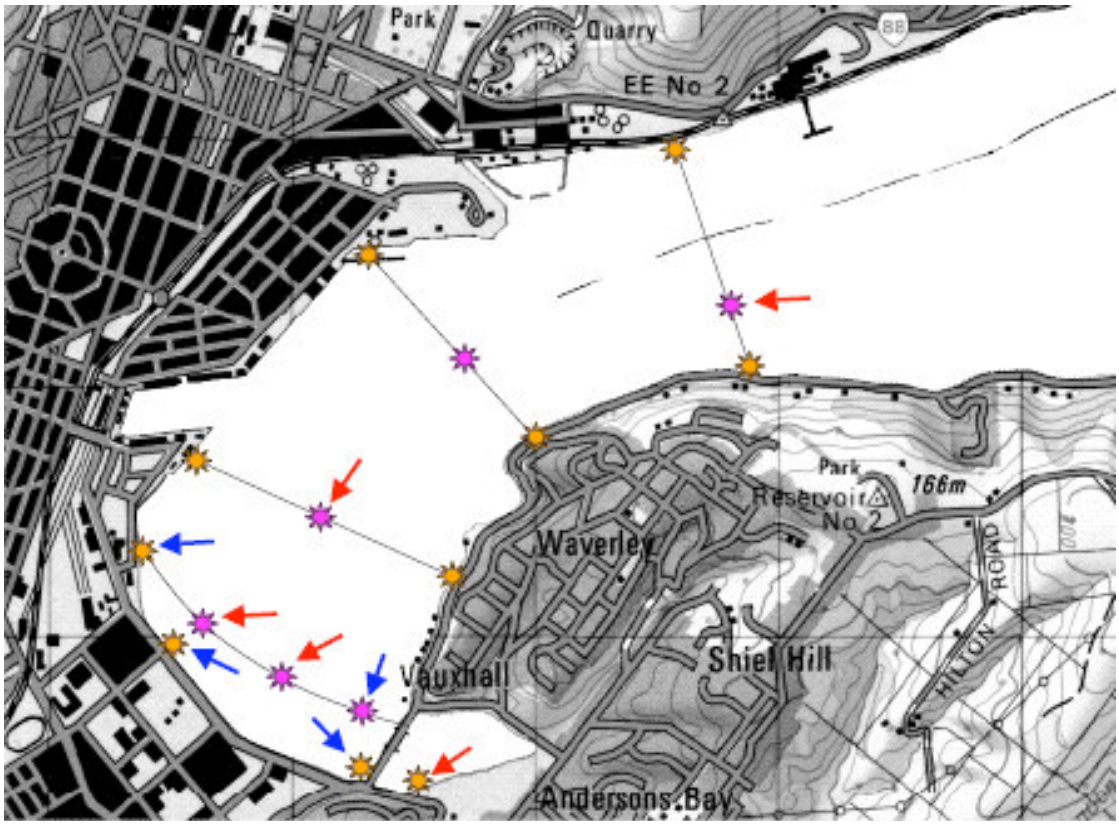
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APPENDIX 1

Upper Otago Harbour Sediment Sampling Sites



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Certified

Consent No: 2002.088

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 30 metres east of the intersection of French Street and Kitchener Street, Dunedin

Legal description of consent location: Lot 1 DP 22365

Grid reference: NZMS 260 I44:163-775

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

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(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive).

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

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Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the foreshore catchment (including French Street) that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
   (c) The stormwater management objectives for the catchment including the level of service for the network;
   (d) Identification of stormwater management problems and issues for the catchment;
   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
      (i) Maintenance of the network; and
      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
   (f) Monitoring procedures to assess the plan's effectiveness; and
   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;
   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

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(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

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Consent No: 2002.089

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 120 metres east of the intersection of Kitchener Street and White Street, Dunedin

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:165-777

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

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(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease
(xiii) polycyclic aromatic hydrocarbons

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 12(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xiii) in condition 2(b).

3. (a) The consent holder shall undertake biological monitoring annually between the months of January to June inclusive. The monitoring shall be undertaken at four sites at the waters edge at low tide; two within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide and two a minimum of 50 metres of the confluence of the stormwater outlet and the waters edge at low tide.

(b) From the top 20 millimetres at each site, three randomly spaced 5 square metre quadrats shall be sampled at two sites; one within 20 metres of each outfall and one at least 50 metres distant from each outfall. For epifauna within each 5 square metre quadrat, the number of each species shall be recorded in five 0.1 square metre quadrats. For infauna a sediment core shall be taken in three 0.1 square metre quadrats and the number of each species shall be recorded. For macroflora, the percentage cover of each species shall be estimated in three 1.0 square metre quadrats.

(c) Results shall be reported to the Consent Authority in accordance with condition 12(e).

4. The consent holder shall undertake three replicate samples of the flesh of cockles *(Austrovenus stutchburyi)* annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide. Analysis shall be from a composite sample of at least 200 grams of cockle flesh, and the number and size of cockles used shall be recorded.

verification
ISO9001
Certified

The cockle flesh samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
(i) faecal coliforms

Dry weight results shall be reported to the Consent Authority in accordance with condition 12(e).

5. The consent holder shall undertake sediment quality sampling using three replicate sediment samples from the top 20 millimetres of sediment that shall be collected at each site as marked on the plans attached as Appendix 1 to this consent. Sampling shall be undertaken:

(a) Annually between January and June at the locations marked by large orange stars; and
(b) Between January and June 2007, and between January and June 2011, at the locations marked by large pink stars. Analysis shall be of all sediment fractions.

The samples shall be analysed for:

(i) total copper
(ii) total lead
(iii) total zinc
(iv) total arsenic
(v) total nickel
(vi) total cadmium
(vii) total chromium
(viii) faecal coliforms and enterococci
(ix) polycyclic aromatic hydrocarbons

Dry weight results shall be reported to the Consent Authority in accordance with condition 12(e).

6. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

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7. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

8. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.
9. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

10. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the DCC Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

11. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Kitchener Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
    (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
    (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
    (c) The stormwater management objectives for the catchment including the level of service for the network;
    (d) Identification of stormwater management problems and issues for the catchment;
    (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
        (i) Maintenance of the network; and
        (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

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(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

12. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

    (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

    (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 11(a) above;

    (c) The methods used by the new connections reported in condition 11(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

    (d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

    (e) The monitoring results specified in conditions 2 to 5 of this consent. At minimum this shall include:

        (i) Presentation of the monitoring results for the previous 12 months;

        (ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

        (iii) Any remedial actions or mitigation measures proposed to be undertaken;

        (iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

    Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

13. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

    (a) The first anniversary of the commencement of this consent; and/or

    (b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

        (i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

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(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



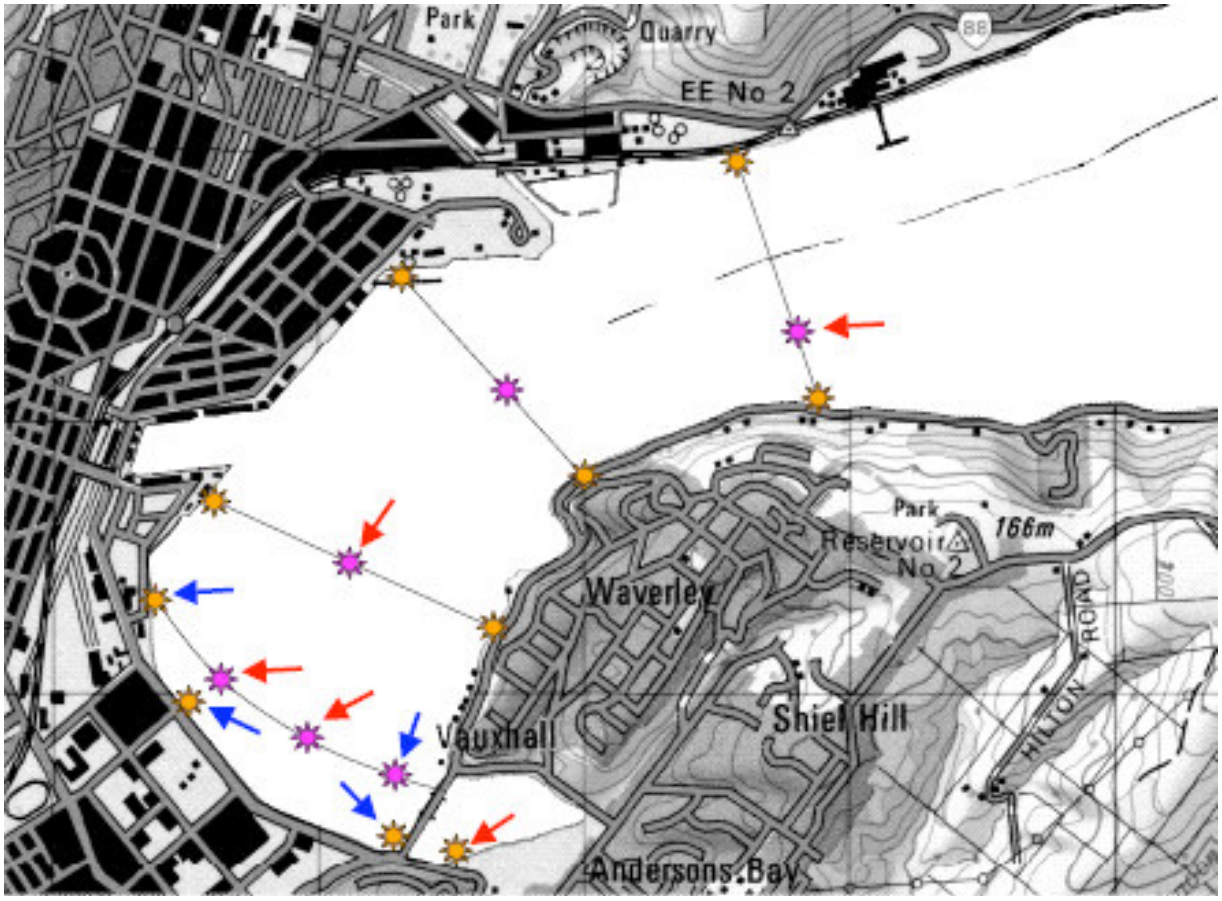
Christopher P Shaw

Manager Consents

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APPENDIX 1



verification
ISO9001
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Consent No: 2002.090

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 40 metres northeast of the intersection of Birch Street and Roberts Street, Dunedin

Legal description of consent location: Lot 1 DP 22587

Grid reference: NZMS 260 I44:162-778

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

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(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

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Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the foreshore catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
   (c) The stormwater management objectives for the catchment including the level of service for the network;
   (d) Identification of stormwater management problems and issues for the catchment;
   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
      (i) Maintenance of the network; and
      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
   (f) Monitoring procedures to assess the plan's effectiveness; and
   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;
   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

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(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

Manager Consents

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Consent No: 2002.091

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 60 metres north of the intersection of Birch Street and Roberts Street, Dunedin

Legal description of consent location: Lot 1 DP 22587

Grid reference: NZMS 260 I44:162-778

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

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8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the foreshore catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
   (c) The stormwater management objectives for the catchment including the level of service for the network;
   (d) Identification of stormwater management problems and issues for the catchment;
   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
      (i) Maintenance of the network; and
      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
   (f) Monitoring procedures to assess the plan's effectiveness; and
   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;
   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;
   (d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

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(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

Manager Consents

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Consent No: 2002.092

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 60 metres northeast of the intersection of Wharf Street and Birch Street, Dunedin

Legal description of consent location: Lot 1 DP 22587

Grid reference: NZMS 260 I44:162-778

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

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(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

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Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the foreshore catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
   (c) The stormwater management objectives for the catchment including the level of service for the network;
   (d) Identification of stormwater management problems and issues for the catchment;
   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
      (i) Maintenance of the network; and
      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
   (f) Monitoring procedures to assess the plan's effectiveness; and
   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;
   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

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(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.093

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Adjacent to Fryatt Street at its intersection with Fish Street, Dunedin

Legal description of consent location: Harbour Board Endowment Otago Harbour District

Grid reference: NZMS 260 I44:163-780

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

verification
ISO9001
Certified

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the foreshore catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
   (c) The stormwater management objectives for the catchment including the level of service for the network;
   (d) Identification of stormwater management problems and issues for the catchment;
   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
      (i) Maintenance of the network; and
      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
   (f) Monitoring procedures to assess the plan's effectiveness; and
   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;
   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

verification
ISO9001
Certified

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.094

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 100 metres east south-east of the intersection of Fryatt Street and Fish Street, Dunedin

Legal description of consent location: Harbour Board Endowment Otago Harbour District

Grid reference: NZMS 260 I44:165-780

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

verification
ISO9001
Certified

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the foreshore catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;

   (c) The stormwater management objectives for the catchment including the level of service for the network;

   (d) Identification of stormwater management problems and issues for the catchment;

   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

      (i) Maintenance of the network; and

      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

   (f) Monitoring procedures to assess the plan's effectiveness; and

   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;

   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

verification
ISO9001
Certified

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.095

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Adjacent to the intersection of Fryatt Street and Tewsley Street, Dunedin

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:166-780

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

verification
ISO9001
Certified

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the foreshore catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
   (c) The stormwater management objectives for the catchment including the level of service for the network;
   (d) Identification of stormwater management problems and issues for the catchment;
   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
      (i) Maintenance of the network; and
      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
   (f) Monitoring procedures to assess the plan's effectiveness; and
   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;
   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

verification
ISO9001
Certified

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.096

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 100 metres south of the intersection of Fryatt Street and Willis Street, Dunedin

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:168-780

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

verification
ISO9001
Certified

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the foreshore catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
   (c) The stormwater management objectives for the catchment including the level of service for the network;
   (d) Identification of stormwater management problems and issues for the catchment;
   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
      (i) Maintenance of the network; and
      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
   (f) Monitoring procedures to assess the plan's effectiveness; and
   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;
   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

verification
ISO9001
Certified

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.097

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Adjacent to the intersection of Mason Street and Fryatt Street, Dunedin

Legal description of consent location: Lot 7 DP 22143

Grid reference: NZMS 260 I44:169-782

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 10(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall undertake sampling of spotties *(Notolabrus celidotus)* or triplefin (*Tripterygion varium*) annually. This sampling is to be carried out within the months of January to June inclusive. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The length and weight of each spottie or triplefin sampled shall be recorded.

The samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons

Dry weight results shall be reported to the Consent Authority in accordance with condition 10(e).

4. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

verification
ISO9001
Certified

5. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

6. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.
7. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

8. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

9. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Mason Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
    (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
    (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
    (c) The stormwater management objectives for the catchment including the level of service for the network;
    (d) Identification of stormwater management problems and issues for the catchment;
    (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
        (i) Maintenance of the network; and
        (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

verification
ISO9001
Certified

(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

10. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

    (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

    (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 9(a) above;

    (c) The methods used by the new connections reported in condition 9(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

    (d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

    (e) The monitoring results specified in conditions 2 and 3 of this consent. At minimum this shall include:

        (i) Presentation of the monitoring results for the previous 12 months;

        (ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

        (iii) Any remedial actions or mitigation measures proposed to be undertaken;

        (iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

    Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

11. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

    (a) The first anniversary of the commencement of this consent; and/or

    (b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

        (i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

verification
ISO9001
Certified

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.098

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 60 metres southeast of the intersection of Bauchop Street and Fryatt Street, Dunedin

Legal description of consent location: Lot 6 DP 22143

Grid reference: NZMS 260 I44:170-783

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

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(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 10(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall undertake sampling of spotties *(Notolabrus celidotus)* or triplefin (*Tripterygion varium*) annually. This sampling is to be carried out within the months of January to June inclusive. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The length and weight of each spottie or triplefin sampled shall be recorded.

The samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons

Dry weight results shall be reported to the Consent Authority in accordance with condition 10(e).

4. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

verification
ISO9001
Certified

5. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

6. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.
7. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

8. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

9. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Mason Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
    (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
    (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
    (c) The stormwater management objectives for the catchment including the level of service for the network;
    (d) Identification of stormwater management problems and issues for the catchment;
    (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
        (i) Maintenance of the network; and
        (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

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(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

10. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

    (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

    (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 9(a) above;

    (c) The methods used by the new connections reported in condition 9(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

    (d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

    (e) The monitoring results specified in conditions 2 and 3 of this consent. At minimum this shall include:

        (i) Presentation of the monitoring results for the previous 12 months;

        (ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

        (iii) Any remedial actions or mitigation measures proposed to be undertaken;

        (iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

    Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

11. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

    (a) The first anniversary of the commencement of this consent; and/or

    (b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

        (i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

        (ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

verification
ISO9001
Certified

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.099

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 70 metres southeast of the intersection of Bauchop Street and Fryatt Street, Dunedin

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:170-783

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

   (i) pH
   (ii) suspended solids
   (iii) faecal coliforms and *Escherichia coli*

verification
ISO9001
Certified

(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 10(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall undertake sampling of spotties *(Notolabrus celidotus)* or triplefin (*Tripterygion varium*) annually. This sampling is to be carried out within the months of January to June inclusive. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The length and weight of each spottie or triplefin sampled shall be recorded.

The samples shall be analysed for:
(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons

Dry weight results shall be reported to the Consent Authority in accordance with condition 10(e).

4. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

5. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

6. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

verification
ISO9001
Certified

7. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

8. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

9. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Mason Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

    (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

    (b) A description of the stormwater network system, capacity of the system to meet current and future needs;

    (c) The stormwater management objectives for the catchment including the level of service for the network;

    (d) Identification of stormwater management problems and issues for the catchment;

    (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

        (i) Maintenance of the network; and

        (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

    (f) Monitoring procedures to assess the plan's effectiveness; and

    (g) A procedure for revising the plan.

verification
ISO9001
Certified

Reporting

10. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

    (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

    (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 9(a) above;

    (c) The methods used by the new connections reported in condition 9(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

    (d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

    (e) The monitoring results specified in conditions 2 and 3 of this consent. At minimum this shall include:

        (i) Presentation of the monitoring results for the previous 12 months;

        (ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

        (iii) Any remedial actions or mitigation measures proposed to be undertaken;

        (iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

    Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

11. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

    (a) The first anniversary of the commencement of this consent; and/or

    (b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

        (i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

        (ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

        (iii) Amending the monitoring specified by conditions of this consent; or

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ISO9001
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(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.100

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 65 metres southeast of the intersection of Halsey Street and Fryatt Street, Dunedin

Legal description of consent location: Lot 6 DP 22143

Grid reference: NZMS 260 I44:171-785

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

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(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

verification
ISO9001
Certified

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Halsey Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
   (c) The stormwater management objectives for the catchment including the level of service for the network;
   (d) Identification of stormwater management problems and issues for the catchment;
   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
      (i) Maintenance of the network; and
      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
   (f) Monitoring procedures to assess the plan's effectiveness; and
   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;
   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;
   (d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

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Certified

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.101

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 60 metres southeast of the intersection of Halsey Street and Fryatt Street, Dunedin

Legal description of consent location: Lot 6 DP 22143

Grid reference: NZMS 260 I44:171-785

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

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Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

verification
ISO9001
Certified

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Wickliffe Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
   (c) The stormwater management objectives for the catchment including the level of service for the network;
   (d) Identification of stormwater management problems and issues for the catchment;
   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
      (i) Maintenance of the network; and
      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
   (f) Monitoring procedures to assess the plan's effectiveness; and
   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;
   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;
   (d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

verification
ISO9001
Certified

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.102

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 80 metres south of the intersection of Akaroa Street and Fryatt Street, Dunedin

Legal description of consent location: Lot 6 DP 22143

Grid reference: NZMS 260 I44:172-785

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

verification
ISO9001
Certified

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Wickliffe Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
   (c) The stormwater management objectives for the catchment including the level of service for the network;
   (d) Identification of stormwater management problems and issues for the catchment;
   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
      (i) Maintenance of the network; and
      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
   (f) Monitoring procedures to assess the plan's effectiveness; and
   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;
   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

verification
ISO9001
Certified

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.103

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 225 metres southeast of the intersection of Wickliffe Street and Fryatt Street, Dunedin

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:174-786

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

verification
ISO9001
Certified

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Wickliffe Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;

   (c) The stormwater management objectives for the catchment including the level of service for the network;

   (d) Identification of stormwater management problems and issues for the catchment;

   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

      (i) Maintenance of the network; and

      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

   (f) Monitoring procedures to assess the plan's effectiveness; and

   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;

verification
ISO9001
Certified

(c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.104

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 350 metres southeast of the intersection of Magnet Street and Parry Street, Dunedin

Legal description of consent location: Harbour Board Endowment Blk IX Otago Harbour SD

Grid reference: NZMS 260 I44:179-789

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the

verification
ISO9001
Certified

Magnet Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

(a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

(b) A description of the stormwater network system, capacity of the system to meet current and future needs;

(c) The stormwater management objectives for the catchment including the level of service for the network;

(d) Identification of stormwater management problems and issues for the catchment;

(e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

  (i) Maintenance of the network; and

  (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

(a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

(b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;

(c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

verification
ISO9001
Certified

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.105

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 535 metres east southeast of the intersection of Magnet Street and Parry Street, Dunedin

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:181-789

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the

verification
ISO9001
Certified

Magnet Street catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

(a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

(b) A description of the stormwater network system, capacity of the system to meet current and future needs;

(c) The stormwater management objectives for the catchment including the level of service for the network;

(d) Identification of stormwater management problems and issues for the catchment;

(e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

  (i) Maintenance of the network; and

  (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

(a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

(b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;

(c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

verification
ISO9001
Certified

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 310 metres southeast of the intersection of Ravensbourne Road and Parry Street, Dunedin

Legal description of consent location: Lots 1/2 DP 16674

Grid reference: NZMS 260 I44:183-790

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

verification
ISO9001
Certified

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the Ravensbourne Road catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:
   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;
   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;
   (c) The stormwater management objectives for the catchment including the level of service for the network;
   (d) Identification of stormwater management problems and issues for the catchment;
   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:
      (i) Maintenance of the network; and
      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;
   (f) Monitoring procedures to assess the plan's effectiveness; and
   (g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:
   (a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;
   (b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;
   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

verification
ISO9001
Certified

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.108

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 190 metres northeast of the intersection of George Street and Beach Street, Port Chalmers, Dunedin

Legal description of consent location: Bed of Otago Harbour DP 3904

Grid reference: NZMS 260 I44:252-855

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the

verification
ISO9001
Certified

Port Chalmers catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

(a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

(b) A description of the stormwater network system, capacity of the system to meet current and future needs;

(c) The stormwater management objectives for the catchment including the level of service for the network;

(d) Identification of stormwater management problems and issues for the catchment;

(e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

  (i) Maintenance of the network; and

  (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

(a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

(b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;

(c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

verification
ISO9001
Certified

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.109

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 130 metres south of the intersection of Blueskin Road and Borlases Road, Port Chalmers, Dunedin

Legal description of consent location: Lot 51 DP 7074

Grid reference: NZMS 260 I44:244-848

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the

verification
ISO9001
Certified

Port Chalmers catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

(a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

(b) A description of the stormwater network system, capacity of the system to meet current and future needs;

(c) The stormwater management objectives for the catchment including the level of service for the network;

(d) Identification of stormwater management problems and issues for the catchment;

(e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

  (i) Maintenance of the network; and

  (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

(a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

(b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;

(c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

verification
ISO9001
Certified

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2002.110

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to the Pacific Ocean at Second Beach via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: Approximately 150 metres south of the intersection of Second Beach Road and Cliffs Road, St Clair, Dunedin.

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:149-740

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of the rainfall event means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) HEM, oil and grease
(xii) UV fluorescent (whitening agent)

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. (a) The consent holder shall undertake sampling of mussels annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, 50 metres to the east of the outlet. The shell length of each mussel sampled shall be recorded.

(b) The sampling of mussels shall be undertaken within a 14 day period (within the months of January to June) associated with the sampling rounds for Green Island and Tahuna Waste Water Treatment Plant discharge consents, unless it is not practicable to do so due to the absence of any fauna to be sampled.

(c) The samples shall be analysed for:
(i) faecal coliforms
(ii) total copper
(iii) total lead
(iv) total zinc
(v) total arsenic
(vi) total nickel
(vii) total cadmium
(viii) total chromium

Dry weight results shall be reported in accordance with condition 9(e).

verification
ISO9001
Certified

4. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

5. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

6. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

8. The consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent a Long Term (35 year) Stormwater Catchment Management Plan for Second Beach that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

   (a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

   (b) A description of the stormwater network system, capacity of the system to meet current and future needs;

   (c) The stormwater management objectives for the catchment including the level of service for the network;

   (d) Identification of stormwater management problems and issues for the catchment;

   (e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

      (i) Maintenance of the network; and

      (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

   (f) Monitoring procedures to assess the plan's effectiveness; and

verification
ISO9001
Certified

(g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

   (a) The location and nature of any new subdivisions or industries situated in a greenfields location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

   (b) The proposed volume of stormwater and potential contaminants in the stormwater being discharged by the new connections reported in condition 8(a) above;

   (c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

   (d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

   (e) The monitoring results specified in conditions 2 and 3 of this consent. At minimum this shall include:

      (i) Presentation of the monitoring results for the previous 12 months;

      (ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

      (iii) Any remedial actions or mitigation measures proposed to be undertaken;

      (iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

   Copies of original laboratory reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of:

   (a) The first anniversary of the commencement of this consent; and/or

   (b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

      (i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

      (ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

verification
ISO9001
Certified

(iii) Amending the monitoring specified by conditions of this consent; or

(iv) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007



Christopher P Shaw

Manager Consents

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verification
ISO9001
Certified

Consent No: 2006.222

COASTAL PERMIT

Pursuant to Section 104A of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to Otago Harbour via an outlet structure

for the purpose of disposing of stormwater runoff

for a term of 5 years from the date of commencement of this consent

Location of activity: The western side of Watson Park, approximately 190 metres Southwest of the intersection of Albertson Avenue and Blundell Avenue, Port Chalmers, Dunedin

Legal description of consent location: Crown Land Seabed

Grid reference: NZMS 260 I44:245-847

Conditions:

General

1. The consent holder shall carry out such maintenance as is considered necessary from time to time to ensure that all aspects of the stormwater system, including the outlet structure, are maintained in a sound, safe and effective operating condition.

Stormwater Discharge Sampling and Monitoring

2. (a) The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.

   (b) The sampling shall be undertaken during storms with an intensity of at least 2.5 millimetres of rainfall in a 24 hour period. The storms must be preceded by at least 72 hours of no measurable rainfall. Where an outlet is under water, sampling shall be taken from the nearest appropriate manhole to the discharge outlet. Should there be more than one outlet discharging under this consent, sampling is only required from one of the outlets. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:

verification
ISO9001
Certified

(i) pH
(ii) suspended solids
(iii) faecal coliforms and *Escherichia coli*
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease

(c) The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2(a) and (b).

Results shall be reported to the Consent Authority in accordance with condition 9(e). Following review of analytical results, the Consent Authority may, at its discretion, cease to require monitoring of any of (i) – (xii) in condition 2(b).

3. The consent holder shall hold an annual meeting with representatives of Save the Otago Peninsula Society Incorporated and the Department of Conservation (Otago Conservancy) and shall report and comment on any monitoring results.

4. Sampling required by this consent shall be undertaken within a 14 day period (between the months of January to June inclusive), unless it is not practicable to do so due to the absence of any fauna to be sampled.

5. All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder in consultation with the Consent Authority.

6. Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

Emergency Procedures

7. In the event of a contaminant spill within the stormwater system, the consent holder shall respond, as a minimum, in accordance with the most up to date version of the Dunedin City Council's Water and Waste Services Business Unit Pollution Emergency Procedures.

Management Plans

8. In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the

verification
ISO9001
Certified

Port Chalmers catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment. The Long Term (35 year) Stormwater Catchment Management Plan shall include as a minimum:

(a) A description of the catchment including identifying the land uses in the catchment or stormwater collection area, including an assessment of possible future land use change, existing and potential sources of contaminants, type of contaminants and stormwater flow;

(b) A description of the stormwater network system, capacity of the system to meet current and future needs;

(c) The stormwater management objectives for the catchment including the level of service for the network;

(d) Identification of stormwater management problems and issues for the catchment;

(e) A description of the long (35 years) and short term programme of works and priorities to implement the management plan, including:

  (i) Maintenance of the network; and

  (ii) Source control measures and structures, including sewage connection detection methods, education and enforcement methods to reduce contaminant inputs, contaminant removal or treatment methods or systems used and their effectiveness, and methods for contaminant control and monitoring of new subdivision connections or new industrial site discharges to the stormwater system;

(f) Monitoring procedures to assess the plan's effectiveness; and

(g) A procedure for revising the plan.

Reporting

9. The consent holder shall supply to the Consent Authority by 1 September of each year, an annual report of:

(a) The location and nature of any new subdivisions or industries situated in a greenfield location, that have connected to the consent holder's reticulated stormwater system in the previous 12 months;

(b) The proposed volume of stormwater and potential contaminants in stormwater being discharged by the new connections reported in condition 8(a) above;

(c) The methods used by the new connections reported in condition 8(a) above, to minimise the level of contaminants and/or volume of stormwater discharged;

(d) Progress with the Long Term (35 year) Stormwater Catchment Management Plan, including a description of the work undertaken for the management plan in the previous 12 months;

verification
ISO9001
Certified

(e) The monitoring results specified in condition 2 of this consent. At minimum this shall include:

(i) Presentation of the monitoring results for the previous 12 months;

(ii) An analysis of the monitoring results in terms of compliance with relevant guidelines and comparison with previously collected data;

(iii) Any remedial actions or mitigation measures proposed to be undertaken;

(iv) Any remedial actions or mitigation measures undertaken in the previous 12 months.

Copies of original laboratory analytical reports for all analyses undertaken shall be available on request.

Review

10. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within two months of

(a) The first anniversary of the commencement of this consent; and/or

(b) Receiving any monitoring information relating to the exercise of this consent for the purpose of:

(i) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which become evident after the date of commencement of the consent; or

(ii) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or

(iii) Amending the monitoring specified by conditions of this consent; or

(v) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Issued at Dunedin this 29th day of November 2007

Christopher P Shaw

Manager Consents

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Appendix B ICMP Summary Report

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Appendix C Cultural Impact Assessment

Cultural Impact Assessment
Discharges of Stormwater
Otago Harbour and Second Beach

by
KTKO Ltd
for
Dunedin City Council
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1. Introduction

Käi Tahu ki Otago Ltd (KTKO Ltd) has been contracted by Dunedin City Council to undertake a Cultural Impact Assessment on the discharge of stormwater into Otago Harbour and at Second Beach. A number of applications for the discharge of stormwater were lodged with the Otago Regional Council in February 2002 and were notified in April 2005. These discharges are existing.

KTKO Ltd has prepared this Cultural Impact Assessment in conjunction with Te Runanga o Otakou. KTKO Ltd is a consultancy business based in Dunedin and is wholly owned by the four Papatipu Runanga of Otago.

This report has been compiled for the following reason:

- To inform Dunedin City Council of the cultural importance of the Otago Harbour and surrounding environs.
- To inform Runanga members of the current operations and the potential effects upon cultural values from the renewal of consents for stormwater discharge.
- To provide a basis on which Käi Tahu and Dunedin City Council can further discuss ways to avoid, mitigate or remedy any effects upon Käi Tahu values.

2. Background to the Application

Stormwater is Dunedin is reticulated via a network of gutters, open channels and pipes and discharged into a number of receiving environments including the upper harbour, Second Beach / St Clair Beach, Kaikorai Stream and the Water of Leith. These applications are for discharges into the coastal marine area at Second Beach and Otago Harbour.

Stormwater from a number of catchments is discharged into the upper Otago Harbour and into the harbour at Port Chalmers. In addition, one sub-catchment drains into the coastal marine area at Second Beach. There are thirty-one discharge points that are the subject of these applications. Application for consent was initially made for discharge to St Clair Beach, however since the discharge is not directly to the coastal marine area, Otago Regional Council has determined that no consent is required. Similarly, discharges at Larnach Road, Macandrew Bay and Moller Park do not require consent. Stormwater is also discharged into the Water of Leith, which then flows into the harbour. No consent is required for this discharge.

Six of the catchments have predominantly residential land-use, with little industry or commercial activity. The others have a mixture of industrial, commercial and residential land-use. The largest area of industrial and commercial land is within the Portobello Road catchment, which drains into the harbour at the intersection of Portobello Road and Portsmouth Drive.

The discharges are existing, having been in place for a number of years. There is no treatment of stormwater, but there are approximately 6,900 mudtanks in place throughout Dunedin which trap heavier sediments and debris. These are cleaned as part of a routine maintenance programme. The design is such that the mudtanks will

block before allowing gross solids to enter the discharge pipeline. The traps also ensure that small spills of fuels and oils are contained. The Council undertakes a programme of regular street sweeping.

In general, the stormwater discharges do not contain sewage; however wastewater may be discharged to the harbour via the Hanover Street combined valve (Halsey Street outfall). This occurs infrequently. Discharge is believed to have occurred most recently in February 2004.

3. Statutory and Planning Framework

3.1 Resource Management Act 1991

The Resource Management Act 1999 (RMA) is the mechanism under which natural and physical resources of New Zealand are managed.

Part II of the RMA (sections 5 – 8) sets outs the purpose and principles of the Act. Relevant clauses are set out below.

> ***5. Purpose*** *– (1) The purpose of this Act is to promote the sustainable management of natural and physical resources.*
>
> *(2) In this Act, "sustainable management" means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural well being and for their health and safety while –*
>
> *a) Sustaining the potential of natural and physical resources to meet the reasonably foreseeable needs of future generations;*
> *b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
> *c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment.*

Section 6 sets out the matters that are of national importance.

> ***6. Matters of national importance*** *– In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance: .....*
>
> *(e) The relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga.*

Section 7 sets out other matters that particular regard is to be had to:

> **7. *Other matters*** *- In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to –*

(a) Käitiakitanga ...

Section 8 states that the principles of the Treaty of Waitangi need to be taken into account.

> **8. *Treaty of Waitangi*** *- In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).*

The Court of Appeal in *Court of Appeal v Attorney General 1987 CA 54/87* defines the principles as follows:

(i) The principle of partnership
(ii) The principle of active protection of Maori people in the use of their lands and waters to the fullest extent practicable
(iii)The principle of utmost good faith in dealings with the other Treaty partner

Within the RMA context a further principle, that of consultation, has been found to arise under the principles of the Treaty of Waitangi. The Environment Court has noted that active protection of Maori interests requires positive action, which will at times oblige both the consenting authority and the applicant to consult, and also to initiate, facilitate, and monitor the consultation process as part of the duty to take into account the principles of active protection and partnership. Consultation must be conducted in a spirit of goodwill and open mindedness, and over a reasonable span of time, and to a degree sufficient for the local authority to be informed on the matters at issue.

3.2 Regional Policy Statement

The Otago Regional Policy statement provides an overview of resource management issues within the region and sets objectives and policies for managing natural resources. Chapter 4 – Manawhenua Perspective, contains matters of resource management significance to Käi Tahu. The following objectives should be considered:

4.4.2 Wähi taoka (Treasured Resources). To recognise and provide for the special significance that all taoka play in the culture of Käi Tahu.

4.4.3 Wai (water). To recognise the principle of wairua and mauri in the management of Otago's water bodies.

4.4.4 Mahika käi (Places where food is produced or procured). To maintain and enhance mahika käi and access those traditional resources.

4.4.5 Kaitiakitanga (Guardianship). To incorporate the concept and spirit of kaitiakitanga in the management of Otago's natural and physical resources in a way consistent with the values of Käi Tahu.

3.3 Otago Regional Council Regional Plan: Coast

Käi Tahu's perspective of the coastal environment is explained in Chapter 4 of the Regional Plan: Coast. The coastal environment holds many values that range from the spiritual realm to the use of coastal resources. It is a taoka. Coastal resources have provided a food resource to coastal dwelling communities for generations. The Otago coastal environment is still a major source of food, livelihood and recreation for many Käi Tahu. Käi Tahu believe that any use and management of the coast must respect the traditions and rights of Käi Tahu and leave an environment suitable for future generations.

The plan specifies Coastal Management Areas. These include Coastal Protection Areas (Schedule 2.1), which are considered to be of regional, national or international importance in terms of their ecological and scenic values, and include areas of spiritual or cultural significance; Coastal Development Areas, which are developed areas within Otago's coastal marine area, and Coastal Recreation Areas, which are regionally important areas in terms of their use for various recreational activities.

Otago Harbour contains all three types of management area. Most of the harbour between Harwood and Taiaroa Heads, not including the shipping channel, is listed as a Coastal Protection Area for its cultural and spiritual values and estuarine values. The intertidal flats are a significant tuaki (cockle) habitat. The rest of the harbour, including the upper harbour, is listed as a Coastal Recreational Area. Its values are listed as boating, fishing and walking. The areas around Port Otago and Port Chalmers and the shipping channel are listed as Coastal Development Areas.

Second Beach and St Clair Beach are listed as Coastal Recreation Areas. Their values are swimming, walking and surfing.

Objectives and policies relevant to these applications are contained within Chapter 5, Coastal Management, and Chapter 10, Discharges.

Objective 5.3.1 is to:

> *To provide for the use and development of Otago's coastal marine area while maintaining or enhancing its natural character, outstanding natural features and landscapes, and its ecosystem, amenity, cultural and historical values.*

Policy 5.4.2 is:

> *Priority will be given to avoiding adverse effects on:*
>
> *(a) The values identified in Schedule 2.1, associated with any coastal protection area; ...*
>
> *when considering the use, development and protection of Otago's coastal marine area.*

Objective 10.3.1 is:

To seek to maintain existing water quality within Otago's coastal marine area and to seek to achieve water quality within the coastal marine area that is, as a minimum, suitable for contact recreation and the eating of shellfish within 10 years of the date of approval of this plan.

Objective 10.3.2 is:

To take into account community, cultural and biological values associated with Otago's coastal marine area when considering the discharge of contaminants into Otago's coastal waters.

Policy 10.4.2 is:

For activities involving the discharge of water or contaminants priority will be given to avoiding adverse effects on values associated with any area identified in Schedules 2 and 3 of this plan as being a coastal protection area, a coastal recreation area, an area of outstanding natural features and landscapes or an area important to marine mammals or birds.

3.4 Ngäi Tahu Claims Settlement Act

The Otago Coast and associated marine area (Te Tai O Arai Te Uru) is identified as a Statutory Acknowledgement Area under the Ngäi Tahu Claims Settlement Act. The Statutory Acknowledgement is a recognition by the Crown of Ngäi Tahu's cultural, spiritual, historical and traditional association with the coastline of Otago.

The statutory acknowledgement explains the Ngäi Tahu association with Te Tai O Arai Te (Appendix 1).

3.5 Käi Tahu ki Otago Natural Resource Management Plan 2005

The Käi Tahu Ki Otago Resource Management Plan was produced by the four Käi Tahu runanga of Otago to provide information on natural resource issues and objectives. The kaupapa of the plan is 'Ki Uta ki Tai' (Mountains to the Sea) and reflects the Käi Tahu ki Otago philosophy of natural resource management. It emphasises the holistic management of the inter-related elements within and between catchments, the air, land and coastal environment.

The plan contains issues, objectives and policies for the Käi Tahu ki Otago rohe and those specific to the Otago Harbour catchment area. Those relevant to these applications are listed below.

3.5.1 Chapter 5 Otago Region

Coastal Environment

Taku Tai Moana Me Wai Mäori Issues

Discharge and Waste:
- Increasing discharges to the coastal environment from the growing number of coastal subdivisions.
- Stormwater discharges e.g. from urban roads containing contaminants such as oil, carbon particles
- Oil/chemical spills.

Taku Tai Moana Me Wai Mäori Objectives

i. The spiritual and cultural significance of taku tai moana me te wai mäori is recognised in all management of the coastal environment.
ii. Te Tai o Arai Te Uru is healthy and supports Käi Tahu ki Otago customs.
iii. There is no direct discharge of human waste to Te Tai o Arai Te Uru and other contaminants being discharged directly or indirectly to the coastal environment are remedied.

Taku Tai Moana Me Wai Mäori Policies

1. To encourage the integrated management of the coastal environment.
6. To encourage any land use activity adjacent to the coastal environment to avoid or mitigate any adverse effects on coastal water quality. For example set back distances for effluent spraying and protection of coastal margins.

Discharges:
7. To oppose the discharge of sewage and industrial effluent directly to the coastal environment.
11. To encourage the retention of waters within catchments to reduce runoff to the coastal environment.

Wähi Tapu o te Taku Tai Moana

Wähi Tapu Issues

Protection of:
- the abode of takaroa (deity of the sea)

Wähi Tapu Objectives

i. Wähi tapu are protected from inappropriate activities.

Mahika Kai (Kai Moana) & Biodiversity

Mahika Kai (Kai Moana) & Biodiversity Issues

- Effective management and protection of customary fishing and sites of particular significance.
- Impact on coastal kai moana, associated habitats and sites from:

- activities occurring in the catchment
- adjacent industrial activity and associated discharges, both point and non-point sources

Mahika Kai (Kai Moana) & Biodiversity Objectives

i. The Marine Environment is managed in a holistic way.
ii. Te Tai o Arai Te Uru supports the full range of healthy ecosystems and species.
iii. There is an abundance of healthy kai moana.

Mahika Kai (Kai Moana) & Biodiversity Policies

3. To promote the integrated catchment management and inter-agency co-operation in the management of the coastal environment in particular adjacent to Mätaitai and Taiäpure and other important areas.

3.5.2 Chapter 8 Otago Harbour Catchment

Wai Mäori And Wai Tai

Wai Mäori and Wai Tai Issues in the Otago Harbour Catchment

- Deterioration of inlet health and impacts on the mauri and life supporting capacity of the sea.
- Point source discharge of wastewater and other contaminants into the Otago Harbour.

Wai Mäori and Wai Tai Policies in the Otago Harbour Catchment

3. To require the reticulation of stormwater from roading in the Dunedin central business district and industrial area.
6. To promote and participate in co-ordinated research into the natural processes within the Otago Harbour.
7. To encourage monitoring, including cultural monitoring, of the health of waters within the Otago Harbour and Catchment.

Mahika Kai and Biodiversity

Mahika Kai and Biodiversity Issues in the Otago Harbour Catchment

- Impact of commercial and other activities on tuaki.
- Some mahika kai species within the Otago Harbour Catchment are considered culturally unsafe for consumption.
- Risks to kaimoana from discharges in the Harbour including sedimentation and storm water runoff.

Mahika Kai and Biodiversity Policies in the Otago Harbour Catchment

1. To identify and protect mahika kai sites of importance to Kä Papatipu Rünaka in the Otago Harbour Catchment.

4. Käi Tahu Association with the Coastal Environment

Käi tahu ki Otago have a strong relationship with the coastal environment. The coast was valued particularly as a mahika kai and as a transport route. This strong association has been acknowledged in the Ngai Tahu Claims Settlement Act by the Statutory Acknowledgement for Te Tai O Arai Te Uru. The extracts below demonstrate this relationship.

4.1 Maori Use of the Harbour (Edward Ellison (Otakou Marae))

History of Maori Use of the Harbour

Evidence of Maori use of the harbour extends back to the Maori's earliest tribal history. In the legend of the Araiteuru waka [canoe], with the arrival and subsequent foundering of this waka at Shag Point, the survivors gave their names to the surrounding landscape. One passenger, Puketapu, journeyed south to gather firewood and while returning north past the area now known as Dunedin was said to have dropped some of the kindling he was carrying from which the bush, which once grew in the bays to the north of Dunedin, was seeded from.

The Takitimu, another early waka, sailed down the east coast of Te Waipounamu, and was wrecked near the Waiau River bar in Southland. The survivors made their way northward by land. The Otago Harbour was surely ventured by these early people.

The waka Uruao had as its master Rakaihautu who is said to have created the gouges in the land that were to become lakes such as Te Anau and Wanaka. Rakihouia, descendant of Rakaihautu, journeyed down the eastern coast of Te Waipounamu discovering the various landmarks and sources of food to be had.

Waitai is the first known Käi Tahu to have set foot on Pukekura [Taiaroa Head], having detached himself from the parent tribe in the Marlborough area. Waitai lived for a time at Pukekura, skirmishing with the local Waitaha before continuing further south to Moka Moka near Bluff. Waitai and his followers developed an intimate knowledge of the land and seaways of the east coast of Te Waipounamu.

The early people made great use of Otago Harbour as a food resource [mahika kai], a means of travel and as a realm of mother nature to be respected. Middens show the evidence of ancient gathering of kai moana. Goat Island [Rangiriri] was given to be the abode of Tangaroa in southern mythology, - Tangaroa, the atua or guardian spirit of all that lives in the sea. This is significant and infers that Otago Harbour was an important fishery. Tangaroa would be acknowledged in karakia [prayer/incantations] before and after each fishing voyage. Food would not be taken on a fishing trip for fear of invoking the wrath of Tangaroa. All sea life were likened to Tangaroa's children.

The ancestors of the Maori used numerous methods of catching fish in the harbour and estuaries/creeks. Netting, trawling, spearing, line fishing. Barracouta, Red Cod, Patiki, Puamorua, Karengo [seaweed], Kina, Koura [crayfish], Kaio, etc. were popular among the fish species caught. All forms of shellfish were also gathered including pipi, cockle, mussel, paua, toheroa, oyster, pupu. Ducks and other birdlife were caught for food, as were seals. Whalebone was utilised for making weapons, tools and ornaments. The creeks feeding into the harbour also provided eel, freshwater koura and whitebait.

This was an environment that remained unchanged from generation to generation. No reason existed to doubt the harbour's ability to provide forever for the local people. The increasing degradation of the harbour environment has affected the Maori people in many ways. Its place as a mahika kai [place of food] had dramatically been altered. The increasing smell emanating from certain areas has been linked with the increasing flow of nutrients into the harbour.

For many years the Maori people have expressed concern at the degradation occurring in the Otago Harbour.

Habits of Use

The harbour provided an important means of transport. Waka would travel from the various villages that were scattered around the harbour to various waka landing sites. Koputai [Port Chalmers] was one such landing site [tauraka] where hunting parties would venture into the bush-clad Kapuketaumahaka [Mt. Cargill] in search of the woodhen [Weka] a favourite food.

Otepoti [Dunedin] had several waka landings. Near Puketahi [Andersons Bay] a waka might be hauled up the beach and the occupants would travel overland to the long beach [Tahuna], and then travel south to Taieri Mouth or further. Likewise the return trip would be the same. Near Toitu Stream (bottom of High Street) was another landing site where trips might be made to catch eels, or journey south overland following the path which the old Southern Motorway travelled. Such journeys might be to the Taieri Plains near Henley, which was a favourite eeling, fishing and duck hunting area; or journey up the Taieri River in search of seasonal food.

The Otakou Maori used what is now present day Dunedin, to run their pigs. Regular visits to the head of the harbour were made to mark the young and cull the boars. When the crops grown in the village were harvested, some pigs would be brought back to Otakou by waka to rip open the earth for planting out in the spring.

During pre-European times various hapu [sub-tribe] lived in the upper harbour area. During the early part of European settlement of Dunedin our people would journey up the Otago Harbour in waka or sailboat, bringing food such as potato, wet or dried fish, pigs etc. to trade with the settlers at the head of the harbour. Much of this trading took place near the outlet of the Toitu Stream. Aramoana salt marsh has been an important spawning area for sea life, an extensive ecosystem playing an important link in the ocean system.

Maori people have continued to use the harbour resource up to the present day, although use has been dramatically reduced in the present day through a variety of causes. The Otakou Fisheries is a company that had its roots in the Otakou community, barracouta being the main catch in its initial years. The gathering of shellfish/seaweed has been gradually curtailed due to the rise of duck weed over the harbour floor. Flat fish have been a popular resource.

4.2 The Käi Tahu ki Otago Natural Resource Management Plan 2005

The Natural Resource Management Plan 2005 also highlights the importance of the coastal area to Käi Tahu ki Otago.

Wai Maori
The bays, inlets and coastal area of the Otago Harbour Catchment sustained a rich fishing resource, from the continental shelf off Cape Saunders to Blueskin Bay. The wider Blueskin Bay area was also once a kohaka (breeding ground) for the right whale, although it is over 150 years since it has seen this activity. Whales also entered Otago Harbour. The rivers and streams provide an important source of freshwater and sustain a range of fisheries including tuna and ïnaka.

Mahika kai
The abundant kaimoana of Te Takutai Moana presented a mainstay of sustenance for generations of our people living in the predominantly coastal settlements. Offshore fishing grounds were often named after ancestral figures as a means of identifying the people with particular harvest or fishing rights. Regionally abundant species were targeted with tried and true technologies. Waka unua were used to troll for makaa (barracoutta) which were a particularly important species to Käi Tahu ki Otago as well as catching species such as ling, hapuka and cod by longline. Large seabirds such as töroa (albatross) were sometimes snared on the tauihu (prow) of the waka or by other means. It is also evident that kekeno (fur seals) were harvested regularly and an occasional whale stranding a bonus for the Käik.

The availability and abundance of certain particularly sweet shellfish such as tuaki and pipi figure highly in the estimation of the local communities such as at Ötäkou on Otago Peninsula. The provision of special items of kai on the menu for guests provides a way of increasing the mana of the community and by reflection the rakätira representing them. The importance of shellfish in the diet of the tüpuna is witnessed by the huge piles of shells in midden material one might see eroding from coastal sites.

Our customs of resource use and management are firmly bedded in the concept of sustainable use, and respect for the diversity of life and ecosystems that co-habit Takutai Moana. Seeding or transfer of types of mature shellfish in woven kete was a way of expanding the range of kai available. This was done under a strict protocol and knowledge of natural observations. Rähui and tapu were mechanisms developed for community control. Rähui were traditionally utilized as a temporary fishing or harvesting ban to allow a resource to replenish should it be recognised that it was depleted and a tapu could be placed to provide for a complete ban but it

might be for a range of reasons other than resource management. The maxim of only taking what you need was strictly adhered to and dissidents were sometimes drastically penalised.

In many areas the reliance on these coastal mahika kai resources increased after the land sales of the 1840s and 1850s, and the associated loss of access to much traditional land-based mahika kai.

Cultural Landscapes in the Otago Harbour Catchment

The landscape of the Otago Harbour Catchment evokes a cultural and spiritual meaning to takata whenua signified through layers of tradition, association and use, reinforced by place names that individually reflect a myriad of traditions, events, ancestors, site use, food or other resources and cultural perspectives. The landscape and associated place names are an integral element of an oral culture to recall and pass on to future generations a framework of values, beliefs and traditions that bind our people to the whenua and all its resources.

Many of the place names around the Otago Harbour and the Blueskin Bay area have been lost, many are no longer in active use or are officially recognised. Place names can be descriptive of an area or resource as well as events or people of importance.

Käika Nohoaka

The Otago Harbour Coastal area was occupied by Waitaha, Ngati Mämoe and Käi Tahu in succession, who, over time have merged through whakapapa. Landscape features, mahika kai, resources and names of tüpuna record this history. Prominent headlands, in particular, were favoured for their defensive qualities and became the base for a succession of rakätira and their followers.

Notable pä on the Otago coast include Mapoutahi (Purakaunui), Pukekura (Taiaroa Head), and Moturata (Taieri Island). Another important centre of population was at Whareakeake, which was important as a pounamu manufacturing settlement.

Smaller population bases were situated at Wharauwerawera/Long Beach, Purakaunui around Blueskin Bay and at Omimi.

Tüpuna such as Waitai, Tukiauau, Whaka-taka-newha, Rakiiamoa, Tarewai, Maru, Te Aparangi, Taoka, Moki II, Kapo, Te Wera, Tu Wiri Roa, Taikawa, and Te Hautapanuiotu are among the many illustrious ancestors of Ngati Mämoe and Käi Tahu lineage whose feats and memories are enshrined in the landscape, bays, tides and whakapapa of Otago.

The results of the struggles, alliances and marriages arising out of these migrations were the eventual emergence of a stable, organised and united series of hapü located at permanent or semi-permanent settlements along the coast, with an intricate network of mahika kai rights and networks that relied to a large extent on coastal resources. Chiefs such as Korako (several), Tahatu, Honekai, Ihutakuru, Karetai, Taiaroa, Pötiki, Tühawaiki, and Pokene being some among a number who had their own villages and fishing grounds. Otago Peninsula (Muaupoko) had

many käika nohoaka with a multitude of hapü occupying them. At one time up to 12 käika existed in the lower Otago Harbour.

Ara Tawhito
The Otago Harbour Catchment was a highway for Käi Tahu ki Otago. When venturing north, where the present day Aramoana village is you would cross over at the mouth then over the hill to continue the journey northward through Purakaunui.

Tracks and trails that linked north to south and settlements with each other were a necessary feature of a people who lived off the land and travelled incessantly on their seasonal round of mahika kai pursuits.

Travel by sea between settlements and hapü was common. Travel by waka hunua (double-hulled canoe) and whale boats (post-contact) was undertaken. Hence tauraka waka (mooring sites) occur up and down the coast and wherever a tauraka waka is located there is also likely to be a nohoaka, fishing ground, kaimoana resource, rimurapa with the sea trail linked to a land trail or mahika kai resource. The tüpuna had a huge knowledge of the coastal environment and weather patterns, passed from generation to generation. This knowledge continues to be held by whänau and hapü and is regarded as a taoka. The traditional mobile lifestyle of the people led to their dependence on the resources of the coast.

4.3 Harbour Planning Study

A Harbour Planning Study hui was held at the Otakou marae in 1991 and the attitudes and concerns of the Otakou runanga were included within a report 'Otago Harbour Issues and Options Paper' by Edward Ellison. The following statements are taken from that report:

6. recognise that pollutants entering a waterway upstream of a food resource in the same stretch of water is against Maori values.
7. recommend that all such pollutants be pumped to a land treatment station and the by-product spread on exotic plantations where the trees will decontaminate the nutrients.
8. need for riparian planting to reduce the amount and toxicity of nutrients passing directly into the harbour.
9. Maori elders lament the loss of clean beaches, clean water and the declining fishery. Memories of how the harbour used to be is a source of much talk.

5. Values of Importance to Käi Tahu

Ki Uta Ki Tai or literally 'Mountains to the Sea' is used by Käi Tahu as an overall approach to natural resource management. Ki Uta Ki Tai encompasses the wider creation traditions and kaitiaki status of the tangata whenua. The application of Ki Uta Ki Tai requires co-ordinated and holistic management of the interrelated elements of a catchment, from the air to the water, the land and the coast. The integration between planning and decision-making is essential and includes ongoing consultation and commitment by all parties to work together.

5.1 Mauri

The primary management principle for Käi Tahu is the maintenance and enhancement of the mauri or life-giving essence of a resource. Mauri can be tangibly represented in terms of elements of the physical health of the land, a river, or surrounding biodiversity. While there are also many intangible qualities associated with the spiritual presence of a resource, elements of physical health which Käi Tahu use to reflect the status of mauri and to identify the enhancements needed include:

- Aesthetic qualities e.g. natural character and indigenous flora and fauna;
- Life supporting capacity and ecosystem robustness;
- Fitness for cultural usage; and
- Productive capacity.

A water body or other natural resource can be desecrated by improper resource management activities. These may extinguish the mauri of the resource and in turn offend the mana of papatipu rünanga who hold traditional rights and responsibilities in respect to the resource. A water body's mauri can be desecrated if it no longer supports the traditional uses and values.

Across the rohe, one of the principle indicators by which Käi Tahu assesses the mauri of a resource is its productivity and the food and other materials sourced from it. Hence Käi Tahu use the nature and extent of mahinga kai as an environmental indicator. If the mauri of an entity is desecrated or defiled, the health and well being of the resource itself, resource users and others depending on the resource are at risk.

5.2 Kaitiakitanga

Preservation of the integrity of valued water bodies and the resources supported by that water body is an important aspect of the responsibilities of those members of Käi Tahu whanui that are identified as kaitiaki.

The importance of maintaining equilibrium of the environment is central to the role of Käitiakitanga. Each generation has an obligation to exercise guardianship. Käitiakitanga need not be in conflict with development but, in essence, seeks to protect and preserve the special characteristics of the various elements of the environment, to recognise the holistic nature of the natural world of which people are but one part, and protect the spiritual and physical wellbeing of one's own.

Values (both tangible and intangible) associated with specific resources of the Otago area include:

- The role of those resources in historical accounts;
- The proximity of important wähi tapu, settlement or other historical sites in or adjacent to specific resources;
- The value of the many and varied resources of an area as traditional sources of mahinga kai, food and other cultural materials; and
- The continued capacity for future generations to access, use and protect the resource.

5.3 Awa / Nga Wai (Water)

As a result of the many cultural activities associated with water, Käi Tahu consider water a highly valuable resource, one which is often referred to as a taoka. This includes the values associated with the water itself, the resources living in the water and the resources in the wider environs that are sustained by the water. The complexity and interdependency of different parts of the hydrological system should be considered when carrying out activities that have known effects on water.

5.4 Mahika Kai

Mahika kai was and remains one of the cornerstones of Käi Tahu culture. Strictly speaking, the term mahika kai means the places where food is gathered or hunted. However, it is often used to refer to the species being harvested. Käi Tahu travel to many different places or mahika kai to hunt or fish. Sometimes associated activities will also be undertaken. These may include collecting flax and other materials for craft work, constructing mohiki and practising older methods of harvesting. These are all modern presentations and developments of earlier Käi Tahu activities associated with mahika kai and are important expressions of Käi Tahu culture and customs.

In relation to the Otago Harbour one of the most important mahika kai resources is the tuaki. Käi Tahu are committed to ensuring the continued survival, enhancement, access to and healthiness of the tuaki resource. Of major concern is the effects of discharge activities on tuaki, fishing grounds and ecosystems, and whether or not these effects reach to the tuaki grounds nearer to the mouth of the harbour.

5.5 Wähi tapu / Wähi toaka

For Käi Tahu, the term wähi tapu or wähi toaka refers to places that hold the respect of people in accordance with tikanga (custom) or history. Whilst some sites are significant to the iwi, some are important to the hapu and whanau who visited, lived at or had special affiliations to that area. Some wähi tapu / wähi toaka were only visited by tohunga (specialists) who performed rituals such as waitohi (blessings) or karakia (incantations).

Urupa (burial sites) are the best modern day examples of wähi tapu, but in addition to the many urupa within the Otago Region, physical resources such as Aoraki, other landforms, springs and remaining areas of indigenous vegetation are other examples.

6. The Effects of Stormwater Discharges on Water Quality in Otago Harbour

The primary contaminants of stormwater are generally heavy metals, particularly lead, copper and zinc, polycyclic aromatic hydrocarbons and micro-organisms. Contaminant levels are highest during the 'first flush' of stormwater during a rainfall event as the rain washes off contaminants that have accumulated as dust or surface films on impervious surfaces. Information on stormwater quality and contaminant levels in the water and sediments within the upper harbour and at Second Beach has

been collated by Ryder Consulting as part of the application. The reports include some historical information together with test results from 2004. Measurements were also taken in 2005 of heavy metal and polycyclic aromatic hydrocarbons in the sediment and in the seawater under both calm and windy conditions. These results are presented separately. The main points of interest from the reports are as follows:

Upper Harbour

- The discharge points are located around the upper harbour basin from Ravensbourne Street to Marne Street in Andersons Bay Inlet. There are also discharges at Port Chalmers. Ryder Consulting's upper harbour basin report considers water quality in the upper harbour, generally south of the Ravensdown works. There is currently no information available about water quality adjacent to Port Chalmers; however, a summary of information is being prepared.

- There is a stormwater discharge at Larnach Road that contributes to the water quality in Andersons Bay Inlet, but does not require consent as it is to a stream that flows into the Inlet. (Note that flooding issues in the Somerville Street area are being dealt with by the Dunedin City Council separately).

- The Hanover Street combined stormwater / wastewater valve (Halsey Street outfall) may surcharge wastewater to the harbour under high flows

Contaminants in harbour sediments

Heavy metals:

- The relatively long residence times in the upper harbour give heavy metals more time to become incorporated into the substratum, rather than being flushed out to sea.

- The following data is from 1968-2002. The ANZECC 2000 guidelines referred to are the 'effects range low' level, ie. the concentration at which potential effects on organisms may occur and further investigation is recommended.

  Iron – Quite significant concentrations are present, especially off the Portobello Road outfall. Due to the relatively low toxicity, there are no upper limits set in ANZECC 2000.

  Copper – Generally low levels in the sediment except off the Portobello Road outfall and in Andersons Bay Inlet, where ANZECC guidelines are exceeded. Copper is toxic to most marine organisms and may affect flora and fauna in these areas.

  Zinc – Contamination is widespread around the south and east of the upper harbour basin. The highest concentrations are off the Portobello Road outfall and in Andersons Bay Inlet. ANZECC 2000 guideline levels are exceeded off Portsmouth Drive, Anderson's Bay Inlet and off Vauxhall and Waverley.

Cadmium – The highest concentrations are off Portobello Road and in Andersons Bay Inlet. ANZECC guidelines levels are exceeded off Portobello Road outfall.

Lead – Contamination is quite widespread around the south and west of the upper harbour basin. The highest concentrations are off the Portobello Road and Orari Street outfalls and in Andersons Bay Inlet. Lead is very toxic to most marine organisms, and ANZECC guidelines are exceeded over most of the upper harbour basin.

Nickel and Chromium – Quite high concentrations in places, particularly off the Portobello Road outfall, but they do not exceed ANZECC guidelines.

Manganese – No ANZECC guidelines. The highest concentrations are off Vauxhall and near the shipping channel.

- Measurements in 2004 show that levels of iron, manganese and nickel have all risen. Levels of copper and zinc show some increases and some decreases. Increases are associated with stormwater outfalls servicing catchments with a high proportion of residential area. Levels of lead and cadmium are generally decreasing.

- Measurements in 2005 show levels of copper, lead and nickel exceed the ANZECC low level guideline values close to the Portobello Road outfall in surficial sediments (0 – 20 mm depth; that is, the most recent sediments deposited). Levels of zinc exceed the ANZECC high level value.

- Although the contaminants are in sediment, the harbour is shallow and sediments are readily stirred up on windy days, making some contaminants available. Testing in 2005 showed that zinc, copper and lead levels in the seawater exceed ANZECC guidelines after three days of wind.

Enterococci

- Highest concentrations are around the south, east and western shores of the upper harbour. The ANZECC secondary contact recreation standard is exceeded off Portsmouth Drive, parts of Andersons Bay Inlet and off Vauxhall and Waverley.

- Levels of enterococci measured in 2004 are generally similar to those measured previously.

Polycyclic aromatic hydrocarbons

- Levels of PAH measured in 2004 exceed guidelines at most sites. The areas with the highest concentrations are off the Portobello Road outfall and in Anderson's Bay Inlet.

- Measurements of surficial sediments off the Portobello Road outfall in 2005 show a large number of PAHs exceed ANZECC 2000 high trigger levels, suggesting that contamination is ongoing or has occurred recently.

Benthic information

- The number of families of marine organisms (algae and invertebrates) were measured at sites in the upper harbour between 1991 – 2002. The lowest number of families (ie. lowest diversity) was off the Orari Street and Portobello Road outfalls and in Anderson's Bay Inlet. This may be due to exposure to the air during low tide, greater freshwater inputs at these sites and/ or contaminant levels.

Contaminants in Stormwater

- Contaminant levels are highest during the 'first flush' of stormwater.

- Levels of copper, lead, zinc, total phosphorus, dissolved reactive phosphorus and total nitrogen measured in stormwater between 1968 and 2002 exceeded ANZECC guideline levels for water. There are no more recent data currently available.

- Sediment in mudtanks measured in 2002 exceeded the guideline levels for lead and zinc.

- Measuring carried out in 2004 showed polycyclic aromatic hydrocarbon levels have decreased considerably at the Portobello Road outfall. Levels of total petroleum hydrocarbons have decreased at the Kitchener Street and Orari Street outfalls.

Contaminants in Seawater

Heavy metals

- There is little historical data for heavy metals or polycyclic aromatic hydrocarbons in seawater. Data that is available from 1990 to 1996 show no exceedences of ANZECC guidelines.

- Levels of metals during testing in 2004 were generally low, with only iron, manganese, copper, nickel and zinc being detectable. Copper and zinc exceeded ANZECC 2000 guidelines at some sites. Testing was carried out after three windy days.

- Measurements in 2005 on a calm day showed levels of all heavy metals to be below ANZECC guidelines. Measurements taken after three windy days showed that levels of zinc, copper and lead exceeded guidelines.

Polycyclic aromatic hydrocarbons and total petroleum hydrocarbons

- Testing in 2004 and testing in 2005 after three days of wind, showed levels of PAH and TPH were below detectable limits.

Nutrients

- Levels of total phosphorus and dissolved reactive phosphorus recorded between 1968 and 2002 frequently exceeded guidelines.

- Levels of total nitrogen recorded during the same period exceeded guidelines off Orari Street and Marne Street (Andersons Bay Inlet) outfalls.

- Levels of nitrate, ammonia and dissolved oxygen generally met guideline levels.

Micro-organisms

- Data from 1968 – 2002 show that levels of enterococci have exceeded guidelines levels off the Portobello Road outlet. Levels of faecal coliforms exceeded guideline levels at all sites measured.

- Testing in 2004 showed very low levels of enterococci in the water column. Testing was carried out in windy conditions, suggesting enterococci in sediments do not resuspend appreciably.

Second Beach

- Mean and median faecal coliform levels in shellfish at Second Beach exceed the guideline level for recreational shellfish gathering (ie. some samples are below guideline levels and some are above).

- Enterococci levels in stormwater are high, but levels in the seawater are generally low and meet the MFE secondary contact recreation standard.

- Levels of heavy metals in the sediment measured in 2005 are low and within guideline values.

- Further monitoring of contaminants in stormwater has been recommended as a condition of consent.

7. Effects of the Proposed Activities on Käi Tahu Values

Levels of contaminants in the harbour sediments, and in some cases within the water column, exceed ANZECC guidelines. These contaminants are toxic to marine organisms. Recent testing shows that there has been little improvement in contaminant levels over recent years. There is very little information presented on the effect of these contaminant levels on marine organisms. The only information presented shows that the biological diversity in parts of the harbour associated with stormwater outfalls is very low.

Runanga are concerned about the lack of information on biological impacts. The adverse impact upon Mauri will be significant if there is any impact upon aquatic life, ecosystems or fitness for cultural usage. Nga Runanga need to be assured that contamination will not affect marine organisms, particularly mahika kai species, outside the immediate area of discharge. Nga Runanga feels these effects need to be specifically addressed.

Nga runanga are also concerned about effects on marine organisms away from the upper harbour, particularly the tuaki beds. Wind and wave action has the potential to resuspend sediment and move contaminants within the harbour. Dredging may move contaminated sediment to the harbour mouth. There has been no testing of contamination levels in shellfish within the harbour.

Nga runanga are concerned that there is still the potential to discharge wastewater to the harbour via the Hanover Street valve (Halsey Street outfall). This is unacceptable and significantly impacts on Käi Tahu values. This situation should be remedied as soon as possible.

As kaitiaki, it is the responsibility of Käi Tahu to ensure that this resource, and all that it encompasses, remains as unchanged as possible. This involves preserving the continued health of all aspects of it, including mahika kai, and in doing so ensuring that the mauri is intact. There are potentially significant effects as a result of these discharges on mahika kai, awa and therefore the mauri of the waters in the harbour and off Second Beach. If the mauri of an entity is desecrated or defiled, the health and wellbeing of the resource, the resource users and others depending on, or associated with, that resource are at risk.

The preferred position of Käi Tahu is that there are no discharges of contaminants to the coastal marine area. It is accepted that removal of all contaminants from the stormwater is not feasible, however runanga consider that more should be done to reduce contaminant levels within it. This includes investigating further treatment options and improving the measures taken to reduce contaminant levels at source, particularly within new residential, industrial and commercial developments.

Measures that might be considered by the Dunedin City Council include:

- Reducing the area of land that is impervious by encouraging increased grassed and planted areas
- Use of grass swales to filter stormwater
- Roofing over car-parking areas and other areas where increased levels of contaminants may be found
- Requiring sediment / grease traps to be installed at all industrial premises, petrol stations and carparks
- Requiring management plans for industrial and commercial facilities to minimise the contaminant loading into stormwater, including the management of spills
- Ensuring industrial waste is not discharged to the stormwater system
- Ensuring there is no discharge of human sewage to the stormwater system
- Ongoing awareness of best management practices and technological improvements that will reduce contaminant levels and a willingness to implement these as appropriate

In terms of these applications, Nga Runanga require

- Monitoring regimes to be put in place to determine the effect on mahika kai species, particularly tuaki
- That adverse effects that surface during the period of consent are investigated and reported to all affected parties
- That if any adverse effects are identified during the term of the consent, reports and further studies as necessary are undertaken by the Dunedin City Council.

8. Conclusion

The Otago Harbour and coastline is a very important area for Käi Tahu. This is evident from the intimate knowledge that Käi Tahu have built up over many generations of the mahika kai and characteristics of the area. Käi Tahu led a nomadic lifestyle, following resources thoughout the catchment. During these journeys early Käi Tahu named places after creation traditions, incidents, mahika kai, weather and tupuna.

The applications have the potential to impact significantly upon Käi Tahu values and beliefs. These adverse impacts are associated with effects on the spiritual value of water, mahika kai, aquatic biota and water quality. Käi Tahu values need to be respected when dealing with any activity that poses risks. These values and beliefs are central to Käi Tahu existence.

Nga Runanga are concerned about the lack of information on the effects on marine organisms and believe that further monitoring is required. Runanga acknowledge that stormwater must be discharged, but consider that more must be done to reduce the level of contaminants within the stormwater. Nga Runanga are concerned about the ongoing potential for wastewater to be discharged to the harbour. This situation should be remedied as soon as possible.

Through proper management and monitoring the effects on Käi Tahu values may be reduced or eliminated. Nga Runanga wish to undertake further discussion with Dunedin City Council as to how this may be achieved.

Appendix 1

Ngäi Tahu Claims Settlement Act Schedule 103

Statutory Acknowledgement for Te Tai O Arai Te Uru (Otago Coastal Marine Area)

Specific Area

The statutory area to which this statutory acknowledgement applies is Te Tai o Arai Te Uru (the Otago Coastal Marine Area), the Coastal Marine Area of the Moeraki, Dunedin Coastal and Molyneaux constituencies of the Otago region, as shown on SO Plans 24250, 24249, and 24252, Otago Land District and as shown on Allocation Plan NT 505 (SO 19901).

Under section 313, the Crown acknowledges Te Rünanga o Ngäi Tahu's statement of Ngäi Tahu's cultural, spiritual, historic, and traditional association to Te Tai o Arai Te Uru as set out below.

Ngäi Tahu Association with Te Tai o Arai Te Uru

The formation of the coastline of Te Wai Pounamu relates to the tradition of Te Waka o Aoraki, which foundered on a submerged reef, leaving its occupants, Aoraki and his brothers, to turn to stone. They are manifested now in the highest peaks in the Ka Tiritiri o Te Moana (the Southern Alps). The bays, inlets, estuaries and fiords which stud the coast are all the creations of Tu Te Rakiwhanoa, who took on the job of making the island suitable for human habitation.

The naming of various features along the coastline reflects the succession of explorers and iwi (tribes) who travelled around the coastline at various times. The first of these was Maui, who fished up the North Island, and is said to have circumnavigated Te Wai Pounamu. In some accounts the island is called Te Waka a Maui in recognition of his discovery of the new lands, with Rakiura (Stewart Island) being Te Puka a Maui (Maui's anchor stone). A number of coastal place names are attributed to Maui, particularly on the southern coast.

The great explorer Rakaihautu travelled overland along the coast, identifying the key places and resources. He also left many place names on prominent coastal features. Another explorer, Tamatea, sailed along the Otago coast in the waka Täkitimu. After the waka eventually broke its back off the coast of Murihiku, Tamatea and the survivors made their way overland back to the North Island, arriving at the coast by the place Tamatea named O-amaru (Öamaru).

Place names along the coast record Ngäi Tahu history and point to the landscape features which were significant to people for a range of reasons. For example, some of the most significant rivers which enter the coastal waters of Otago include: Waitaki, Kakaunui, Waihemo (Shag), Waikouaiti, Kaikarae (Kaikorai), Tokomairiro, Mata-au (Clutha), Pounawea (Catlins). Estuaries include: Waitete (Waitati), Ötäkou (Otago), Makahoe (Papanui Inlet), Murikauhaka (Mate-au and Koau estuaries), Tahaukupu (Tahakopa estuary), Waipätiki (Wapati Estuary). Islands in the coastal area include

Okaihe (St Michaels Island), Moturata (Taieri Island), Paparoa, Matoketoke, Hakinikini, and Aonui (Cooks Head).

Particular stretches of the coastline also have their own traditions. The tradition of the waka (canoe) Arai Te Uru and its sinking at the mouth of the Waihemo (Shag River) has led to the coastal area of Otago being known as Te Tai o Araiteuru (the coast of Arai Te Uru). Accounts of the foundering, the wreckage, and the survivors of this waka are marked by numerous landmarks almost for the length of the Otago coast. The boulders on Moeraki coast (Kai Hinaki) and the Moeraki pebbles are all associated with the cargo of gourds, kumara and taro seed which were spilled when the Arai Te Uru foundered.

For Ngäi Tahu, traditions such as these represent the links between the cosmological world of the gods and present generations. These histories reinforce tribal identity and solidarity, and continuity between generations, and document the events which shaped the environment of Te Wai Pounamu and Ngäi Tahu as an iwi.

Because of its attractiveness as a place to establish permanent settlements, including pä (fortified settlements), the coastal area was visited and occupied by Waitaha, Ngati Mämoe and Ngäi Tahu in succession, who, through conflict and alliance, have merged in the whakapapa (genealogy) of Ngäi Tahu whänui. Battle sites, urupä and landscape features bearing the names of tüpuna (ancestors) record this history. Prominent headlands, in particular, were favoured for their defensive qualities and became the headquarters for a succession of rangatira and their followers. Notable pä on the Otago coast include: Makotukutuku (Öamaru), Te Raka-a-hineatea (Moeraki), Te Pä Katata, Pä a Te Wera, (Huriawa Peninsula), Mapoutahi (Purakaunui), Pukekura (Taiaroa Head), Moturata (Taieri Island). The estuaries from the Waitaki River to the Chaslands also supported various hapu.

Tüpuna such as Waitai, Tukiauau, Whaka-taka-newha, Rakiiamoa, Tarewai, Maru, Te Aparangi, Taoka, Moki II, Kapo, Te Wera, Tu Wiri Roa, Taikawa, Te Hautapanuiotu among the many illustrious ancestors of Ngati Mämoe and Ngäi Tahu lineage whose feats and memories are enshrined in the landscape, bays, tides and whakapapa of Otago.

The results of the struggles, alliances and marriages arising out of these migrations were the eventual emergence of a stable, organised and united series of hapu located at permanent or semi-permanent settlements along the coast, with an intricate network of mahinga kai (food gathering) rights and networks that relied to a large extent on coastal resources. Chiefs such as Korako (several), Tahatü, Honekai, Ihutakuru, Karetai, Taiaroa, Potiki, Tuhawaiki, and Pokene being some among a number who had their own villages and fishing grounds. Otago Peninsula (Muaupoko) had many kaunga nohoanga with a multitude of hapu occupying them. At one time up to 12 kainga existed in the lower Otago harbour, some larger and more important than others.

The whole of the coastal area offered a bounty of mahinga Käi, including a range of kaimoana (sea food); sea fishing; eeling and harvest of other freshwater fish in lagoons and rivers; marine mammals providing whale meat and seal pups; waterfowl, sea bird egg gathering and forest birds; and a variety of plant resources including

harakeke (flax), fern and ti root. In many areas the reliance on these resources increased after the land sales of the 1840s and 1850s, and the associated loss of access to much traditional land-based mahinga kai.

Many reefs along the coast are known by name and are customary fishing grounds, many sand banks, channels, currents and depths are also known for their kaimoana. One example is Poatiri (Mt Charles — Cape Saunders) the name of which refers to a fish hook. Poatiri juts out into the Pacific, close to the continental shelf, and is a very rich fishing ground. Another example is Blueskin Bay which was once a kohanga (breeding ground) for the right whale, although it is well over 150 years since it has seen this activity.

Other resources were also important in the coastal area. Paru (black mud used for dying) was obtained from some areas. Some of the permanent coastal settlements, such as those at the mouth of the Mata-au (Clutha River), and at Ötäkou and Purakaunui, were important pounamu manufacturing sites. Trading between these villages to the south and north via sea routes was an important part of the economy.

The Otago coast was also a major highway and trade route, particularly in areas where travel by land was difficult. Pounamu and titi were traded north with kumara, taro, waka, stone resources and carvings coming south. Travel by sea between settlements and hapu was common, with a variety of different forms of waka, including the southern waka hunua (double-hulled canoe) and, post-contact, whale boats plying the waters continuously. Hence tauranga waka (landing places) occur up and down the coast in their hundreds and wherever a tauranga waka is located there is also likely to be a nohoanga (settlement), fishing ground, kaimoana resource, rimurapa (bull kelp — used to make the poha, in which titi were and still are preserved) with the sea trail linked to a land trail or mahinga kai resource. The tüpuna had a huge knowledge of the coastal environment and weather patterns, passed from generation to generation. This knowledge continues to be held by whänau and hapu and is regarded as a taonga. The traditional mobile lifestyle of the people led to their dependence on the resources of the coast.

Numerous urupä are being exposed or eroded at various times along much of coast. Water burial sites on the coast, known as waiwhakaheketupapaku, are also spiritually important and linked with important sites on the land. Places where kaitangata (the eating of those defeated in battle) occurred are also wähi tapu. Urupä are the resting places of Ngäi Tahu tüpuna and, as such, are the focus for whänau traditions. These are places holding the memories, traditions, victories and defeats of Ngäi Tahu tüpuna, and are frequently protected in secret locations.

The mauri of the coastal area represents the essence that binds the physical and spiritual elements of all things together, generating and upholding all life. All elements of the natural environment possess a life force, and all forms of life are related. Mauri is a critical element of the spiritual relationship of Ngäi Tahu whänui with the coastal area.

Purposes of Statutory Acknowledgement

Pursuant to section 215, and without limiting the rest of this schedule, the purposes of this statutory acknowledgement are –

(a) To require that consent authorities forward summaries of resource consent applications to Te Runanga O Ngäi Tahu as required by regulations made pursuant to section 207 (clause 12.2.3 of the deed of settlement); and
(b) To require that consent authorities, the Historic Places Trust, or the Environment Court, as the case may be, have regard to this statutory acknowledgement in relation to the Mata-au, as provided in sections 208 to 210 (clause 12.2.4 of the deed of settlement); and
(c) To empower the Minister responsible for management of the Mata-au or the Commissioner of Crown Lands, as the case may be, to enter into a Deed of Recognition as provided in section 212 (clause 12.2.6 of the deed of settlement); and
(d) To enable Te Runanga O Ngäi Tahu and any member of Ngäi Tahu Whanui to cite this statutory acknowledgement as evidence of the association of Ngäi Tahu to the Mata-au as provided in section 211 (clause 12.2.5 of the deed of settlement).

Limitations on Effect of Statutory Acknowledgement

Except as expressly provided in sections 208 to 211, 213 and 215, -

(a) This statutory acknowledgement does not affect, and is not to be taken into account in, the exercise of any power, duty or function by any person or entity under any statute, regulation or bylaw; and
(b) Without limiting paragraph (a), no person or entity, in considering any matter or making any decision or recommendation under any statute, regulation or bylaw, may give any greater to lesser weight to Ngäi Tahu's association to the Mata-au (as described in this statutory acknowledgement) than that person or entity would give under the relevant statute, regulation or bylaw, if this statutory acknowledgement did not exist in respect of the Mata-au.

Except as expressly provided in this act, this statutory acknowledgement does not affect the lawful rights or interests of any person who is not a party to the deed of settlement.

Except as expressly provided in this act, this statutory acknowledgment does not, of itself, have the effect of granting, creating or providing evidence of any estate or interest in, or any rights of any kind whatsoever relating to, the Mata-au.

D

Appendix D DCC Monitoring Framework

E

Appendix E Action Plan

Discharge Quality Improvement Action Plan

Through the 3 Waters Strategic Direction Statement, the Dunedin City Council has stated its objective to "improve the quality of our discharges to minimise the impact on the environment". This overall objective is supported by the following commitments.

- We will resolve all known cross connections between the foul and stormwater networks by 2015, and have an ongoing programme to disconnect the systems as new issues are identified.
- We will reduce the contaminant load in our stormwater. We will use source control where practical, or otherwise consider effective stormwater treatment.
- We will reduce the number of foul sewer overflows arising as a result of capacity.

The DCC has employed an integrated catchment management planning approach to ensure that resources are targeted to the areas where they can deliver maximum benefit against the strategic objectives. The ICMP's were completed in late 2011. As part of a longer term commitment, the Council has committed $2.6m to support the delivery of associated action plans in the period 2011-2014 (Table 1). Tables 2a and 2b represent the consolidated action plan for the period 2011-2014 to deliver against the above objective and commitments, for which funding is provided in the Long Term Plan. Table 2a shows only those actions that relate to stormwater quality improvements in the catchments that are subject to the current consent applications. Table 2b shows actions that are being taken in other catchments or on the wastewater network to provide an overall view of the Council's commitment to meeting its strategic objectives.

The ICMP's also include many other actions that are not directly related to discharge quality (e.g. flooding issues). These are not shown on the action plans below.

Table 1: Budget commitments to Discharge Quality Improvements (2011-2013/14)

Budget	**2011/12**	**2012/13**	**2013/14**	**3 year total**
Operating	30k	167k	187k	$384
Wastewater Network New Capital	25k	50k	50k	$125k
WW Treatment New Capital	650k	0	0	$650k
WW Network Renewals	0	1,500k	0	$1,500k
Total	**705k**	**1,692k**	**212k**	**$2,609**

Table 2a : Actions directly relevant to the consent application.

Reference number	Catchment	Action / Task	Description / Expected Outcome	Budget Cost	LTP Budget Line	Timeframe
0001	Port Chalmers	Remove wastewater/stormwater cross connection	Cap fitted on connection preventing overflow from Foul to Storm sewer	-	-	Complete
0002	All Harbour Catchments	Redesign the city-wide framework for stormwater quality and harbour environment monitoring.	Undertaken as part of the consent application process to provide a suitably robust forward monitoring programme	$30k	Operating	Completed subject to outcome of consent application
0003	All catchments	Incorporate stormwater management considerations into draft spatial plan	Ensure that urban design aspects of the spatial plan support stormwater management objectives	-	-	Draft spatial plan complete and being revised after public consultation
0004	All Harbour Catchments	Wastewater emergency overflow monitoring to SW network or receiving environment	Known and suspected overflow points are monitored for frequency and volume to inform plan for cessation	$25k/yr	WW Network New Capital	In progress. All monitors to be operational by 2014
0005	St Clair	Investigate source of potential wastewater contamination	To determine whether stormwater contamination is caused by WW overflow or other. Then programme works to resolve.	-	May require future capital	In progress.
0006	All catchments	Deliver erosion and sediment control course in Dunedin for DCC / ORC staff, consultants and contractors	Improved understanding and expertise of best practice in erosion and sediment control	On charged to attendees	Opex	Completed
0007	All catchments	Improved monitoring of catchpit maintenance contract	To ensure that contractors are performing to required standards.	-	-	Ongoing, with significant improvement evident
0008	All Harbour Catchments	Implement the revised city-wide framework for stormwater quality and harbour environment monitoring	Robust dataset informs future decision making	$50k/yr	Operating	From 2012/13
0009	All Harbour catchments	Ensure that stormwater management objectives are effectively incorporated into revised catchpit maintenance contract	To be undertaken as part of overall contract review	-		Prior to contract expiry in 2013
0010	Halsey St	Investigate microbial contamination of stormwater and potential sources.	Instigate sampling regime to locate source of faecal contamination and inform plan for cessation.	$20k	Operating	2012/13
0011	South Dunedin	Review regulatory controls to ensure they fully support ICMP objectives.	Develop 2nd generation district plan, clearly incorporating stormwater management objectives. Draft stormwater bylaw	$20k	Operating	Commence in 2012/13
0012	Mason St	Undertake further stormwater monitoring to investigate the extent of potential wastewater contamination and likely sources within the Mason Street catchment.	Instigate sampling regime to locate source of faecal contamination and inform plan for cessation	$20k	Operating	2012/13

0013	South Dunedin	Undertake further quality monitoring and pipe survey to identify source of point discharge PAH contaminants.	Instigate sampling regime to locate source of PAH contamination and inform plan for cessation	$47k	Operating	2012/13
0014	All catchments	Develop Dunedin specific Erosion and Sediment control guide.	To improve erosion and sediment control practices	tbc	operating	2012/13
0015	Portsmouth Drive	Position and effectiveness of drain inlets needs confirmation (Midland St and Portsmouth Drive intersection)	Appraisal and subsequent upgrade to drain inlets in these locations to alleviate flooding and sediment input to Otago Harbour	$10k	Operating (may require future capital)	Appraisal 2013/14
0016	All catchments	Review the education / advice provided to property owners responsible for watercourses to ensure adequate information and assistance is provided.	Advice leaflet developed and information attached to LIMs to enable better watercourse management across the board and improved ownership responsibility	$30k	Operating	2013/14
0017	All catchments	Work with ORC to develop a plan for education programmes in relation to best practice site management of industrial premises.	Improved control of contaminants entering the stormwater systems from industrial premises	$20k	Operating	2013/14

Table 2b: Other actions to improve the quality of discharges – not directly related to the catchments subject to the current consent applications.

REF	Catchment	Action / Task	Description / Expected Outcome	Budget Cost	LTP Budget Line	Timeframe
1001	Mosgiel	Increase capacity of Mosgiel to Green Island WWTP transfer pumps	Increased capacity of effluent transfer system has reduced the likelihood/frequency of foul effluent overflow at Mosgiel WWTP to the Silverstream	$650k	WW Treatment New Capital	Complete
1002	Mosgiel	Monitor the effectiveness of stormwater swale at the Granvista development	Gain better understanding of effectiveness of swales as a pre-treatment method for stormwater quality.	tbc	OPEX	Ongoing
1003	Mosgiel	Network inflow and infiltration reduction renewals	Network renewals focussed in the Murray St area will reduce inflow and infiltration of groundwater to the foul sewer and subsequently the likelihood/frequency of foul effluent overflow from the system to storm and from Mosgiel WWTP to the Silverstream	$1,500k	WW Network Renewals	2012/13
1004	Mosgiel	Investigate stormwater quality, in particular the extent of microbial contamination.	Instigate sampling regime to locate source of faecal contamination and inform plan for cessation.	$47k	Operating	2013/14
1005	All Catchments	Review the education / advice provided to property owners responsible for watercourses to ensure adequate information and assistance is provided.	Advice leaflet developed and information attached to LIMs to enable better watercourse management across the board and improved ownership responsibility	$30k	Operating	2013/14
1006	All Catchments	Work with ORC to develop a plan for education programmes in relation to best practice site management of industrial premises.	Improved control of contaminants entering the stormwater systems from industrial premises	$20k	Operating	2013/14

F

Appendix F Stormwater Compliance Monitoring Reports

Stormwater Discharges from Dunedin City

Compliance Monitoring 2007

(ORC Resource Consents yet to be granted)



Prepared for

Dunedin City Council

by

Ryder Consulting Ltd.

June 2007

Stormwater Discharges from Dunedin City

Compliance Monitoring 2007

(ORC Resource Consents yet to be granted)

prepared by

Brian Stewart

Ryder Consulting

June 2007

Cover photo: Halsey and Fryatt Street stormwater outfalls

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Executive Summary

Prior to consents being granted for Dunedin's stormwater outfalls a preliminary survey of major outfalls was carried out.

The survey comprised assessment of benthic communities, contamination of stormwater and contamination of sediments

Stormwater from all outfalls monitored show variable levels of contamination, with numerous parameters being present at concentrations above recommended ANZECC guidelines or trigger values.

This survey provides a baseline against which future monitoring may be compared.

1. Introduction

1.1 Background

As with all urban centres throughout New Zealand and most of the world, Dunedin's stormwater is reticulated to receiving environments via networks of gutters, open channels and pipes. The principal receiving water environments for Dunedin's reticulated stormwater are the upper basin of Otago Harbour, Second Beach/St. Clair Beach on the open coast, Kaikorai Stream and the Water of Leith. Dunedin City Council (DCC) has recently sought resource consents for its major urban stormwater discharges into the coastal marine environment (i.e. Otago Harbour, St. Clair Beach and Second Beach).

Conditions under which consents will be granted include compliance monitoring. Specifically:

Condition 2.

(a) *The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.*

(b) *The sampling shall be undertaken during storms, preceded by at least 72 hours of no measurable precipitation, with an intensity of at least 2.5 millimetres (depth) of rain in a 24 hour period. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:*

(i) pH
(ii) suspended solids
(iii) faecal coliforms and Escherichia coli
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic

(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease
(xiii) Polycyclic aromatic hydrocarbons ***(Portobello Road, Orari and Kitchener Street consents only)***

(c) *The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b).*

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road catchment discharge consent only

(a) *The consent holder shall undertake to determine the source and extent of the high levels of polycyclic aromatic hydrocarbons in the historic sediment deposits associated with discharge from the Portobello Road stormwater outlet.*

(b) *Updates on the progress of the investigation in condition 3(a) shall be provided in writing to the Consent Authority by 1 September each year.*

(c) *No later than six months prior to the expiry of this consent, the consent holder shall provide a report to the Consent Authority stating the outcomes of the investigation in condition 3(a) and outlining the best practicable option(s) to mitigate the effects of these contaminated sediments.*

For the Portobello Road, Orari and Kitchener Street discharge consents only

(a) *The consent holder shall undertake biological monitoring annually between the months of January to June inclusive. The monitoring shall be undertaken at four sites at the waters edge at low tide; two within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide and two a minimum of 50 metres of the confluence of the stormwater outlet and the waters edge at low tide.*

(b) *At each site, three randomly spaced 5m^2 quadrats shall be sampled. For epifauna within each 5m^2 quadrat, the number of each species shall be recorded in five 0.1m^2 quadrats. For infauna a sediment core shall be*

taken in three 0.1m^2 quadrats and the number of each species shall be recorded. For macroflora, the percentage cover of each species shall be estimated in three 1.0m^2 quadrats.

(c) *Results shall be reported to the Consent Authority in accordance with condition 8(e).*

For the Portobello Road, Orari and Kitchener Street discharge consents only

The consent holder shall undertake sampling of the flesh of cockles (Austrovenus stutchburyi) annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide. The size of each cockle sampled shall be recorded. The cockle flesh samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
(i) faecal coliforms

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road and Orari Street discharge consents only

The consent holder shall undertake sampling of deceased octopus annually, between the months of January to June inclusive (to align with the autumn die-off of octopus). Samples will include flesh and, if available, digestive gland. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The total arm span and weight of each octopus sampled shall be recorded. The samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel

(f) total cadmium

(g) total chromium

(h) polycyclic aromatic hydrocarbons

Results shall be reported to the Consent Authority in accordance with condition 8(e). Should no deceased octopus be present, the consent holder shall notify the Consent Authority that sampling is unable to be undertaken.

For the Mason Street discharge consent only

The consent holder shall undertake sampling of spotties (Notolabrus celidotus) or triplefin (Tripterygion varium) annually. This sampling is to be carried out within the months of January to June inclusive. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The length and weight of each fish sampled shall be recorded. The samples shall be analysed for:

(a) total copper

(b) total lead

(c) total zinc

(d) total arsenic

(e) total nickel

(f) total cadmium

(g) total chromium

(h) polycyclic aromatic hydrocarbons

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road, Orari and Kitchener Street discharge consents only

The consent holder shall undertake sediment quality sampling using three replicate sediment samples that shall be collected at each site as marked on the plans attached as Appendix 1 to this consent. Sampling shall be undertaken:

(a) annually between January and June at the locations marked by large orange stars; and

(b) between January and June 2007, and between January and June 2010, at the locations marked by large pink stars. The samples will comprise the top 20mm of sediment and shall be analysed for:

(i) total copper

(ii) total lead

(iii) total zinc
(iv) total arsenic
(v) total nickel
(vi) total cadmium
(vii) total chromium
(viii) faecal coliforms and enterococci
(ix) polycyclic aromatic hydrocarbons
Results shall be reported to the Consent Authority in accordance with condition 8(e).

Condition 3. *The biological sampling of epifauna, infauna, macroflora, cockles, octopus, spotties or triplefins and sediment quality sampling required by Coastal Permits etc, shall be undertaken within a 14 day period (within the months of January to June), unless it is not practicable to do so due to the absence of any fauna to be sampled.*

Condition 4. *All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder and be acceptable to the Consent Authority.*

Condition 5. *Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.*

Second Beach

Condition 2.

(a) *The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of the rainfall event means that sampling in the manner described in condition 2(b) is not possible.*

(b) *The sampling shall be undertaken during storms, preceded by at least 72 hours of no measurable precipitation, with an intensity of at least 2.5 millimetres (depth) of rain in a 24 hour period. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:*

(i) pH
(ii) suspended solids
(iii) faecal coliforms and Escherichia coli
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) HEM, oil and grease
(xii) UV fluorescent (whitening agent)

(c) *The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b). Results shall be reported in accordance with condition 8(e).*

Condition 3.

(a) *The consent holder shall undertake sampling of mussels annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, 50 metres to the east of the outlet. The shell length of each mussel sampled shall be recorded.*

(b) *The sampling of mussels shall be undertaken within a 14 day period (within the months of January to June) associated with the sampling rounds for Green Island and Tahuna WWTP discharge consents, unless it is not practicable to do so due to the absence of any fauna to be sampled.*

(c) *The samples shall be analysed for:*
(i) faecal coliforms
(ii) total copper
(iii) total lead
(iv) total zinc
(v) total arsenic
(vi) total nickel
(vii) total cadmium
(viii) total chromium

(d) *Results shall be reported in accordance with condition 8(e).*

Condition 4. *All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder and be acceptable to the Consent Authority.*

Condition 5. *Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.*

The following report presents the results of an initial round of sampling/monitoring carried out during 2007. A full round of sampling/monitoring will be undertaken in 2008 once the Consents have been granted

1.2 Stormwater Outfalls

Stormwater is discharged from Dunedin City to the Upper Otago Harbour, Second Beach and Port Chalmers from thirteen reasonably large and permanent stormwater outfalls (Figures 1a, 1b and 1c), and from a number of smaller outfalls and non-point sources Table 1). Many of the outfalls have very long histories dating back to the days of the early settlement of Dunedin and a numbers were dual purpose outfalls, discharging both wastewater and stormwater. All wastewater connections, however, have since been rerouted to the wastewater system.

Some of the outfalls discharge to water or to land (e.g. Marne Street, Somerville Street), and do, therefore, not require permits to discharge to the CMA and are not considered in this report.

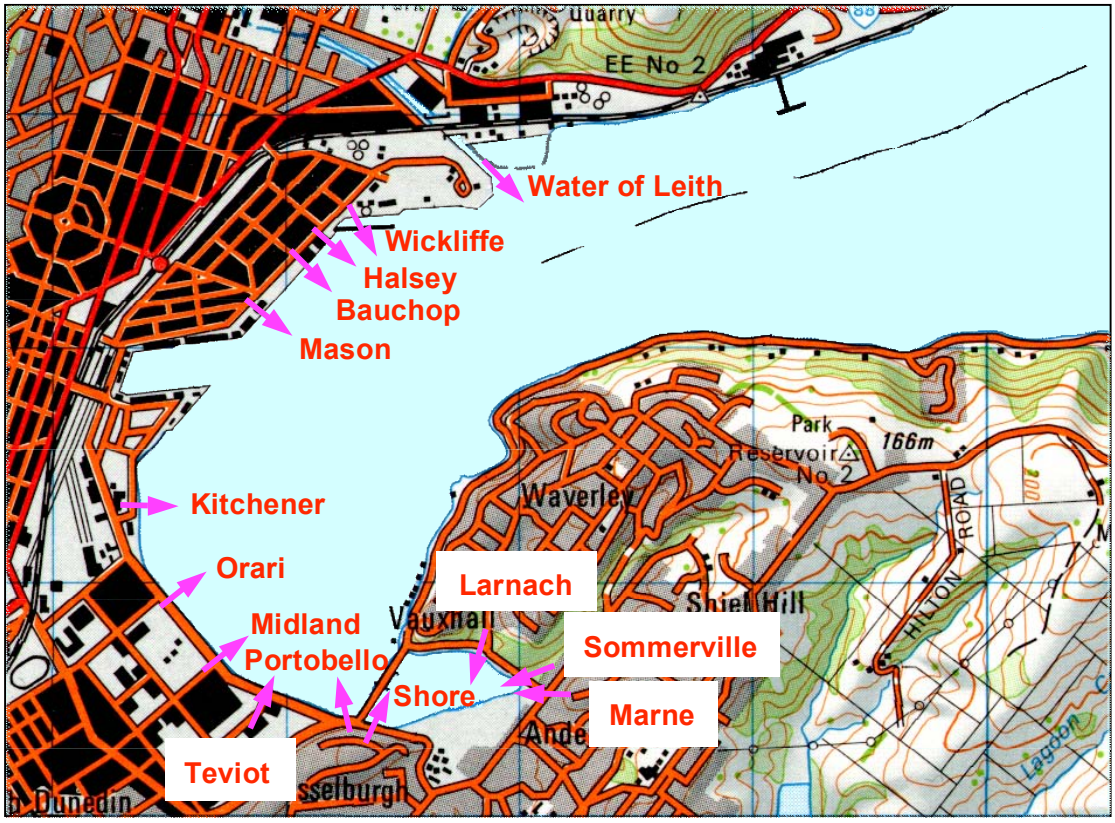


Figure 1a. *Major stormwater outfalls, labeled by catchment name, discharging from Dunedin City to the Upper Otago Harbour Basin.*



Figure 1b. *Location of the Second Beach stormwater outfall.*

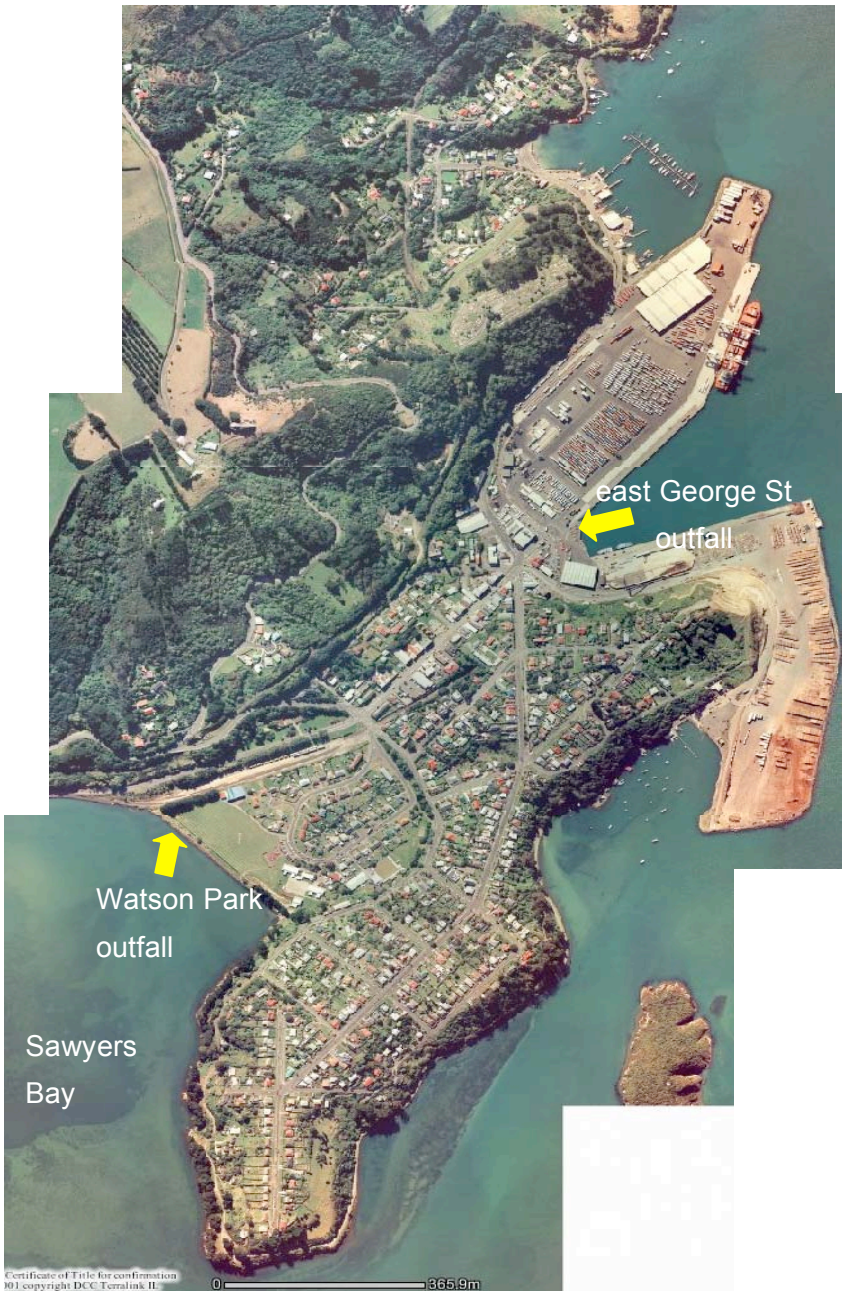


Figure 1c. *Location of major outfalls discharging stormwater from Port Chalmers.*

A total of 31 consents have been sought for the individual stormwater outfalls listed in Table 1.

Table 1. *List of stormwater outfalls for which discharge permits have been applied.*

Consent ref	DCC ref	Location	Catchment	Description	Max flow rate (l/s)	Outlet structure
2002.080	4	Shore St	Shore St	1500mm dia	2,380	Yes
2002.081	5	Portobello Rd	Portobello Rd	twin 1500mm dia conduits	pump rate 6,300	Yes
2002.082	6	Teviot St	Foreshore	375mm dia.	105	Yes
2002.083	7	Midland St	Foreshore	450mm dia	143	No
2002.084	8(a)	Orari St	Orari St	375mm dia	101	No
2002.085	8(b)	Orari St	Orari St	2700mm dia	10,350	Yes
2002.086	9(a)	Kitchener St	Kitchener St	600mm dia	310	Yes
2002.087	9(b)	Kitchener St	Kitchener St	1500mmdia	3,880	Yes
2002.088	10	French St	Foreshore	450mm dia	185	No
2002.089	11	Kitchener St	Foreshore	300 mm dia.	78	No
2002.090	12(a)	Birch St	Foreshore	225 mm dia.	37	No
2002.091	12(b)	Birch St	Foreshore	225 mm dia.	55	No
2002.092	12(c)	Wharf St	Foreshore	225 mm dia.	52	No
2002.093	13(a)	Fryatt St	Foreshore	150 mm dia.	40	No
2002.094	13(b)	Fryatt St	Foreshore	450mm dia	180	No
2002.095	13(c)	Fryatt St	Foreshore	300mm dia	54	No
2002.096	14	Fryatt St	Foreshore	300mm dia	116	No
2002.097	15(a)	Mason St	Mason St	2175mm dia. conduit	5,000	Yes
2002.098	15(b)	Mason St	Bauchop St	450mm dia	90	No
2002.099	15(c)	Mason St	Bauchop St	1350mm dia. culvert	1,500	No
2002.100	16(a)	Halsey St	Halsey St	1950mm conduit	3,800	No
2002.101	16(b)	Halsey St	Wickliffe St	1950mm conduit	2,600	No
2002.102	16(c)	Halsey St	Wickliffe St	300mm dia	113	Yes
2002.103	17	Wickliffe St	Wickliffe St	1,050 mm dia.	1,660	No
2002.104	18(a)	Magnet St	Magnet St	300mm dia	73	No
2002.105	18(b)	Magnet St	Magnet St	300mm dia	66	No
2002.106	19	Ravensbourne Rd	?	300 mm dia.	117	Yes
2002.108		George St (Port Otago)	Port Chalmers	750 mm dia.	1,000	No
2002.109		George St/SH88	Port Chalmers	1,250 mm dia.	1,200	Yes
2002.110		Second Beach Rd	St. Clair	1,050 x 1,050 mm tunnel	7,000	Yes
2006.222		Sawyers Bay, western side of Watson Park, Port Chalmers	Port Chalmers	150 mm dia.	20	Yes

2. Methods

2.1 Stormwater

Grab samples of stormwater were collected from each stormwater outfall within 1 hour of the commencement of a heavy rain event (>2.5mm) in an endeavour to ensure that first flush water was gathered. Collections took place only if there was an antecedent period of at least 72 hours with no rain before the target rain event.

Samples were sent to Hill Laboratories in Hamilton to be analysed for arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn), faecal coliforms and *E. coli*. Samples collected from the Kitchener Street, Orari Street and Portobello Road outfalls were additionally analysed for polycyclic aromatic hydrocarbons (PAHs). Samples were also collected during a period of low flow a week after the targeted rainfall event and sent to ESR in Christchurch for analysis of fluorescent whitening agents (FWAs) and faecal coliforms. FWAs are used in laundry detergents and indicate possible sewage infiltration to the stormwater system. Gilpin *et al*., (2004) recommend that stormwater be sampled at low flows to get a more accurate picture of sewage infiltration because the FWAs are usually present in only very low concentrations and are more readily detected at low flows.

2.2 Sediments

Three replicate 250cm^3 samples were collected from the top 20mm of sediment within 20m from each of the Kitchener Street, Orari Street and Portobello Road Outfalls. To gain a clear picture of sediment contamination within the upper harbour basin, further replicate sediment samples were collected at each of the sites indicated by orange and pink stars in Figure 2. Samples were chilled and sent to Hill laboratories in Hamilton for analysis for total arsenic, total cadmium, total chromium, total copper, total nickel, total lead, total zinc, faecal coliforms, enterococci and PAHs.

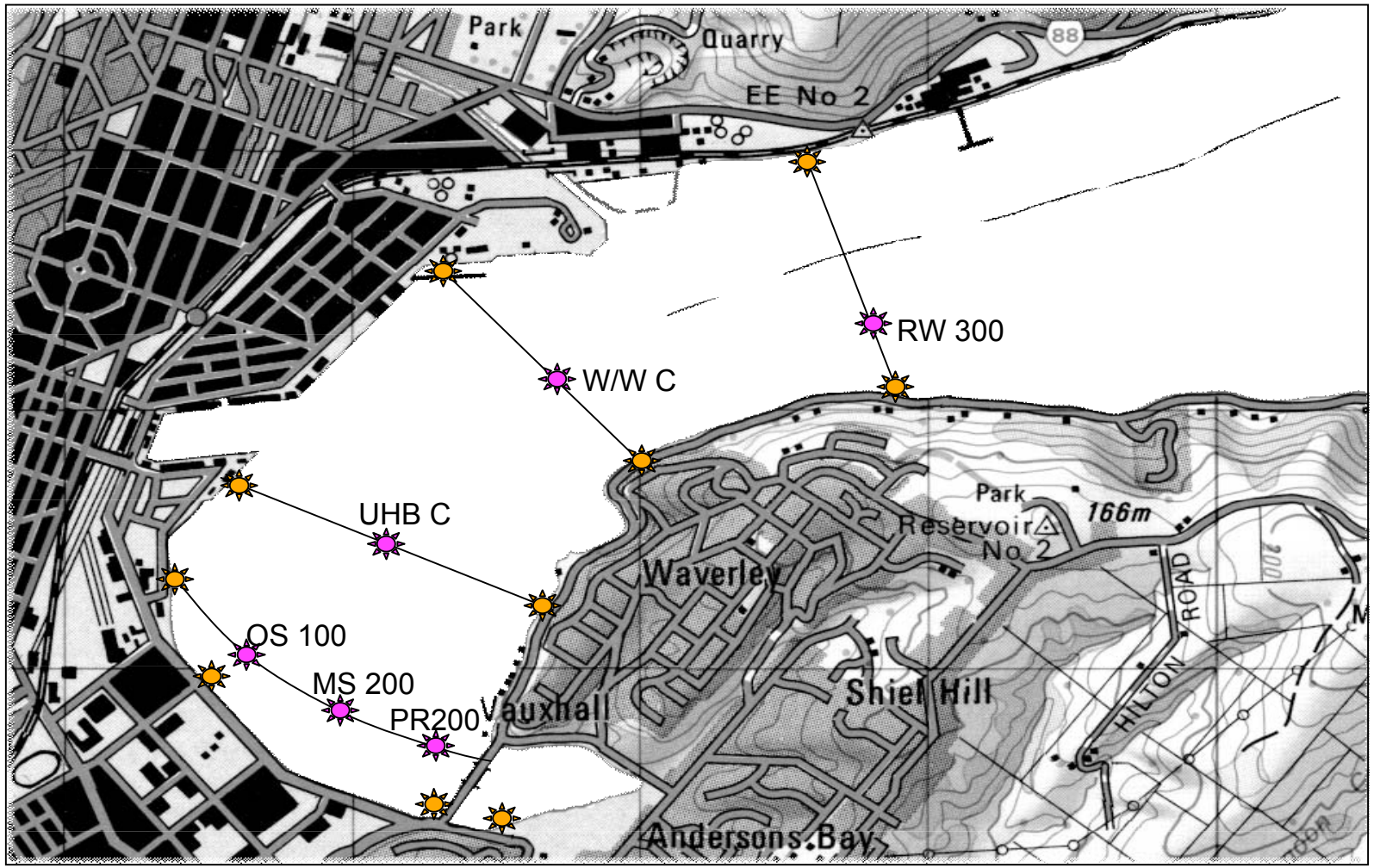


Figure 2. *Upper Harbour Basin sediment sampling sites. Orange stars sampled annually; pink stars sampled 5 yearly. Anticlockwise, starting at top, orange sites are: Rowing Club, Wickliffe St, White St, Kitchener St, Orari St, Portobello Rd, Shore St, Boatshed, Cove Drainage and Retaining Wall. Pink sites are coded according to location (see Table 4).*

2.3 Biological Monitoring

At the Portobello Road, Orari Street and Kitchener Street outfalls two sites within 20m of each outfall and at the waters edge at low tide were sampled for flora and fauna. An additional two sites were sampled at no less than 50m from each outfall at the waters edge. At each site, three randomly spaced $5m^2$ quadrats were sampled, giving a total of 12 quadrats at each outfall. For epifauna within each $5m^2$ quadrat, the number of each species was recorded in five $0.1m^2$ quadrats. For infauna a sediment core was taken in three $0.1m^2$ quadrats per site, giving 12 cores per outfall. Sediment was returned to the laboratory, washed through a 500μm sieve and the number of each species retained was recorded. For macroflora, the percentage cover of each species was estimated in three $1.0m^2$ quadrats per site, giving 12 quadrats per outfall. For both epifauna and infauna a Shannon Weiner diversity index (Zar 1996) was calculated to enable diversity to be compared from year to year.

2.4 Cockle, Mussel, Fish and Octopus Flesh

Daily patrols of the shoreline at low tide adjacent to the Portobello Road and Orari Street stormwater outfalls were made, beginning in late March, to seek mature octopus (*Octopus maorum*) during the annual autumn die-off. When dying octopus were found within 50m of either of the above outfalls a composite sample comprising mantle and arm tissue was collected from each octopus. Where possible a sample of digestive gland was also collected. The tissue was then bagged, chilled, and sent to Hill Laboratories in Hamilton for analysis for, PAHs, As, Cd, Cr, Cu, Ni, Pb and Zn.

Within 14 days of the targeted rainfall event, a minimum of 15-20 large cockles (*Austrovenus stutchburyi*) were collected from within 20m of the confluence of the stormwater outlet and the waters edge at low tide at each of the Portobello Road, Orari Street and Kitchener Street outfalls. Cockles were individually measured, bagged, and chilled and sent to Hill Laboratories for analysis for As, Cd, Cr, Cu, Ni, Pb and Zn. A further 15-20 cockles were collected at each site and sent for analysis for faecal coliforms, and a further 15-20 for PAH analysis.

Within the same two weeks either spotties (*Notolabrus celidotus*) or variable triplefins (*Tripterygion vrium*) were caught using baited fish traps off the Mason Street wharf no more than 50m from the Mason Street stormwater outfall. Fish were weighed and measured, then chilled, bagged, and sent to Hill Laboratories for analysis for As, Cd, Cr, Cu, Ni, Pb and Zn and for PAHs.

At second Beach a minimum of a minimum of twelve mussels (*Perna canaliculus*) were collected from the rock reef to the east of the Second Beach stormwater outfall at a distance of no more than 50m from the outfall. Only mussels of mature size (≥80mm) were collected. Mussels were individually measured, bagged, and chilled and sent to Hill Laboratories for analysis for, As, Cd, Cr, Cu, Ni, Pb and Zn. A further 12-15 mussels were collected and sent for analysis for faecal coliforms.

3. Results and Discussion

3.1 Stormwater

During the first hour of a storm event that produced 6.4mm rainfall on 11 April 2007 water samples were collected from stormwater outfalls at Second Beach,

Shore Street, Portobello Road, Teviot Street, Midland Street, Orari Street, Kitchener Street, Mason Street, Bauchop Street, Halsey Street and Wickliffe Street in Dunedin and from Watson Park and east George Street in Port Chalmers.

Stormwater at Second Beach was clear but at all other sites was heavily discoloured, particularly at Kitchener Street and Halsey Street. Contaminant levels at Teviot Street and at Orari Street were all below ANZECC (2000) guidelines for protection of 80% of species (Table 1) and Portobello Road and Shore Street exceeded trigger levels for just a single parameter each. It should be noted that Orari Street and Portobello Road both operate with sump systems and it is not clear if, in fact, the first flush had reached the outfall for these sites at the time of sampling. The highest levels of contaminants were at Kitchener Street, although a number of heavy metals were still well below trigger levels at this site (Table 2). PAHs were detected only in Orari Street stormwater and then only Pyrene at very low levels (Table 3)

Microbiological levels were high to very high at all sites bar Teviot and Orari Streets (Table 2). This is perhaps not unexpected for first flush samples with a considerable amount of animal faeces being washed into the stormwater system from streets and pavements. FWAs were detected at low flows at all sites except George St (Port Chalmers), Teviot Street, Midland Street, Orari Street and Halsey Street (Table 2). Bauchop Street had particularly high levels of FWAs leading to speculation that there is gross contamination of stormwater by sewage somewhere within this catchment.

Faecal coliform levels too, were high during low flows at Mason, Bauchop and Wickliffe Streets, further suggesting possible contamination by sewage.

When the above results were obtained it was decided that additional samples of stormwater should be collected from Kitchener Street, Bauchop Street, Mason Street and Halsey Street during a storm event and analysed for FWAs to provide some comparison with low flow values. Reults for these analyses will be reported once a suitable storm event has been sampled.

Table 2. *Levels of contaminants detected in stormwater from outfalls in and around Dunedin during a storm event on 11 April 2007. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For faecal coliforms orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

		Stormwater													
	Parameter	pH	Suspended Solids	As	Cd	Cr	Cu	Ni	Pb	Zn	Oil & Grease	FWA	E. coli	Faecal Coliforms	Faecal Coliforms (low flow)
	units		g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	µg/L	mpn/100ml	cfu/100ml	cfu/100ml
Catchement	Second Beach	7.7	<3	BDL	BDL	0.0007	0.0027	0.0009	0.001	0.038	5	0.147	560	560	
	Pt Chalmers George St	6.9	87	BDL	0.00028	0.005	0.0213	0.0029	0.0342	0.288	10	BDL	1400	1400	
	Pt Chalmers Watson Pk	6.8	37	BDL	BDL	BDL	0.009	BDL	0.0141	0.231	8	0.002	14000	39000	
	Shore Street	7.9	41	0.04	BDL	BDL	0.01	0.01	0.003	0.02	BDL	0.081	300	300	
	Portobello Road	7.9	18	BDL	BDL	BDL	BDL	BDL	BDL	0.08	4	0.003	460	590	
	Teviot Street	7.9	25	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8	BDL	7	7	
	Midland Street	7.7	30	BDL	BDL	BDL	0.02	BDL	0.005	0.1	BDL	BDL	290	290	
	Orari Street	7.8	28	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	50	80	
	Kitchener Street	7.1	104	BDL	BDL	0.004	0.034	0.003	0.0442	0.445	9	0.18	13000	13000	580
	Mason Street	7.1	62	0.006	BDL	BDL	0.022	0.004	0.0258	0.25	5	0.007	22000	22000	16000
	Bauchop Street	7.6	44	0.03	BDL	BDL	0.029	0.01	0.01	0.23	4	2.028	2200	2200	2800
	Halsey Street	7.3	119	0.03	BDL	BDL	0.024	0.009	0.021	0.12	9	BDL	9000	9000	
	Wickliffe Street	7.7	35	0.03	BDL	BDL	0.01	0.01	0.006	0.1	6	0.024	25000	30000	20000

Table 3. *PAHs (g/m^3) detected in stormwater from the Kitchener Street, Orari Street and Portobello Road outfalls. BDL indicates Below Detectable Limits.*

	Kitchener St	Orari St	Portobello Rd
Acenaphthene	BDL	BDL	BDL
Acepaphthylene	BDL	BDL	BDL
Anthracene	BDL	BDL	BDL
Benzo[a]anthracene	BDL	BDL	BDL
Benzo[a]pyrene	BDL	BDL	BDL
Benzo[a]fluorathene	BDL	BDL	BDL
Benzo[g,h,i]perylene	BDL	BDL	BDL
Benzo[k]fluorathene	BDL	BDL	BDL
Chrysene	BDL	BDL	BDL
Dibenzo[a,h]anthracene	BDL	BDL	BDL
Fluoranthene	BDL	BDL	BDL
Fluorene	BDL	BDL	BDL
Indeno[1,2,3-c,d]pyrene	BDL	BDL	BDL
Naphthalene	BDL	BDL	BDL
Phenanthrene	BDL	BDL	BDL
Pyrene	BDL	0.0001	BDL

3.2 Sediments

Sediments were sampled in April 2007. Surface sediments were generally clean at most sites with little surface detritus. However, at Portobello Road sediments were very dark and smelled strongly of petro-carbons and a visible oil slick formed in depressions dug to remove sediments. At Wickliffe Street, sediments were dark and smelled strongly of hydrogen sulphide, indicating anoxic conditions.

As expected, copper, nickel, lead and zinc levels are elevated in sediments near stormwater outfalls that discharge from large or industrialised catchments (Table 4). Cadmium is high off Portobello Road and Orari Street, as is arsenic. Arsenic is, however, also high at Boatshed, Cove Drainage and Retaining wall, all sites well removed from any stormwater outlets. It is unclear why this may be so, but these three sites are adjacent to outcrops of basement rock along the southern side of the harbour and the geology of the area may be having an effect. As observed in previous investigations PAHs are to be found at high levels in much of the Upper

harbour Basin, with particularly high levels adjacent to the Portobello Road outfall (Table 4).

Table 4. *Contaminant levels in sediments at various locations within 20m of stormwater outfalls and within the Upper Otago Harbour Basin. Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

	Sediments Within 20m									
Parameter	As	Cd	Cr	Cu	Ni	Pb	Zn	PAH	Enterococci	Faecal Coliforms
Units	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	cfu/100g	MPN/g
ANZECC Low trigger value	20	1.5	80	65	21	50	200	4		
ANZECC high trigger value	70	10	370	270	52	220	410	45		
	As	Cd	Cr	Cu	Ni	Pb	Zn	PAH	Enterococci	Faecal Coliforms
Rowing Club	10.6	0.16	17.6	14.2	11.3	18.9	101	6.973	200	<2
Wickliffe Street	17.3	0.61	38	121	19.2	76.1	412	9.214	58000	2
White Street	11.6	0.29	68.5	433	29.5	147	4450	12.962	400	<2
Kitchener Street	4.63	0.38	22.6	69.53	10.6	117.9	249.3	8.877	6633	20
Orari Street	18.58	62.97	0.273	25.13	23.63	12.8	68.27	10.23	12.67	23000
Orari St 100m	13.7	0.36	26.3	25.9	12.6	170	227	6.67	3600	15
Midland St 200m	15.4	0.29	22.4	19	10.7	36	165	7.24	20000	2
Portobello Road	29	48.5	1.84	60.1	169.3	20.43	306.3	436.27	72667	23
Portobello Rd 200m	17.4	0.49	41.8	52.6	17.3	81.3	309	8.97	66000	2
Shore Street	9.5	0.44	21.8	50.9	10.7	113	484	9.559	9000	<2
Boatshed	27.4	0.29	41.7	108	24.5	112	339	6.666	3400	<2
Cove Drainage	21.5	0.08	15.8	11.3	23.5	19.7	99.2	0.365	800	2
Retaining Wall	25.3	0.12	23.6	13.3	15.9	26.9	141	0.296	<100	2
Retaining Wall 300m	16.2	0.26	0.27	15.2	12.4	6.7	131	0.3	<2	<2
W/W Centre	11.1	0.22	30.8	15.3	14.6	5.6	168	0.34	<2	<2
UHB Centre	10.5	0.24	24.3	15.2	11.3	23	119	0.65	24000	<2

3.3 Biological Monitoring

On 16 April 2007 biological sampling was carried out at the Kitchener Street outfall. On 18 April biological sampling was carried out at the Orari Street and Portobello Road outfalls. The tide on both days was very low at 1.07m below mean sea level and 1.14m below means sea level respectively.

Macroalgal cover was very spares at all sites except >50m from the Kitchener Street outfall (Tables 5-7).

Table 5. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Kitchener Street outfall.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Codium fragilis	5					5
Lenormandia chauvinii			3		3	3
Ulva lactuca						
Gracilaria chilensis						

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Codium fragilis			5	3		
Lenormandia chauvinii	50	70	40	5	20	3
Ulva lactuca						
Gracilaria chilensis						

Table 6. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Orari Street outfall.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Codium fragilis		5				
Lenormandia chauvinii	2	2	3	0.5	4	7
Ulva lactuca	0.5	0.5		0.5		
Gracilaria chilensis						

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Codium fragilis					7	
Lenormandia chauvinii	2	0.5	0.5	0.5	0.5	2
Ulva lactuca						
Gracilaria chilensis					0.5	
Uptilota spp			0.5			

Table 7. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Portobello Rd outfall.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Codium fragilis						
Lenormandia chauvinii						
Ulva lactuca						
Gracilaria chilensis						

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Codium fragilis						
Lenormandia chauvinii						
Ulva lactuca						
Gracilaria chilensis	2	2				
Enteromorpha intestinalis					0.5	

Epifauna was also reasonably sparse at all three outfalls (Tables 8-10) but with numbers of animals per square metre higher at more than 50m distant from each outfall than within 20m of the outfalls (Tables 8-10).

Table 8. *Epifauna within 20m (top) and greater than 50m (overleaf) of the Kitchener Street outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Anemones															
Anthopleura spp		1		1					1						
Polychaete worms															
Pomatoceros caerulus		6	4							45					2
Barnacles															
Eminius modestus															4
Chitons															
Sipharochiton palliserpentis														1	
Gastropod snails															
Cominella glandiformis					1	1									1
Diloma subrostrata	4	5	4	8	15	11	13	17	7	35	11	10	27	31	22
Sigapatella novaezelandiae			1												
Patelloidea corticata	1														
Bivalves															
Austrovenus stutchburyi						1		2	3						
Ostrea heffordi	2	5	3				1			7				5	7
Mytilus galloprovincialis					1										

Table 8 continued….

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Spirorbis spp							83			8					
Barnacles															
Eminius modestus			100												
Chamaesipho columna			100												
Chitons															
Acanthochitona zelandica		1													
Gastropod snails															
Cominella glandiformis	1	1	2												
Diloma subrostrata	5	6	4	8	12	3	4	11	16	5	8	1	2	1	1
Zethalia zelandicum													2	2	1
Bivalves															
Austrovenus stutchburyi	1					1	1	1	1	2	6		9	1	1

Table 9. *Epifauna within 20m (top) and greater than 50m (bottom) of the Orari Street outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Chitons															
Acanthochitona zelandica		1													
Gastropod snails															
Cominella glandiformis											1				
Diloma subrostrata	8	7	7	4	9	3	5	5	4	6	11	13	13	1	6
Cellana radians											2				
Bivalves															
Austrovenus stutchburyi	2	8	9	7	9	9	13	17	11	19	15	16	7	27	11
Ostrea heffordi						1					1		1		
Perna canaliculus											1				
Macomona liliana							1								

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Gastropod snails															
Cominella glandiformis									2						
Diloma subrostrata	1						1	1	1						1
Bivalves															
Austrovenus stutchburyi	17	37	19	28	35	37	39	28	24	31	37	19	24	33	32
Macomona liliana												1			

Table 10. *Epifauna within 20m (top) and greater than 50m (overleaf) of the Portobello Rd outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Barnacles															
Eminius modestus				35											
Chamaesipho columna															
Gastropod snails															
Diloma subrostrata		2		1		1	1		1	1				1	1
Melagraphis aethiops	1														
Zeacumantus subcarinatus	1	1						1				1	1		1
Bivalves															
Austrovenus stutchburyi	3	3	4	1	2		1	5	3	1	2	1	1	1	4

Table 10 continued….

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus				34	2					18		8			57
Barnacles															
Chamaesipho columna				7											
Chitons															
Chiton glaucus					1		1								
Gastropod snails															
Diloma subrostrata	1			3	2	3	3			2		1	1	1	
Melagraphis aethiops												1			
Sigapatella novaezelandiae			1												
Cellana radians				1			1								
Bivalves															
Austrovenus stutchburyi	11	5	4	5	5	5	5	7	1	9	2	8	6	2	4
Macomona liliana			1												

Diversity was, however, variable with Orari Street and Portobello Road showing greater diversity further from the outfall while Kitchener Street showed the converse (Table 11).

Table 11. *Diversity (H') of epifauna within 20m and greater than 50m of the Kitchener Street, Orari Street and Portobello Road outfalls.*

Site	<20m	>50m
Kitchener Street	0.48	0.71
Orari Street	0.36	0.05
Portobello Road	0.53	0.5

Cockles became noticeably smaller as one moved from Kitchener Street to Portobello Road (Table 12).

Table 12. *Size of cockles collected at Kitchener Street, Orari Street and Portobello Road.*

Site	n=	Mean weight (g)	Mean length (mm)
Kitchener Street	59	18.8	37.1
Orari Street	62	12.3	32.4
Portobello Road	64	9.4	30.1

Infauna was dominated by nemertean and polychaete worms at most sites, although cockles (*Austrovenus stutchburyi*) were very common at sites greater than 50m from each outfall (Tables 13-15).

Table 13. *Abundance of species of infauna collected <20m and >50m from the Kitchener Street outfall.*

Kitchener Street			Location	<20m							>50m						
2007			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Glyceridae			1				3	4	2		2		2		6
		Nephtyidae					1	1	1	3			2			1	3
		Nereidae									2	2			2		6
		Opheliidae										1				1	2
		Sabellidae		2			1			3							
		Spionidae			2	2	1	13	3	21	1	1			3		5
Hemichordata																	
	Enteropneusta																
Nemertea				21	19		5	4	2	51	5	4	7	2	7		25
Crustacea																	
	Decapoda																
			Helice crassa								1						1
	Amphipoda	Haustoriidae															
		Jassidae			3					3							
		Phoxocephalidae		1	1					2		2			1	2	5
Mollusca																	
	Polyplacophora																
			Acanthochitona zelandica													1	1
	Gastropoda																
			Diloma subrostrata								2	2	1				5
	Bivalvia																
		Veneridae								4							6
			Austrovenus stutchburyi			1	2				7	2	1	2	1	3	
			Puyseguria spp.				1				2				1	2	
		Tellinidae								3							3
			Macomona liliana								1		1				6
Chordata																	2
	Urochordata																
		Ascidiacea			1					3							
		Animals per core		24	26	3	11	18	9	94	23	14	14	4	17	10	74
		Animals per m2		4776	5174	597	2189	3582	1791	18706	4577	2786	2786	796	3383	1990	14726
		Species per site		3	6	2	6	3	4	10	9	7	6	2	7	6	14

Table 14. *Abundance of species of infauna collected <20m and >50m from the Orari Street outfall.*

Orari Street			Location	<20m							>50m						
2007			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Glyceridae			5	2		1		8		1		2	2	4	9
		Maldanidae							1	1	1						1
		Nephtyidae		1		1			1	3	3	1	1	1	1	1	8
		Nereidae		1		1		1	3	6	2				4		6
		Opheliidae					1			1							
		Orbiniidae					2			2							
		Pectenariidae												1	2		3
		Sabellidae						1		1							
		Serpulidae				1				1							
		Spionidae			3			3		6	2	3		1			6
Nemertea				3	3	4	6	6	3	25	5	2	2			2	11
Sipuncula					1					1							
Crustacea																	
	Decapoda																
			Helice crassa		1		1			2							
	Amphipoda																
		Jassidae		3				1		4							
		Phoxocephalidae			2	1				3	1				2		3
Mollusca																	
	Polyplacophora																
			Acanthochitona zelandica														
	Gastropoda																
			Diloma subrostrata			2		1		3	1					1	2
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi	6	5	4	1	5	8	29	7	5	4	3	7	8	34
			Puyseguria spp.					2	2	4			2				2
		Mesodesmatidae															
			Paphies australis					1		1							
		Tellinidae															
			Macomona liliana	2	2	1	1			6	1	1			1	2	5
		Animals per core		17	24	20	13	24	21	107	24	15	12	9	21	21	90
		Animals per m^2		3383	4776	3980	2587	4776	4179	21293	4776	2985	2388	1791	4179	4179	17910
		Species per site		6	8	9	6	10	6	19	9	6	4	5	7	6	12

Table 15. *Abundance of species of infauna collected <20m and >50m from the Portobello Road outfall.*

Portobello Road	2007		Location	<20m							>50m						
				Site 1			Site 2				Site 1			Site 2			
			Sample	1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Glyceridae		1					1	2							
		Maldanidae				1				1							
		Nephtyidae		1	1	2	1	2	3	1	2	3	1	2	3	4	15
		Nereidae		1		1	2	2	2	8	2	3	1	2	4	7	19
		Sabellidae		1		1	2	3		7							
		Spionidae		5	2	3	6	4	2	22		3	1		1	1	6
Hemichordata																	
	Enteropneusta						11	6	3	2							
Nemertea				11	9	6	7	6	6	45		1	3	1	2	1	8
Sipuncula					1	2				3						1	1
Crustacea																	
	Amphipoda																
		Phoxocephalidae				1				1	1	1	2				4
Mollusca																	
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi	1		1			1	3	5		3	3	2		13
		Mesodesmatidae															
			Paphies australis								1						1
		Tellinidae															
			Macomona liliana	1					2	3	2	3	2	3	3	1	14
		Animals per core		22	13	18	29	23	20	98	13	14	13	11	15	15	81
		Animals per m^2		4378	2587	3582	5771	4577	3980	19502	2587	2786	2587	2189	2985	2985	16119
		Species per site		8	4	9	6	6	8	12	6	6	7	5	6	6	9

3.4 Analyses of Cockle, Mussels, Fish and Octopus flesh

Although levels of heavy metals in the cockle flesh showed no clear trend from Kitchener Street to Portobello Road, PAH concentrations were significantly higher adjacent to the Portobello Road outfall (Table 16). All heavy metals were at concentrations well below accepted food standards (Table 17). There are no specific guidelines for PAH in shellfish flesh for New Zealand, but food standards for British Columbia recommend an upper limit for benzo[a]pyrene (Table 18). It should be noted that, as already stated, cockles became smaller as one nears the Portobello Road outfall. Whether this is due to PAH contamination or exposure at low tides and to fresh water remains to be determined. Faecal coliform levels were all below detectable limits (Table 16).

Table 16. *Contaminant concentrations in cockle flesh from within 20m of the Kitchener Street, Orari Street and Portobello Road stormwater outfalls.*

	Cockles										
Parameter	As	Cd	Cr	Cu	Ni	Pb	Zn	PAH	Faecal coliforms	Mean Weight	Mean length
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	CFU/100ml	(g)	(mm)
Portobello Road	2.5	0.014	0.32	0.64	0.71	0.17	6.3	4.912	<18	9.4	30.1
Orari Street	2.5	0.011	0.32	0.70	1.00	0.11	6.4	0.018	<18	12.3	32.4
Kitchener Street	3.5	0.016	0.34	0.81	0.64	0.08	8.0	0.009	<18	18.8	37.1

Table 17. *Heavy metal concentrations for NZ and US FDA guidelines for adults (expressed as mg/kg dry weight). '-' means no guideline is available.*

	Cu	Zn	Pb	Cd	Cr	Ni
Food Regs/NZ DoH	150.0	2000.0	10.0	5.0	-	-
US FDA	-	-	4.2	-	11.0	80.0
Australia NZ food standards code	-	-	2.0	2.0	-	-

Table 18. *British Columbian guidelines for B[a]P concentration in shellfish for human consumption*

B[a]P concentration in the edible portion of fish/shellfish (µg B[a]P/kg wet weight)	Safe quantity for weekly consumption* on a regular basis (g wet weight)	B[a]P Portobello Road cockles
4	50	249
2	100	
1	200	

*low and moderate consumption levels, according to the State of Washington, are 45 g/wk (or 6.5 g/d) and 140 g/wk (or 20 g/d).

As for cockles in the upper harbour basin, mussels from Second Beach showed levels of contamination that were well below accepted food guidelines (Table 19). Concentrations of most contaminants were not dissimilar to those observed in cockles (Tables 16 and 19) and show little evidence of contamination by stormwater.

Table 19. *Contaminant concentrations in mussel flesh from within 20m of the Second Beach stormwater outfall.*

	Mussels								
Parameter	As	Cd	Cr	Cu	Ni	Pb	Zn	PAH	Faecal coliforms
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	CFU/100ml
Second Beach	1.6	0.0780	0.33	1.00	0.4	0.140	12.0	0.0355	<18

Twelve triplefins were caught in baited fish traps set off the Mason Street wharf on 8 May, 2007. The fish were small (Table 20), but representative of the size classes commonly seen amongst variable triplefins. Contaminant levels in the fish flesh was, once again, not dissimilar to that found in cockles, although it could be argued that the concentration of most contaminants, with the exception of zinc, were lower

in the fish (Table 21). At first glance one is tempted to say that this is not unexpected, given that the cockles are filter feeders while the fish are predators. However, contaminants tend to become more concentrated as one moves up the food chain. Triplefins do not prey on shellfish, but do eat smaller fish and a variety of other invertebrates. The fact that contaminant levels are low in fish flesh suggests that heavy metal and PAH contamination around the Mason Street stormwater outfall is low.

Table 20. *Size and weight of triplefins captured near the Mason Street Stormwater outfall.*

	Fish Sizes (mm)	Weight (g)
	75	4.7
	71	3.9
	73	4.4
	61	2.2
	49	1.1
	78	5.3
	77	5.6
	79	6.1
	75	4.1
	46	0.9
	52	1.6
	74	4.6
Mean =	67.5	3.7

Table 21. *Contaminant concentrations in the flesh of triplefins captured near the Mason Street Stormwater outfall.*

	Fish									
Parameter	As	Cd	Cr	Cu	Ni	Pb	Zn	PAH	Mean Size	Mean Weight
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	(mm)	(g)
Mason Street	1.9	0.0047	0.1	0.54	<0.02	0.140	21.0	0.0056	67.5	3.7

On 30 April a small octopus was found immediately in front of the Orari Street stormwater outfall. A large octopus was found on 10 May ~40m from the Portobello Road outfall. Both octopodes were very recently dead so collecting samples of flesh and digestive gland was not difficult. Contaminant levels within the digestive gland were, as expected, higher than in the remainder of the octopus flesh in both cases (Table 22).

Table 22. *Contaminant concentrations in the flesh (upper) and digestive glands (lower) of octopus collected near the Orari Street and Portobello Road Stormwater outfalls.*

	Octopus									
Parameter	As	Cd	Cr	Cu	Ni	Pb	Zn	PAH	Arm span	Weight
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	(mm)	(g)
Portobello Road	12.0	0.001	<0.02	3.30	0.1	0.023	13.0	0.0043	2603.0	11783.6
Orari Street	7.7	0.008	<0.02	3.90	0.1	0.220	14.0	-	680.0	197.4

	Octopus (Digestive gland)									
Parameter	As	Cd	Cr	Cu	Ni	Pb	Zn	PAH	Arm span	Weight
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	(mm)	
Portobello Road	12.0	0.260	<0.2	44.00	0.5	0.074	26.0	0.0599	2603.0	11783.6
Orari Street	7.7	3.300	9.2	740.00	5.2	0.440	160.0	-	680.0	197.4

Once again, however, contaminant concentrations are quite low and certainly well below food guidelines, with the exception of cadmium in the digestive gland of the Orari Street specimen. Arsenic levels are higher than those found in either fish or shellfish but reasons for this are unclear. An octopus sampled in the autumn of 2006 from near Orari Street also had high arsenic levels.

Octopodes are higher on the food web than shellfish, but results of analyses for cockles, fish and octopodes obtained this year do not give any clear indication as to where an organisms lies with respect to trophic level.

4. Conclusion

Ultimately there will be 31 sites at which monitoring or stormwater will take place. In addition, sediments will be sampled at a number of these sites. However, this more modest 2007 survey provides a reasonable baseline dataset against which future monitoring may be compared. For interest sake historical data for the same sites have been included this year for comparison (Tables 23 and 24). Any trends observed in these data for sediment values should be viewed with extreme caution however, as sampling in some previous years may have used entirely different protocols. Stormwater sampling, however, is comparable.

Table 23. *Contaminants in sediments in the upper Otago harbour basin in the vicinity of selected stormwater outfalls through time.*

	As		Cadmium		Cr		Copper		Ni		Pb		Zn		PAH		Enterococci	
	Historic	2007	Historic	2007	Historic	2007	Historic	2007	Historic	2007	Historic	2007	Historic	2007	Historic	2007	Historic	2007
Rowing Club		10.6	0.03	0.16	16.8	17.6	9.8	14.2		11.3		18.9	80.8	101		6.973		200
Wickliffe		17.3		0.61		38		121		19.2		76.1		412		9.214		58000
White St		11.6		0.29		68.5		433		29.5		147		4450		12.962		400
Kitchener St		4.63		0.38	7.1	22.6		69.53	5.8	10.6		117.9	170	249.33		8.877	130	6633
Orari St		18.58	0.45	62.97	17.5	0.27	20	25.13	10.4	23.63	185	12.8	239	68.27	13.407	10.230	557	12.67
Orari 100		13.7	0.29	0.36	16	26.3	28	25.9	8.8	12.6	170	170	230	227		6.67	1300	3600
Midland 200		15.4	0.41	0.29	22	22.4	24	19	8.3	10.7	36	36	190	165		7.24	130	20000
Portobello Rd		29	2	48.50	41	1.84	210	60.1	15	169.33	410	20.43	1300	306.33	425.83	436.270	1120	72667
PR 200		17.4	1	0.49	32	41.8	100	52.6	13	17.3	130	81.3	430	309	12.288	8.97	40	66000
Shore St		9.5	0.45	0.44	9.6	21.8	30	50.9	5.4	10.7	130	113	300	484		9.559	2400	9000
Boatshed		27.4		0.29		41.7		108		24.5		112		339		6.666		3400
Cove Drainage		21.5		0.08		15.8		11.3		23.5		19.7		99.2		0.365		800
Retaining wall		25.3		0.12		23.6		13.3		15.9		26.9		141		0.296		<100
RW 300		16.2	0.14	0.26	28.33	0.27	16.3	15.2	13.3	12.4	40	6.7	149	131		0.3		<2
W/W centre		11.1		0.22	2.75	30.8		15.3	3.63	14.6	25	5.6		168		0.34		<2
UHB Centre		10.5	0.26	0.24	26.8	24.3	15.2	15.2	10	11.3	27	23	118	119		0.65		24000

Table 24. *Contaminants in stormwater being discharged to the upper Otago harbour basin through time. BDL = below detectable limits.*

	Parameter	Suspended Solids		Cd		Cr		Cu		Ni		Pb		Zn		PAH	
	units		g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3
Catchement	Second Beach		<3		BDL		0.0007		0.0027		0.0009		0.001		0.038		
	Pt Chalmers George St		87		0.00028		0.005		0.0213		0.0029		0.0342		0.288		
	Pt Chalmers Watson Pk		37		BDL		BDL		0.009		BDL		0.0141		0.231		
	Shore Street	75.4	41		BDL		BDL		0.01		0.01		0.003		0.02		
	Portobello Road	28	18	0.0003	BDL	0.0029	BDL	0.03	BDL	0.002	BDL	0.021	BDL	0.895	0.08	0.0031	BDL
	Teviot Street		25		BDL		BDL		BDL		BDL		BDL		BDL		
	Midland Street		30		BDL		BDL		0.02		BDL		0.005		0.1		
	Orari Street	38.1	28	0.0005	BDL	0.002	BDL	0.0132	BDL	0.002	BDL	0.022	BDL	0.191	BDL	0.0026	0.0001
	Kitchener Street		104		BDL		0.004		0.034		0.003		0.0442		0.445		
	Mason Street		62		BDL		BDL		0.022		0.004		0.0258		0.25		
	Bauchop Street		44		BDL		BDL		0.029		0.01		0.01		0.23		
	Halsey Street		119		BDL		BDL		0.024		0.009		0.021		0.12		
	Wickliffe Street		35		BDL		BDL		0.01		0.01		0.006		0.1		

There has been a decline in contaminant levels at stormwater outfalls for which there are historic data provided. This is expected for lead as it has been removed from paint and petrol and levels in the environment are very gradually declining. The reduction in the levels of other contaminants is gratifying, but may merely be a function of the intensity of the storm events when sampling occurred. It will be of interest to see if any long term trends can be discerned as monitoring continues.

Benthic and infaunal communities in the vicinity of the Portobello Road, Orari Street and Kitchener Street outfalls have reasonably low diversity, but this is generalised and not associated with any one outfall and is likely symptomatic of a large proportion of the upper harbour basin. Rainer (1981) and Grove (1995) certainly found less diversity in soft-bottom macrofaunal communities as on moves from harbour mouth to the head of Otago Harbour. There is a trend towards smaller cockles as one nears the Portobello Road outfall. This may be as a result of PAH contamination, which is extremely high at this site, but a number of other factors, not least of which are freshwater exposure and exposure at low tide, must also be considered.

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Compliance Monitoring 2008

Stormwater Discharges from Dunedin City

(ORC Resource Consents 2002.080-2002.110 and 2006.222)



Prepared for

Dunedin City Council

by

Ryder Consulting Ltd.

July 2008

ryderconsulting
ecology + planning + project management

Compliance Monitoring 2008

Stormwater Discharges from Dunedin City

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prepared by

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July 2008

Cover photo: Orari Street stormwater outfall pump discharging

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Executive Summary

This report presents the findings for the first annual monitoring of Dunedin's stormwater outfalls since discharge consents were granted.

The survey comprised assessment of benthic communities, of contamination of stormwater and of contamination of sediments and benthic fauna, including octopus, cockles and mussels.

Stormwater from all outfalls monitored showed variable levels of contamination, with numerous parameters being present at concentrations above recommended ANZECC guidelines or trigger values.

Overall contaminant levels were similar to those observed in a preliminary survey carried out in 2007, with no clear trends discernible at this juncture.

1. Introduction

1.1 Background

As with all urban centres throughout New Zealand and indeed most of the world, Dunedin's stormwater is reticulated to receiving environments via networks of gutters, open channels and pipes. The principal receiving water environments for Dunedin's reticulated stormwater are the upper basin of Otago Harbour, Second Beach/St. Clair Beach on the open coast, Kaikorai Stream and the Water of Leith. Dunedin City Council (DCC) was, on 29th November 2007, granted resource consents for its major urban stormwater discharges into the coastal marine environment (i.e. Otago Harbour, Sawyers Bay. Port Chalmers and Second Beach).

Conditions under which consents have been granted include compliance monitoring. Specifically:

Condition 2.

(a) *The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.*

(b) *The sampling shall be undertaken during storms, preceded by at least 72 hours of no measurable precipitation, with an intensity of at least 2.5 millimetres (depth) of rain in a 24 hour period. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:*

(i) pH
(ii) suspended solids
(iii) faecal coliforms and Escherichia coli
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic

(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease
(xiii) Polycyclic aromatic hydrocarbons ***(Portobello Road, Orari and Kitchener Street consents only)***

(c) *The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b).*

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road catchment discharge consent only

(a) *The consent holder shall undertake to determine the source and extent of the high levels of polycyclic aromatic hydrocarbons in the historic sediment deposits associated with discharge from the Portobello Road stormwater outlet.*

(b) *Updates on the progress of the investigation in condition 3(a) shall be provided in writing to the Consent Authority by 1 September each year.*

(c) *No later than six months prior to the expiry of this consent, the consent holder shall provide a report to the Consent Authority stating the outcomes of the investigation in condition 3(a) and outlining the best practicable option(s) to mitigate the effects of these contaminated sediments.*

For the Portobello Road, Orari and Kitchener Street discharge consents only

(a) *The consent holder shall undertake biological monitoring annually between the months of January to June inclusive. The monitoring shall be undertaken at four sites at the waters edge at low tide; two within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide and two a minimum of 50 metres of the confluence of the stormwater outlet and the waters edge at low tide.*

(b) *At each site, three randomly spaced 5m^2 quadrats shall be sampled. For epifauna within each 5m^2 quadrat, the number of each species shall be recorded in five 0.1m^2 quadrats. For infauna a sediment core shall be*

taken in three 0.1m^2 quadrats and the number of each species shall be recorded. For macroflora, the percentage cover of each species shall be estimated in three 1.0m^2 quadrats.

(c) *Results shall be reported to the Consent Authority in accordance with condition 8(e).*

For the Portobello Road, Orari and Kitchener Street discharge consents only

The consent holder shall undertake sampling of the flesh of cockles (Austrovenus stutchburyi) annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide. The size of each cockle sampled shall be recorded. The cockle flesh samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
(i) faecal coliforms

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road and Orari Street discharge consents only

The consent holder shall undertake sampling of deceased octopus annually, between the months of January to June inclusive (to align with the autumn die-off of octopus). Samples will include flesh and, if available, digestive gland. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The total arm span and weight of each octopus sampled shall be recorded. The samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel

(f) total cadmium

(g) total chromium

(h) polycyclic aromatic hydrocarbons

Results shall be reported to the Consent Authority in accordance with condition 8(e). Should no deceased octopus be present, the consent holder shall notify the Consent Authority that sampling is unable to be undertaken.

For the Mason Street discharge consents only

The consent holder shall undertake sampling of spotties (Notolabrus celidotus) or triplefin (Tripterygion varium) annually. This sampling is to be carried out within the months of January to June inclusive. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The length and weight of each fish sampled shall be recorded. The samples shall be analysed for:

(a) total copper

(b) total lead

(c) total zinc

(d) total arsenic

(e) total nickel

(f) total cadmium

(g) total chromium

(h) polycyclic aromatic hydrocarbons

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road, Orari and Kitchener Street discharge consents only

The consent holder shall undertake sediment quality sampling using three replicate sediment samples that shall be collected at each site as marked on the plans attached as Appendix 1 to this consent. Sampling shall be undertaken:

(a) annually between January and June at the locations marked by large orange stars; and

(b) between January and June 2007, and between January and June 2010, at the locations marked by large pink stars. The samples will comprise the top 20mm of sediment and shall be analysed for:

(i) total copper

(ii) total lead

(iii) total zinc
(iv) total arsenic
(v) total nickel
(vi) total cadmium
(vii) total chromium
(viii) faecal coliforms and enterococci
(ix) polycyclic aromatic hydrocarbons
Results shall be reported to the Consent Authority in accordance with condition 8(e).

Condition 3. *The biological sampling of epifauna, infauna, macroflora, cockles, octopus, spotties or triplefins and sediment quality sampling required by Coastal Permits etc, shall be undertaken within a 14 day period (within the months of January to June), unless it is not practicable to do so due to the absence of any fauna to be sampled.*

Condition 4. *All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder and be acceptable to the Consent Authority.*

Condition 5. *Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.*

Second Beach
Condition 2.

(a) *The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of the rainfall event means that sampling in the manner described in condition 2(b) is not possible.*

(b) *The sampling shall be undertaken during storms, preceded by at least 72 hours of no measurable precipitation, with an intensity of at least 2.5 millimetres (depth) of rain in a 24 hour period. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:*

(i) pH
(ii) suspended solids
(iii) faecal coliforms and Escherichia coli
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) HEM, oil and grease
(xii) UV fluorescent (whitening agent)

(c) *The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b). Results shall be reported in accordance with condition 8(e).*

Condition 3.

(a) *The consent holder shall undertake sampling of mussels annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, 50 metres to the east of the outlet. The shell length of each mussel sampled shall be recorded.*

(b) *The sampling of mussels shall be undertaken within a 14 day period (within the months of January to June) associated with the sampling rounds for Green Island and Tahuna WWTP discharge consents, unless it is not practicable to do so due to the absence of any fauna to be sampled.*

(c) *The samples shall be analysed for:*
(i) faecal coliforms
(ii) total copper
(iii) total lead
(iv) total zinc
(v) total arsenic
(vi) total nickel
(vii) total cadmium
(viii) total chromium

(d) *Results shall be reported in accordance with condition 8(e).*

Condition 4. *All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder and be acceptable to the Consent Authority.*

Condition 5. *Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.*

The following report presents the results of the latest round of sampling/monitoring carried out between January and June 2008.

1.2 Stormwater Outfalls

Stormwater is discharged from Dunedin City to the Upper Otago Harbour, Second Beach and Port Chalmers from fourteen reasonably large and permanent stormwater outfalls (Figures 1a, 1b and 1c), and from a number of smaller outfalls and non-point sources (Table 1). Many of the outfalls have very long histories dating back to the days of the early settlement of Dunedin and a numbers were dual-purpose outfalls, discharging both wastewater and stormwater. All current outfalls, however, are designated to discharge stormwater.

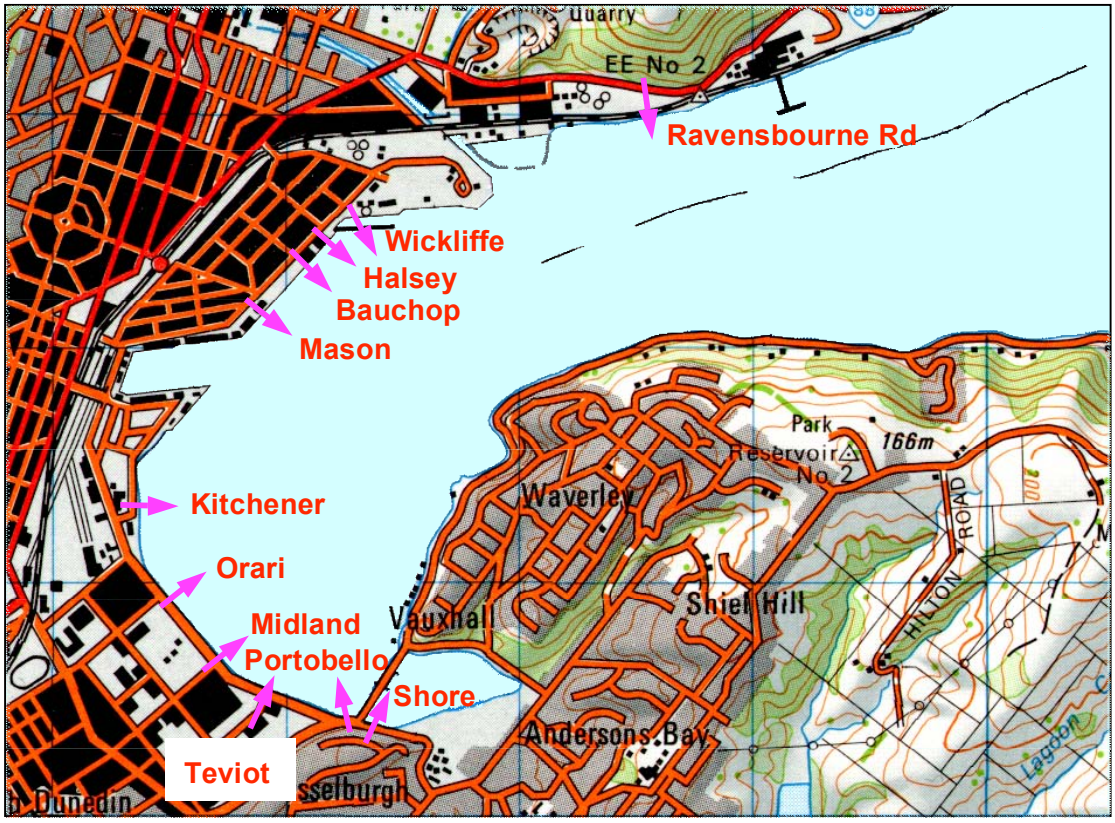


Figure 1a. *Major stormwater outfalls, labeled by catchment name, discharging from Dunedin City to the Upper Otago Harbour Basin.*



Figure 1b. *Location of the Second Beach stormwater outfall.*

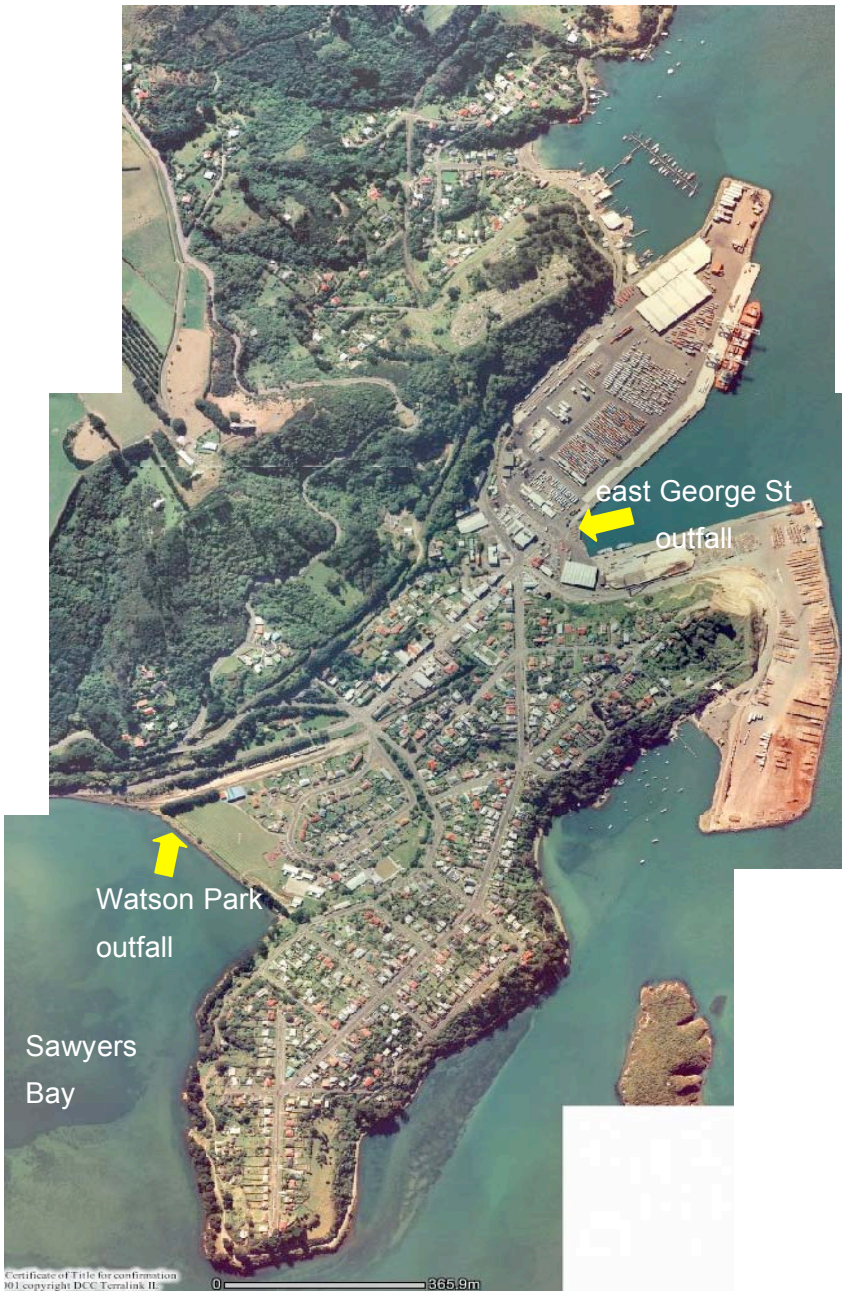


Figure 1c. *Location of major outfalls discharging stormwater from Port Chalmers.*

A total of 31 consents have been granted for the individual stormwater outfalls listed in Table 1.

Table 1. *List of stormwater outfalls for which discharge permits have been granted.*

Consent ref	DCC ref	Location	Catchment	Description	Max flow rate (l/s)	Outlet structure
2002.080	4	Shore St	Shore St	1500mm dia	2,380	Yes
2002.081	5	Portobello Rd	Portobello Rd	twin 1500mm dia conduits	pump rate 6,300	Yes
2002.082	6	Teviot St	Foreshore	375mm dia.	105	Yes
2002.083	7	Midland St	Foreshore	450mm dia	143	No
2002.084	8(a)	Orari St	Orari St	375mm dia	101	No
2002.085	8(b)	Orari St	Orari St	2700mm dia	10,350	Yes
2002.086	9(a)	Kitchener St	Kitchener St	600mm dia	310	Yes
2002.087	9(b)	Kitchener St	Kitchener St	1500mmdia	3,880	Yes
2002.088	10	French St	Foreshore	450mm dia	185	No
2002.089	11	Kitchener St	Foreshore	300 mm dia.	78	No
2002.090	12(a)	Birch St	Foreshore	225 mm dia.	37	No
2002.091	12(b)	Birch St	Foreshore	225 mm dia.	55	No
2002.092	12(c)	Wharf St	Foreshore	225 mm dia.	52	No
2002.093	13(a)	Fryatt St	Foreshore	150 mm dia.	40	No
2002.094	13(b)	Fryatt St	Foreshore	450mm dia	180	No
2002.095	13(c)	Fryatt St	Foreshore	300mm dia	54	No
2002.096	14	Fryatt St	Foreshore	300mm dia	116	No
2002.097	15(a)	Mason St	Mason St	2175mm dia. conduit	5,000	Yes
2002.098	15(b)	Mason St	Bauchop St	450mm dia	90	No
2002.099	15(c)	Mason St	Bauchop St	1350mm dia. culvert	1,500	No
2002.100	16(a)	Halsey St	Halsey St	1950mm conduit	3,800	No
2002.101	16(b)	Halsey St	Wickliffe St	1950mm conduit	2,600	No
2002.102	16(c)	Halsey St	Wickliffe St	300mm dia	113	Yes
2002.103	17	Wickliffe St	Wickliffe St	1,050 mm dia.	1,660	No
2002.104	18(a)	Magnet St	Magnet St	300mm dia	73	No
2002.105	18(b)	Magnet St	Magnet St	300mm dia	66	No
2002.106	19	Ravensbourne Rd	?	300 mm dia.	117	Yes
2002.108		George St (Port Otago)	Port Chalmers	750 mm dia.	1,000	No
2002.109		George St/SH88	Port Chalmers	1,250 mm dia.	1,200	Yes
2002.110		Second Beach Rd	St. Clair	1,050 x 1,050 mm tunnel	7,000	Yes
2006.222		Sawyers Bay, western side of Watson Park, Port Chalmers	Port Chalmers	150 mm dia.	20	Yes

2. Methods

2.1 Stormwater

A number of the outfalls listed in Table 1 do not have outfall structures or are located in places that are inaccessible. Consequently it is neither practical nor possible to sample from the entire 31 outfalls listed, as agreed by the ORC.

However, the monitoring programme undertaken samples all major Dunedin stormwater catchments and gives a comprehensive picture of the state of contaminants in Dunedin's stormwater. Grab samples of stormwater were collected from each stormwater outfall within 1 hour of the commencement of a rain event (>0.5mm) in an endeavour to ensure that first flush water was gathered. Collections took place only if there was an antecedent period of at least 72 hours with no rain before the target rain event. Samples were sent to Hill Laboratories in Hamilton to be analysed for arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn), faecal coliforms and *E. coli*. Samples collected from the Kitchener Street, Orari Street and Portobello Road outfalls were additionally analysed for polycyclic aromatic hydrocarbons (PAHs). Samples were also collected during a period of low flow a week after the targeted rainfall event and sent to ESR in Christchurch for analysis of fluorescent whitening agents (FWAs). FWAs are used in laundry detergents and indicate possible sewage infiltration to the stormwater system (Petch 1996). Gilpin *et al*., (2004) recommend that stormwater be sampled at low flows to get a more accurate picture of sewage infiltration because the FWAs are usually present in only very low concentrations and are more readily detected at low flows.

2.2 Sediments

Three replicate 250cm^3 samples were collected from the top 20mm of sediment within 20m from each of the Kitchener Street, Orari Street and Portobello Road Outfalls. To gain a clear picture of sediment contamination within the upper harbour basin, further replicate sediment samples were collected at each of the sites indicated by orange stars in Figure 2. Samples were chilled and sent to Hill laboratories in Hamilton for analysis for total arsenic, total cadmium, total

chromium, total copper, total nickel, total lead, total zinc, faecal coliforms, enterococci and PAHs.

2.3 Biological Monitoring

At the Portobello Road, Orari Street and Kitchener Street outfalls two sites within 20m of each outfall and at the waters edge at low tide were sampled for flora and fauna according to the protocols outlined in Kingsford and Battershill (1998). An additional two sites were sampled at no less than 50m from each outfall at the waters edge. At each site, three randomly spaced $5m^2$ quadrats were sampled, giving a total of 12 quadrats at each outfall. For epifauna within each $5m^2$ quadrat, the number of each species was recorded in five $0.1m^2$ quadrats. For infauna a sediment core was taken in three $0.1m^2$ quadrats per site, giving 12 cores per outfall. Sediment was returned to the laboratory, washed through a 500μm sieve and animals retained identified to at least family level (Bates *et al*. 2007). The abundance of each species was then recorded. For macroflora, the percentage cover of each species was estimated in three $1.0m^2$ quadrats per site, giving 12 quadrats per outfall. For both epifauna and infauna a Shannon Weiner diversity index (Zar 1996) was calculated to enable community diversity to be compared from year to year.

2.4 Cockle, Mussel, Fish and Octopus Flesh

Daily patrols of the shoreline at low tide adjacent to the Portobello Road and Orari Street stormwater outfalls were made, beginning in late March, to seek mature octopus (*Octopus maorum*) during the annual autumn die-off. This year, however, the die-off did not commence until into July. Consequently samples to be analysed for PAHs, As, Cd, Cr, Cu, Ni, Pb and Zn were collected a little later than hoped.

For shellfish a minimum of 15-20 large cockles (*Austrovenus stutchburyi*) were collected from within 20m of the confluence of the stormwater outlet and the waters edge at low tide at each of the Portobello Road, Orari Street and Kitchener Street outfalls. Cockles were individually measured, bagged, and chilled and sent to Hill Laboratories for analysis for As, Cd, Cr, Cu, Ni, Pb and Zn. A further 15-20 cockles were collected at each site and sent for analysis for faecal coliforms, and a further 15-20 for PAH analysis.

Within the same period that cockles were collected variable triplefins (*Tripterygion varium*) were caught using baited fish traps off the Mason Street wharf no more than 50m from the Mason Street stormwater outfall. Fish were weighed and measured, then chilled, bagged, and sent to Hill Laboratories for analysis for As, Cd, Cr, Cu, Ni, Pb and Zn and for PAHs.

At Second Beach a minimum of a minimum of twelve mussels (*Perna canaliculus*) were collected from the rock reef to the east of the Second Beach stormwater outfall at a distance of no more than 50m from the outfall. Only mussels of mature size (≥80mm) were collected. Mussels were bagged and chilled and sent to Hill Laboratories for analysis for, As, Cd, Cr, Cu, Ni, Pb and Zn. A further 12-15 mussels were collected and sent for analysis for faecal coliforms.

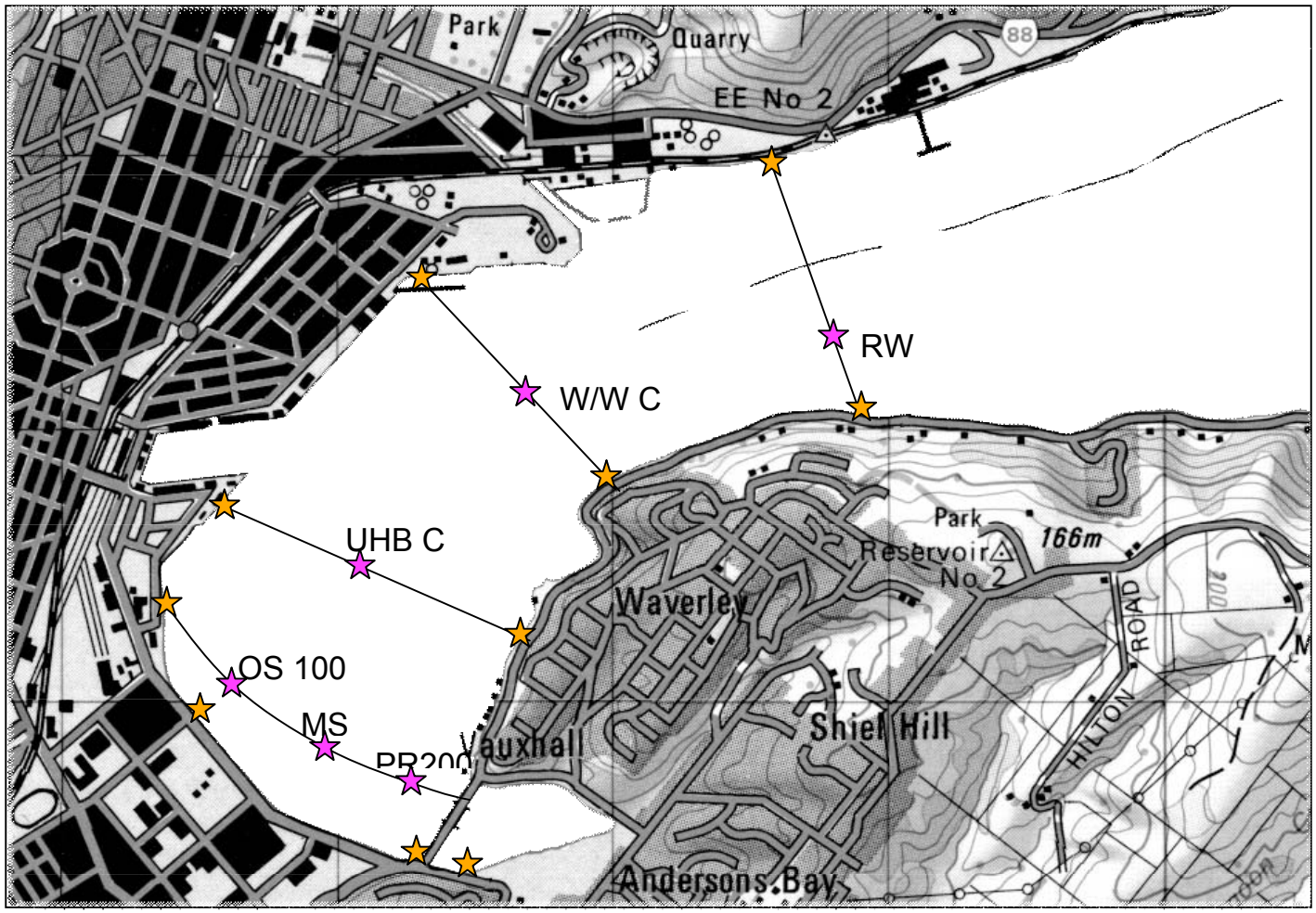


Figure 2. *Upper Harbour Basin sediment sampling sites. Orange stars sampled annually; pink stars sampled 5 yearly. Anticlockwise, starting at top, orange sites are: Rowing Club, Wickliffe St, White St, Kitchener St, Orari St, Portobello Rd, Shore St, Boatshed, Cove Drainage and Retaining Wall. Pink sites are coded according to location (see Table 4).*

3. Results and Discussion

3.1 Stormwater

During the first hour of a storm event that produced 0.5mm rainfall on 17 June 2008 water samples were collected from stormwater outfalls at Second Beach, Shore Street, Portobello Road, Teviot Street, Midland Street, Orari Street, Kitchener Street, Mason Street, Bauchop Street, Halsey Street, Wickliffe Street and Ravensbourne Road in Dunedin and from Watson Park and east George Street in Port Chalmers.

Stormwater at Second Beach and Ravensbourne Road was flowing clear at sampling time but at all other sites was discoloured, particularly at Portobello Road, Orari Street, Kitchener Street and George Street. Contaminant levels are compared with levels in stormwater collected during a preliminary survey conducted in 2007 (Table 2, Figure 3). Only at the Watson Park outfall in Port Chalmers were contaminant levels all below ANZECC (2000) guidelines for protection of 80% of species (Table 2, Figure 3). For the Ravensbourne Road outfall, just zinc exceeded the ANZECC trigger level. For Shore Street, Teviot Street, Midland Street, Kitchener Street, Mason Street, Bauchop Street, Halsey Street and Wickliffe Street both copper and zinc levels exceeded ANZECC guidelines. Trigger levels for copper, lead and zinc were exceeded at George Street (Port Chalmers), Second Beach, Orari Street and Portobello Road with George Street (Port Chalmers) also showing moderate cadmium levels (Table 2, Figure 3). It should be noted that Orari Street and Portobello Road both operate with sump systems and it is not clear if, in fact, the first flush had reached the outfall for these sites at the time of sampling. The operation of these sump systems needs to e investigated further to determine the best sampling time with respect to

these two outfalls. The highest levels of contaminants overall were at George Street, although it must be pointed out that samples here are taken from the mud tank due to the inaccessibility of the outfall beneath the container terminal. Under high flow conditions sediment in the mud tank may be disturbed by water movement and will thus contribute to contaminant levels. This would also be reflected at the outfall. The highest levels of zinc were at Portobello Road. Generally speaking, contaminant levels are much as they were in 2007 apart from lead levels which have fallen slightly and zinc levels which have risen at Second Beach, George Street, Shore Street, Portobello Road, Teviot Street, Midland Street and Orari Street.

Microbiological levels were high to very high at all sites bar Midland Street, Kitchener Street and Ravensboune Road, with Watson Park also having low E. coli levels (Table 2, Figure 3). High microbial counts are perhaps not unexpected for first flush samples with a considerable amount of animal faeces being washed into the stormwater system from streets and pavements. Of note is a significant increase in levels at Teviot Street compared to 2007 levels, with Portobello Road also showing increased microbial levels, but not on the same scale (Table 2, Figure 3).

FWAs were detected at low flows at all sites except George St (Port Chalmers), and Ravensbourne Road (Table 2). Shore Street, Kitchener Street and Wickliffe Street all showed decreases in the levels of FWAs compared with last year with remaining outfalls showing increases. As in 2007, Bauchop Street had particularly high levels of FWAs leading to speculation that there is gross contamination of stormwater by sewage somewhere within this catchment. There are no standards

for FWAs in New Zealand but levels above 0.2µg/L are cause for concern (Brent Gilpin, ESR, pers. comm.). It is expected that contaminants of this nature will be further investigated as part of the development and implementation of the long-term stormwater catchment management plans and DCC's 3-Waters strategy.

Unlike last year, when PAHs were detected only in Orari Street stormwater and then only Pyrene at very low levels (Table 3), PAH levels this year are markedly higher at all three outfalls at which this parameter is monitored (Table 3). However, total PAH levels were similarly high among the outfalls (Table 3) suggesting that Portobello Road is not the main source of PAHs to the upper harbour.

Table 2. *Levels of contaminants detected in stormwater from outfalls in and around Dunedin during a storm event on 11 April 2007 and 17 June 2008. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For faecal coliforms orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

		Stormwater													
	Parameter	As		Cd		Cr		Cu		Ni		Pb		Zn	
	units	g/m^3		g/m^3		g/m^3		g/m^3		g/m^3		g/m^3		g/m^3	
		2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Catchement	Second Beach	BDL	0.0013	BDL	0.00006	7E-04	0.0028	0.0027	0.012	0.0009	0.0021	0.001	0.011	0.038	0.16
	Pt Chalmers George St	BDL	0.0031	0.00028	0.00140	0.005	0.012	0.0213	0.039	0.0029	0.0093	0.0342	0.041	0.288	0.66
	Pt Chalmers Watson Pk	BDL	BDL	BDL	BDL	BDL	0.0064	0.009	0.0025	BDL	BDL	0.0141	0.0018	0.231	0.027
	Shore Street	0.04	BDL	BDL	BDL	BDL	BDL	0.01	0.014	0.01	BDL	0.003	0.0085	0.02	0.44
	Portobello Road	BDL	0.002	BDL	0.00023	BDL	0.002	BDL	0.026	BDL	0.0035	BDL	0.019	0.08	0.94
	Teviot Street	BDL	0.002	BDL	0.00008	BDL	0.0018	BDL	0.0094	BDL	0.0019	BDL	0.0066	BDL	0.13
	Midland Street	BDL	0.0033	BDL	0.00013	BDL	0.0035	0.02	0.031	BDL	0.0016	0.005	0.0054	0.1	0.35
	Orari Street	BDL	BDL	BDL	BDL	BDL	0.0032	BDL	0.014	BDL	0.0033	BDL	0.023	BDL	0.22
	Kitchener Street	BDL	BDL	BDL	BDL	0.004	0.002	0.034	0.0056	0.003	BDL	0.0442	0.007	0.445	0.036
	Mason Street	0.006	BDL	BDL	BDL	BDL	BDL	0.022	0.012	0.004	BDL	0.0258	0.0089	0.25	0.16
	Ravensbourne Road		BDL		BDL		0.00061		0.0023		0.0007		0.0015		0.053
	Bauchop Street	0.03	BDL	BDL	BDL	BDL	0.0015	0.029	0.0096	0.01	BDL	0.01	0.0035	0.23	0.12
	Halsey Street	0.03	BDL	BDL	0.00022	BDL	BDL	0.024	0.0043	0.009	BDL	0.021	0.0022	0.12	0.033
	Wickliffe Street	0.03	BDL	BDL	BDL	BDL	0.0017	0.01	0.013	0.01	BDL	0.006	0.0084	0.1	0.2

Table 2 continued….

		Stormwater											
	Parameter	pH		Suspended Solids		Oil & Grease		FWA		E. coli		Faecal Coliforms	
	units			g/m^3		g/m^3		µg/L		mpn/100ml		cfu/100ml	
		2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Catchement	Second Beach	7.7	7.3	BDL	37	5	BDL	0.147	0.19	560	6800	560	8300
	Pt Chalmers George St	6.9	7.1	87	150	10	8.7	BDL	BDL	1400	930	1400	1400
	Pt Chalmers Watson Pk	6.8	7.9	37	39	8	BDL	0.002	0.003	14000	150	39000	150
	Shore Street	7.9	7.2	41	24	BDL	BDL	0.081	0.031	300	5100	300	5100
	Portobello Road	7.9	7.3	18	46	4	9.7	0.003	0.049	460	5000	590	5000
	Teviot Street	7.9	7.1	25	33	8	4.4	BDL	0.006	7	120000	7	240000
	Midland Street	7.7	7.7	30	19	BDL	BDL	BDL	0.004	290	130	290	130
	Orari Street	7.8	7.4	28	77	BDL	11	BDL	0.005	50	6000	80	7000
	Kitchener Street	7.1	7.7	104	41	9	BDL	0.18	0.029	13000	70	13000	70
	Mason Street	7.1	7	62	37	5	7.9	0.007	0.07	22000	26000	22000	26000
	Ravensbourne Road		7		8.5		8.8		BDL		120		130
	Bauchop Street	7.6	7.8	44	16	4	BDL	2.028	4.92	2200	400	2200	400
	Halsey Street	7.3	7.9	119	35	9	BDL	BDL	0.004	9000	1700	9000	1700
	Wickliffe Street	7.7	7.5	35	27	6	9.5	0.024	0.003	25000	10000	30000	10000

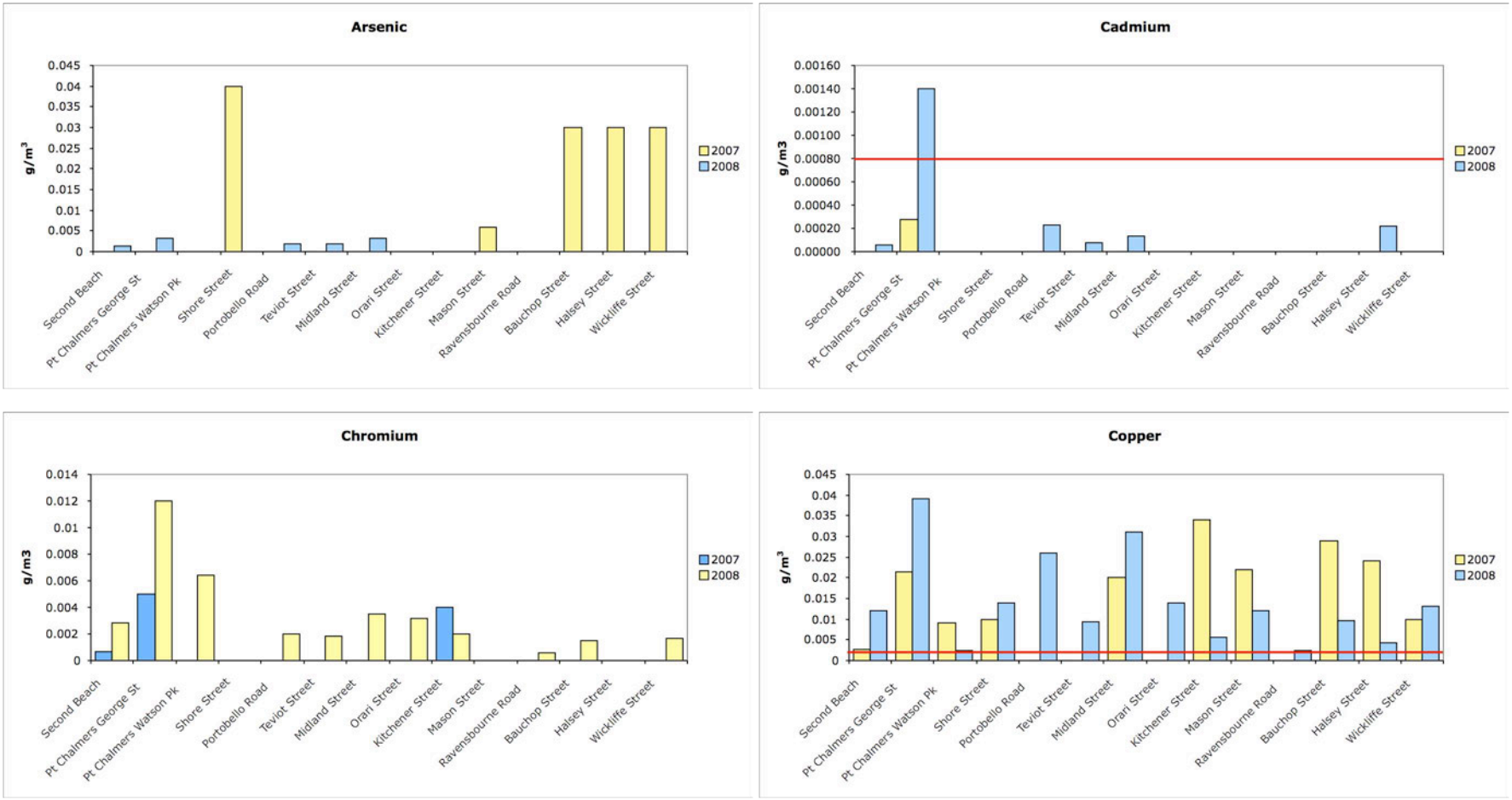


Figure 3. *Graphical representation of contaminant levels in stormwater at outfalls around upper Otago Harbour in 2007 and 2008. Red line indicates ANZECC trigger level for protection of 80% of species.*

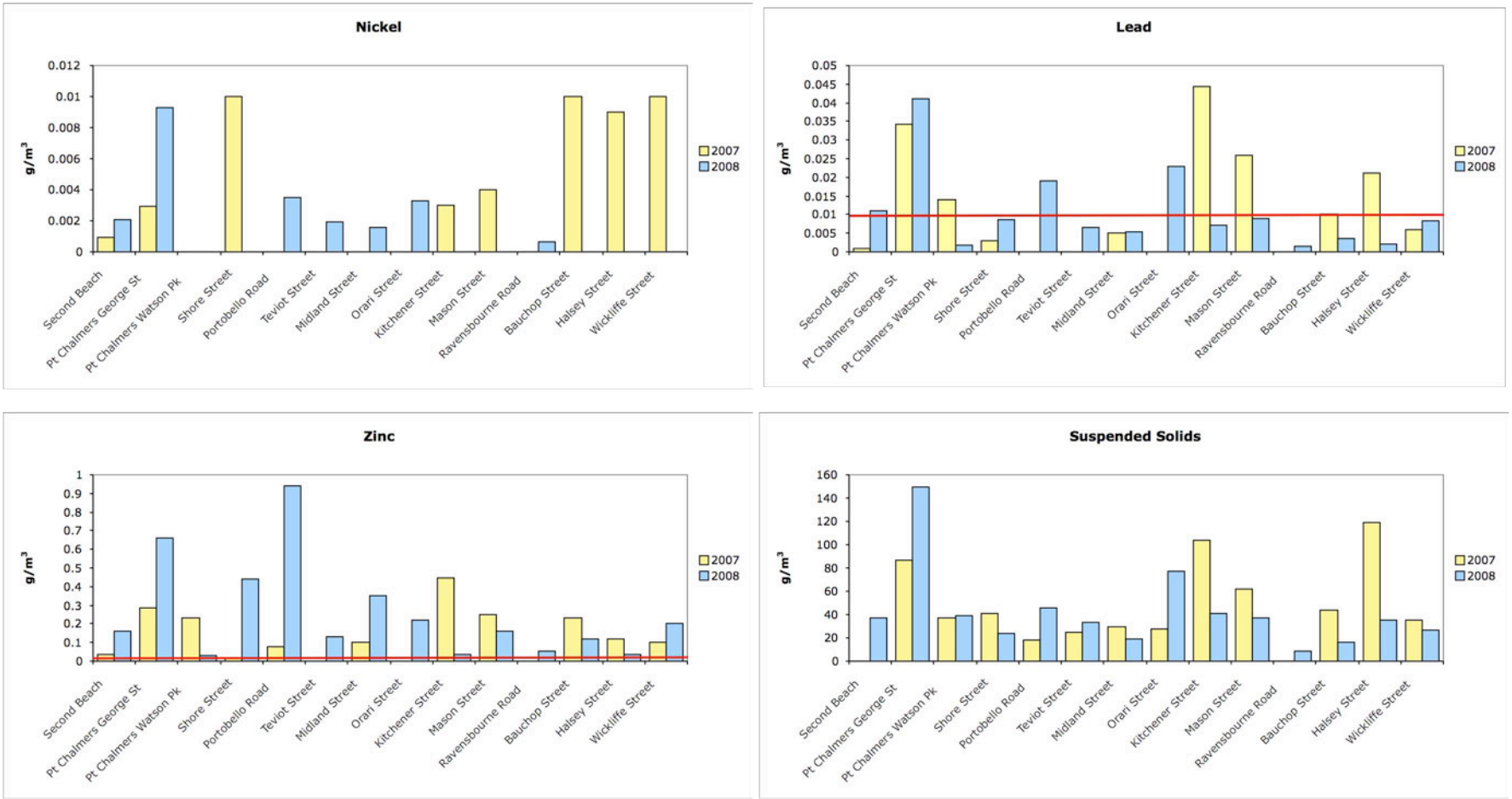


Figure 3. (continued….)

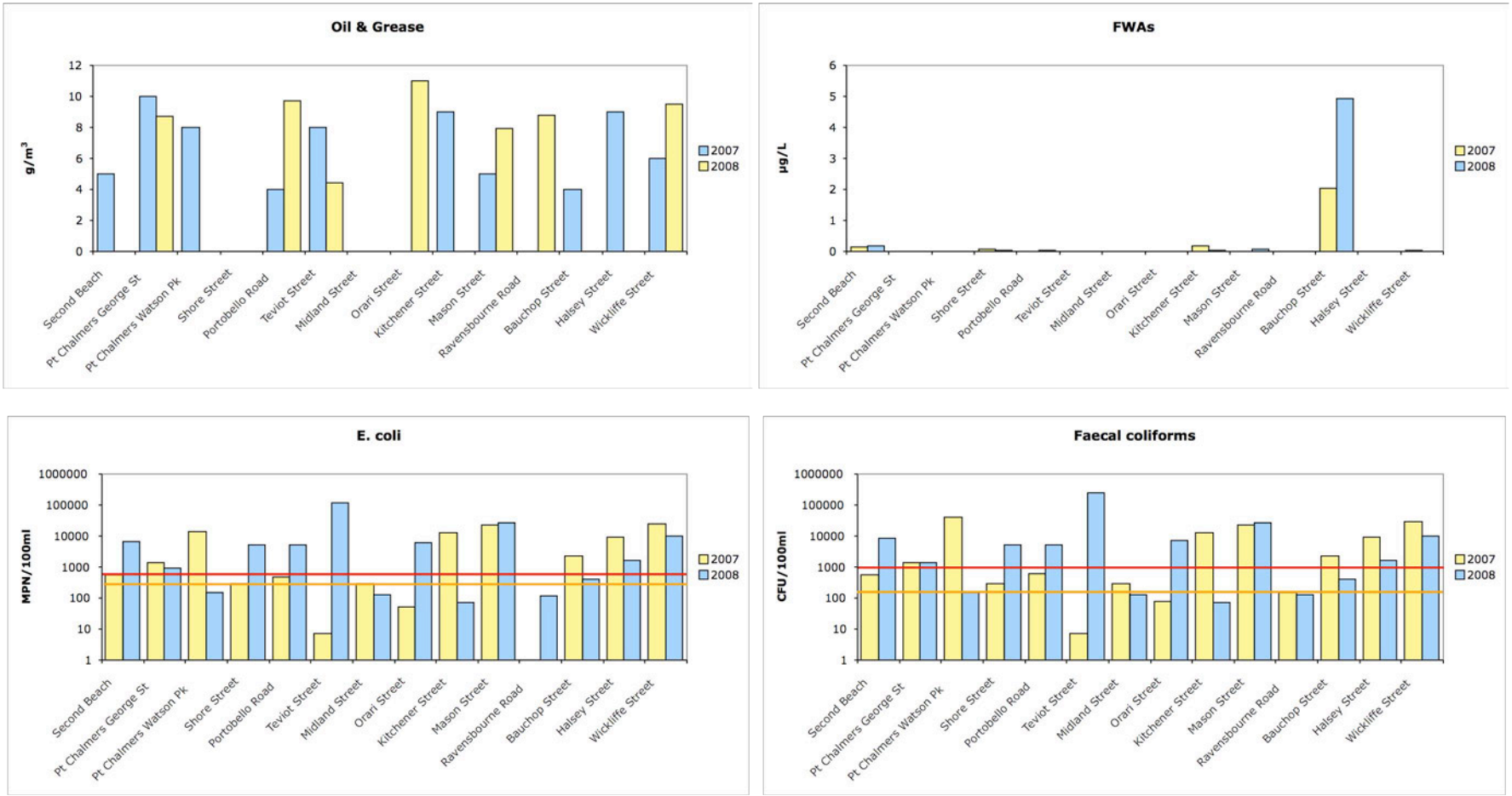


Figure 3. ***(continued)*** *Graphical representation of contaminant levels in stormwater at outfalls around upper Otago Harbour in 2007 and 2008. For microbiological graphs amber line indicates guideline for primary contact, red line indicates guideline for secondary contact.* ***Note log scale on Y axis of microbiological graphs.***

Table 3. *PAHs (g/m^3) detected in stormwater from the Kitchener Street, Orari Street and Portobello Road outfalls in 2007 and 2008. BDL indicates Below Detectable Limits.*

	Kitchener St		Orari St		Portobello Rd	
	2007	2008	2007	2008	2007	2008
Acenaphthene	BDL	bdl	BDL	BDL	BDL	0.00034
Acepaphthylene	BDL	100	BDL	92	BDL	100
Anthracene	BDL	87	BDL	89	BDL	87
Benzo[a]anthracene	BDL	BDL	BDL	BDL	BDL	0.00015
Benzo[a]pyrene	BDL	BDL	BDL	BDL	BDL	BDL
Benzo[a]fluorathene + Benzo[k]fluorathene	BDL	BDL	BDL	BDL	BDL	0.00018
Benzo[g,h,i]perylene	BDL	BDL	BDL	0.00014	BDL	BDL
Biphenyl-d10	-	67	-	67	-	67
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL
Dibenzo[a,h]anthracene	BDL	BDL	BDL	BDL	BDL	BDL
Fluoranthene	BDL	BDL	BDL	0.00011	BDL	0.00028
Fluorene	BDL	73	BDL	70	BDL	74
Indeno[1,2,3-c,d]pyrene	BDL	BDL	BDL	BDL	BDL	BDL
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL
Phenanthrene	BDL	BDL	BDL	BDL	BDL	BDL
Pyrene	BDL	BDL	0.0001	BDL	BDL	0.00037
Total PAH	0.00	327.00	0.00	318.00	0.00	328.00

3.2 Sediments

Sediments were sampled in May 2008 at sites detailed in Figure 2. Surface sediments were generally clean at most sites with little surface detritus apart from a layer of leaf litter at Portobello Road. Additionally, at Portobello Road, sediments were very dark and smelled strongly of petro-carbons with a visible oil slick forming in footprints and depressions dug to remove sediments. At Wickliffe Street, sediments were dark and smelled strongly of hydrogen sulphide, indicating anoxic conditions. Investigations into PAH levels at the Portobello Road outfall are detailed in Stewart (2005, 2006). Note that the Portobello Road catchment has been chosen as the pilot for the stormwater catchment management plan development.

As expected, copper, nickel, lead and zinc levels are elevated in sediments near stormwater outfalls that discharge from large or industrialised catchments such as White Street, Wickliffe Street and Portobello Road (Table 4, Figure 4). Arsenic levels have fallen from last year except at White Street, Kitchener Street and

Retaining Wall, and cadmium levels have fallen across all sites except two (Wickliffe Street and Retaining Wall) (Table 4, Figure 4). Lead has increased at six of the ten sites monitored with levels at Portobello Road and Boatshed being particularly high (Table 4, Figure 4). The levels for arsenic and cadmium at Retaining wall were not expected as this site is well removed from any or the major stormwater outfalls. This site is, however, adjacent to outcrops of basement rock along the southern side of the harbour and the geology of the area may be having an effect. Zinc levels in sediment have increased at all sites except White Street and Shore Street.

As observed in previous investigations PAHs are to be found at moderate to high levels in much of the Upper harbour Basin, with particularly high levels adjacent to the Portobello Road outfall and, to a lesser extent, the Kitchener Street outfall this year (Table 4). Stormwater inputs of PAHs were much higher this year than last year indicating the PAHs are still being added to the upper harbour. However, the extremely high levels of PAHs in older sediments off Portobello Road are believed to have been sourced from the now defunct gas works. It will be of interest to see if the decline in sediment PAHs off Portobello Road observed this year continues. Investigations on this matter will be reported on as per Condition 3 of Consent 2002.081.

Trends in contaminant levels at the various sites through time are unclear with just two years of sampling revealing high variability among contaminants and among sites (Figure 4). Trends, if any, may become more apparent with the addition of further data from future monitoring rounds.

Table 4. *Contaminant levels in sediments at various locations within 20m of stormwater outfalls and within the Upper Otago Harbour Basin with 2007 values (yellow) compared with 2008 values (green). Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

Sediments within 20m of outfall																				
Units	mg/kg dry wt		mg/kg dry wt		mg/kg dry wt		mg/kg dry wt		mg/kg dry wt		mg/kg dry wt		mg/kg dry wt		mg/kg dry wt		MPN/g		MPN/g	
ANZECC Low trigger value	20		1.5		80		65		21		50		200		4					
ANZECC high trigger value	70		10		370		270		52		220		410		45					
Parameter	2007 As	2008 As	2007 Cd	2008 Cd	2007 Cr	2008 Cr	2007 Cu	2008 Cu	2007 Ni	2008 Ni	2007 Pb	2008 Pb	2007 Zn	2008 Zn	2007 PAH	2008 PAH	2007 Entero cocci	2008 Entero cocci	2007 Faecal coliforms	2008 Faecal Coliforms
Rowing Club	10.6	9.8	0.2	0.2	17.6	12.0	14	13	11.3	14.0	18.9	27	101	130	7.0	5.8	2	11	<2	17
Wickliffe Street	17.3	11.0	0.6	0.7	38.0	34.0	121	68	19.2	23.0	76.1	140	412	740	9.2	1.2	580	>1600	2	540
White Street	11.6	18.0	0.3	0.2	68.5	56.0	433	160	29.5	21.0	147.0	180	4450	2500	13.0	11.1	4	2	<2	<2
Kitchener Street	4.6	7.5	0.4	0.4	22.6	18.0	70	56	10.6	12.0	117.9	97	249	280	8.9	140.5	66	920	20	13
Orari Street	18.6	4.3	63.0	0.1	0.3	16.0	25	13	23.6	8.1	12.8	39	68	130	10.2	12.6	<2	8	23000	4
Portobello Road	29.0	23.0	48.5	1.8	1.8	54.0	60	160	169.3	18.0	20.4	330	306	1400	436.3	250.3	727	170	23	43
Shore Street	9.5	7.1	0.4	0.3	21.8	16.0	51	44	10.7	9.0	113.0	110	484	300	9.6	21.0	90	>1600	<2	540
Boatshed	27.4	16.0	0.3	0.2	41.7	19.0	108	33	24.5	16.0	112.0	800	339	370	6.7	5.5	34	33	<2	2
Cove Drainage	21.5	17.0	0.1	0.1	15.8	35.0	11	19	23.5	44.0	19.7	20	99	150	0.4	0.0	8	17	2	8
Retaining Wall	25.3	36.0	0.1	0.2	23.6	31.0	13	19	15.9	25.0	26.9	27	141	170	0.3	3.9	<2	8	2	<2

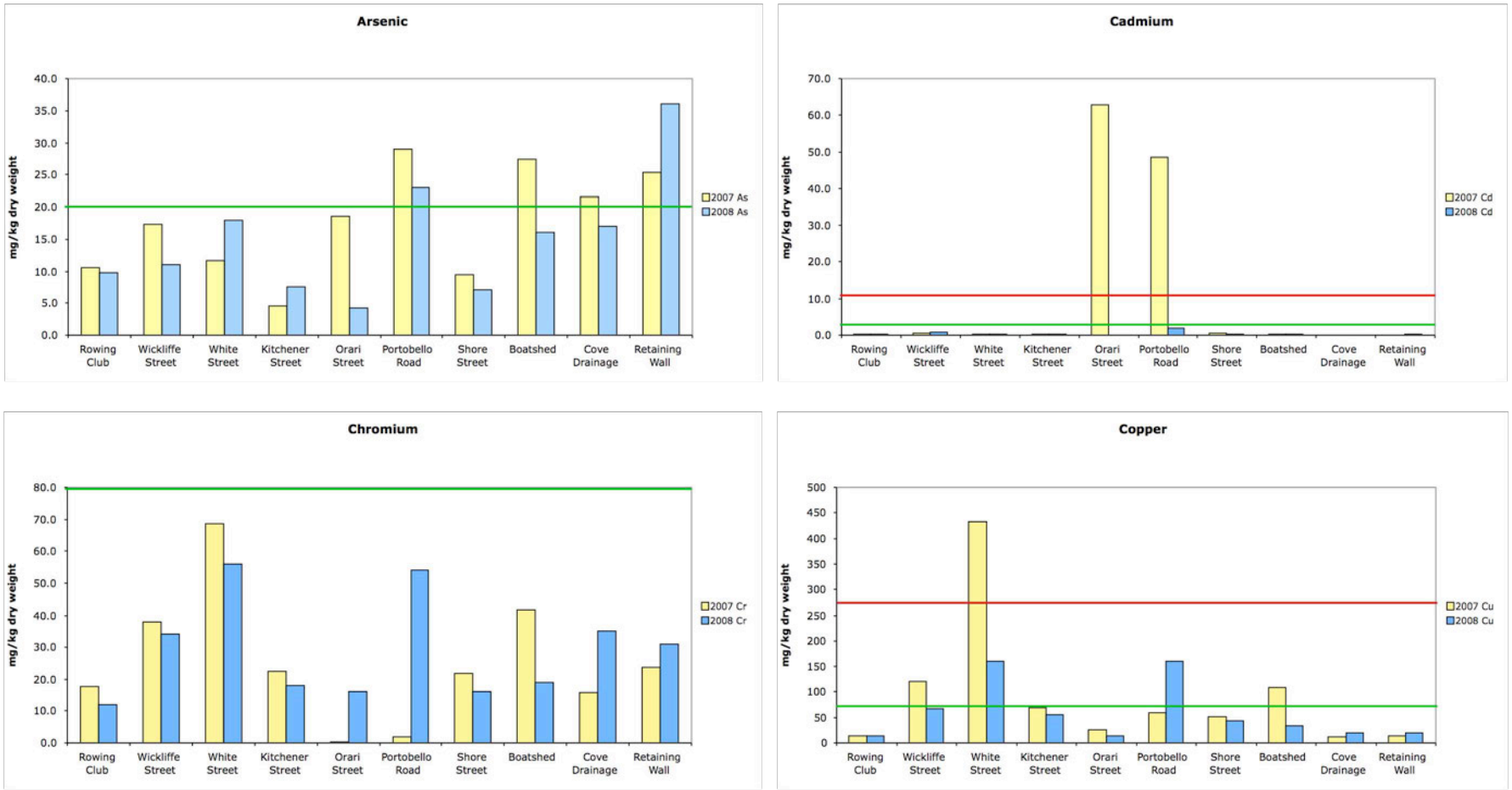


Figure 4. *Graphical representation of contaminant levels in sediment at sampling sites around upper Otago Harbour in 2007 and 2008. Green line indicates ANZECC low trigger level, red line is high trigger level.*

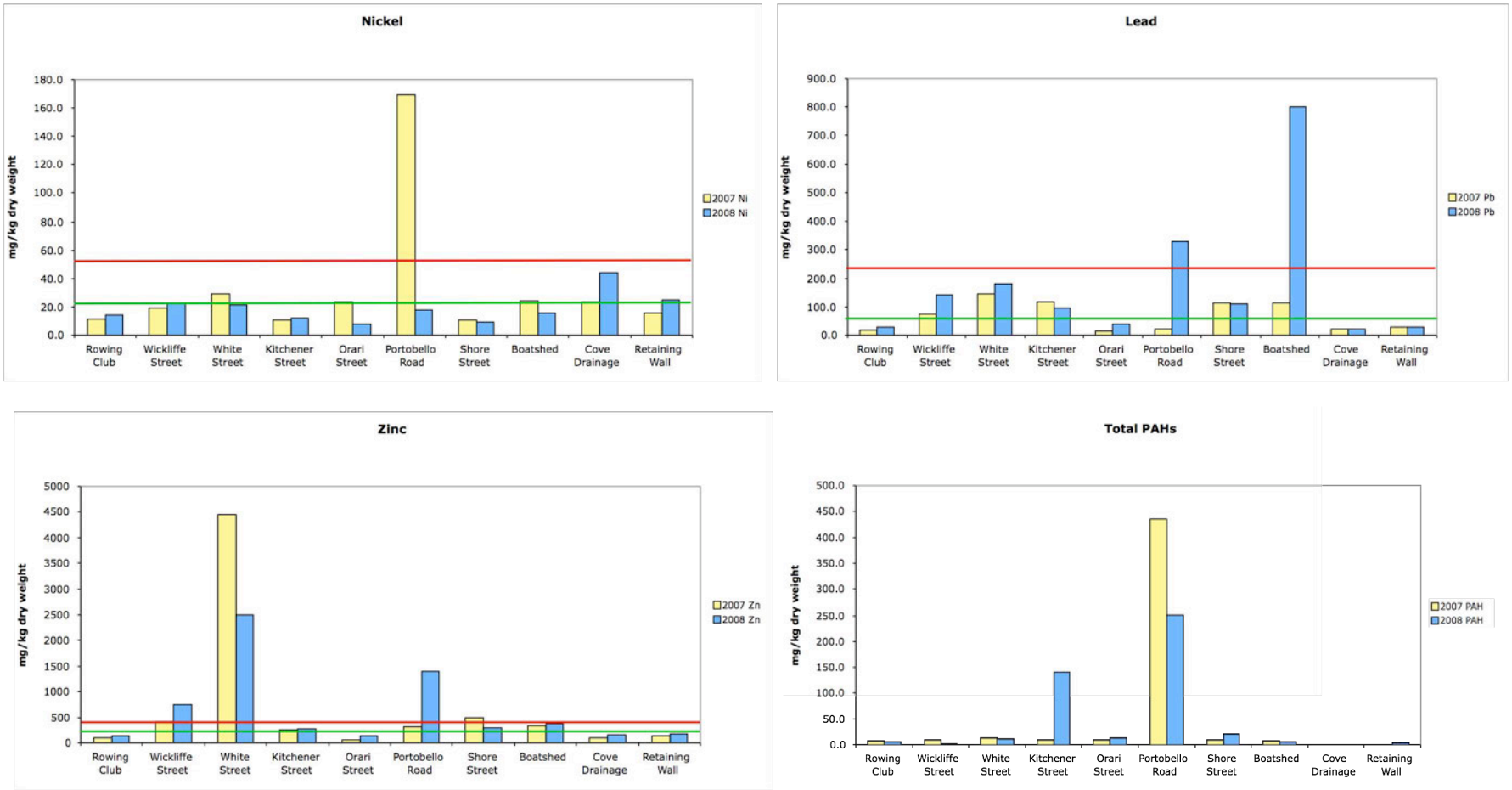


Figure 4 (continued). *Graphical representation of contaminant levels in sediment at sampling sites around upper Otago Harbour in 2007 and 2008. Green line indicates ANZECC low trigger level, red line is high trigger level.*

3.3 Biological Monitoring

On 26 May 2008 biological sampling was carried out at the Kitchener Street and Orari Street outfalls. On 28 May 2008 biological sampling was carried out at the Portobello Road outfall. The tide on both days was moderately low at 0.62m below mean sea level and 0.66m below mean sea level respectively.

There was a reasonable diversity of mainly red algae at Kitchener Street and Orari Street but just one species present at Portobello Road. Despite the diversity, percentage cover was very low at all sites except >50m from the Orari Street outfall where some quite large clumps of *Ceramium uncinatum* were present (Tables 5-7). These results are similar to results for macroalgae in 2007 (Stewart 2007a).

Table 5. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Kitchener Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca						
Ceramium uncinatum	3	4	0.5	3	5	3
Euptilota formosissima				1	2	1
Gracilaria chilensis						
Lenormandia chauvinii			0.5	0.5	1	
Lomentaria umbellata					2	1

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca						
Ceramium uncinatum	2	5	4	6		1
Euptilota formosissima		4	3			1
Gracilaria chilensis						
Lenormandia chauvinii	4	1	5			
Lomentaria umbellata						

Table 6. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Orari Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa			0.1	0.5		
Codium fragilis						
Ulva lactuca				35		
Ceramium uncinatum	5	1	8	10	5	3
Euptilota formosissima	1.0	0.5	1	0.5	0.2	0.2
Gracilaria chilensis						
Lenormandia chauvinii	1	0.5	0.5		2	
Lomentaria umbellata	2	0.5	1			1

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis		3	1			
Ulva lactuca				5		
Ceramium uncinatum	40.0	30	20	30	8	25
Euptilota formosissima			2		1	
Gracilaria chilensis						
Lenormandia chauvinii	2.0	1	1		4	2
Lomentaria umbellata						

Table 7. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Portobello Rd outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca						
Ceramium uncinatum	1	1	2			
Euptilota formosissima						
Gracilaria chilensis						
Lenormandia chauvinii						
Lomentaria umbellata						

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca						
Ceramium uncinatum	0.2			5	1	0.2
Euptilota formosissima						
Gracilaria chilensis						
Lenormandia chauvinii						
Lomentaria umbellata						

Epifauna was reasonably abundant at all three outfalls (Tables 8-10) with the small topshell *Micrelenchus tenebrosus* and cockles, *Austrovenus stutchburyi*, comprising the majority of animals. Numbers of animals per square metre was higher at more than 50m distant from the Portobello Road outfall than within 20m of the outfall, but the reverse was true for Kitchener Street and Orari Street (Tables 8-10).

Table 8. *Epifauna within 20m (top) and greater than 50m (overleaf) of the Kitchener Street outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus										8			1		
Crabs															
Macrophthalmus hirtipes							1								1
Gastropod snails															
Buccinulum vittatum								1							
Cominella glandiformis												1			
Diloma subrostrata			1										1		
Maoricolpus roseus			1							1					
Micrelenchus tenebrosus	14	7	8	7	8		9	4	6	26	1	8	42	14	6
Bivalves															
Austrovenus stutchburyi	16	18	13	23	19	13	16	12	9	9	6	7	16	18	22
Macomona liliana							1								
Ostrea heffordi	1				2				1	31					

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Anemones															
Anthopleura spp															1
Polychaete worms															
Pomatoceros caerulus	1							6	18						
Chitons															
Chiton glaucus													1		
Gastropod snails															
Buccinulum vittatum					1					1					
Diloma subrostrata		1			1		1	1			1				
Maoricolpus roseus	1														
Micrelenchus tenebrosus	6	8	16	33	18	9	30	9	5	3	5	2	6	2	4
Bivalves															
Austrovenus stutchburyi	1									8	4	5	4	3	9
Macomona liliana													1		
Ostrea heffordi	1		1	1	2		16	7	13						1
Ophiuroidea									1						

Table 9. *Epifauna within 20m (top) and greater than 50m (bottom) of the Orari Street outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Chitons															
Acanthochitona zelandica															1
Gastropod snails															
Buccinulum vittatum								1							
Notoacmea spp															1
Diloma subrostrata					1							1			
Maoricolpus roseus				1											
Maoricrypta monoxyla					1										
Micrelenchus tenebrosus	1	2	3	8	6	2	8	7	6	4	8	5	5	4	6
Zeacumantus subcarinatus										1	2	1		1	1
Bivalves															
Austrovenus stutchburyi	2	6	8	9	17	22	19	16	21	18	27	12	18	15	19
Ostrea heffordi									2					1	1
Perna canaliculus					1										

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Crabs															
Macrophthalmus hirtipes										1					1
Chitons															
Acanthochitona zelandica												1			1
Gastropod snails															
Micrelenchus tenebrosus	4	5	3	1	3	3	1	2	3	2	3	2	1	2	3
Bivalves															
Austrovenus stutchburyi	4	5	6	4	7	10	2	19	16	18	11	21	8	24	13

Table 10. *Epifauna within 20m (top) and greater than 50m (overleaf) of the Portobello Rd outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus					1										
Gastropod snails															
Amphibola crenata											1				
Micrelenchus tenebrosus		1	1			1			1				1		
Bivalves															
Austrovenus stutchburyi	1	2	3	2	3	5		1	3	5	3	7	2	3	5
Macomona liliana				1											
Ostrea heffordi			1		2										

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus	18										7	1			
Gastropod snails															
Notoacmea spp	1														
Diloma subrostrata		2										1			
Micrelenchus tenebrosus	3		3	1			2	1			1	1	3		
Bivalves															
Austrovenus stutchburyi			5	6	7	1	4	3	3	4	2	3	1	1	3
Macomona liliana				1											1
Ostrea heffordi											3	1			
Ophiuroidea										2					

Diversity within animal communities was, however, variable with Kitchener Street and Portobello Road showing greater diversity further from the outfall while Orari Street showed the converse (Table 11). Overall diversity has not changed from that observed in 2007 ($F_{1,4} = 0.880$, $p = 0.401$ for <20m sites; $F_{1,4} = 0.077$, $p = 0.795$ for >50m sites). Neither is there a significant difference in epifaunal diversity among sites <20m from the outfalls and sites >50m from the outfalls ($F_{1,4} = 0.508$, $p = 0.515$).

Table 11. *Diversity (H') of epifauna within 20m and greater than 50m of the Kitchener Street, Orari Street and Portobello Road outfalls. 2008 data compared with 2007 data.*

	<20m		>50m	
Site	2007	2008	2007	2008
Kitchener Street	0.48	0.48	0.71	0.57
Orari Street	0.36	0.37	0.05	0.25
Portobello Road	0.53	0.33	0.5	0.63

As in 2007, cockles became noticeably smaller as one moved from Kitchener Street to Portobello Road (Table 12). However, when compared using ANOVA at a significance level of 0.05 overall size of cockles from 2007 to 2008 has not changed significantly ($F_{1,4} = 0.45$, $p = 0.539$).

Table 12. *Size of cockles collected at Kitchener Street, Orari Street and Portobello Road in 2007 and 2008.*

	2007			2008		
	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)
Kitchener Street	59	18.8	37.1	54	16.36	35.5
Orari Street	62	12.3	32.4	74	8.65	29.8
Portobello Road	64	9.4	30.1	74	7.87	28.3

Infauna at all three sites was dominated by polychaete worms with glyceriids being the most abundant at all sites except at >50m from Portobello Road. Cockles (*Austrovenus stutchburyi*) were also common, particularly at Orari Street (Tables 13-15). Numbers of animals per square metre ranged from 199 at replicate 2, Site

2 at >50m from the Kitchener Street outfall to 2985 at replicate 2, Site 2 at <20m from the Portobello Road outfall.

Table 13. *Abundance of species of infauna collected <20m and >50m from the Kitchener Street outfall.*

Kitchener Street			Location	<20m							>50m						
2008			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Capitellidae						1		1							
		Glyceridae		4	4	2	2	6	3	21	3	3	2	3	1	2	14
		Nereidae		1				2		3	1						1
		Nereididae									1						1
		Sabellidae				1				1							
		Spionidae			1					1			2				2
Crustacea																	
	Decapoda																
			Macrophthalmus hirtipes						1	1							
	Amphipoda	Haustoriidae											1				1
		Jassidae														1	1
		Phoxocephalidae						1		1				1			1
Mollusca																	
	Gastropoda	Amphibolidae	*Amphibola crenata*														
		Lepsiella										1					1
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi						2	2		1					1
		Mesodesmatidae															
			Paphies australis								1						1
	Cnidaria																
		Actinaria											1				1
		Animals per core		5	5	3	2	10	6	31	6	5	6	4	1	3	25
		Animals per m^2		995	995	597	398	1990	1194	6169	1194	995	1194	796	199	597	4975
		Species per site								8							11

Table 14. *Abundance of species of infauna collected <20m and >50m from the Orari Street outfall.*

Orari Street			Location	<20m							>50m						
2008			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Arenicolidae		1						1							
		Glyceridae		3	3	4		1	4	15		5	2	3	6	2	18
		Nephtyidae										1			1		2
		Nereidae			2	6	3		2	13	1	1	1	2		1	6
		Nereididae										1					1
		Opheliidae											1				1
		Orbiniidae							1	1							
		Oweniidae		1						1							
		Pectenariidae										2					2
		Sabellidae		1						1							
		Serpulidae														1	1
		Spionidae				1				1	2	1		1			4
Nemertea					1					1							
Crustacea																	
	Amphipoda																
		Jassidae													1		1
		Phoxocephalidae		1						1					1		1
	Tanaidacea				1					1							
Mollusca																	
	Gastropoda	Amphibolidae	*Amphibola crenata*														
			Diloma subrostrata					2		2							
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi	5	2	4	2	2	2	17	3	1	1	2	3	3	13
			Puyseguria spp.			1	1			2		1					1
		Tellinidae															
			Macomona liliana	1	1			1	1	4	1		1	1			3
		Animals per core		13	10	16	6	6	10	61	7	13	6	9	12	7	54
		Animals per m^2		2587	1990	3184	1194	1194	1990	12139	1393	2587	1194	1791	2388	1393	10746
		Species per site								14							13

Table 15. *Abundance of species of infauna collected <20m and >50m from the Portobello Road outfall.*

Portobello Rd			Location	<20m							>50m						
2008				Site 1			Site 2				Site 1			Site 2			
			Sample	1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Glyceridae		4	17	3	3	7	4	38				1	2		3
		Lumbrineridae				1				1							
		Nephtyidae					1	1		2							
		Nereidae				3		1		4							
		Oweniidae		1				1		2							
		Sabellidae			1					1							
		Spionidae		5	3	3	2	4	4	21		1			2		3
Hemichordata																	
	Enteropneusta					2	1			3							
Crustacea																	
	Amphipoda																
		Oedicerotidae			1					1							
		Phoxocephalidae					1	1		2				1		1	2
Mollusca																	
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi						2	2	1	2			1	1	5
		Tellinidae															
			Macomona liliana								2				1		3
		Animals per core		10	22	12	8	15	10	77	3	3	0	2	6	2	16
		Animals per m^2		1990	4378	2388	1592	2985	1990	15323	597	597	0	398	1194	398	3184
		Species per site								11							5

3.4 Analyses of Cockle, Mussels, Fish and Octopus flesh

Unlike last year when levels of heavy metals in the cockle flesh showed no clear trend from Kitchener Street to Portobello Road, levels of all metals this year except nickel were highest at Portobello Road (Table 16). PAHs on the other hand, although still highest at Portobello Road, are significantly lower at this site than observed last year (Table 16). All heavy metals were at concentrations two orders of magnitude below accepted food standards (Table 17). There are no specific guidelines for PAH in shellfish flesh for New Zealand, but food standards for British Columbia recommend an upper limit for benzo[a]pyrene (Table 18). It should be noted that, as already stated, cockles became smaller as one nears the Portobello Road outfall. Whether this is due to PAH contamination or exposure at low tides and to fresh water, or some other factor, remains to be determined. Faecal coliform levels were quite high at Portobello Road and moderately high at Orari and Kitchener Streets. This differs markedly from 2007 when all samples had faecal coliform levels below detectable limits (Table 16).

Table 16. *Contaminant concentrations in cockle flesh from within 20m of the Kitchener Street, Orari Street and Portobello Road stormwater outfalls in 2007 and 2008. Green shading indicates a decrease in contaminant level, pink indicates and increase, white = no change.*

	Cockles																	
Parameter	As		Cd		Cr		Cu		Ni		Pb		Zn		PAH		Faecal coliforms	
Units	mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		MPN/100g	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Portobello Rd	2.5	4.0	0.014	0.023	0.32	0.65	0.64	1.20	0.71	1.30	0.17	0.42	6.3	11.0	4.912	0.640	<18	1300
Orari Street	2.5	2.8	0.011	0.010	0.32	0.15	0.70	0.85	1.00	1.10	0.11	0.07	6.4	7.7	0.018	0.047	<18	230
Kitchener St	3.5	3.3	0.016	0.015	0.34	0.27	0.81	0.67	0.64	1.30	0.08	0.08	8.0	8.6	0.009	0.028	<18	78

Table 17. *Heavy metal concentrations for NZ and US FDA guidelines for adults (expressed as mg/kg dry weight). '-' means no guideline is available.*

	Cu	Zn	Pb	Cd	Cr	Ni
Food Regs/NZ DoH	150.0	2000.0	10.0	5.0	-	-
US FDA	-	-	4.2	-	11.0	80.0
Australia NZ food standards code	-	-	2.0	2.0	-	-

Table 18. *British Columbian guidelines for B[a]P concentration in shellfish for human consumption*

B[a]P concentration in the edible portion of fish/shellfish (µg B[a]P/kg wet weight)	Safe quantity for weekly consumption* on a regular basis (g wet weight)	B[a]P Portobello Road cockles 2007 (µg B[a]P/kg wet weight)	B[a]P Portobello Road cockles 2008 (µg B[a]P/kg wet weight)
4	50	249	34
2	100		
1	200		

*low and moderate consumption levels, according to the State of Washington, are 45 g/wk (or 6.5 g/d) and 140 g/wk (or 20 g/d).

As for cockles in the upper harbour basin, mussels from Second Beach showed levels of contamination that were well below accepted food guidelines (Table 19). Concentrations of most contaminants were not dissimilar to those observed in cockles (Tables 16 and 19), with the exception of nickel, which is an order of magnitude lower in Second Beach mussels than in harbour cockles. Overall,

however, there is little evidence of contamination of shellfish by stormwater at either site.

Table 19. *Contaminant concentrations in mussel flesh from within 20m of the Second Beach stormwater outfall.*

	Mussels															
Parameter	As		Cd		Cr		Cu		Ni		Pb		Zn		Faecal coliforms	
Units	mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		CFU/100m	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Second Beach	1.6	1.9	0.08	0.08	0.33	0.20	1.00	0.69	0.4	0.3	0.14	0.11	12.0	9.4	<18	20

Seventeen triplefins were caught in baited fish traps set off the Mason Street wharf on 10 June 2008. The fish were small (Table 20), but representative of the size classes commonly seen amongst variable triplefins and were similar to those fish caught in 2007 (Table 20). Levels of chromium, nickel and PAHs were lower in fish than in shellfish while levels of cadmium and zinc were higher. Levels of arsenic, copper and lead, however, were similar to that found in cockles (Tables 16 & 21).

It could, therefore, be argued that the concentration of most contaminants in the fish, with the exception of cadmium and zinc, were similar to or lower than in cockles, as was the case in 2007 (Table 21). At first glance one is tempted to say that this is not unexpected, given that the cockles are filter feeders while the fish are predators. However, contaminants tend to become more concentrated as one moves up the food chain. Triplefins do not prey on shellfish, but do eat smaller fish and a variety of other invertebrates. The fact that contaminant levels are low in fish flesh suggests that heavy metal and PAH contamination around the Mason Street stormwater outfall is low.

Table 20. *Size and weight of triplefins captured near the Mason Street Stormwater outfall in 2007 and 2008.*

	2007	2008	2007	2008
	Fish Sizes (mm)		Weight (g)	
	75	70	4.7	4
	71	67	3.9	2.9
	73	46	4.4	0.9
	61	65	2.2	3
	49	63	1.1	2.7
	78	75	5.3	5.5
	77	58	5.6	2.4
	79	67	6.1	3.4
	75	72	4.1	4.5
	46	83	0.9	6.4
	52	71	1.6	4.8
	74	68	4.6	3.8
		72		4.8
		65		2.8
		59		2.7
		56		2.2
		60		2.4
Mean =	67.5	65.71	3.7	3.48

Table 21. *Contaminant concentrations in the flesh of triplefins captured near the Mason Street Stormwater outfall. BDL = below detectable limits.*

Fish															
As		Cd		Cr		Cu		Ni		Pb		Zn		PAH	
mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg	
2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
1.9	1.6	0.0047	0.0047	0.1	BDL	0.54	0.52	BDL	BDL	0.140	0.120	21	20	0.0056	0.0023

Despite frequent patrols along the foreshore in the vicinity of Portobello Road, Orari Street and Kitchener Street outfalls no octopus were found within the designated sampling period and it is assumed that the annual autumn die-off occurred later than usual, possibly due to the warm summer temperatures experienced this year. However, one animal was finally found a week outside the sampling period approximately 200m south of the Orari Street outfall. Others were seen, but at such great distances from outfalls that it was deemed inappropriate to sample them. The single large animal sampled this year was found on 7 July. As before subsamples of flesh and digestive gland were collected and sent to Hill Laboratories in Hamilton for analysis. As already stated, this sampling falls outside the consent condition time frame, but no octopus were found within the

January –June period and it was felt that 7 July is close enough to the designated time as to make sampling worthwhile. In 2007 two octopus, one from in front of the Orari Street stormwater outfall and one ~40m from the Portobello Road outfall were found. For reference the results for analysis of the flesh from the 2007 animals and the 2008 animal are presented in Table 22.

Table 22. *Contaminant concentrations in the flesh (upper) and digestive glands (lower) of octopus collected near the Orari Street and Portobello Road Stormwater outfalls.*

	Octopus																			
Parameter	As		Cd		Cr		Cu		Ni		Pb		Zn		PAH		Arm span		Weight	
Units	mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		(mm)		(g)	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Portobello R	12.0	-	0.001	-	<0.02	-	3.30	-	0.1	-	0.023	-	13.0	-	0.0043	-	2603	-	11784	-
Orari Street	7.7	20.0	0.008	0.0012	<0.02	<0.02	3.90	2.60	0.1	0.023	0.220	0.029	14.0	19.0	-	0.0127	680	2154	197	10562

	Octopus (Digestive gland)																			
Parameter	As		Cd		Cr		Cu		Ni		Pb		Zn		PAH		Arm span		Weight	
Units	mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		(mm)			
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Portobello R	12.0	-	0.260	-	<0.2	-	44.00	-	0.5	-	0.074	-	26.0	-	0.0599	-	2603	-	11784	-
Orari Street	7.7	13.0	3.300	0.066	9.2	<0.02	740.00	27.00	5.2	2.8	0.440	0.026	160.0	26.0	-	0.0251	680	2154	197	10562

Contaminant concentrations in octopus were quite low and certainly well below all food guidelines (Table 22). Arsenic levels were once again higher than those found in either fish or shellfish, and higher than in the animal analysed last year but reasons for this are unclear. An octopus sampled in the autumn of 2006 from near Orari Street also had high arsenic levels. Copper levels, however, are an order of magnitude lower than those found in an octopus from the same area last year.

Octopus are higher on the food web than shellfish, but results of analyses for cockles, fish and octopus [in 2006/07] obtained so far do not give any clear indication as to where an organism lies with respect to trophic level.

4. Discussion and Conclusion

In 2008 water samples were colleted from a total of 14 major Dunedin City stormwater outfalls. In addition, sediments were sampled from near 5 of these outfalls and from an additional 5 sites located some distance from the outfalls to gain a clearer picture of the distribution of contaminants in sediment in the upper Otago Harbour. Flesh from fish, cockles, mussels and octopus was also collected for contaminant analysis. For interest sake historical data for some of the same sites have been included for comparison (Tables 23 and 24). Any trends observed in these data for historical sediment values should be viewed with extreme caution as sampling in some previous years may have used entirely different protocols. For example, sediments may have been collected from different depths within the substrate and by different methods meaning that results are not directly comaprable. Stormwater sampling, however, should be comparable assuming previous investigators targeted the first flush.

There has been a decline in the levels of some contaminants at stormwater outfalls for which historic data are provided. This is perhaps to be expected for lead as it has been removed from paint and petrol and levels in the environment are very gradually declining. The reduction in the levels of some other contaminants is very slight, but gratifying, although such fluctuations may be merely a function of the intensity of the storm events when sampling occurred. It should be recognised that there are currently no longer any contaminants for which levels appear to be increasing. However, the high levels of FWAs at Bauchop Street in both 2007 and 2008 clearly suggest that there is some gross cross contamination by wastewater somewhere in this catchment. The relatively low levels of faecal coliforms at this site would suggest that this may not be the case, but it must be remembered that the samples were collected at different times (high flow for faecals, low flow for FWAs). Council will be investigating to further determine the likely source. It is also expected that the development and implementation of the long-term stormwater catchment management plans and DCC's 3-Water Strategy will contribute to addressing this issue. It will be of interest to see if any long-term trends in contaminant levels can be discerned as monitoring continues.

Benthic and infaunal communities in the vicinity of the Portobello Road, Orari Street and Kitchener Street outfalls have reasonably low diversity, but this is generalised and not associated with any one outfall and is likely symptomatic of a large proportion the upper harbour basin. There is a trend towards smaller cockles as one nears the Portobello Road outfall. This may be as a result of historic PAH contamination, which is extremely high beneath the surface at this site, but a number of other factors, not least of which are freshwater exposure and exposure at low tide, must also be considered.

Rainer (1981) and Grove (1995) certainly found less diversity in soft-bottom macrofaunal communities as one moves from harbour mouth to the head of Otago Harbour. It should be pointed out that much of the shoreline around the upper harbour has been extensively modified and as such cannot be regarded as an inlet typical of those found throughout the region. Despite this the communities sampled in the upper Otago Harbour near stormwater outfalls are numerically dominated by polychaete worms and amphipods, as is usual for sheltered soft shores around New Zealand (Morton and Miller 1973), and show distinct similarities to communities found in other moderately impacted inlets in Otago (Stewart 2007b, 2008a,b).

While not pristine, the upper harbour and the communities associated with the intertidal areas adjacent to major stormwater outfalls appear not to be undergoing any significant further degradation as a result of stormwater inputs. It is to be hoped that if the trend towards lower contaminant levels in stormwater is continued, both water quality and community health in the harbour will gradually improve over time.

Only after problem areas and problem contaminants have been identified can measures be taken to mitigate any effects. Consequently no mitigation measures have been undertaken by the DCC at this stage, apart from investigations into the remediation of PAH contamination at the Portobello Road outfall (Stewart 2006) and the intended investigations in relation to FWA's as previously mentioned. It is expected that further stormwater monitoring over time and investigations under the 3 Waters strategy will define problem areas such that mitigation measures may be undertaken.

Table 23. *Contaminants in stormwater being discharged to the upper Otago harbour basin through time. BDL = below detectable limits.*

	Parameter	Suspended Solids			Cd			Cr			Cu		
	units	g/m^3			g/m^3			g/m^3			g/m^3		
		Historic	2007	2008	Historic	2007	2008	Historic	2007	2008	Historic	2007	2008
Catchement	Second Beach		<3	37.0		BDL	0.00006		0.0007	0.0028		0.0027	0.012
	Pt Chalmers George St		87.0	150.0		0.00028	0.00140		0.005	0.012		0.0213	0.039
	Pt Chalmers Watson Pk		37.0	39.0		BDL	BDL		BDL	0.0064		0.009	0.0025
	Shore Street	75.4	41.0	24.0		BDL	BDL		BDL	BDL		0.01	0.014
	Portobello Road	28.0	18.0	46.0	0.0003	BDL	0.00023	0.0029	BDL	0.002	0.03	BDL	0.026
	Teviot Street		25.0	33.0		BDL	0.00008		BDL	0.0018		BDL	0.0094
	Midland Street		30.0	19.0		BDL	0.00013		BDL	0.0035		0.02	0.031
	Orari Street	38.1	28.0	77.0	0.0005	BDL	BDL	0.002	BDL	0.0032	0.0132	BDL	0.014
	Kitchener Street		104.0	41.0		BDL	BDL		0.004	0.002		0.034	0.0056
	Mason Street		62.0	37.0		BDL	BDL		BDL	BDL		0.022	0.012
	Ravensbourne Road			8.5			BDL			0.00061			0.0023
	Bauchop Street		44.0	16.0		BDL	BDL		BDL	0.0015		0.029	0.0096
	Halsey Street		119.0	35.0		BDL	0.00022		BDL	BDL		0.024	0.0043
	Wickliffe Street		35.0	27.0		BDL	BDL		BDL	0.0017		0.01	0.013

	Parameter	Ni			Pb			Zn			PAH		
	units	g/m^3			g/m^3			g/m^3			g/m^3		
		Historic	2007	2008	Historic	2007	2008	Historic	2007	2008	Historic	2007	2008
Catchement	Second Beach		0.0009	0.0021		0.001	0.011		0.038	0.16			
	Pt Chalmers George St		0.0029	0.0093		0.0342	0.041		0.288	0.66			
	Pt Chalmers Watson Pk		BDL	BDL		0.0141	0.0018		0.231	0.027			
	Shore Street		0.01	BDL		0.003	0.0085		0.02	0.44			
	Portobello Road	0.002	BDL	0.0035	0.021	BDL	0.019	0.895	0.08	0.94	0.0031	BDL	328
	Teviot Street		BDL	0.0019		BDL	0.0066		BDL	0.13			
	Midland Street		BDL	0.0016		0.005	0.0054		0.1	0.35			
	Orari Street	0.002	BDL	0.0033	0.022	BDL	0.023	0.191	BDL	0.22	0.0026	0.0001	318
	Kitchener Street		0.003	BDL		0.0442	0.007		0.445	0.036		BDL	327
	Mason Street		0.004	BDL		0.0258	0.0089		0.25	0.16			
	Ravensbourne Road			0.00066			0.0015			0.053			
	Bauchop Street		0.01	BDL		0.01	0.0035		0.23	0.12			
	Halsey Street		0.009	BDL		0.021	0.0022		0.12	0.033			
	Wickliffe Street		0.01	BDL		0.006	0.0084		0.1	0.2			

Table 24. *Contaminants in sediments in the upper Otago harbour basin in the vicinity of selected stormwater outfalls through time.*

	As			Cadmium			Cr			Copper			Ni			Pb			Zn			PAH			Enterococci		
	Historic	2007	2008	Historic	2007	2008	Historic	2007	2008	Historic	2007	2008	Historic	2007	2008	Historic	2007	2008	Historic	2007	2008	Historic	2007	2008	Historic	2007	2008
Rowing Club		10.6	9.8	0.0	0.2	0.2	16.8	17.6	12	9.8	14.2	13		11.3	14		18.9	27	80.8	101	130		6.97	5.78		200	11
Wickliffe		17.3	11.0		0.6	0.74		38	34		121.0	68		19.2	23		76.1	140		412	740		9.21	1.18		58000	>1600
White St		11.6	18.0		0.3	0.22		68.5	56		433.0	160		29.5	21		147	180		4450	2500		12.96	11.05		400	2
Kitchener St		4.6	7.5		0.4	0.35	7.1	22.6	18		69.5	56	5.8	10.6	12		117.9	97	170	249.33	280		8.88	140.49	130	6633	920
Orari St		18.6	4.3	0.5	63.0	0.13	17.5	0.27	16	20	25.1	13	10.4	23.6	8.1	185	12.8	39	239	68.27	130	13.41	10.23	12.59	557	12.67	8
Orari 100		13.7		0.3	0.4		16	26.3		28	25.9		8.8	12.6		170	170		230	227			6.67		1300	3600	
Midland 200		15.4		0.4	0.3		22	22.4		24	19.0		8.3	10.7		36	36		190	165			7.24		130	20000	
Portobello Rd		29.0	23.0	2.0	48.5	1.8	41	1.84	54	210	60.1	160	15	169.3	18	410	20.43	330	1300	306.33	1400	425.83	436.27	250.30	1120	72667	170
PR 200		17.4		1.0	0.5		32	41.8		100	52.6		13	17.3		130	81.3		430	309		12.29	8.97		40	66000	
Shore St		9.5	7.1	0.5	0.4	0.32	9.6	21.8	16	30	50.9	44	5.4	10.7	9	130	113	110	300	484	300		9.56	21.01	2400	9000	>1600
Boatshed		27.4	16.0		0.3	0.21		41.7	19		108.0	33		24.5	16		112	800		339	370		6.67	5.54		3400	33
Cove Drainage		21.5	17.0		0.1	0.13		15.8	35		11.3	19		23.5	44		19.7	20		99.2	150		0.37	0.00		800	17
Retaining wall		25.3	36.0		0.1	0.15		23.6	31		13.3	19		15.9	25		26.9	27		141	170		0.30	3.91		<100	8
RW 300		16.2		0.1	0.3		28.33	0.27		16.3	15.2		13.3	12.4		40	6.7		149	131			0.30			<2	
W/W centre		11.1			0.2		2.75	30.8			15.3		3.63	14.6		25	5.6			168			0.34			<2	
UHB Centre		10.5		0.3	0.2		26.8	24.3		15.2	15.2		10	11.3		27	23		118	119			0.65			24000	

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Compliance Monitoring 2009

Stormwater Discharges from Dunedin City

(ORC Resource Consents 2002.080-2002.110 and 2006.222)



Prepared for

Dunedin City Council

by

Ryder Consulting Ltd.

July 2009

ryderconsulting
ecology + planning + project management

Compliance Monitoring 2009

Stormwater Discharges from Dunedin City
(ORC Resource Consents 2002.080-2002.110 and 2006.222)

prepared by

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Cover photo: Upper harbour intertidal zone from the Orari Street stormwater outfall

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Executive Summary

This report presents the findings for the second annual monitoring of Dunedin's stormwater outfalls since discharge consents were granted.

The survey comprised assessment of benthic communities, of contamination of stormwater and of contamination of sediments and benthic fauna, including octopus, cockles and mussels.

Stormwater from all outfalls monitored showed variable levels of contamination, with numerous parameters being present at concentrations above recommended ANZECC guidelines or trigger values.

Overall contaminant levels were similar to those observed in a preliminary surveys carried out in 2007 and 2008, with no clear trends discernible at this juncture.

1. Introduction

1.1 Background

As with all urban centres throughout New Zealand and indeed most of the world, Dunedin's stormwater is reticulated to receiving environments via networks of gutters, open channels and pipes. The principal receiving water environments for Dunedin's reticulated stormwater are the upper basin of Otago Harbour, Second Beach/St. Clair Beach on the open coast, Kaikorai Stream and the Water of Leith. Dunedin City Council (DCC) was, on 29th November 2007, granted resource consents for its major urban stormwater discharges into the coastal marine environment (i.e. Otago Harbour, Sawyers Bay. Port Chalmers and Second Beach).

Conditions under which consents have been granted include compliance monitoring. Specifically:

Condition 2.

(a) *The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.*

(b) *The sampling shall be undertaken during storms, preceded by at least 72 hours of no measurable precipitation, with an intensity of at least 2.5 millimetres (depth) of rain in a 24 hour period. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:*
(i) pH
(ii) suspended solids
(iii) faecal coliforms and Escherichia coli
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease
(xiii) Polycyclic aromatic hydrocarbons ***(Portobello Road, Orari and Kitchener Street consents only)***

(c) *The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b).*

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road catchment discharge consent only

(a) *The consent holder shall undertake to determine the source and extent of the high levels of polycyclic aromatic hydrocarbons in the historic sediment deposits associated with discharge from the Portobello Road stormwater outlet.*

(b) *Updates on the progress of the investigation in condition 3(a) shall be*

provided in writing to the Consent Authority by 1 September each year.

(c) *No later than six months prior to the expiry of this consent, the consent holder shall provide a report to the Consent Authority stating the outcomes of the investigation in condition 3(a) and outlining the best practicable option(s) to mitigate the effects of these contaminated sediments.*

For the Portobello Road, Orari and Kitchener Street discharge consents only

(a) *The consent holder shall undertake biological monitoring annually between the months of January to June inclusive. The monitoring shall be undertaken at four sites at the waters edge at low tide; two within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide and two a minimum of 50 metres of the confluence of the stormwater outlet and the waters edge at low tide.*

(b) *At each site, three randomly spaced 5m^2 quadrats shall be sampled. For epifauna within each 5m^2 quadrat, the number of each species shall be recorded in five 0.1m^2 quadrats. For infauna a sediment core shall be taken in three 0.1m^2 quadrats and the number of each species shall be recorded. For macroflora, the percentage cover of each species shall be estimated in three 1.0m^2 quadrats.*

(c) *Results shall be reported to the Consent Authority in accordance with condition 8(e).*

For the Portobello Road, Orari and Kitchener Street discharge consents only

The consent holder shall undertake sampling of the flesh of cockles (Austrovenus stutchburyi) annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide. The size of each cockle sampled shall be recorded. The cockle flesh samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
(i) faecal coliforms

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road and Orari Street discharge consents only

The consent holder shall undertake sampling of deceased octopus annually, between the months of January to June inclusive (to align with the autumn die-off of octopus). Samples will include flesh and, if available, digestive gland. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The total arm span and weight of each octopus sampled shall be recorded. The samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons

Results shall be reported to the Consent Authority in accordance with condition 8(e). Should no deceased octopus be present, the consent holder shall notify the Consent Authority that sampling is unable to be undertaken.

For the Mason Street discharge consents only

The consent holder shall undertake sampling of spotties (Notolabrus

celidotus) or triplefin (Tripterygion varium) annually. This sampling is to be carried out within the months of January to June inclusive. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The length and weight of each fish sampled shall be recorded. The samples shall be analysed for:
(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road, Orari and Kitchener Street discharge consents only

The consent holder shall undertake sediment quality sampling using three replicate sediment samples that shall be collected at each site as marked on the plans attached as Appendix 1 to this consent. Sampling shall be undertaken:

(a) annually between January and June at the locations marked by large orange stars; and

(b) between January and June 2007, and between January and June 2010, at the locations marked by large pink stars. The samples will comprise the top 20mm of sediment and shall be analysed for:
(i) total copper
(ii) total lead
(iii) total zinc
(iv) total arsenic
(v) total nickel
(vi) total cadmium
(vii) total chromium
(viii) faecal coliforms and enterococci
(ix) polycyclic aromatic hydrocarbons
Results shall be reported to the Consent Authority in accordance with condition 8(e).

Condition 3. *The biological sampling of epifauna, infauna, macroflora, cockles, octopus, spotties or triplefins and sediment quality sampling required by Coastal Permits etc, shall be undertaken within a 14 day period (within the months of January to June), unless it is not practicable to do so due to the absence of any fauna to be sampled.*

Condition 4. *All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder and be acceptable to the Consent Authority.*

Condition 5. *Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.*

Second Beach
Condition 2.

(a) *The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of the rainfall event means that sampling in the manner described in condition 2(b) is not possible.*

(b) *The sampling shall be undertaken during storms, preceded by at least 72 hours of no measurable precipitation, with an intensity of at least 2.5 millimetres (depth) of rain in a 24 hour period. Sampling shall be*

undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:
(i) pH
(ii) suspended solids
(iii) faecal coliforms and Escherichia coli
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) HEM, oil and grease
(xii) UV fluorescent (whitening agent)

(c) *The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b). Results shall be reported in accordance with condition 8(e).*

Condition 3.
(a) *The consent holder shall undertake sampling of mussels annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, 50 metres to the east of the outlet. The shell length of each mussel sampled shall be recorded.*

(b) *The sampling of mussels shall be undertaken within a 14 day period (within the months of January to June) associated with the sampling rounds for Green Island and Tahuna WWTP discharge consents, unless it is not practicable to do so due to the absence of any fauna to be sampled.*

(c) *The samples shall be analysed for:*
(i) faecal coliforms
(ii) total copper
(iii) total lead
(iv) total zinc
(v) total arsenic
(vi) total nickel
(vii) total cadmium
(viii) total chromium
(d) *Results shall be reported in accordance with condition 8(e).*

Condition 4. *All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder and be acceptable to the Consent Authority.*

Condition 5. *Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.*

The following report presents the results of the latest round of sampling/monitoring carried out between January and June 2009.

1.2 Stormwater Outfalls

Stormwater is discharged from Dunedin City to the Upper Otago Harbour, Second Beach and Port Chalmers from fourteen reasonably large and permanent stormwater outfalls (Figures 1a, 1b and 1c), and from a number of smaller outfalls and non-point sources (Table 1). Many of the outfalls have very long histories dating back to the days of the early settlement of Dunedin and a numbers were

dual-purpose outfalls, discharging both wastewater and stormwater. All current outfalls, however, are designated to discharge stormwater.

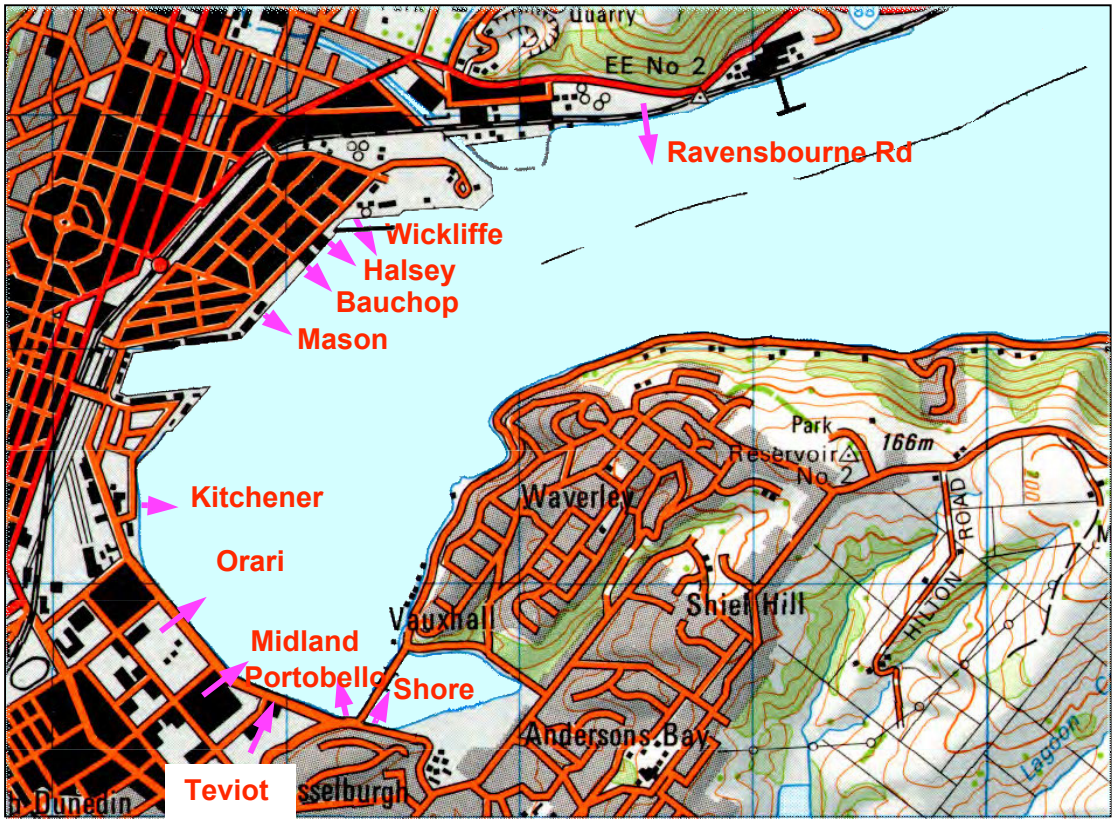


Figure 1a. *Major stormwater outfalls, labeled by catchment name, discharging from Dunedin City to the Upper Otago Harbour Basin.*



Figure 1b. *Location of the Second Beach stormwater outfall.*

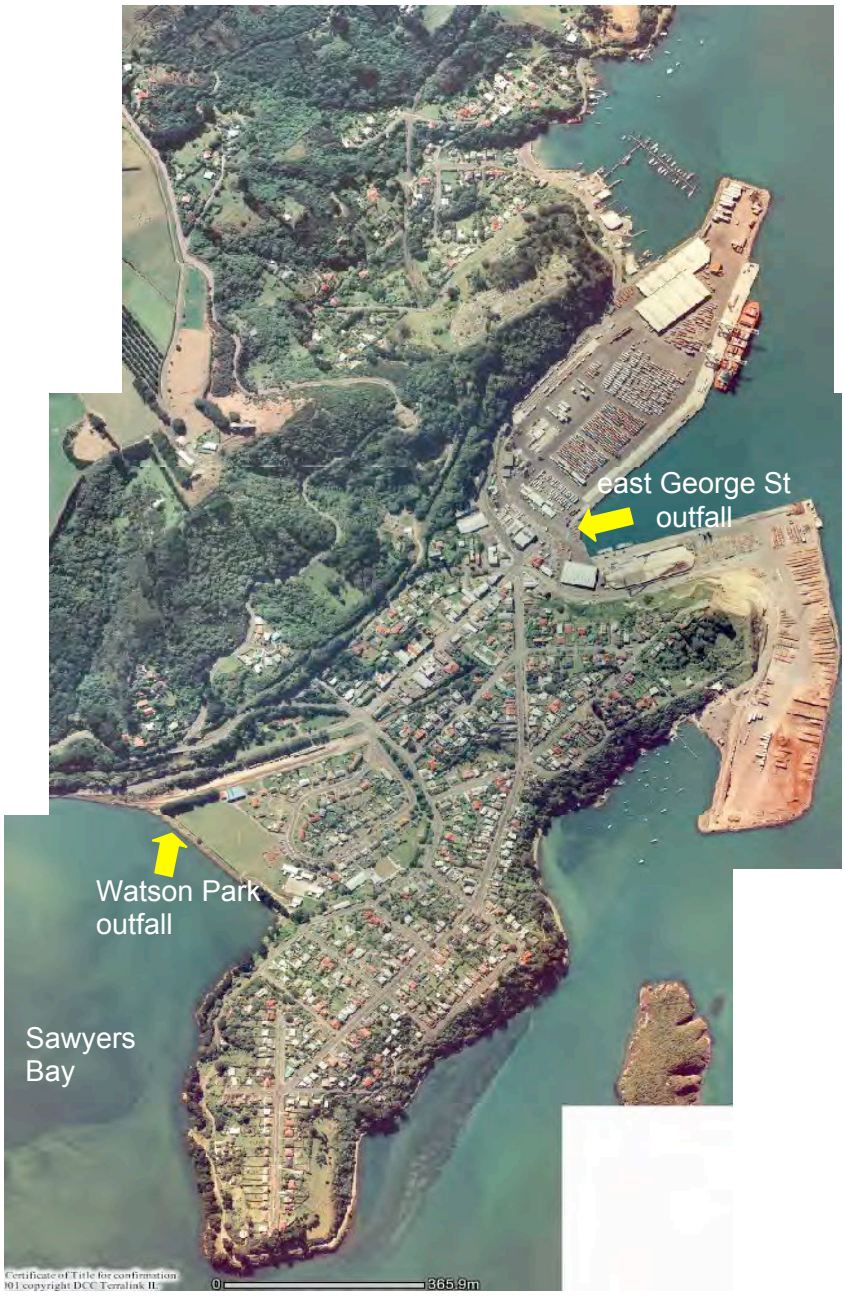


Figure 1c. *Location of major outfalls discharging stormwater from Port Chalmers.*

A total of 31 consents have been granted for the individual stormwater outfalls listed in Table 1.

Table 1. *List of stormwater outfalls for which discharge permits have been granted.*

Consent ref	DCC ref	Location	Catchment	Description	Max flow rate (l/s)	Outlet structure
2002.080	4	Shore St	Shore St	1500mm dia	2,380	Yes
2002.081	5	Portobello Rd	Portobello Rd	twin 1500mm dia conduits	pump rate 6,300	Yes
2002.082	6	Teviot St	Foreshore	375mm dia.	105	Yes
2002.083	7	Midland St	Foreshore	450mm dia	143	No
2002.084	8(a)	Orari St	Orari St	375mm dia	101	No
2002.085	8(b)	Orari St	Orari St	2700mm dia	10,350	Yes
2002.086	9(a)	Kitchener St	Kitchener St	600mm dia	310	Yes
2002.087	9(b)	Kitchener St	Kitchener St	1500mmdia	3,880	Yes
2002.088	10	French St	Foreshore	450mm dia	185	No
2002.089	11	Kitchener St	Foreshore	300 mm dia.	78	No
2002.090	12(a)	Birch St	Foreshore	225 mm dia.	37	No
2002.091	12(b)	Birch St	Foreshore	225 mm dia.	55	No
2002.092	12(c)	Wharf St	Foreshore	225 mm dia.	52	No
2002.093	13(a)	Fryatt St	Foreshore	150 mm dia.	40	No
2002.094	13(b)	Fryatt St	Foreshore	450mm dia	180	No
2002.095	13(c)	Fryatt St	Foreshore	300mm dia	54	No
2002.096	14	Fryatt St	Foreshore	300mm dia	116	No
2002.097	15(a)	Mason St	Mason St	2175mm dia. conduit	5,000	Yes
2002.098	15(b)	Mason St	Bauchop St	450mm dia	90	No
2002.099	15(c)	Mason St	Bauchop St	1350mm dia. culvert	1,500	No
2002.100	16(a)	Halsey St	Halsey St	1950mm conduit	3,800	No
2002.101	16(b)	Halsey St	Wickliffe St	1950mm conduit	2,600	No
2002.102	16(c)	Halsey St	Wickliffe St	300mm dia	113	Yes
2002.103	17	Wickliffe St	Wickliffe St	1,050 mm dia.	1,660	No
2002.104	18(a)	Magnet St	Magnet St	300mm dia	73	No
2002.105	18(b)	Magnet St	Magnet St	300mm dia	66	No
2002.106	19	Ravensbourne Rd	Gas Works	300 mm dia.	117	Yes
2002.108		George St (Port Otago)	Port Chalmers	750 mm dia.	1,000	No
2002.109		George St/SH88	Port Chalmers	1,250 mm dia.	1,200	Yes
2002.110		Second Beach Rd	St. Clair	1,050 x 1,050 mm tunnel	7,000	Yes
2006.222		Sawyers Bay, western side of Watson Park, Port Chalmers	Port Chalmers	150 mm dia.	20	Yes

2. Methods

2.1 Stormwater

A number of the outfalls listed in Table 1 do not have outfall structures or are located in places that are inaccessible. Consequently it is neither practical nor possible to sample from the entire 31 outfalls listed, as agreed by the ORC. However, the monitoring programme undertaken samples all major Dunedin stormwater catchments and gives a comprehensive picture of the state of contaminants in Dunedin's stormwater. Catchment names have been altered slightly from those used last year to reflect the naming to be used under the DCCs

3 Waters Strategy (See Table 2). Grab samples of stormwater were collected from each stormwater outfall within 1 hour of the commencement of a rain event (>0.5mm) in an endeavour to ensure that first flush water was gathered. Collections took place only if there was an antecedent period of at least 72 hours with no rain before the target rain event. Samples were sent to Hill Laboratories in Hamilton to be analysed for arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn), faecal coliforms and *E. coli.* Samples collected from the Kitchener Street, Orari Street and Portobello Road outfalls were additionally analysed for polycyclic aromatic hydrocarbons (PAHs). Samples were also collected during a period of low flow a week after the targeted rainfall event and sent to ESR in Christchurch for analysis of fluorescent whitening agents (FWAs). FWAs are used in laundry detergents and indicate possible sewage infiltration to the stormwater system (Petch 1996). Gilpin *et al*., (2004) recommend that stormwater be sampled at low flows to get a more accurate picture of sewage infiltration because the FWAs are usually present in only very low concentrations and are more readily detected at low flows.

2.2 Sediments

Three replicate 250cm^3 samples were collected from the top 20mm of sediment within 20m from each of the Kitchener Street, Orari Street and Portobello Road Outfalls. To gain a clear picture of sediment contamination within the upper harbour basin, further replicate sediment samples were collected at each of the sites indicated by orange stars in Figure 2. Samples were chilled and sent to Hill laboratories in Hamilton for analysis for total arsenic, total cadmium, total chromium, total copper, total nickel, total lead, total zinc, faecal coliforms, enterococci and PAHs.

2.3 Biological Monitoring

At the Portobello Road, Orari Street and Kitchener Street outfalls two sites within 20m of each outfall and at the waters edge at low tide were sampled for flora and fauna according to the protocols outlined in Kingsford and Battershill (1998). An additional two sites were sampled at no less than 50m from each outfall at the waters edge. At each site, three randomly spaced 5m^2 quadrats were sampled, giving a total of 12 quadrats at each outfall. For epifauna within each 5m^2 quadrat, the number of each species was recorded in five 0.1m^2 quadrats. For infauna a sediment core was taken in three 0.1m^2 quadrats per site, giving 12 cores per outfall. Sediment was returned to the laboratory, washed through a 500μm sieve

and animals retained identified to at least family level (Bates *et al*. 2007). The abundance of each species was then recorded. For macroflora, the percentage cover of each species was estimated in three 1.0m^2 quadrats per site, giving 12 quadrats per outfall. For both epifauna and infauna a Shannon Weiner diversity index (Zar 1996) was calculated to enable community diversity to be compared from year to year.

2.4 Cockle, Mussel, Fish and Octopus Flesh

Daily patrols of the shoreline at low tide adjacent to the Portobello Road and Orari Street stormwater outfalls were made, beginning in late March, to seek mature octopus (*Octopus maorum* or *Robsonella australis*) during the annual autumn die-off.

For shellfish a minimum of 15-20 large cockles (*Austrovenus stutchburyi*) were collected from within 20m of the confluence of the stormwater outlet and the waters edge at low tide at each of the Portobello Road, Orari Street and Kitchener Street outfalls. Cockles were individually measured, bagged, and chilled and sent to Hill Laboratories for analysis for As, Cd, Cr, Cu, Ni, Pb and Zn. A further 15-20 cockles were collected at each site and sent for PAH analysis, and a further 15-20 to Hill Laboratories in Christchurch for analysis for faecal coliforms.

Within the same period that cockles were collected variable triplefins (*Tripterygion varium*) were caught using baited fish traps off the Mason Street wharf no more than 50m from the Mason Street stormwater outfall. Fish were weighed and measured, then chilled, bagged, and sent to Hill Laboratories for analysis for As, Cd, Cr, Cu, Ni, Pb and Zn and for PAHs.

At Second Beach a minimum of twelve mussels (*Perna canaliculus*) were collected from the rock reef to the east of the Second Beach stormwater outfall at a distance of no more than 50m from the outfall. Only mussels of mature size (≥80mm) were collected. Mussels were bagged and chilled and sent to Hill Laboratories in Hamilton for analysis for, As, Cd, Cr, Cu, Ni, Pb and Zn. A further 12-15 mussels were collected and sent to Hill Laboratories, Christchurch, for analysis for faecal coliforms.

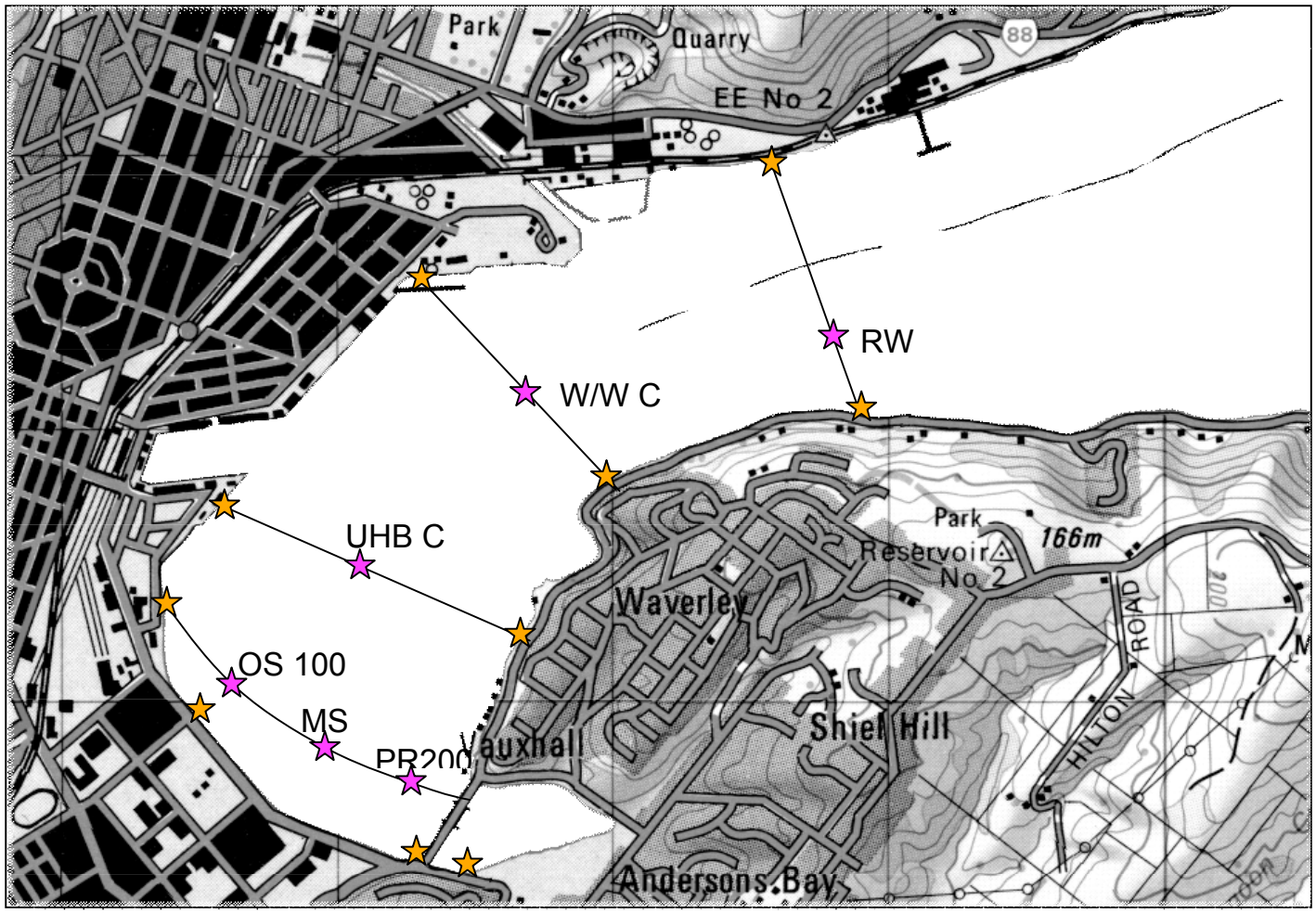


Figure 2. *Upper Harbour Basin sediment sampling sites. Orange stars sampled annually; pink stars sampled 5 yearly. Anticlockwise, starting at top, orange sites are: Rowing Club, Wickliffe St, White St, Kitchener St, Orari St, Portobello Rd, Shore St, Boatshed, Cove Drainage and Retaining Wall. Pink sites are coded according to location (see Table 4).*

3. Results

3.1 Stormwater

During the first hour of a storm event that produced 8.8mm rainfall on 12 May 2009 water samples were collected from stormwater outfalls at Second Beach, Shore Street, Portobello Road, Teviot Street, Midland Street, Orari Street, Kitchener Street, Mason Street, Bauchop Street, Halsey Street, Wickliffe Street and Ravensbourne Road in Dunedin and from Watson Park and east George Street in Port Chalmers. This storm event had an antecedent dry period of 86 hours.

Stormwater at Ravensbourne Road was flowing clear at sampling time but at all other sites was discoloured, particularly at Portobello Road, Orari Street, Kitchener Street, Wickliffe Street and George Street. Second Beach was moderately discoloured. Contaminant levels are compared with levels in stormwater collected during a preliminary survey conducted in 2007 and the first annual survey conducted in 2008 (Table 2, Figure 3). This year in stormwater at both the Watson Park outfall in Port Chalmers and at Teviot Street contaminant levels were all below ANZECC (2000) guidelines for protection of 80% of species (Table 2, Figure 3). For Bauchop Street, Orari Street and the Ravensbourne Road outfalls, just zinc exceeded the ANZECC trigger level. This is an improvement over last year when just Ravensbourne Road could be included in this group. For Shore Street, Midland Street and Portobello Road both copper and zinc levels exceeded ANZECC guidelines. Trigger levels for copper, lead and zinc were exceeded at George Street (Port Chalmers), Second Beach, Kitchener Street and Wickliffe Street with Mason Street also showing moderate cadmium levels (Table 2, Figure 3). It should be noted that Orari Street and Portobello Road both operate with sump systems and it is not clear if, in fact, the first flush had reached the outfall for these sites at the time of sampling. However, these sumps were operating at the time of sampling so it is assumed the first flush for these two outfalls was sampled.

The highest levels of contaminants overall were at Wickliffe Street, although it must be pointed out that samples here are taken from the stormwater pipe itself due to the inaccessibility of the outfall beneath the container wharf at high tide. As for last year, the highest levels of zinc were at Portobello Road. Generally speaking, contaminant levels showed considerable variability with location when compared with results from 2007 and 2008. Arsenic levels have risen at Orari, Kitchener, Mason, Bauchop, Halsey and Wickliffe Streets over last years levels but have fallen at some of these sites compared with 2007 (Figure 3). Chromium is down at

all sites bar Wickliffe Street, but copper is generally up. Nickel, lead and zinc show highly variable results with no trends clearly discernible (Figure 3).

Microbiological levels were high to very high at all sites except Ravensboune Road and Watson Park (Table 2, Figure 3). Two other sites (Teviot Street and Orari Street) have moderate (amber alert) to low levels of E. coli and Faecal coliforms High microbial counts are perhaps not unexpected for first flush samples with a considerable amount of animal faeces and decaying vegetable matter being washed into the stormwater system from streets and pavements. Of note are marked increases in microbial levels at Shore Street, Wickliffe Street, Midland Street, Kitchener Street, Mason Street, Bauchop Street, Halsey Street and Second Beach compared to 2008 levels (Table 2, Figure 3).

A new portable fluorimeter was used for the first time this year meaning results from past years may not be directly comparable, but relative values still provide valuable information. FWAs were detected at low flows at all sites this year (Table 2). All sites except Second Beach and Bauchop Street showed increases in the levels of FWAs compared with 2007 and 2008. Bauchop Street had particularly high levels of FWAs in 2007 and 2008, but, following an investigation of this catchment and the cessation of an illegal wastewater discharge, FWA levels have dropped markedly. There are no standards for FWAs in New Zealand but levels above 0.2µg/L are cause for concern (Brent Gilpin, ESR, pers. comm.). It is expected that contaminants of this nature will continue to be investigated as part of the development and implementation of the long-term stormwater catchment management plans and DCC's 3-Waters strategy.

PAHs were detected at only the Portobello Road outfall this year. This is unlike 2007, when PAHs were detected only in Orari Street stormwater (just Pyrene at very low levels) (Table 3), and in 2008 when PAH levels were high at all three outfalls at which this parameter is monitored (Table 3). However, total PAH levels were very much lower at Portobello Road than in the previous year (Table 3). Anthracene, Fluorene and Biphenyl-d10, the three PAHs that contributed the major component of last years totals, were notably absent or at extremely low levels this year. Anthracene and Biphenyl-d10 are components of coal tar and it may be that the input of this substance (a by-product of gas production) to the upper harbour via stormwater is tailing off. It will be of interest to see if this trend continues in future years.

Table 2. *Levels of contaminants detected in stormwater from outfalls in and around Dunedin during a storm event on 11 April 2007, 17 June 2008 and 12 May 2009. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

		Stormwater																				
	Parameter	As			Cd			Cr			Cu			Ni			Pb			Zn		
	units	g/m^3			g/m^3			g/m^3			g/m^3			g/m^3			g/m^3			g/m^3		
Catchment	Outfall	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
St Clair	Second Beach	BDL	0.0013	0.0015	BDL	0.00006	0.00006	0.0007	0.0028	0.0035	0.0027	0.012	0.019	0.0009	0.0021	0.0022	0.001	0.011	0.013	0.038	0.16	0.15
Port Chalmers	George St	BDL	0.0031	BDL	0.00028	0.00140	0.00011	0.005	0.012	0.0031	0.0213	0.039	0.025	0.0029	0.0093	0.0026	0.0342	0.041	0.018	0.288	0.66	0.19
	Watson Pk	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0064	BDL	0.009	0.0025	BDL	BDL	BDL	BDL	0.0141	0.0018	BDL	0.231	0.027	BDL
Shore Street	Shore Street	0.04	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01	0.014	0.02	0.01	BDL	BDL	0.003	0.0085	0.0069	0.02	0.44	0.21
Portobello Road	Portobello Road	BDL	0.002	BDL	BDL	0.00023	BDL	BDL	0.002	BDL	BDL	0.026	0.01	BDL	0.0035	0.0028	BDL	0.019	0.0067	0.08	0.94	0.64
Andersons Bay	Teviot Street	BDL	0.002	BDL	BDL	0.00008	BDL	BDL	0.0018	BDL	BDL	0.0094	BDL	BDL	0.0019	BDL	BDL	0.0066	BDL	BDL	0.13	BDL
	Midland Street	BDL	0.0033	BDL	BDL	0.00013	BDL	BDL	0.0035	0.0031	0.02	0.031	0.057	BDL	0.0016	BDL	0.005	0.0054	0.0083	0.1	0.35	0.18
Orari Street	Orari Street	BDL	BDL	0.032	BDL	BDL	BDL	BDL	0.0032	BDL	BDL	0.014	BDL	BDL	0.0033	BDL	BDL	0.023	BDL	BDL	0.22	0.031
Kitchener St	Kitchener Street	BDL	BDL	0.0096	BDL	BDL	BDL	0.004	0.002	BDL	0.034	0.0056	0.023	0.003	BDL	0.0036	0.0442	0.007	0.018	0.445	0.036	0.38
Mason Street	Mason Street	0.006	BDL	0.0077	BDL	BDL	0.0077	BDL	BDL	BDL	0.022	0.012	0.021	0.004	BDL	0.0055	0.0258	0.0089	0.014	0.25	0.16	0.35
Gas Works	Ravensbourne Rd		BDL	BDL		BDL	BDL		0.00061	BDL		0.0023	BDL		0.00066	BDL		0.0015	0.0029		0.053	0.047
Halsey, Wickliffe, Bauchop	Bauchop Street	0.03	BDL	0.021	BDL	BDL	BDL	BDL	0.0015	BDL	0.029	0.0096	BDL	0.01	BDL	BDL	0.01	0.0035	BDL	0.23	0.12	0.13
	Halsey Street	0.03	BDL	0.01	BDL	0.00022	BDL	BDL	BDL	BDL	0.024	0.0043	0.021	0.009	BDL	0.0035	0.021	0.0022	0.0097	0.12	0.033	0.3
	Wickliffe Street	0.03	BDL	0.003	BDL	BDL	0.00052	BDL	0.0017	0.0076	0.01	0.013	0.059	0.01	BDL	0.0042	0.006	0.0084	0.033	0.1	0.2	0.53
	Protection for 80% of species																					
	ANZECC guidelines	0.36			0.0008			0.04			0.0025			0.017			0.0094			0.031		

		Stormwater																	
	Parameter	pH			Suspended Solids			Oil & Grease			FWA			E. coli			Faecal Coliforms		
	units				g/m^3			g/m^3			µg/L			mpn/100ml			cfu/100ml		
Catchment	Outfall	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
St Clair	Second Beach	7.7	7.3	7.4	BDL	37	41	5	BDL	BDL	0.147	0.19	0.098	560	6800	14000	560	8300	14000
Port Chalmers	George St	6.9	7.1	7.3	87	150	26	10	8.7	BDL	BDL	BDL	0.03	1400	930	1000	1400	1400	1000
	Watson Pk	6.8	7.9	8.2	37	39	7.4	8	BDL	BDL	0.002	0.003	0.124	14000	150	10	39000	150	10
Shore Street	Shore Street	7.9	7.2	7.3	41	24	20	BDL	BDL	BDL	0.081	0.031	0.142	300	5100	16000	300	5100	16000
Portobello Road	Portobello Road	7.9	7.3	7.6	18	46	30	4	9.7	BDL	0.003	0.049	0.177	460	5000	2800	590	5000	2800
Andersons Bay	Teviot Street	7.9	7.1	7.9	25	33	12	8	4.4	BDL	BDL	0.006	0.096	7	120000	210	7	240000	210
	Midland Street	7.7	7.7	7.7	30	19	30	BDL	BDL	BDL	BDL	0.004	0.132	290	130	6000	290	130	6000
Orari Street	Orari Street	7.8	7.4	8.1	28	77	16	BDL	11	BDL	BDL	0.005	0.11	50	6000	210	80	7000	210
Kitchener St	Kitchener Street	7.1	7.7	7.4	104	41	45	9	BDL	BDL	0.18	0.029	0.072	13000	70	10000	13000	70	10000
Mason Street	Mason Street	7.1	7	7.4	62	37	37	5	7.9	BDL	0.007	0.07	0.051	22000	26000	50000	22000	26000	50000
Gas Works	Ravensbourne Rd		7	8.1		8.5	18		8.8	BDL		BDL	0.096		120	90	150	130	90
Halsey, Wickliffe, Bauchop	Bauchop Street	7.6	7.8	8.1	44	16	13	4	BDL	BDL	2.028	4.92	0.031	2200	400	3000	2200	400	3000
	Halsey Street	7.3	7.9	7.2	119	35	27	9	BDL	BDL	BDL	0.004	0.011	9000	1700	70000	9000	1700	70000
	Wickliffe Street	7.7	7.5	8.0	35	27	100	6	9.5	9.5	0.024	0.003	0.021	25000	10000	220000	30000	10000	220000
	Protection for 80% of species													Amber	260		150		Primary
	ANZECC guidelines	7.2-7.8												Red	550		1000		Secondary

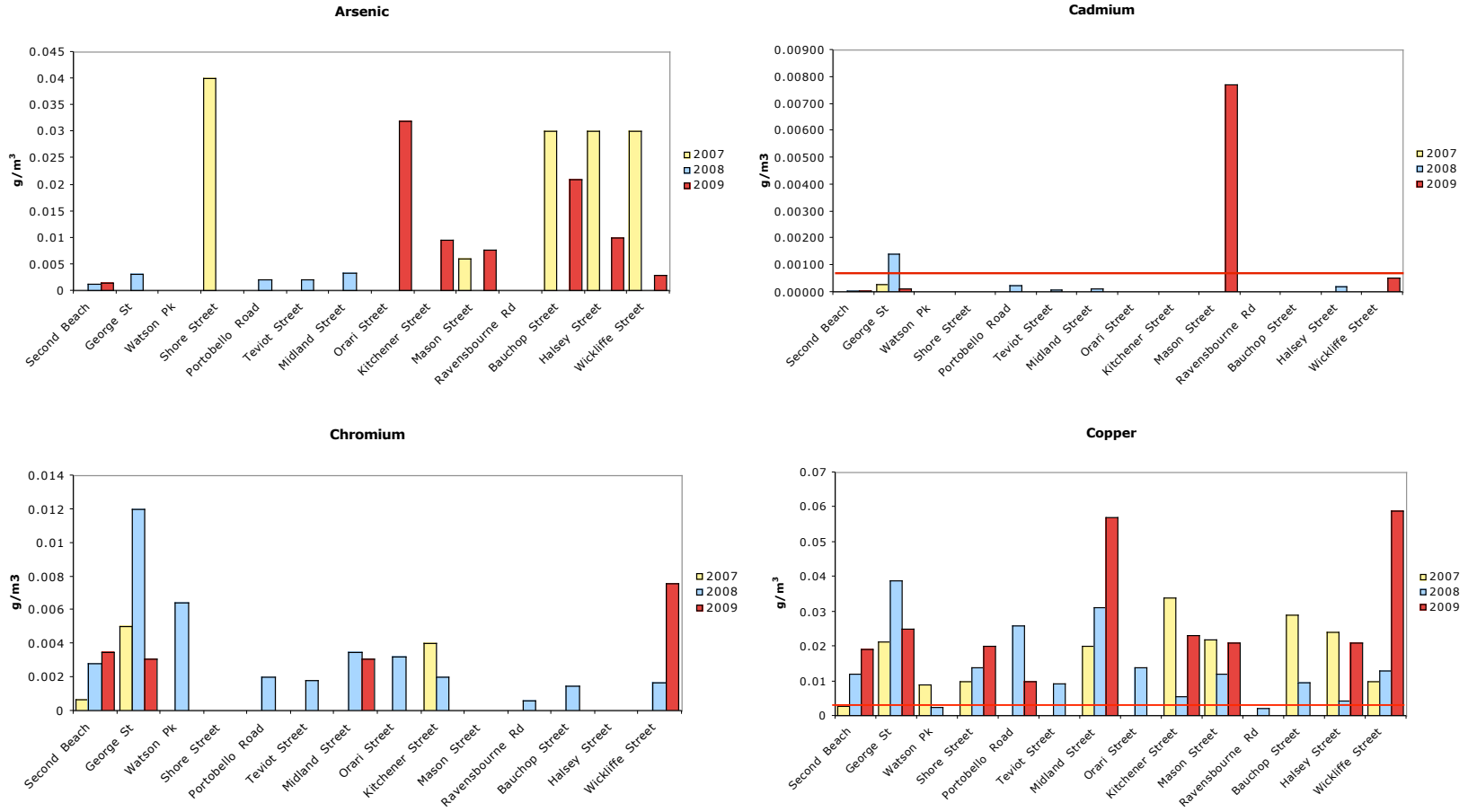


Figure 3. *Graphical representation of contaminant levels in stormwater at outfalls around upper Otago Harbour in 2007, 2008 and 2009. Red line indicates ANZECC trigger level for protection of 80% of species.*

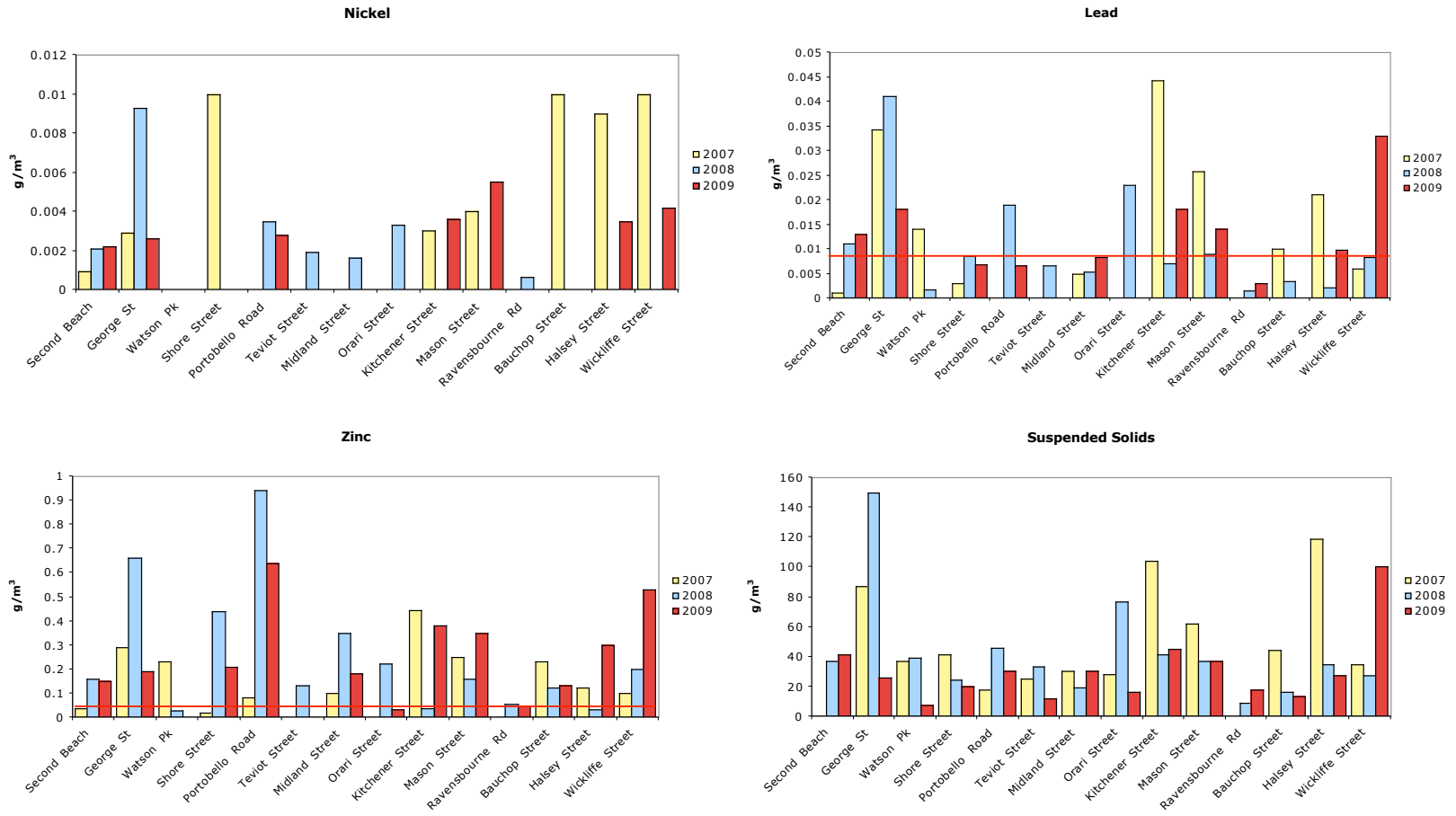


Figure 3. (continued….)

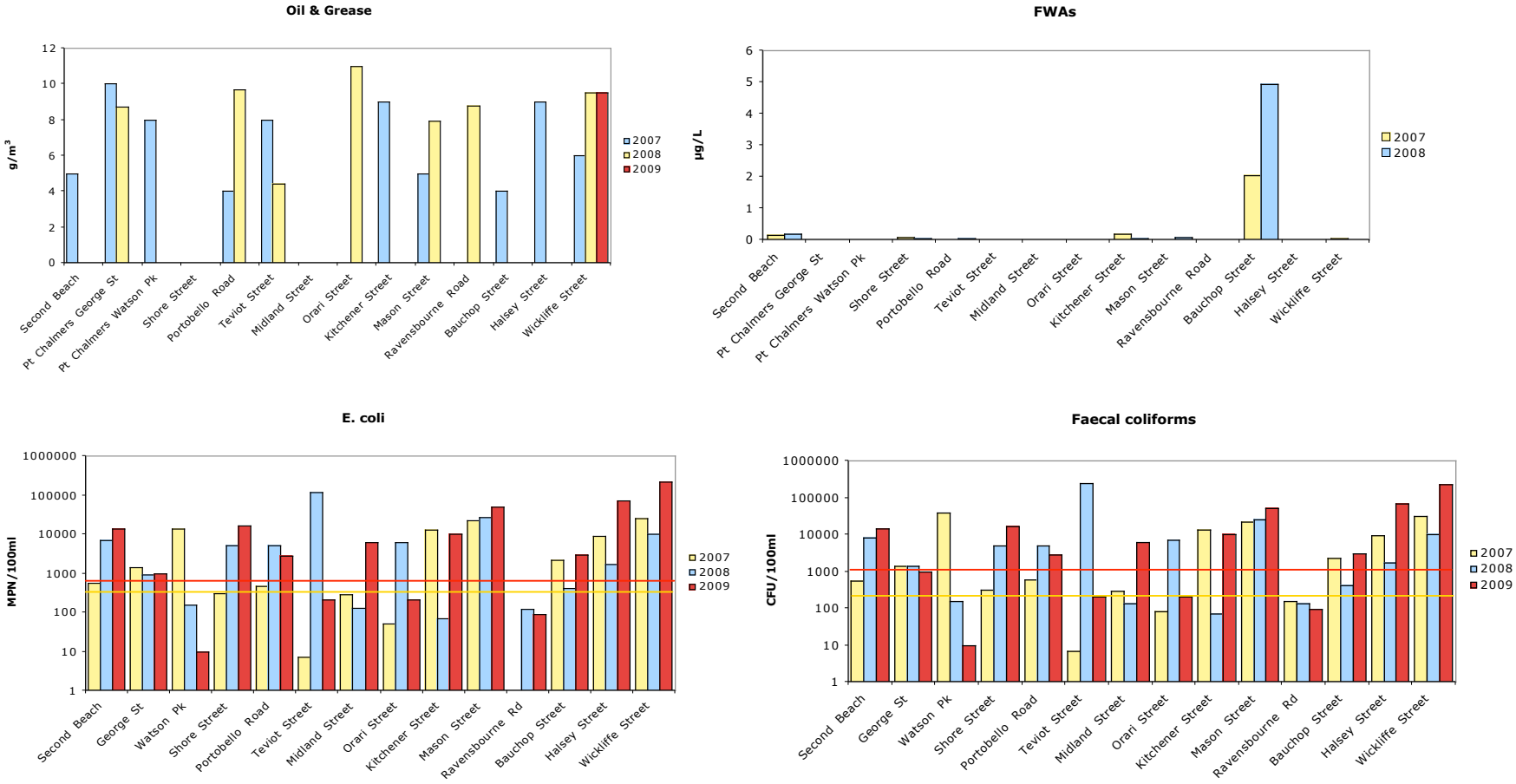


Figure 3. ***(continued)*** *Graphical representation of contaminant levels in stormwater at outfalls around upper Otago Harbour in 2007, 2008 and 2009. For microbiological graphs amber line indicates guideline for primary contact, red line indicates guideline for secondary contact.* ***Note log scale on Y axis of microbiological graphs.***

Table 3. *PAHs (g/m^3) detected in stormwater from the Kitchener Street, Orari Street and Portobello Road outfalls in 2007, 2008 and 2009. BDL indicates Below Detectable Limits.*

	Kitchener St			Orari St			Portobello Rd		
	2007	2008	2009	2007	2008	2009	2007	2008	2009
Acenaphthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00034	0.000024
Acepaphthylene	BDL	100	BDL	BDL	92	BDL	BDL	100	0.000029
Anthracene	BDL	87	BDL	BDL	89	BDL	BDL	87	0.000008
Benzo[a]anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00015	0.000014
Benzo[a]pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000017
Benzo[a]fluorathene + Benzo[k]fluorathene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00018	0.000033
Benzo[g,h,i]perylene	BDL	BDL	BDL	BDL	0.00014	BDL	BDL	BDL	0.000014
Biphenyl-d10	-	67	BDL	-	67	BDL	-	67	BDL
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Dibenzo[a,h]anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fluoranthene	BDL	BDL	BDL	BDL	0.00011	BDL	BDL	0.00028	0.00001
Fluorene	BDL	73	BDL	BDL	70	BDL	BDL	74	BDL
Indeno[1,2,3-c,d]pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000013
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Phenanthrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Pyrene	BDL	BDL	BDL	0.0001	BDL	BDL	BDL	0.00037	0.000011
Total PAH	0.00	327.00	BDL	0.00	318.00	BDL	0.00	328.00	0.00017

3.2 Sediments

Sediments were sampled in May 2009 at sites detailed in Figure 2. Surface sediments were generally clean at most sites with little surface detritus apart from a layer of leaf litter at Portobello Road and at Wickliffe Street. Additionally, at Portobello Road, sediments were very dark and smelled strongly of petro-carbons with a visible oil slick forming in footprints and depressions dug to remove sediments. At Wickliffe Street, sediments were dark and smelled strongly of hydrogen sulphide, indicating anoxic conditions. Investigations into PAH levels at the Portobello Road outfall are detailed in Stewart (2005, 2006). Note that the Portobello Road catchment has been chosen as the pilot for the stormwater catchment management plan development.

As expected, copper, nickel, lead and zinc levels are elevated in sediments near stormwater outfalls that discharge from large or industrialised catchments such as White Street, Kitchener Street and Portobello Road (Table 4, Figure 4). Arsenic levels are similar to last year or have fallen except at Orari Street where there is a marked increase (Table 4, Figure 4). Lead has decreased at five of the ten sites monitored but levels at Portobello Road remain high (Table 4, Figure 4). The high levels seen at Boatshed last year have fallen significantly. The moderately high level for arsenic at Retaining wall is much as last year and is once again unexpected due to this site being well removed from any or the major stormwater outfalls. This site is, however, adjacent to outcrops of basement rock along the southern side of the harbour and the geology of the area may be having an effect.

Zinc levels in sediment have increased at all sites except Retaining Wall, Boatshed and White Street.

As observed in previous investigations PAHs are to be found at moderate to high levels in much of the Upper harbour Basin, with particularly high levels adjacent to the Portobello Road outfall (Table 4). Stormwater inputs of PAHs were generally lower this year than last year indicating that, while PAHs are still being added to the upper harbour, the amount varies through time and with site. The extremely high levels of PAHs in older sediments off Portobello Road are believed to have been sourced from the now defunct gas works. The levels of PAHs off Portobello Road observed this year are higher than those from last year and similar to those observed in 2007. Wave action disturbing surface sediments around the time of sampling will undoubtedly have a bearing on PAH levels at any particular site.

Trends in contaminant levels at the various sites through time are unclear with just three years of sampling revealing high variability among contaminants and among sites (Figure 4). Trends, if any, may become more apparent with the addition of further data from future monitoring rounds.

Table 4. *Contaminant levels in sediments at various locations within 20m of stormwater outfalls and within the Upper Otago Harbour Basin with 2007 (yellow) and 2008 (green) values compared with 2009 values (blue). Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

Sediments within 20m of outfall																															
	AS			Cd			Cr			Cu			Ni			Pb			Zn			PAH			Enterococci			Faecal coliforms		
Units	mg/kg dry wt			mg/kg dry wt			mg/kg dry wt			mg/kg dry wt			mg/kg dry wt			mg/kg dry wt			mg/kg dry wt			mg/kg dry wt			MPN/g			MPN/g		
Parameter	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
Rowing Club	10.6	9.8	7.3	0.2	0.2	0.1	17.6	12.0	16.0	14	13	14	11.3	14.0	13.0	18.9	27	27	101	130	160	7.0	5.8	0.5	2	11	<2	<2	17	5
Wickliffe Street	17.3	11.0	6.9	0.6	0.7	0.8	38.0	34.0	16.0	121	68	50	19.2	23.0	13.0	76.1	140	77	412	740	810	9.2	1.2	7.3	580	>1600	330	2	540	33
White Street	11.6	18.0	5.4	0.3	0.2	0.2	68.5	56.0	26.0	433	160	170	29.5	21.0	11.0	147.0	180	170	4450	2500	2400	13.0	11.1	15.9	4	2	<2	<2	<2	<2
Kitchener Street	4.6	7.5	7.0	0.4	0.4	0.3	22.6	18.0	98.0	70	56	90	10.6	12.0	15.0	117.9	97	130	249	280	300	8.9	140.5	4.8	66	920	5	20	13	70
Orari Street	18.6	4.3	20.0	63.0	0.1	0.9	0.3	16.0	37.0	25	13	61	23.6	8.1	16.0	12.8	39	120	68	130	680	10.2	12.6	28.3	<2	8	23	23000	4	33
Portobello Road	29.0	23.0	24.0	48.5	1.8	2.0	1.8	54.0	50.0	60	160	190	169.3	18.0	26.0	20.4	330	290	306	1400	1600	436.3	250.3	525.2	727	170	<2	23	43	2
Shore Street	9.5	7.1	6.2	0.4	0.3	0.3	21.8	16.0	18.0	51	44	41	10.7	9.0	11.0	113.0	110	79	484	300	330	9.6	21.0	8.6	90	>1600	<2	<2	540	<2
Boatshed	27.4	16.0	17.0	0.3	0.2	0.2	41.7	19.0	26.0	108	33	49	24.5	16.0	17.0	112.0	800	170	339	370	360	6.7	5.5	38.8	34	33	33	<2	2	79
Cove Drainage	21.5	17.0	19.0	0.1	0.1	0.4	15.8	35.0	32.0	11	19	38	23.5	44.0	23.0	19.7	20	55	99	150	270	0.4	0.0	0.1	8	17	<2	2	8	<2
Retaining Wall	25.3	36.0	24.0	0.1	0.2	<0.1	23.6	31.0	39.0	13	19	17	15.9	25.0	26.0	26.9	27	42	141	170	150	0.3	3.9	0.0	<2	8	<18	2	<2	33
ANZECC Low trigger value	20			1.5			80			65			21			50			200			4								
ANZECC high trigger value	70			10			370			270			52			220			410			45								

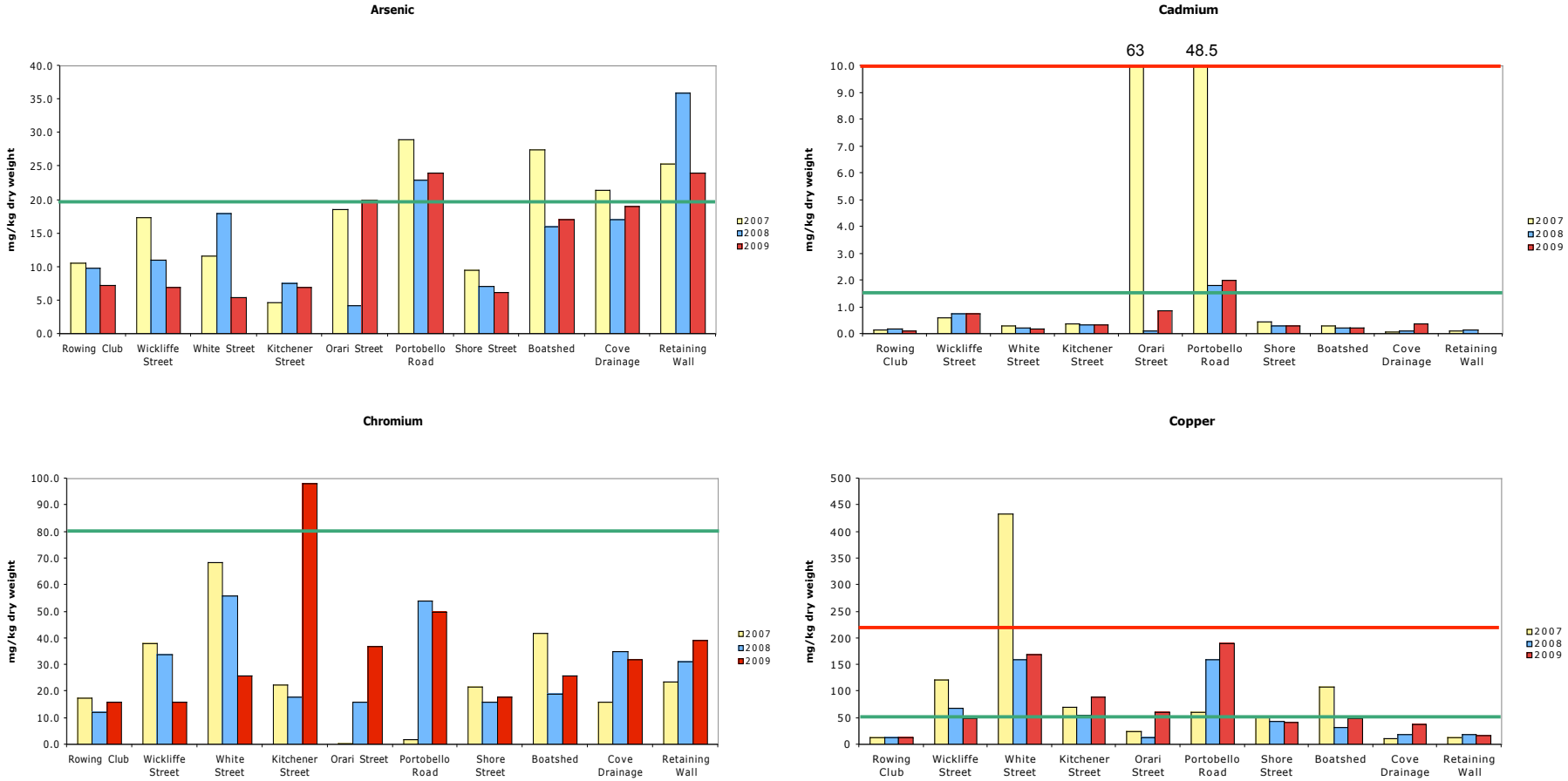


Figure 4. *Graphical representation of contaminant levels in sediment at sampling sites around upper Otago Harbour in 2007, 2008 and 2009. Green line indicates ANZECC low trigger level, red line is high trigger level.*

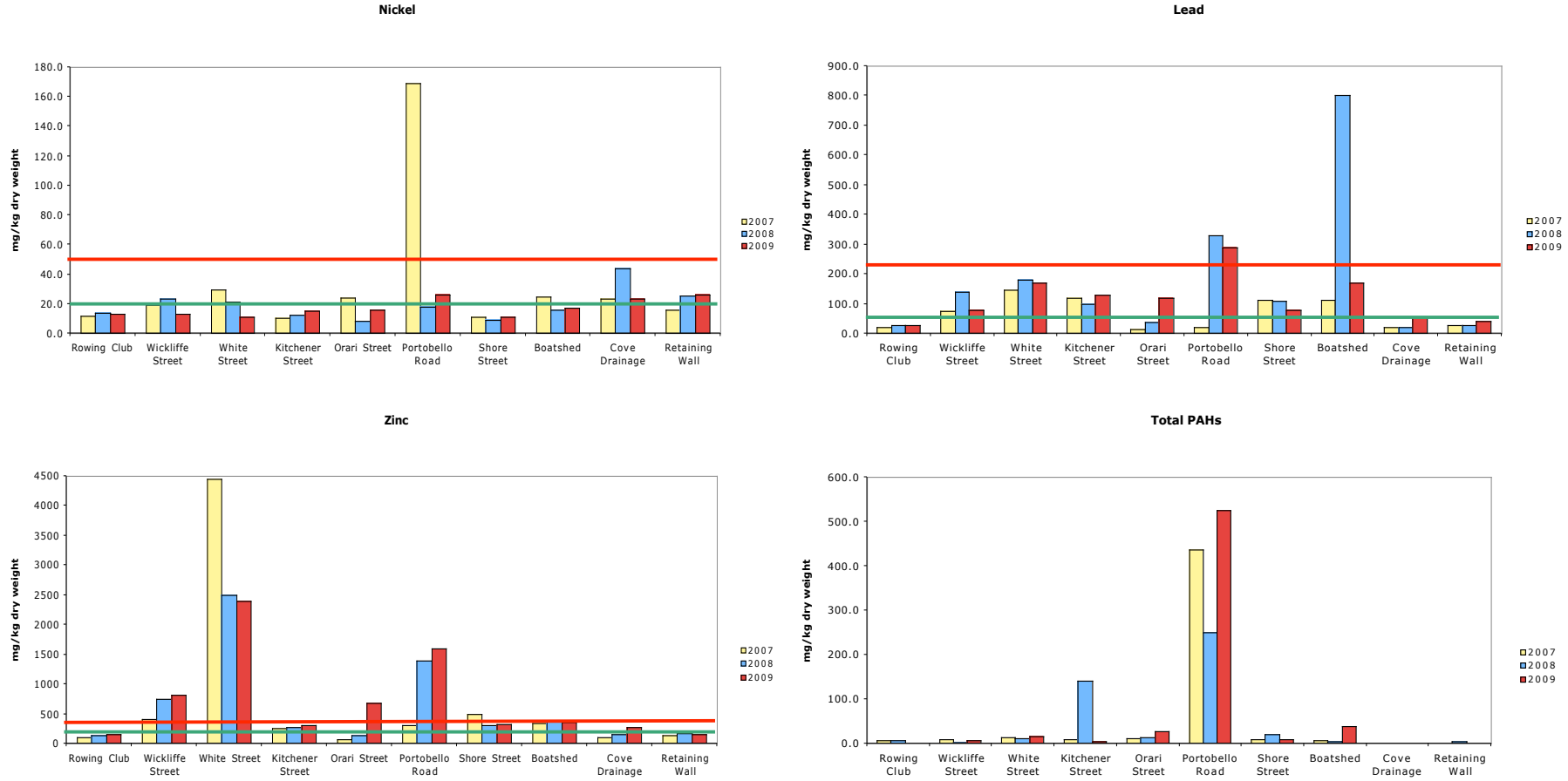


Figure 4 (continued). *Graphical representation of contaminant levels in sediment at sampling sites around upper Otago Harbour in 2007, 2008 and 2009. Green line indicates ANZECC low trigger level, red line is high trigger level.*

3.3 Biological Monitoring

On 25 May 2009 biological sampling was carried out at the Portobello Road and Orari Street outfalls. On 26 May 2009 biological sampling was carried out at the Kitchener Street outfall. The tide on both days was very low at 0.98m below mean sea level and 1.00m below mean sea level respectively.

There was a reasonable diversity of mainly red algae at all three sites. Just a single species was present at Portobello Road last year. Despite the diversity, percentage cover was generally low except at >50m from the Kitchener Street outfall and <20m from the Orari Street outfall. At both these locations quite large clumps of *Ceramium uncinatum* were present with almost 100% cover in some quadrats at Kitchener Street (Tables 5-7). Cover at Orari Street was similar to 2007 and 2008, but cover at >50m from Kitchener Street was higher than in the past (Stewart 2007a, Stewart 2008c).

Table 5. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Kitchener Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca						
Ceramium uncinatum		1		1	1	
Euptilota formosissima		5		2	1	2
Gracilaria chilensis						
Lenormandia chauvinii	5	10	1	2	2	15
Lomentaria umbellata						1

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis	2				2	
Ulva lactuca						
Ceramium uncinatum	95	75	40	5	85	70
Euptilota formosissima		3	2	5	5	
Gracilaria chilensis						
Lenormandia chauvinii	3	20	15	30	5	30
Lomentaria umbellata			2	5	5	10

Table 6. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Orari Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca						
Ceramium uncinatum		5	60		50	50
Euptilota formosissima	18	20	5	5	5	1
Gracilaria chilensis			2			
Lenormandia chauvinii	1	5	5	1		3
Lomentaria umbellata	1	1	1	1	3	2

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa			1		1	
Codium fragilis						
Ulva lactuca						
Ceramium uncinatum	2		1	10	2	
Euptilota formosissima	8	8	5		2	1
Gracilaria chilensis						
Lenormandia chauvinii	2	2	5	2	4	3
Lomentaria umbellata						

Table 7. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Portobello Rd outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis	10	5				
Ulva lactuca						
Ceramium uncinatum	8	10	15	10	25	
Euptilota formosissima	5		1			
Gracilaria chilensis						
Lenormandia chauvinii	1	1	1			2
Lomentaria umbellata				1		

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca						
Ceramium uncinatum	5	25	5			8
Euptilota formosissima	3	3		2	2	2
Gracilaria chilensis			12	1		
Lenormandia chauvinii			2			
Lomentaria umbellata						2

Epifauna was moderately abundant at all three outfalls (Tables 8-10) with the small topshell *Micrelenchus tenebrosus* and cockles, *Austrovenus stutchburyi*, comprising the majority of animals. Numbers of animals per square metre was higher at more than 50m distant from the Portobello Road outfall than within 20m

of the outfall, but, as for 2008, the reverse was true for Kitchener Street. Orari Street showed very little difference ($39m^{-2}$ at <20m; $37m^{-2}$ at >50m) in animal abundance per square metre with locality (Tables 8-10).

Table 8. *Epifauna within 20m (top) and greater than 50m (bottom) of the Kitchener Street outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus				1						1					
Spirorbis spp			3	1	2		2								
Crabs															
Macrophthalmus hirtipes										1					
Barnacles															
Eminius modestus									1						
Chamaesipho columna			63									18			
Gastropod snails															
Buccinulum vittatum								1	1						
Maoricolpus roseus						1									1
Melagraphis aethiops			1									1			
Micrelenchus tenebrosus	6	10	41	97	4	21	2	1	2	2	3	7	6	7	3
Bivalves															
Austrovenus stutchburyi	1	2	1	1	3	2	1	4	2	3	3		2	1	2
Ostrea heffordi			14	7			2					1	1	1	3

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus										2					
Gastropod snails															
Buccinulum vittatum		1													
Maoricolpus roseus														1	
Micrelenchus tenebrosus	10	6	1	13	7	4	8	5	8	5	34	6	9	3	4
Bivalves															
Ostrea heffordi		5								8					26
Ascidians															
Pyura pachydermatina	12	6													
Cnemidocarps bicornuta													1		

Table 9. *Epifauna within 20m (top) and greater than 50m (overleaf) of the Orari Street outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Gastropod snails															
Notoacmea spp									1						
Cominella glandiformis													1		
Micrelenchus tenebrosus	1		1	3	2		3	5	1	3	1	4	1	4	1
Sigapatella novaezelandiae													1		
Bivalves															
Austrovenus stutchburyi	3	5	53	7	4	3	3	6	5	7	5	3	4	2	1
Ostrea heffordi								1			1				

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Spirorbis spp			6												
Gastropod snails															
Buccinulum vittatum										1					
Cominella glandiformis	1														
Melagraphis aethiops														1	
Micrelenchus tenebrosus				1		1		1	2	1	1	1		1	1
Bivalves															
Austrovenus stutchburyi	2	4	5	5	4	7	8	6	7	10	5	6	3	5	4

Table 10. *Epifauna within 20m (top) and greater than 50m (bottom) of the Portobello Rd outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus			5	13											2
Gastropod snails															
Buccinulum vittatum							1								
Melagraphis aethiops					1	1					1				
Micrelenchus tenebrosus	4		4	4	2	4	1		1			1			2
Sigapatella novaezelandiae															1
Bivalves															
Austrovenus stutchburyi	2	1			1	1			1					1	1
Ostrea heffordi			31	2								3			5

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus		3	6				2				14	2			
Spirorbis spp											7				
Barnacles															
Eminius modestus					48										
Chamaesipho columna			4												
Gastropod snails															
Notoacmea spp								1							
Cominella glandiformis		1													
Maoricrypta monoxyla														1	
Melagraphis aethiops	2	3	1					1				1	1	1	1
Micrelenchus tenebrosus	1	1		3	4	2	1		1	1		1			
Bivalves															
Austrovenus stutchburyi			2	2	4	3	1	4	1	1			1	8	7
Mytilus galloprovincialis											1				
Ostrea heffordi	1	1								2	8				

Diversity within animal communities was, however, variable with Portobello Road showing greater diversity further from the outfall while Kitchener Street showed the converse (Table 11). Diversity at Orari Street was very similar at both sites. Overall diversity has not changed from that observed in 2007 and 2008 ($F_{2,6}$ = 0.517, p = 0.621 for <20m sites; $F_{2,6}$ = 0.105, p = 0.902 for >50m sites). Neither is there a significant difference in epifaunal diversity among sites <20m from the outfalls and sites >50m from the outfalls ($F_{1,4}$ = 0.031, p = 0.868).

Table 11. *Diversity (H') of epifauna within 20m and greater than 50m of the Kitchener Street, Orari Street and Portobello Road outfalls. 2009 data compared with 2007and 2008 data.*

	<20m			>50m		
Site	2007	2008	2009	2007	2008	2009
Kitchener Street	0.48	0.48	0.55	0.71	0.57	0.42
Orari Street	0.36	0.37	0.3	0.05	0.25	0.31
Portobello Road	0.53	0.33	0.62	0.5	0.63	0.84

As in 2007 and 2008, cockles became noticeably smaller and less abundant as one moved from Kitchener Street to Portobello Road (Table 12). However, when compared using ANOVA at a significance level of 0.05 overall size of cockles from year to year has not changed significantly ($F_{2,6} = 0.374$, $p = 0.703$).

Table 12. *Size of cockles collected at Kitchener Street, Orari Street and Portobello Road in 2007, 2008 and 2009.*

	2007			2008			2009		
	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)
Kitchener Street	59	18.8	37.1	54	16.36	35.5	80	19.6	38.1
Orari Street	62	12.3	32.4	74	8.65	29.8	80	12.3	33.0
Portobello Road	64	9.4	30.1	74	7.87	28.3	80	10	30.1

A suggestion was made at the discussion of the 2008 report that growth rings should be measured on cockles to determine how age and size were related at the different sites. This was attempted for the 2009 sampling round but, due to most cockles having ill-defined and very closely spaced growth rings, results were considered to be too inaccurate to be meaningful and were disregarded. It would be fair to say, however, that at all sites cockles are slower growing than at prime cockle sites further down harbour or in Papanui and Waitati Inlets (Stewart 2006b, 2008d).

Infauna at all three sites was dominated by polychaete worms with glyceriids being the most abundant at all sites. Cockles (*Austrovenus stutchburyi*) were also common, particularly at both <20m and >50m from the Orari Street outfall (Tables 14-16). Numbers of animals per square metre ranged from 0 at replicate 3, Site 2 at >50m from the Kitchener Street outfall to 9751 at replicate 3, Site 1 at <20m from the Kitchener Street outfall.

Despite the variability on overall numbers at animals at the various sites, diversity has not changed significantly from year to year ($F_{2,6} = 0.567$, $p = 0.595$ for <20m sites; $F_{2,6} = 3.911$, $p = 0.082$ for >50m sites), nor is it significantly different among locations ($F_{1,4} = 0.043$, $p = 0.845$) (Table 13).

Table 13. *Diversity (H') of infauna within 20m and greater than 50m of the Kitchener Street, Orari Street and Portobello Road outfalls. 2009 data compared with 2007and 2008 data.*

	<20m			>50m		
Site	2007	2008	2009	2007	2008	2009
Kitchener Street	0.67	0.53	0.44	0.98	0.73	0.56
Orari Street	1.01	0.86	0.74	0.88	0.87	0.74
Portobello Road	0.74	0.67	0.8	0.84	0.68	0.76

Table 14. *Abundance of species of infauna collected <20m and >50m from the Kitchener Street outfall.*

Kitchener Street			Location	<20m							>50m						
2009			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**														
Annelida																	
	Polychaeta																
		Arenicolidae				2				2							
		Glyceridae		33	24	37	35	20	19	168	1	6		1	2		10
		Nephtyidae			1	2	2	1	1	7							
		Nereidae		4	3	6	6	3		22							
		Spionidae		1	2	2	3			8	2	1					3
Crustacea																	
	Decapoda																
			Macrophthalmus hirtipes												1		1
	Amphipoda	Haustoriidae															
		Lysianassidae										1					1
		Oedicerotidae							1	1							
		Phoxocephalidae		2	2			1		5		3		3			6
Mollusca																	
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi	1	1		3	3	2	10							
		Tellinidae															
			Macomona liliana		1		1			2							
		Animals per core		41	34	49	50	28	23	225	3	11	0	4	3	0	21
		Animals per m^2		8159	6766	9751	9950	5572	4577	44775	597	2189	0	796	597	0	4179
		Species per site								9							5

Table 15. *Abundance of species of infauna collected <20m and >50m from the Orari Street outfall.*

Orari Street			Location	<20m							>50m						
2009			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3	sum	1	2	3	1	2	3	sum
Phylum		**Family**	**Genus/species**														
Annelida																	
	Polychaeta																
		Arenicolidae												2			2
		Eunicidae										1					1
		Glyceridae		5	4	3	3	8	3	26	10	6		6	6		28
		Nephtyidae			5	1			1	7					1		1
		Nereidae			2					2	1				1		2
		Nereididae					1			1		1			1		2
		Oweniidae									1						1
		Spionidae				1				1				1			1
		Syllidae													1		1
Hemichordata																	
	Enteropneusta				1					1							
Crustacea																	
	Amphipoda																
		Phoxocephalidae					1	2		3							
	Tanaidacea															1	1
Mollusca																	
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi	4	3	5	3	4	4	23	3	4	4	5	1	3	20
			Puyseguria spp.				1		1	2					1	1	2
		Mesodesmatidae															
			Paphies subtriangulata														
			Paphies australis	1						1							
		Tellinidae															
			Macomona liliana		1	1	2		1	5	2		1		1	1	5
		Animals per core		10	16	11	11	14	10	72	17	12	5	14	13	6	67
		Animals per m^2		1990	3184	2189	2189	2786	1990	14328	3383	2388	995	2786	2587	1194	13333
		Species per site								11							13

Table 16. *Abundance of species of infauna collected <20m and >50m from the Portobello Road outfall.*

Portobello Rd			Location	<20m							>50m						
2009				Site 1			Site 2				Site 1			Site 2			
			Sample	1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Arenicolidae														1	1
		Glyceridae		2	3	3		4	3	15	3	3	1		3	2	12
		Nephtyidae		2	1		1		1	5				1	3	1	5
		Nereidae			2				1	3	1			1			2
		Opheliidae					1			1							
		Orbiniidae							1	1							
		Oweniidae		1						1							
		Pectenariidae					1			1							
		Spionidae											1			1	2
		Syllidae									1						1
Crustacea																	
	Decapoda																
			Elamena producta	1						1							
	Amphipoda																
		Haustoriidae						1		1							
	Ostracoda					1				1							
Mollusca																	
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi	1	1	2			1	5	1		2		3	2	8
		Tellinidae															
			Macomona liliana										1	1	1		3
		Animals per core		7	7	6	3	5	7	35	6	3	5	3	10	7	34
		Animals per m^2		1393	1393	1194	597	995	1393	6965	1194	597	995	597	1990	1393	6766
		Species per site								11							8

3.4 Analyses of Cockle, Mussels, Fish and Octopus flesh

Unlike last year when levels of heavy metals in the cockle flesh showed no clear trend from Kitchener Street to Portobello Road, levels of all metals this year except nickel were highest at Portobello Road (Table 17). PAHs on the other hand, although still highest at Portobello Road, are again lower at this site than observed last year, as are PAHs at Orari Street (Table 17). All heavy metals were at concentrations two orders of magnitude below accepted food standards (Table 18). There are no specific guidelines for PAH in shellfish flesh for New Zealand, but food standards for British Columbia recommend an upper limit for benzo[a]pyrene (Table 19).

It should be noted that, as already stated, and as found in previous surveys, cockles became smaller as one nears the Portobello Road outfall. Whether this is due to PAH contamination or exposure at low tides and to fresh water, or some other factor, remains to be determined. Faecal coliform levels in cockle flesh were highest at Portobello Road but were not at Orari and Kitchener Streets. This differs from 2008 when all samples had detectable faecal coliform levels (Table 17). However, in 2007, FCs were not detected in any cockle samples.

Table 17. *Contaminant concentrations in cockle flesh from within 20m of the Kitchener Street, Orari Street and Portobello Road stormwater outfalls in 2007, 2008 and 2009. Green shading indicates a decrease in contaminant level, pink indicates and increase, white = no change.*

	Parameter	Units		Portobello Rd	Orari Street	Kitchener St
Cockles	As	mg/kg	2007	2.5	2.5	3.5
			2008	4.0	2.8	3.3
			2009	2.9	4.9	3.8
	Cd	mg/kg	2007	0.014	0.011	0.016
			2008	0.023	0.010	0.015
			2009	0.021	0.024	0.017
	Cr	mg/kg	2007	0.32	0.32	0.34
			2008	0.65	0.15	0.27
			2009	0.22	0.30	0.31
	Cu	mg/kg	2007	0.64	0.70	0.81
			2008	1.20	0.85	0.67
			2009	0.82	1.10	0.89
	Ni	mg/kg	2007	0.71	1.00	0.64
			2008	1.30	1.10	1.30
			2009	0.89	0.93	1.00
	Pb	mg/kg	2007	0.17	0.11	0.08
			2008	0.42	0.07	0.08
			2009	0.099	0.110	0.082
	Zn	mg/kg	2007	6.3	6.4	8.0
			2008	11.0	7.7	8.6
			2009	7.4	10.0	9.0
	PAH	mg/kg	2007	4.912	0.018	0.009
			2008	0.640	0.047	0.028
			2009	0.613	0.038	0.028
	Faecal coliforms	MPN/100g	2007	<18	<18	<18
			2008	1300	230	78
			2009	78.0	<18	<18

Table 18. *Heavy metal concentrations for NZ and US FDA guidelines for adults (expressed as mg/kg dry weight). '-' means no guideline is available.*

	Cu	Zn	Pb	Cd	Cr	Ni
Food Regs/NZ DoH	150.0	2000.0	10.0	5.0	-	-
US FDA	-	-	4.2	-	11.0	80.0
Australia NZ food standards code	-	-	2.0	2.0	-	-

Table 19. *British Columbian guidelines for B[a]P concentration in shellfish for human consumption*

B[a]P concentration in the edible portion of fish/shellfish (µg B[a]P/kg wet weight)	Safe quantity for weekly consumption* on a regular basis (g wet weight)	B[a]P Portobello Road cockles 2007 (µg B[a]P/kg wet weight)	B[a]P Portobello Road cockles 2008 (µg B[a]P/kg wet weight)
4	50	249	34
2	100		
1	200		

*low and moderate consumption levels, according to the State of Washington, are 45 g/wk (or 6.5 g/d) and 140 g/wk (or 20 g/d).

As for cockles in the upper harbour basin, mussels from Second Beach showed levels of contamination that were well below accepted food guidelines (Table 20). Concentrations of most contaminants were not dissimilar to those observed in cockles (Table 17), with the exception of nickel, which is lower in Second Beach

mussels than in cockles and lead, which is higher in mussels. Overall, however, there is little evidence of contamination of shellfish by stormwater at either site.

Table 20. *Contaminant concentrations in mussel flesh from within 20m of the Second Beach stormwater outfall.*

	Parameter	Units		
Second Beach Mussels	As	mg/kg	2007	1.6
			2008	1.9
			2009	1.9
	Cd	mg/kg	2007	0.078
			2008	0.083
			2009	0.084
	Cr	mg/kg	2007	0.33
			2008	0.20
			2009	0.11
	Cu	mg/kg	2007	1.00
			2008	0.69
			2009	1.50
	Ni	mg/kg	2007	0.4
			2008	0.3
			2009	0.3
	Pb	mg/kg	2007	0.14
			2008	0.11
			2009	0.20
	Zn	mg/kg	2007	12.0
			2008	9.4
			2009	14.0
	Faecal coliforms	CFU/100ml	2007	<18
			2008	20
			2009	45

Ten triplefins were caught in baited fish traps set off the Mason Street wharf on 20 and 21 May 2009. The fish were small (Table 20), but representative of the size classes commonly seen amongst variable triplefins. Sizes and weights were, however, slightly up on those caught in 2007 and 2008 (Table 21). Levels of arsenic, cadmium, chromium, nickel and PAHs were lower in fish than in cockles while levels of copper, lead and zinc were higher. Levels of chromium were lowest in Second Beach mussels (Tables 17 & 22).

It could, therefore, be argued that the concentration of most contaminants in the fish, with the exception of copper, lead and zinc, were similar to or lower than in cockles (Table 22). This is similar to the situation in 2007 and 2008. At first glance one is tempted to say that this is not unexpected, given that the cockles are filter feeders while the fish are predators. However, contaminants tend to become more concentrated as one moves up the food chain. Triplefins do not prey on shellfish, but do eat smaller fish and a variety of other invertebrates. The fact that contaminant levels are relatively low in fish flesh suggests that heavy metal and PAH contamination around the Mason Street stormwater outfall is low.

Table 21. *Size and weight of triplefins captured near the Mason Street Stormwater outfall in 2007, 2008 and 2009.*

	2007	2008	2009	2007	2008	2009
	Fish Sizes (mm)			Weight (g)		
	75	70	101	4.7	4	13.1
	71	67	88	3.9	2.9	9.8
	73	46	96	4.4	0.9	10.6
	61	65	71	2.2	3	4.5
	49	63	62	1.1	2.7	2.8
	78	75	81	5.3	5.5	6.9
	77	58	70	5.6	2.4	4.1
	79	67	78	6.1	3.4	6.6
	75	72	79	4.1	4.5	6
	46	83	59	0.9	6.4	2.1
	52	71		1.6	4.8	
	74	68		4.6	3.8	
		72			4.8	
		65			2.8	
		59			2.7	
		56			2.2	
		60			2.4	
Mean =	67.5	65.71	78.50	3.7	3.48	6.65

Table 22. *Contaminant concentrations in the flesh of triplefins captured near the Mason Street Stormwater outfall. BDL = below detectable limits.*

	Parameter	Units		Mason Street
Fish	As	mg/kg	2007	1.9
			2008	1.6
			2009	1.9
	Cd	mg/kg	2007	0.0047
			2008	0.0047
			2009	0.0110
	Cr	mg/kg	2007	0.05
			2008	BDL
			2009	0.14
	Cu	mg/kg	2007	0.54
			2008	0.52
			2009	1.20
	Ni	mg/kg	2007	BDL
			2008	BDL
			2009	<0.095
	Pb	mg/kg	2007	0.140
			2008	0.120
			2009	0.43
	Zn	mg/kg	2007	21
			2008	20
			2009	21
	PAH	mg/kg	2007	0.0056
			2008	0.0023
			2009	0.0060
	Mean Size	(mm)	2007	67.5
			2008	65.7
			2009	78.5
	Mean Weight	(g)	2007	3.7
			2008	3.5
			2009	6.65

A single large octopus (*Octopus maorum*) and a single smaller octopus (*Robsonella australis*) (Figures 5 and 6) were found on the foreshore adjacent to the Orari Street and Portobello Road outfalls respectively on 26 May 2009. As in previous years subsamples of flesh and digestive gland were collected and sent to Hill Laboratories in Hamilton for analysis. In 2008 a single animals was found

approximately 200m south of the Orari Street outfall. In 2009 two octopus, one from 10m to the north of the Orari Street stormwater outfall and one from in front of the Portobello Road outfall were found. For reference the results for analysis of the flesh from the 2007 animals and the 2008 animal are presented in Table 23.



Figure 5. *Large* Octopus maorum *found adjacent to the Orari Street stormwater outfall, May 2009.*



Figure 6. *Small* Robsonella australis *found adjacent to the Portobello Road stormwater outfall, May 2009.*

Contaminant concentrations in octopus were quite low and certainly well below all food guidelines (Table 23). Arsenic levels were once again generally higher than those found in either fish or shellfish and similar to levels found in 2008. An octopus sampled in the autumn of 2006 from near Orari Street also had high arsenic levels. Copper levels in digestive glands, however, are much higher than

last year, but similar to 2007 levels than those found in an octopus from the same area last year.

Table 23. *Contaminant concentrations in the flesh (upper) and digestive glands (lower) of octopus collected near the Orari Street and Portobello Road Stormwater outfalls.*

	Parameter	Units		Portobello Rd	Orari Street
Octopus	As	mg/kg	2007	12.0	7.7
			2008	-	20.0
			2009	4.9	24.0
	Cd	mg/kg	2007	0.001	0.008
			2008	-	0.0012
			2009	0.019	0.010
	Cr	mg/kg	2007	<0.02	<0.02
			2008	-	<0.02
			2009	0.15	0.62
	Cu	mg/kg	2007	3.30	3.90
			2008	-	2.60
			2009	7.30	2.60
	Ni	mg/kg	2007	0.1	0.1
			2008	-	0.023
			2009	<0.10	<0.10
	Pb	mg/kg	2007	0.023	0.220
			2008	-	0.029
			2009	0.23	0.11
	Zn	mg/kg	2007	13.0	14.0
			2008	-	19.0
			2009	20.0	23.0
	PAH	mg/kg	2007	0.0043	-
			2008	-	0.0127
			2009	0.754	0.026
	Arm span	(mm)	2007	2603	680
			2008	-	2154
			2009	547	2168
	Weight	(g)	2007	11784	197
			2008	-	10562
			2009	218	11252

	Parameter	Units		Portobello Rd	Orari Street
Octopus (digestive gland)	As	mg/kg	2007	12.0	7.7
			2008	-	13.0
			2009	5.7	22
	Cd	mg/kg	2007	0.260	3.300
			2008	-	0.066
			2009	1.4	9.6
	Cr	mg/kg	2007	<0.2	9.2
			2008	-	<0.02
			2009	<0.12	<0.20
	Cu	mg/kg	2007	44.0	740.0
			2008	-	27.0
			2009	230.0	520.0
	Ni	mg/kg	2007	0.5	5.2
			2008	-	2.8
			2009	1.7	0.66
	Pb	mg/kg	2007	0.074	0.440
			2008	-	0.026
			2009	0.25	0.25
	Zn	mg/kg	2007	26.0	160.0
			2008	-	26.0
			2009	87.0	310.0
	PAH	mg/kg	2007	0.0599	-
			2008	-	0.0251
			2009	0.26	0.116
	Arm span	(mm)	2007	2603	680
			2008	-	2154
			2009	547	2168
	Weight		2007	11784	197
			2008	-	10562
			2009	218	11252

Octopus are higher on the food web than shellfish, but results of analyses for cockles, fish and octopus [in 2006-2008] obtained so far do not give any clear indication as to where an organism lies with respect to trophic level.

4. Discussion and Conclusion

In 2009 water samples were colleted from a total of 14 major Dunedin City stormwater outfalls. In addition, sediments were sampled from near 5 of these outfalls and from an additional 5 sites located some distance from the outfalls to gain a clearer picture of the distribution of contaminants in sediment in the upper Otago Harbour. Flesh from fish, cockles, mussels and octopus was also collected for contaminant analysis. For interest sake historical data for some of the same sites have been included for comparison (Tables 24 and 25). Any trends observed in these data for historical sediment values should be viewed with extreme caution as sampling in some previous years may have used entirely different protocols. For example, sediments may have been collected from different depths within the substrate and by different methods meaning that results are not directly comparable. Stormwater sampling, however, should be comparable assuming previous investigators targeted the first flush.

There has been a decline in the levels of some contaminants at stormwater outfalls for which historic data are provided. This is perhaps to be expected for lead as it has been removed from paint and petrol and levels in the environment are very gradually declining. The reduction in the levels of some other contaminants is very slight, but gratifying, although such fluctuations may be merely a function of the intensity of the storm events when sampling occured. However, it should be recognised that there are currently some contaminants for which levels appear to be increasing or, fluctuating (Tables 24 and 25). The high levels of FWAs at Bauchop Street observed in both 2007 and 2008 suggested that there is some gross cross contamination by wastewater somewhere in this catchment. Investigations up-pipe last year pinpointed this discharge and remedial action was taken. As a consequence the FWA levels at Bauchop Street this year are comparable with other locations. It is expected that the development and implementation of the long-term stormwater catchment management plans and DCC's 3-Water Strategy will contribute to addressing the issue of future contaminants in stormwater. It will be of interest to see if any long-term trends in contaminant levels can be discerned as monitoring continues.

Benthic and infaunal communities in the vicinity of the Portobello Road, Orari Street and Kitchener Street outfalls have reasonably low diversity, but this is generalised and not associated with any one outfall and is likely symptomatic of a large proportion the upper harbour basin. As in past years there is a trend towards smaller cockles as one nears the Portobello Road outfall. This may be as a result of historic PAH contamination, which is extremely high beneath the surface at this site, but a number of other factors, not least of which are freshwater exposure and exposure at low tide, must also be considered.

Rainer (1981) and Grove (1995) certainly found less diversity in soft-bottom macrofaunal communities as one moves from harbour mouth to the head of Otago Harbour. It should be pointed out that much of the shoreline around the upper harbour has been extensively modified and as such cannot be regarded as an inlet typical of those found throughout the region. Despite this the communities sampled in the upper Otago Harbour near stormwater outfalls are numerically dominated by polychaete worms and amphipods, as is usual for sheltered soft shores around New Zealand (Morton and Miller 1973), and show distinct similarities to communities found in other moderately impacted inlets in Otago (Stewart 2007b, 2008a,b).

While not pristine, the upper harbour and the communities associated with the intertidal areas adjacent to major stormwater outfalls appear not to be undergoing any significant further degradation as a result of stormwater inputs. It is to be hoped that if the trend towards lower contaminant levels in stormwater is continued, both water quality and community health in the harbour will gradually improve over time.

Only after problem areas and problem contaminants have been identified can measures be taken to mitigate any effects. No additional mitigation measures have been undertaken by the DCC at this stage, apart from investigations into the remediation of PAH contamination at the Portobello Road outfall (Stewart 2006), the elimination of the source of FWAs at Bauchop Street, and the usual street sweeping and mud tank clearance. It is expected that further stormwater monitoring over time and investigations under the 3 Waters strategy will define problem areas such that mitigation measures may be undertaken.

Table 24. *Contaminants in stormwater being discharged to the upper Otago harbour basin through time. BDL = below detectable limits. Pink cells denote levels higher than at any past sampling event; green cells denote levels lower than at any past sampling event.*

	Parameter	Suspended Solids				Cd				Cr				Cu			
	units	g/m^3				g/m^3				g/m^3				g/m^3			
		Historic	2007	2008	2009	Historic	2007	2008	2009	Historic	2007	2008	2009	Historic	2007	2008	2009
Catchement	Second Beach		<3	37.0	41		BDL	0.00006	0.00006		0.0007	0.0028	0.0035		0.0027	0.012	0.019
	Pt Chalmers George St		87.0	150.0	26		0.00028	0.00140	0.00011		0.005	0.012	0.0031		0.0213	0.039	0.025
	Pt Chalmers Watson Pk		37.0	39.0	7.4		BDL	BDL	BDL		BDL	0.0064	BDL		0.009	0.0025	BDL
	Shore Street	75.4	41.0	24.0	20		BDL	BDL	BDL		BDL	BDL	BDL		0.01	0.014	0.02
	Portobello Road	28.0	18.0	46.0	30	0.0003	BDL	0.00023	BDL	0.0029	BDL	0.002	BDL	0.03	BDL	0.026	0.01
	Teviot Street		25.0	33.0	12		BDL	0.00008	BDL		BDL	0.0018	BDL		BDL	0.0094	BDL
	Midland Street		30.0	19.0	30		BDL	0.00013	BDL		BDL	0.0035	0.0031		0.02	0.031	0.057
	Orari Street	38.1	28.0	77.0	16	0.0005	BDL	BDL	BDL	0.002	BDL	0.0032	BDL	0.0132	BDL	0.014	BDL
	Kitchener Street		104.0	41.0	45		BDL	BDL	BDL		0.004	0.002	BDL		0.034	0.0056	0.023
	Mason Street		62.0	37.0	37		BDL	BDL	0.0077		BDL	BDL	BDL		0.022	0.012	0.021
	Ravensbourne Road			8.5	18			BDL	BDL			0.00061	BDL			0.0023	BDL
	Bauchop Street		44.0	16.0	13		BDL	BDL	BDL		BDL	0.0015	BDL		0.029	0.0096	0.021
	Halsey Street		119.0	35.0	27		BDL	0.00022	BDL		BDL	BDL	BDL		0.024	0.0043	BDL
	Wickliffe Street		35.0	27.0	100		BDL	BDL	0.00052		BDL	0.0017	0.0076		0.01	0.013	0.059

	Parameter	Ni				Pb				Zn				PAH			
	units	g/m^3				g/m^3				g/m^3				g/m^3			
		Historic	2007	2008	2009	Historic	2007	2008	2009	Historic	2007	2008	2009	Historic	2007	2008	2009
	Second Beach		0.0009	0.0021	0.0022		0.001	0.011	0.013		0.038	0.16	0.15				
	Pt Chalmers George St		0.0029	0.0093	0.0026		0.0342	0.041	0.018		0.288	0.66	0.19				
	Pt Chalmers Watson Pk		BDL	BDL	BDL		0.0141	0.0018	BDL		0.231	0.027	BDL				
	Shore Street		0.01	BDL	BDL		0.003	0.0085	0.0069		0.02	0.44	0.21				
	Portobello Road	0.002	BDL	0.0035	0.0028	0.021	BDL	0.019	0.0067	0.895	0.08	0.94	0.64	0.0031	BDL	328	0.00017
	Teviot Street		BDL	0.0019	BDL		BDL	0.0066	BDL		BDL	0.13	BDL				
	Midland Street		BDL	0.0016	BDL		0.005	0.0054	0.0083		0.1	0.35	0.18				
	Orari Street	0.002	BDL	0.0033	BDL	0.022	BDL	0.023	BDL	0.191	BDL	0.22	0.031	0.0026	0.0001	318	BDL
	Kitchener Street		0.003	BDL	0.0036		0.0442	0.007	0.018		0.445	0.036	0.38		BDL	327	BDL
	Mason Street		0.004	BDL	0.0055		0.0258	0.0089	0.014		0.25	0.16	0.35				
	Ravensbourne Road			0.00066	BDL			0.0015	0.0029			0.053	0.047				
	Bauchop Street		0.01	BDL	0.0035		0.01	0.0035	0.0097		0.23	0.12	0.3				
	Halsey Street		0.009	BDL	BDL		0.021	0.0022	BDL		0.12	0.033	0.13				
	Wickliffe Street		0.01	BDL	0.0042		0.006	0.0084	0.033		0.1	0.2	0.53				

Table 25. *Contaminants in sediments in the upper Otago harbour basin in the vicinity of selected stormwater outfalls through time. Pink cells denote levels higher than at any past sampling event; green cells denote levels lower than at any past sampling event.*

	Arsenic				Cadmium				Chromium				Copper				Nickel				Lead				Zinc				PAH				Enterococci			
	Historic	2007	2008	2009	Historic	2007	2008	2009	Historic	2007	2008	2009	Historic	2007	2008	2009	Historic	2007	2008	2009	Historic	2007	2008	2009	Historic	2007	2008	2009	Historic	2007	2008	2009	Historic	2007	2008	2009
Rowing Club		10.6	9.8	7.3	0.0	0.2	0.2	0.1	16.8	17.6	12	16.0	9.8	14.2	13	14		11.3	14	13.0		18.9	27	27	80.8	101	130	160		6.97	5.78	0.5		200	11	<2
Wickliffe		17.3	11.0	6.9		0.6	0.74	0.8		38	34	16.0		121.0	68	50		19.2	23	13.0		76.1	140	77		412	740	810		9.21	1.18	7.3		58000	>1600	330
White St		11.6	18.0	5.4		0.3	0.22	0.2		68.5	56	26.0		433.0	160	170		29.5	21	11.0		147	180	170		4450	2500	2400		12.96	11.05	15.9		400	2	<2
Kitchener St		4.6	7.5	7.0		0.4	0.35	0.3	7.1	22.6	18	98.0		69.5	56	90	5.8	10.6	12	15.0		117.9	97	130	170	249.33	280	300		8.88	140.49	4.8	130	6633	920	5
Orari St		18.6	4.3	20.0	0.5	63.0	0.13	0.9	17.5	0.27	16	37.0	20	25.1	13	61	10.4	23.6	8.1	16.0	185	12.8	39	120	239	68.27	130	680	13.41	10.23	12.59	28.3	557	12.67	8	23
Orari 100		13.7			0.3	0.4			16	26.3			28	25.9			8.8	12.6			170	170			230	227				6.67			1300	3600		
Midland 200		15.4			0.4	0.3			22	22.4			24	19.0			8.3	10.7			36	36			190	165				7.24			130	20000		
Portobello Rd		29.0	23.0	24.0	2.0	48.5	1.8	2.0	41	1.84	54	50.0	210	60.1	160	190	15	169.3	18	26.0	410	20.43	330	290	1300	306.33	1400	1600	425.83	436.27	250.30	525.2	1120	72667	170	<2
PR 200		17.4			1.0	0.5			32	41.8			100	52.6			13	17.3			130	81.3			430	309			12.29	8.97			40	66000		
Shore St		9.5	7.1	6.2	0.5	0.4	0.32	0.3	9.6	21.8	16	18.0	30	50.9	44	41	5.4	10.7	9	11.0	130	113	110	79	300	484	300	330		9.56	21.01	8.6	2400	9000	>1600	<2
Boatshed		27.4	16.0	17.0		0.3	0.21	0.2		41.7	19	26.0		108.0	33	49		24.5	16	17.0		112	800	170		339	370	360		6.67	5.54	38.8		3400	33	33
Cove Drainage		21.5	17.0	19.0		0.1	0.13	0.4		15.8	35	32.0		11.3	19	38		23.5	44	23.0		19.7	20	55		99.2	150	270		0.37	0.00	0.1		800	17	<2
Retaining wall		25.3	36.0	24.0		0.1	0.15	<0.1		23.6	31	39.0		13.3	19	17		15.9	25	26.0		26.9	27	42		141	170	150		0.30	3.91	0.0		<100	8	<18
RW 300		16.2			0.1	0.3			28.33	0.27			16.3	15.2			13.3	12.4			40	6.7			149	131				0.30				<2		
W/W centre		11.1				0.2			2.75	30.8				15.3			3.63	14.6			25	5.6				168				0.34				<2		
UHB Centre		10.5			0.3	0.2			26.8	24.3			15.2	15.2			10	11.3			27	23			118	119				0.65				24000		

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Compliance Monitoring 2010

Stormwater Discharges from Dunedin City

(ORC Resource Consents 2002.080-2002.110 and 2006.222)



Prepared for

Dunedin City Council

by

Ryder Consulting Ltd.

July 2010

ryderconsulting
environment + planning + project management

Compliance Monitoring 2010

Stormwater Discharges from Dunedin City
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Cover photo: Tide gate at the Shore Street stormwater outfall

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Executive Summary

This report presents the findings for the third annual monitoring of Dunedin's stormwater outfalls since discharge consents were granted.

The survey comprised assessment of benthic communities, of contamination of stormwater and of contamination of sediments and benthic fauna, including octopus, cockles and mussels.

Stormwater from all outfalls monitored showed variable levels of contamination, with numerous parameters being present at concentrations above recommended ANZECC guidelines or trigger values.

Sediments too showed varying levels of contamination from outfall to outfall with levels of contaminants breaching ANZECC trigger values for lead, zinc and PAHs at the majority of sites

Overall contaminant levels were similar to those observed in previous surveys carried out in 2007, 2008 and 2009, with no clear trends discernible at this juncture.

1. Introduction

1.1 Background

As with all urban centres throughout New Zealand and indeed most of the world, Dunedin's stormwater is reticulated to receiving environments via networks of gutters, open channels and pipes. The principal receiving water environments for Dunedin's reticulated stormwater are the upper basin of Otago Harbour, Second Beach/St. Clair Beach on the open coast, Kaikorai Stream and the Water of Leith. Dunedin City Council (DCC) was, on 29th November 2007, granted resource consents for its major urban stormwater discharges into the coastal marine environment (i.e. Otago Harbour, Sawyers Bay. Port Chalmers and Second Beach).

Conditions under which consents have been granted include compliance monitoring. Specifically:

Condition 2.

(a) *The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.*

(b) *The sampling shall be undertaken during storms, preceded by at least 72 hours of no measurable precipitation, with an intensity of at least 2.5 millimetres (depth) of rain in a 24 hour period. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:*
(i) pH
(ii) suspended solids
(iii) faecal coliforms and Escherichia coli
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease
(xiii) Polycyclic aromatic hydrocarbons ***(Portobello Road, Orari and Kitchener Street consents only)***

(c) *The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b).*

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road catchment discharge consent only

(a) *The consent holder shall undertake to determine the source and extent of the high levels of polycyclic aromatic hydrocarbons in the historic sediment deposits associated with discharge from the Portobello Road stormwater outlet.*

(b) *Updates on the progress of the investigation in condition 3(a) shall be*

provided in writing to the Consent Authority by 1 September each year.

(c) *No later than six months prior to the expiry of this consent, the consent holder shall provide a report to the Consent Authority stating the outcomes of the investigation in condition 3(a) and outlining the best practicable option(s) to mitigate the effects of these contaminated sediments.*

For the Portobello Road, Orari and Kitchener Street discharge consents only

(a) *The consent holder shall undertake biological monitoring annually between the months of January to June inclusive. The monitoring shall be undertaken at four sites at the waters edge at low tide; two within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide and two a minimum of 50 metres of the confluence of the stormwater outlet and the waters edge at low tide.*

(b) *At each site, three randomly spaced 5m^2 quadrats shall be sampled. For epifauna within each 5m^2 quadrat, the number of each species shall be recorded in five 0.1m^2 quadrats. For infauna a sediment core shall be taken in three 0.1m^2 quadrats and the number of each species shall be recorded. For macroflora, the percentage cover of each species shall be estimated in three 1.0m^2 quadrats.*

(c) *Results shall be reported to the Consent Authority in accordance with condition 8(e).*

For the Portobello Road, Orari and Kitchener Street discharge consents only

The consent holder shall undertake sampling of the flesh of cockles (Austrovenus stutchburyi) annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide. The size of each cockle sampled shall be recorded. The cockle flesh samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
(i) faecal coliforms

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road and Orari Street discharge consents only

The consent holder shall undertake sampling of deceased octopus annually, between the months of January to June inclusive (to align with the autumn die-off of octopus). Samples will include flesh and, if available, digestive gland. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The total arm span and weight of each octopus sampled shall be recorded. The samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons

Results shall be reported to the Consent Authority in accordance with condition 8(e). Should no deceased octopus be present, the consent holder shall notify the Consent Authority that sampling is unable to be undertaken.

For the Mason Street discharge consents only

The consent holder shall undertake sampling of spotties (Notolabrus

celidotus) or triplefin (Tripterygion varium) annually. This sampling is to be carried out within the months of January to June inclusive. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The length and weight of each fish sampled shall be recorded. The samples shall be analysed for:
(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road, Orari and Kitchener Street discharge consents only

The consent holder shall undertake sediment quality sampling using three replicate sediment samples that shall be collected at each site as marked on the plans attached as Appendix 1 to this consent. Sampling shall be undertaken:

(a) annually between January and June at the locations marked by large orange stars; and

(b) between January and June 2007, and between January and June 2010, at the locations marked by large pink stars. The samples will comprise the top 20mm of sediment and shall be analysed for:
(i) total copper
(ii) total lead
(iii) total zinc
(iv) total arsenic
(v) total nickel
(vi) total cadmium
(vii) total chromium
(viii) faecal coliforms and enterococci
(ix) polycyclic aromatic hydrocarbons
Results shall be reported to the Consent Authority in accordance with condition 8(e).

Condition 3. *The biological sampling of epifauna, infauna, macroflora, cockles, octopus, spotties or triplefins and sediment quality sampling required by Coastal Permits etc, shall be undertaken within a 14 day period (within the months of January to June), unless it is not practicable to do so due to the absence of any fauna to be sampled.*

Condition 4. *All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder and be acceptable to the Consent Authority.*

Condition 5. *Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.*

Second Beach
Condition 2.

(a) *The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of the rainfall event means that sampling in the manner described in condition 2(b) is not possible.*

(b) *The sampling shall be undertaken during storms, preceded by at least 72 hours of no measurable precipitation, with an intensity of at least 2.5 millimetres (depth) of rain in a 24 hour period. Sampling shall be*

undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:
(i) pH
(ii) suspended solids
(iii) faecal coliforms and Escherichia coli
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) HEM, oil and grease
(xii) UV fluorescent (whitening agent)

(c) *The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b). Results shall be reported in accordance with condition 8(e).*

Condition 3.
(a) *The consent holder shall undertake sampling of mussels annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, 50 metres to the east of the outlet. The shell length of each mussel sampled shall be recorded.*

(b) *The sampling of mussels shall be undertaken within a 14 day period (within the months of January to June) associated with the sampling rounds for Green Island and Tahuna WWTP discharge consents, unless it is not practicable to do so due to the absence of any fauna to be sampled.*

(c) *The samples shall be analysed for:*
(i) faecal coliforms
(ii) total copper
(iii) total lead
(iv) total zinc
(v) total arsenic
(vi) total nickel
(vii) total cadmium
(viii) total chromium
(d) *Results shall be reported in accordance with condition 8(e).*

Condition 4. *All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder and be acceptable to the Consent Authority.*

Condition 5. *Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.*

The following report presents the results of the latest round of sampling/monitoring carried out between January and June 2010.

1.2 Stormwater Outfalls

Stormwater is discharged from Dunedin City to the Upper Otago Harbour, Second Beach and Port Chalmers from fourteen reasonably large and permanent stormwater outfalls (Figures 1a, 1b and 1c), and from a number of smaller outfalls and non-point sources (Table 1). Many of the outfalls have very long histories dating back to the days of the early settlement of Dunedin and a numbers were

dual-purpose outfalls, discharging both wastewater and stormwater. All current outfalls, however, are designated to discharge stormwater.



Figure 1a. *Major stormwater outfalls, labeled by catchment name, discharging from Dunedin City to the Upper Otago Harbour Basin.*



Figure 1b. *Location of the Second Beach stormwater outfall.*

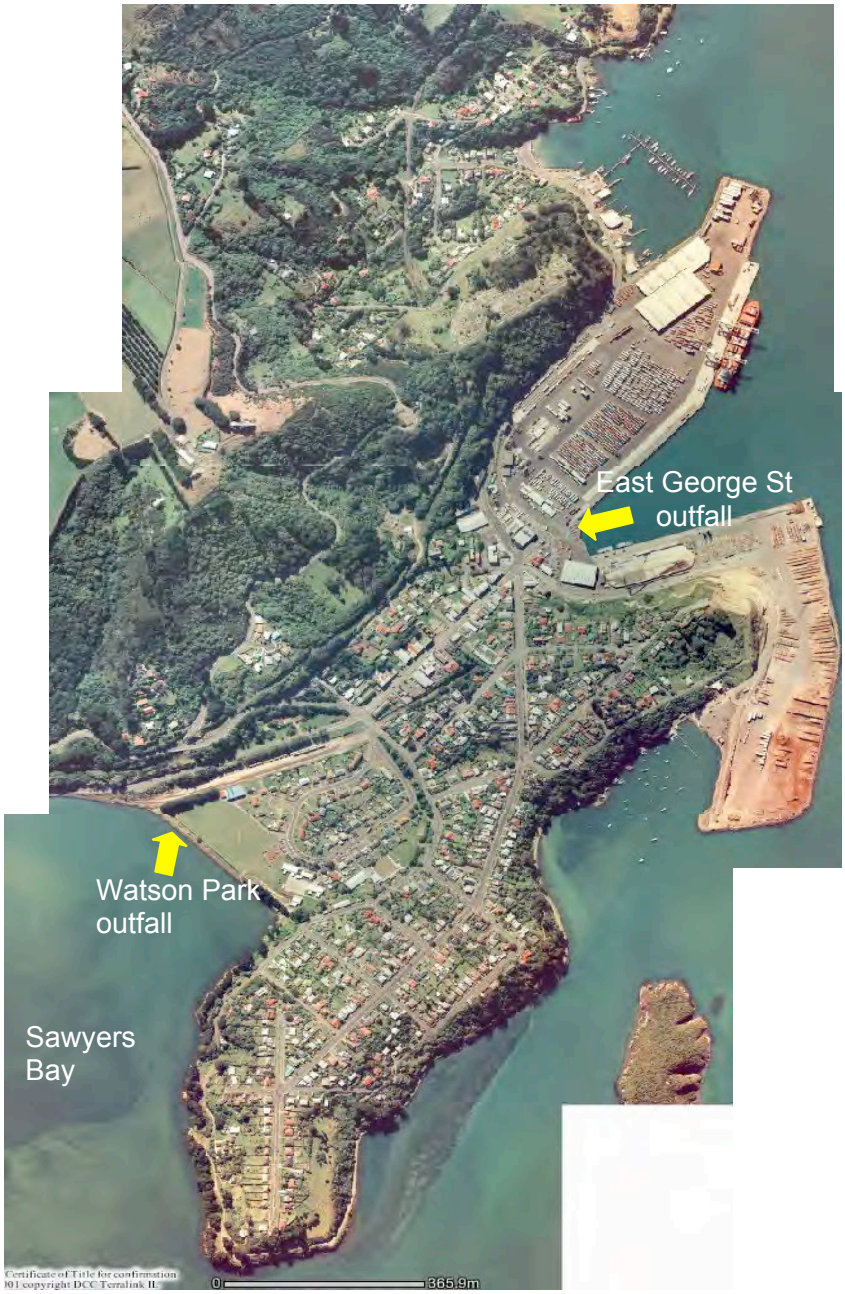


Figure 1c. *Location of major outfalls discharging stormwater from Port Chalmers.*

A total of 31 consents have been granted for the individual stormwater outfalls listed in Table 1.

Table 1. *List of stormwater outfalls for which discharge permits have been granted.*

Consent ref	DCC ref	Location	Catchment	Description	Max flow rate (l/s)	Outlet structure
2002.080	4	Shore St	Shore St	1500mm dia	2,380	Yes
2002.081	5	Portobello Rd	Portobello Rd	twin 1500mm dia conduits	pump rate 6,300	Yes
2002.082	6	Teviot St	Foreshore	375mm dia.	105	Yes
2002.083	7	Midland St	Foreshore	450mm dia	143	No
2002.084	8(a)	Orari St	Orari St	375mm dia	101	No
2002.085	8(b)	Orari St	Orari St	2700mm dia	10,350	Yes
2002.086	9(a)	Kitchener St	Kitchener St	600mm dia	310	Yes
2002.087	9(b)	Kitchener St	Kitchener St	1500mmdia	3,880	Yes
2002.088	10	French St	Foreshore	450mm dia	185	No
2002.089	11	Kitchener St	Foreshore	300 mm dia.	78	No
2002.090	12(a)	Birch St	Foreshore	225 mm dia.	37	No
2002.091	12(b)	Birch St	Foreshore	225 mm dia.	55	No
2002.092	12(c)	Wharf St	Foreshore	225 mm dia.	52	No
2002.093	13(a)	Fryatt St	Foreshore	150 mm dia.	40	No
2002.094	13(b)	Fryatt St	Foreshore	450mm dia	180	No
2002.095	13(c)	Fryatt St	Foreshore	300mm dia	54	No
2002.096	14	Fryatt St	Foreshore	300mm dia	116	No
2002.097	15(a)	Mason St	Mason St	2175mm dia. conduit	5,000	Yes
2002.098	15(b)	Mason St	Bauchop St	450mm dia	90	No
2002.099	15(c)	Mason St	Bauchop St	1350mm dia. culvert	1,500	No
2002.100	16(a)	Halsey St	Halsey St	1950mm conduit	3,800	No
2002.101	16(b)	Halsey St	Wickliffe St	1950mm conduit	2,600	No
2002.102	16(c)	Halsey St	Wickliffe St	300mm dia	113	Yes
2002.103	17	Wickliffe St	Wickliffe St	1,050 mm dia.	1,660	No
2002.104	18(a)	Magnet St	Magnet St	300mm dia	73	No
2002.105	18(b)	Magnet St	Magnet St	300mm dia	66	No
2002.106	19	Ravensbourne Rd	Gas Works	300 mm dia.	117	Yes
2002.108		George St (Port Otago)	Port Chalmers	750 mm dia.	1,000	No
2002.109		George St/SH88	Port Chalmers	1,250 mm dia.	1,200	Yes
2002.110		Second Beach Rd	St. Clair	1,050 x 1,050 mm tunnel	7,000	Yes
2006.222		Sawyers Bay, western side of Watson Park, Port Chalmers	Port Chalmers	150 mm dia.	20	Yes

2. Methods

2.1 Stormwater

A number of the outfalls listed in Table 1 do not have outfall structures or are located in places that are inaccessible. Consequently it is neither practical nor possible to sample from the entire 31 outfalls listed, as agreed by the ORC. However, the monitoring programme undertaken samples all major Dunedin stormwater catchments and gives a comprehensive picture of the state of contaminants in Dunedin's stormwater. Catchment names have been altered

slightly from those used last year to reflect the naming to be used under the DCCs Three Waters Strategy (See Table 2, page16). Grab samples of stormwater were collected from each stormwater outfall within 1 hour of the commencement of a rain event (>0.5mm) in an endeavour to ensure that first flush water was gathered. Collections took place only if there was an antecedent period of at least 72 hours with no rain before the target rain event. Samples were sent to Hill Laboratories in Hamilton to be analysed for arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn), faecal coliforms and *E. coli*. Samples collected from the Kitchener Street, Orari Street and Portobello Road outfalls were additionally analysed for polycyclic aromatic hydrocarbons (PAHs). Samples were also collected during a period of low flow a week after the targeted rainfall event and sent to ESR in Christchurch for analysis of fluorescent whitening agents (FWAs). FWAs are used in laundry detergents and indicate possible sewage infiltration to the stormwater system (Petch 1996). Gilpin *et al*., (2004) recommend that stormwater be sampled at low flows to get a more accurate picture of sewage infiltration because the FWAs are usually present in only very low concentrations and are more readily detected at low flows.

2.2 Sediments

Three replicate 250cm^3 samples were collected from the top 20mm of sediment within 20m from each of the Kitchener Street, Orari Street and Portobello Road Outfalls. To gain a clear picture of sediment contamination within the upper harbour basin, further replicate sediment samples were collected at each of the sites indicated by orange stars in Figure 2. Samples were chilled and sent to Hill laboratories in Hamilton for analysis for total arsenic, total cadmium, total chromium, total copper, total nickel, total lead, total zinc, faecal coliforms, enterococci and PAHs.

2.3 Biological Monitoring

At the Portobello Road, Orari Street and Kitchener Street outfalls two sites within 20m of each outfall and at the waters edge at low tide were sampled for flora and fauna according to the protocols outlined in Kingsford and Battershill (1998). An additional two sites were sampled at no less than 50m from each outfall at the waters edge. At each site, three randomly spaced 5m^2 quadrats were sampled, giving a total of 12 quadrats at each outfall. For epifauna within each 5m^2 quadrat, the number of each species was recorded in five 0.1m^2 quadrats. For infauna a sediment core was taken in three 0.1m^2 quadrats per site, giving 12 cores per

outfall. Sediment was returned to the laboratory, washed through a 500μm sieve and animals retained identified to at least family level (Bates *et al*. 2007). The abundance of each species was then recorded. For macroflora, the percentage cover of each species was estimated in three 1.0m^2 quadrats per site, giving 12 quadrats per outfall. For both epifauna and infauna a Shannon Weiner diversity index (Zar 1996) was calculated to enable community diversity to be compared from year to year.

2.4 Cockle, Mussel, Fish and Octopus Flesh

Daily patrols of the shoreline at low tide adjacent to the Portobello Road and Orari Street stormwater outfalls were made, beginning in late March, to seek mature octopus (*Pinnoctopus cordiformis* – formerly *Octopus maorum* or *Octopus huttoni* – formerly *Robsonella australis*) during the annual autumn die-off.

For shellfish a minimum of 15-20 large cockles (*Austrovenus stutchburyi*) were collected from within 20m of the confluence of the stormwater outlet and the waters edge at low tide at each of the Portobello Road, Orari Street and Kitchener Street outfalls. Cockles were individually measured, bagged, and chilled and sent to Hill Laboratories for analysis for As, Cd, Cr, Cu, Ni, Pb and Zn. A further 15-20 cockles were collected at each site and sent for PAH analysis, and a further 15-20 to Hill Laboratories in Christchurch for analysis for faecal coliforms.

Within the same period that cockles were collected variable triplefins (*Tripterygion varium*) were caught using baited fish traps off the Mason Street wharf no more than 50m from the Mason Street stormwater outfall. Fish were weighed and measured, then chilled, bagged, and sent to Hill Laboratories for analysis for As, Cd, Cr, Cu, Ni, Pb and Zn and for PAHs.

At Second Beach a minimum of twelve mussels (*Perna canaliculus*) were collected from the rock reef to the east of the Second Beach stormwater outfall at a distance of no more than 50m from the outfall. Only mussels of mature size (≥80mm) were collected. Mussels were bagged and chilled and sent to Hill Laboratories in Hamilton for analysis for, As, Cd, Cr, Cu, Ni, Pb and Zn. A further 12-15 mussels were collected and sent to Hill Laboratories, Christchurch, for analysis for faecal coliforms.

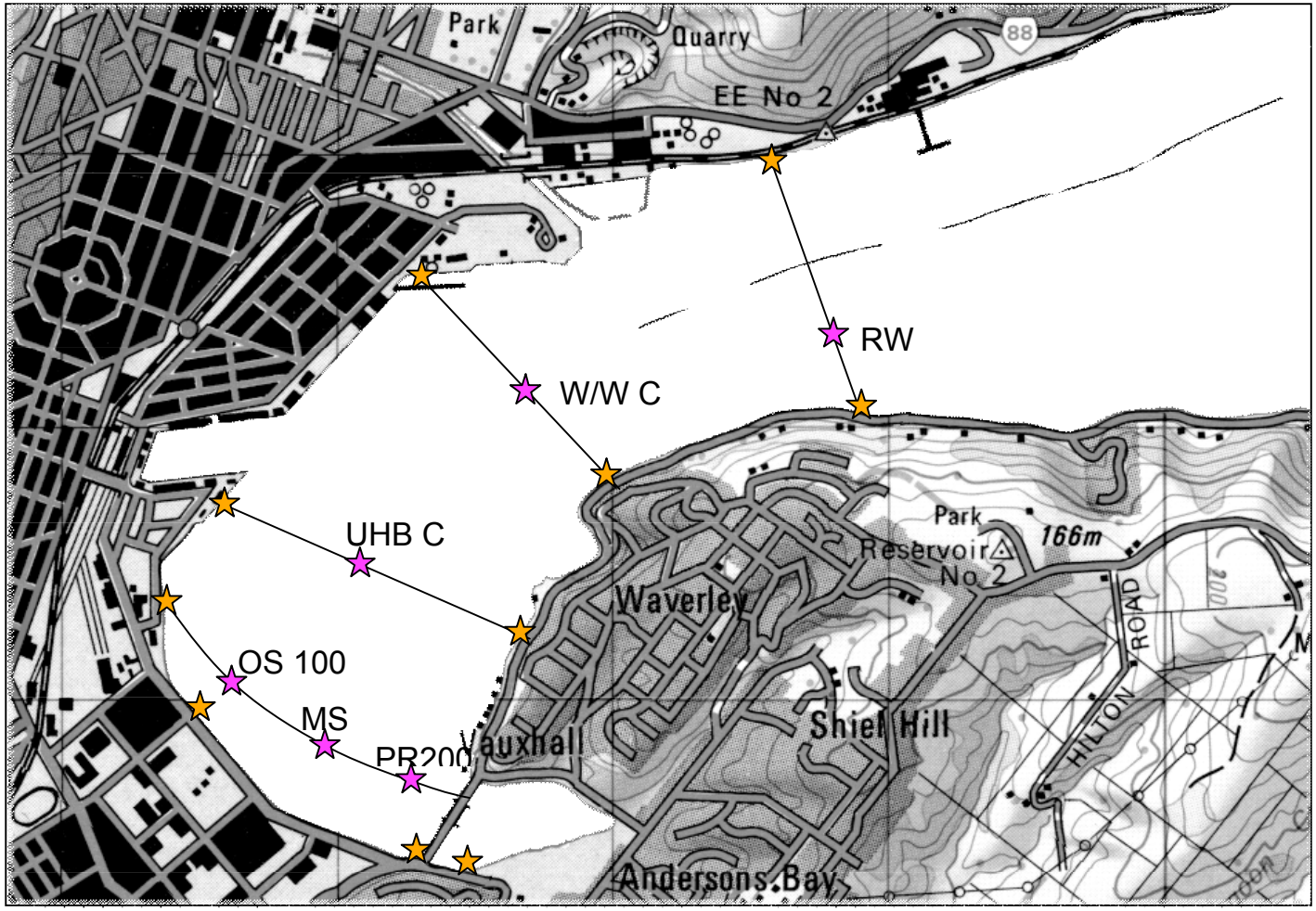


Figure 2. *Upper Harbour Basin sediment sampling sites. Orange stars sampled annually; pink stars sampled 5 yearly. Anticlockwise, starting at top, orange sites are: Rowing Club, Wickliffe St, White St, Kitchener St, Orari St, Portobello Rd, Shore St, Boatshed, Cove Drainage and Retaining Wall. Pink sites are coded according to location (see Table 4).*

3. Results

3.1 Stormwater

During the first hour of a storm event that produced 2.6mm rainfall on 23 April 2010 water samples were collected from stormwater outfalls at Second Beach, Shore Street, Portobello Road, Teviot Street, Midland Street, Orari Street, Kitchener Street, Mason Street, Bauchop Street, Halsey Street, Wickliffe Street and Ravensbourne Road in Dunedin and from Watson Park and east George Street in Port Chalmers. This storm event had an antecedent dry period of 192 hours.

Stormwater at Ravensbourne Road was flowing clear at sampling time but at all other sites was strongly discoloured, particularly at Teviot Street, Midland Street, Orari Street, Kitchener Street, Wickliffe Street, Mason Street, Halsey Street and George Street. Second Beach, Portobello Road and Watson Park were all moderately discoloured. Contaminant levels are compared with levels in stormwater collected during a preliminary survey conducted in 2007 and the first and second annual surveys conducted in 2008 and 2009 (Table 2, Figure 3). This year all contaminants, with the exception of zinc and copper were below ANZECC (2000) guidelines for protection of 80% of species (Table 2). Zinc exceeded the ANZECC trigger level for all outfalls and copper was below trigger levels for just Watson Park, Bauchop Street and Halsey Street. This is much the same as last year but with an overall improvement in lead levels with no outfall having lead values higher than the ANZECC guideline, compared with six outfalls having high lead levels in 2009 (Table 2, Figure 3). It should be noted that Orari Street and Portobello Road both operate with sump systems and it is not clear if, in fact, the first flush had reached the outfall for these sites at the time of sampling. However, these sumps were operating at the time of sampling so it is assumed the first flush for these two outfalls was sampled.

Unlike last year when the highest levels of contaminants overall were at Wickliffe Street, there was no outfall this year that was clearly "worse" than others. Midland Street had the highest levels of copper and nickel, but the highest levels of other metals were shared among Halsey Street (As), Wickliffe Street (Cd), Orari Street (Cr), George Street (Pb) and Teviot Street (Zn). Generally speaking, contaminant levels showed considerable variability with location when compared with results from 2007, 2008 and 2009. Nickel at Midland Street and zinc at Teviot Street stand out as being at levels higher than might be expected based on previous results (Figure 3). If such levels continue in future sampling it will be worthwhile

carrying out further investigations in these catchments to determine possible sources.

Microbiological levels were high to very high at all sites this year with all values exceeding the guidelines for secondary contact recreation for both faecal coliforms and *E. Coli* (Table 2, Figure 3). Mason Street, Kitchener Street and Portobello Road in particular show marked increases in microbe levels compared with 2009, with Second Beach also showing an increase, but in just faecal coliforms. Wickliffe Street, on the other hand, shows a marked decrease in microbial levels (Table 2, Figure 3). High microbial counts are perhaps not unexpected for first flush samples with a considerable amount of animal faeces and decaying vegetable matter being washed into the stormwater system from streets and pavements.

FWAs were detected at low flows at all sites this year (Table 2). Levels were generally comparable with last year with values at some sites increasing slightly while those at other decreased slightly. Midland Street had the highest values, but well short of the extreme levels seen at Bauchop Street in 2007 and 2008 (Figure 3). There are no standards for FWAs in New Zealand but levels above 0.2µg/L are cause for concern (Brent Gilpin, ESR, pers. comm.). It is expected that contaminants of this nature will continue to be investigated as part of the development and implementation of the long-term stormwater catchment management plans and DCC's Three Waters strategy.

PAHs were detected at all three outfalls where this parameter is monitored this year, albeit at very low levels. This differs from last year when PAHs were detected at just the Portobello Road outfall. In 2007 PAHs were detected only in Orari Street stormwater (just Pyrene at very low levels) (Table 3), and in 2008 PAH levels were high at all three outfalls (Table 3). Total PAH levels were very slightly lower at Portobello Road than in the previous year (Table 3). Anthracene, Fluorene and Biphenyl-d10, the three PAHs that contributed the major component of the 2008 total, were once again notably absent this year. Anthracene and Biphenyl-d10 are components of coal tar and, as suggested last year, it may be that the input of these substances (a by-product of gas production) to the upper harbour via stormwater is tailing off. It will be of interest to see if the trend of decreasing PAH input at Portobello road continues in future years.

Table 2. *Levels of contaminants detected in stormwater from outfalls in and around Dunedin during a storm event on 11 April 2007, 17 June 2008, 12 May 2009 and 23 April 2010. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

		Stormwater															
Three Waters Project ICMP Catchment	Parameter	As				Cd				Cr				Cu			
	units	g/m^3				g/m^3				g/m^3				g/m^3			
	Outfall	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
St Clair	Second Beach	BDL	0	0	BDL	BDL	0.00006	0.00006	0.00007	0	0	0	0	0.003	0.012	0.019	0.005
Port Chalmers	George St	BDL	0	BDL	BDL	###	0.00140	0.00011	0.00033	0.01	0.01	0	0	0.021	0.039	0.025	0.015
Port Chalmers	Watson Pk	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01	BDL	BDL	0.009	0.003	BDL	BDL
Shore Street	Shore Street	0.04	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01	0.014	0.02	0.012
South Dunedin	Portobello Road	BDL	0	BDL	BDL	BDL	0.00023	BDL	BDL	BDL	0	BDL	BDL	BDL	0.026	0.01	0.006
Andersons Bay	Teviot Street	BDL	0	BDL	BDL	BDL	0.00008	BDL	0.00026	BDL	0	BDL	BDL	BDL	0.009	BDL	0.014
Andersons Bay	Midland Street	BDL	0	BDL	BDL	BDL	0.00013	BDL	BDL	BDL	0	0	BDL	0.02	0.031	0.057	0.021
Orari Street	Orari Street	BDL	BDL	0.03	0.001	BDL	BDL	BDL	0.00016	BDL	0	BDL	0	BDL	0.014	BDL	0.01
Kitchener Street	Kitchener Street	BDL	BDL	0.01	BDL	BDL	BDL	BDL	BDL	0	0	BDL	BDL	0.034	0.006	0.023	0.012
Mason Street	Mason Street	0.01	BDL	0.01	BDL	BDL	BDL	0.0077	0.00051	BDL	BDL	BDL	BDL	0.022	0.012	0.021	0.016
Ravensbourne	Ravensbourne Rd		BDL	BDL	BDL		BDL	BDL	BDL		0	BDL	BDL		0.002	BDL	0.003
Halsey Street	Bauchop Street	0.03	BDL	0.02	BDL	BDL	BDL	BDL	0.00049	BDL	0	BDL	BDL	0.029	0.01	BDL	0.003
Halsey Street	Halsey Street	0.03	BDL	0.01	0.004	BDL	0.00022	BDL	0.00026	BDL	BDL	BDL	BDL	0.024	0.004	0.021	0.002
Halsey Street	Wickliffe Street	0.03	BDL	0	BDL	BDL	BDL	0.00052	0.00078	BDL	0	0.01	0	0.01	0.013	0.059	0.006
	Protection for 80% of species																
	ANZECC guidelines	0.36				0.0008				0.04				0.0025			

Table 2. *continued…*

Three Waters Project ICMP Catchment	Parameter	Stormwater Ni				Pb				Zn			
	units	g/m³				g/m³				g/m³			
	Outfall	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
St Clair	Second Beach	0.0009	0.0021	0.0022	0.0013	0.001	0.011	0.013	0.00021	0.038	0.16	0.15	0.092
Port Chalmers	George St	0.0029	0.0093	0.0026	0.006	0.0342	0.041	0.018	0.0048	0.288	0.66	0.19	0.42
Port Chalmers	Watson Pk	BDL	BDL	BDL	0.0035	0.0141	0.0018	BDL	BDL	0.231	0.027	BDL	0.29
Shore Street	Shore Street	0.01	BDL	BDL	BDL	0.003	0.0085	0.0069	BDL	0.02	0.44	0.21	0.115
South Dunedin	Portobello Road	BDL	0.0035	0.0028	0.0035	BDL	0.019	0.0067	0.00055	0.08	0.94	0.64	0.153
Andersons Bay	Teviot Street	BDL	0.0019	BDL	0.0033	BDL	0.0066	BDL	BDL	BDL	0.13	BDL	1.79
Andersons Bay	Midland Street	BDL	0.0016	BDL	0.0075	0.005	0.0054	0.0083	BDL	0.1	0.35	0.18	0.22
Orari Street	Orari Street	BDL	0.0033	BDL	0.0011	BDL	0.023	BDL	0.00015	BDL	0.22	0.031	0.3
Kitchener Street	Kitchener Street	0.003	BDL	0.0036	0.0035	0.0442	0.007	0.018	0.00196	0.445	0.036	0.38	0.62
Mason Street	Mason Street	0.004	BDL	0.0055	BDL	0.0258	0.0089	0.014	0.00102	0.25	0.16	0.35	0.43
Ravensbourne	Ravensbourne Rd		0.0007	BDL	0.0015		0.0015	0.0029	0.00023		0.053	0.047	0.144
Halsey Street	Bauchop Street	0.01	BDL	BDL	BDL	0.01	0.0035	BDL	BDL	0.23	0.12	0.13	0.121
Halsey Street	Halsey Street	0.009	BDL	0.0035	BDL	0.021	0.0022	0.0097	0.0021	0.12	0.033	0.3	0.136
Halsey Street	Wickliffe Street	0.01	BDL	0.0042	BDL	0.006	0.0084	0.033	BDL	0.1	0.2	0.53	0.24
	Protection for 80% of species												
	ANZECC guidelines	0.017				0.0094				0.031			

Three Waters Project ICMP Catchment	Parameter	Stormwater pH				Suspended Solids				Oil & Grease				FWA				E. coli				Faecal Coliforms			
	units					g/m³				g/m³				µg/L				MPN/100ml				cfu/100ml			
	Outfall	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
St Clair	Second Beach	7.7	7.3	7.4	7.3	BDL	37	41	BDL	5	BDL	BDL	BDL	0.147	0.19	0.098	0.04	560	6800	14000	4800	560	8300	14000	92000
Port Chalmers	George St	6.9	7.1	7.3	6.8	87	150	26	170	10	8.7	BDL	BDL	BDL	BDL	0.03	0.079	1400	930	1000	1100	1400	1400	1000	1100
Port Chalmers	Watson Pk	6.8	7.9	8.2	7.1	37	39	7.4	240	8	BDL	BDL	BDL	0.002	0.003	0.124	0.105	14000	150	10	>1600	39000	150	10	>1600
Shore Street	Shore Street	7.9	7.2	7.3	7.4	41	24	20	9.5	BDL	BDL	BDL	BDL	0.081	0.031	0.142	0.98	300	5100	16000	7000	300	5100	16000	9400
South Dunedin	Portobello Road	7.9	7.3	7.6	7.6	18	46	30	8.1	4	9.7	BDL	BDL	0.003	0.049	0.177	0.151	460	5000	2800	54000	590	5000	2800	54000
Andersons Bay	Teviot Street	7.9	7.1	7.9	7	25	33	12	84	8	4.4	BDL	6.4	BDL	0.006	0.096	0.135	7	120000	210	16000	7	240000	210	16000
Andersons Bay	Midland Street	7.7	7.7	7.7	7.5	30	19	30	52	BDL	BDL	BDL	BDL	BDL	0.004	0.132	0.218	290	130	6000	3500	290	130	6000	5400
Orari Street	Orari Street	7.8	7.4	8.1	7.1	28	77	16	130	BDL	11	BDL	BDL	BDL	0.005	0.11	0.052	50	6000	210	1700	80	7000	210	3500
Kitchener Street	Kitchener Street	7.1	7.7	7.4	6.9	104	41	45	50	9	BDL	BDL	BDL	0.18	0.029	0.072	0.023	13000	70	10000	92000	13000	70	10000	160000
Mason Street	Mason Street	7.1	7	7.4	7	62	37	37	138	5	7.9	BDL	BDL	0.007	0.07	0.051	0.156	22000	26000	50000	350000	22000	26000	50000	350000
Ravensbourne	Ravensbourne Rd		7	8.1	7.3		8.5	18	61		8.8	BDL	BDL		BDL	0.096	0.136		120	90	11000	150	130	90	11000
Halsey Street	Bauchop Street	7.6	7.8	8.1	7.4	44	16	13	53	4	BDL	BDL	BDL	2.028	4.92	0.031	0.067	2200	400	3000	7900	2200	400	3000	35000
Halsey Street	Halsey Street	7.3	7.9	7.2	6.8	119	35	27	50	9	BDL	BDL	BDL	BDL	0.004	0.011	0.061	9000	1700	70000	17000	9000	1700	70000	92000
Halsey Street	Wickliffe Street	7.7	7.5	8.0	7.3	35	27	100	86	6	9.5	9.5	BDL	0.024	0.003	0.021	0.048	25000	10000	220000	35000	30000	10000	220000	54000
	Protection for 80% of species																Primary	Amber	>260			>150			
	ANZECC guidelines	7.2-7.8															Secondary	Red	>550			>1000			

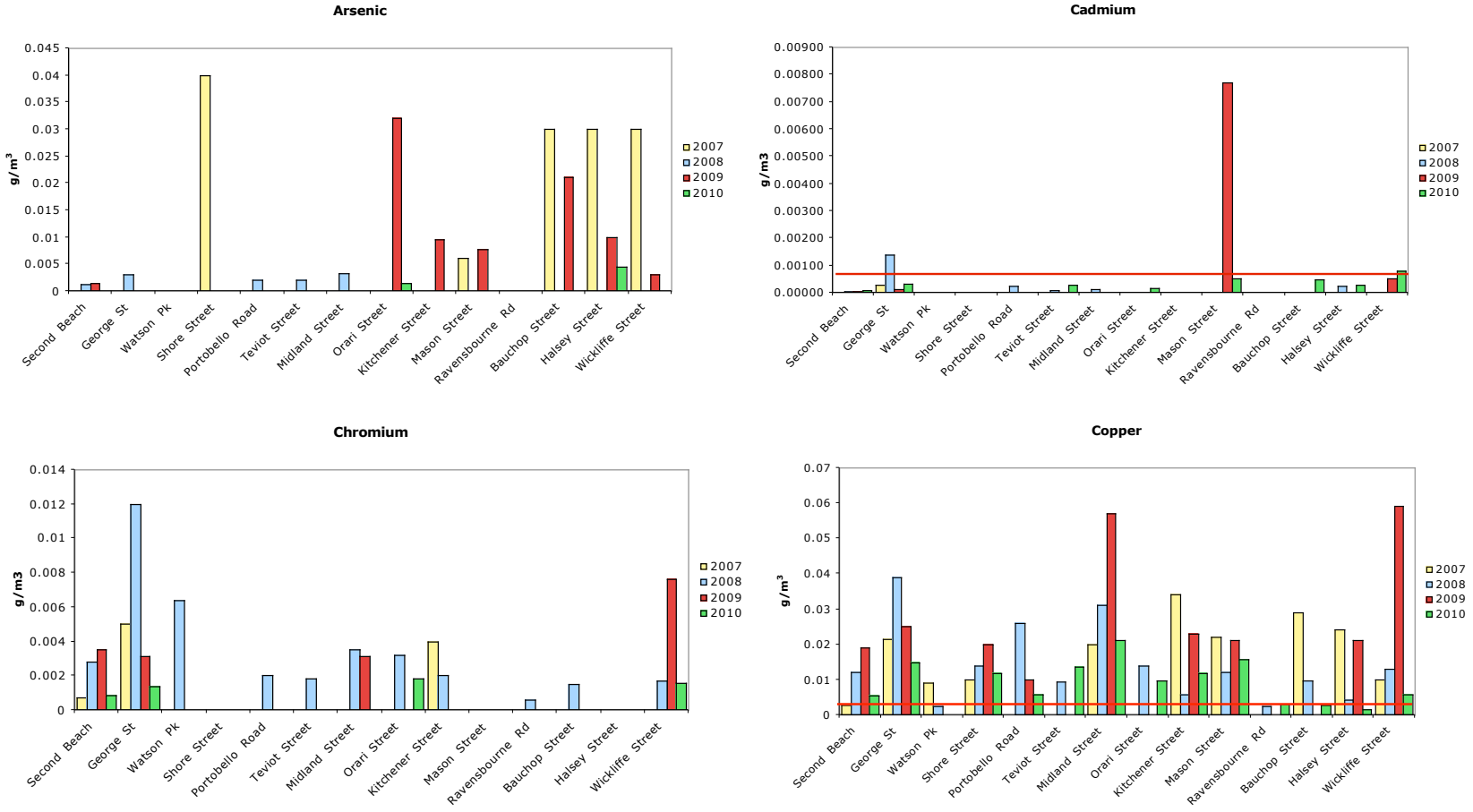


Figure 3. *Graphical representation of contaminant levels in stormwater at outfalls around upper Otago Harbour in 2007, 2008, 2009 and 2010. Red line indicates ANZECC trigger level for protection of 80% of species.*

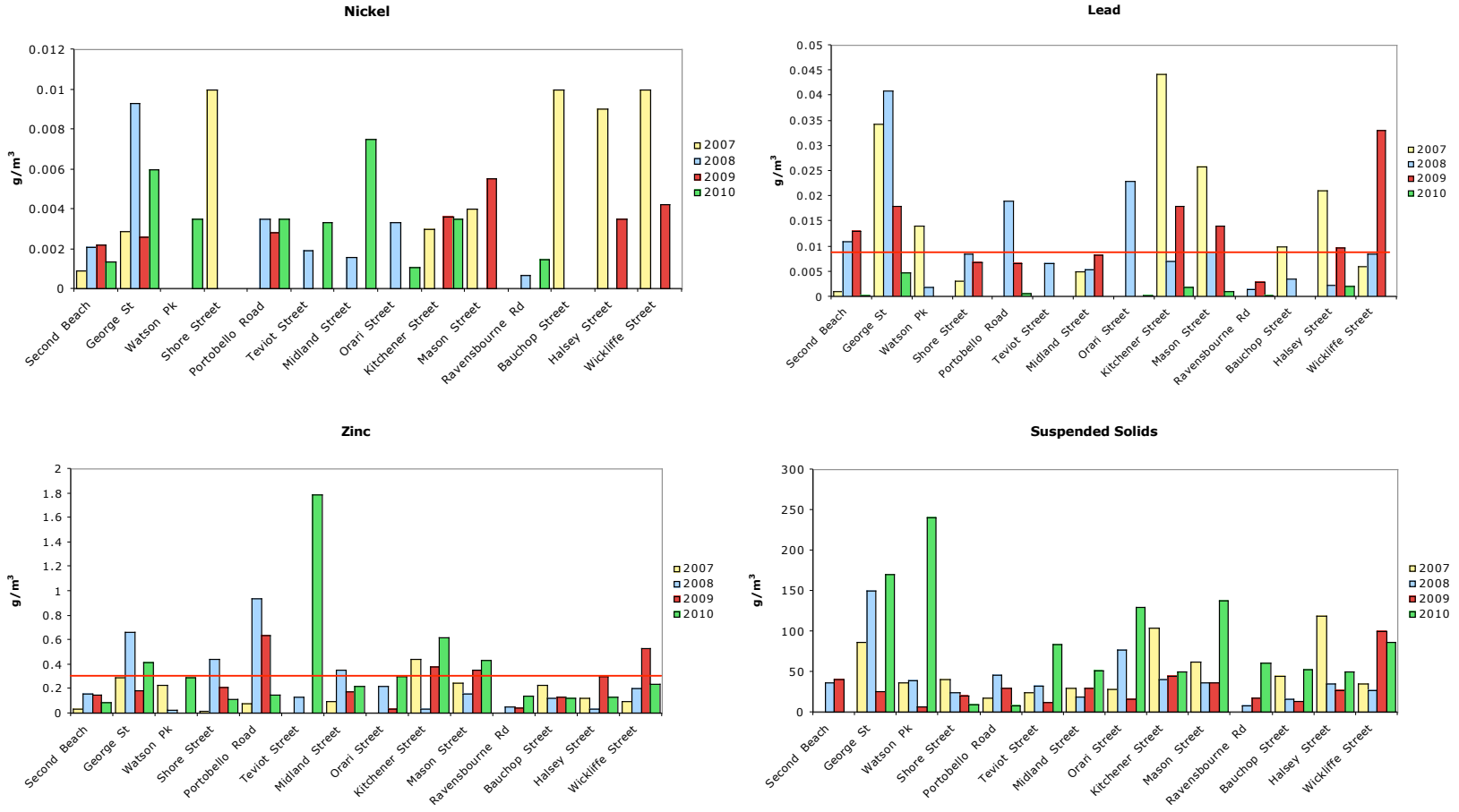


Figure 3. (continued….)

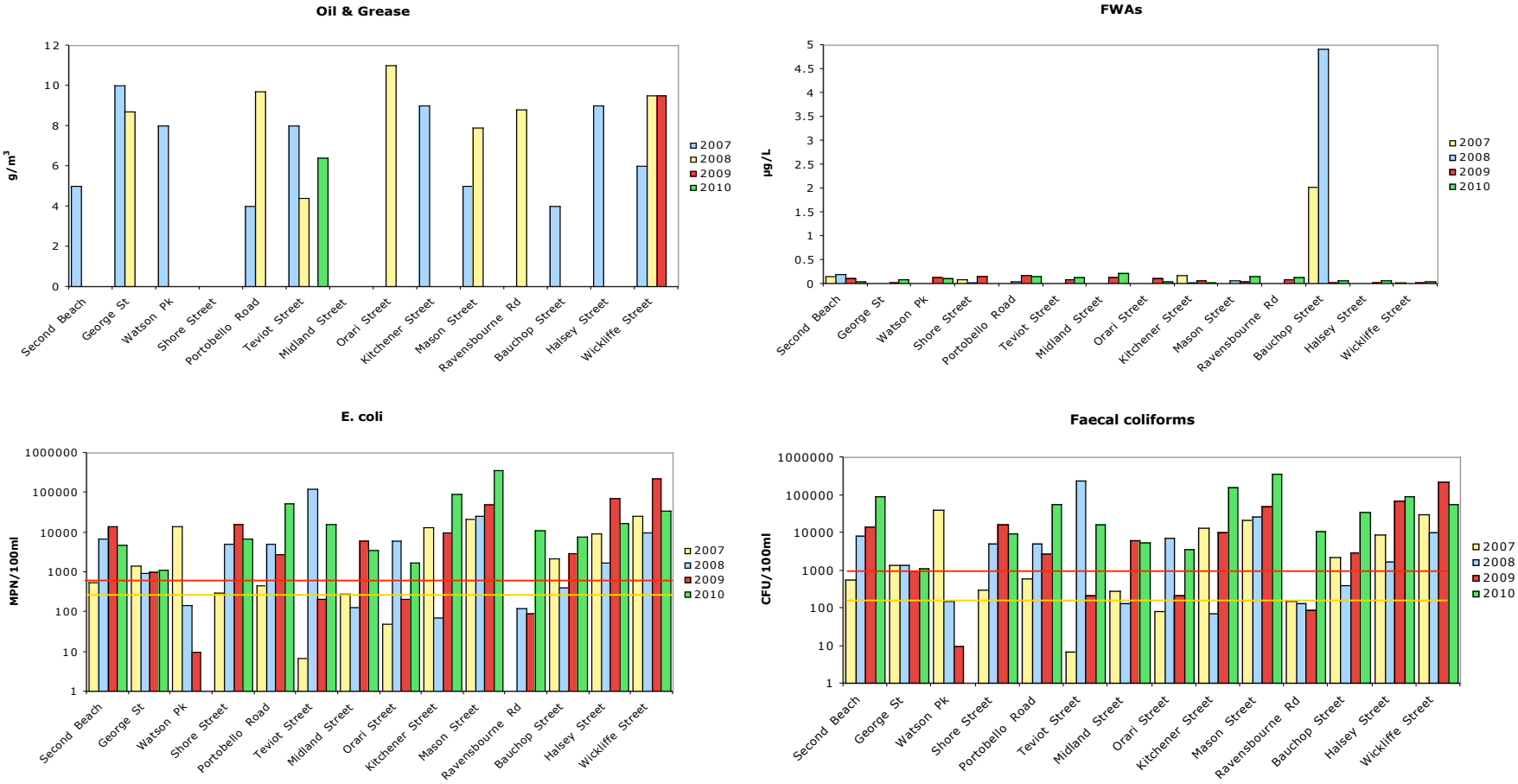


Figure 3. ***(continued)*** *Graphical representation of contaminant levels in stormwater at outfalls around upper Otago Harbour in 2007, 2008, 2009 and 2010. For microbiological graphs amber line indicates guideline for primary contact, red line indicates guideline for secondary contact.* ***Note log scale on Y axis of microbiological graphs.***

Table 3. *PAHs (g/m^3) detected in stormwater from the Kitchener Street, Orari Street and Portobello Road outfalls in 2007, 2008, and 2009 and 2010. BDL indicates Below Detectable Limits.*

	Kitchener St				Orari St				Portobello Rd			
	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
Acenaphthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00034	0.000024	BDL
Acepaphthylene	BDL	100	BDL	BDL	BDL	92	BDL	BDL	BDL	100	0.000029	BDL
Anthracene	BDL	87	BDL	BDL	BDL	89	BDL	BDL	BDL	87	0.000008	BDL
Benzo[a]anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00015	0.000014	BDL
Benzo[a]pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000017	BDL
Benzo[a]fluorathene + Benzo[j]fluorathene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00012	BDL	0.00018	0.000033	0.000158
Benzo[g,h,i]perylene	BDL	BDL	BDL	BDL	BDL	0.00014	BDL	BDL	BDL	BDL	0.000014	BDL
Benzo[k]fluorathene	-	67	BDL	BDL	-	67	BDL	BDL	-	67	BDL	BDL
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Dibenzo[a,h]anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fluoranthene	BDL	BDL	BDL	0.0001	BDL	0.00011	BDL	0.00017	BDL	0.00028	0.00001	BDL
Fluorene	BDL	73	BDL	BDL	BDL	70	BDL	BDL	BDL	74	BDL	BDL
Indeno[1,2,3-c,d]pyren	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000013	BDL
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Phenanthrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Pyrene	BDL	BDL	BDL	BDL	0.0001	BDL	BDL	0.00023	BDL	0.00037	0.000011	BDL
Total PAH	0.00	327.00	BDL	0.0001	0.00	318.00	BDL	0.0005	BDL	328.00	0.00017	0.00016

The one result that stands out this year is the high level of oil and grease at Teviot Street. The value is not unusually high compared with levels at the various outfalls through time, but it is the only site at which oil and grease was detected this year (Figure 3).

3.2 Sediments

Sediments were sampled on 27th April 2010 at sites detailed in Figure 2. Surface sediments were generally clean at most sites with little surface detritus apart from a layer of organic particles (wood and bark fragments) at Portobello Road and a layer of dead leaves at Wickliffe Street. Additionally, at Portobello Road, sediments were very dark and smelled strongly of petro-carbons with a visible oil slick forming in footprints and depressions dug to remove sediments. At Wickliffe Street, sediments were dark and smelled strongly of hydrogen sulphide, indicating anoxic conditions. Investigations into PAH levels at the Portobello Road outfall are detailed in Stewart (2005, 2006). Note that the South Dunedin (Portobello Road) catchment was used as the pilot for the stormwater catchment management plan development for the DCC's Three Waters Strategy and a complete ICMP has recently been finalised for this catchment. The ICMP contains recommendations for addressing problems and issues highlighted in this catchment that will be considered and programmed for action where practicable.

Unlike last year when copper, nickel, lead and zinc levels were generally elevated in sediments near stormwater outfalls that discharge from large or industrialised catchments such as White Street, Kitchener Street and Portobello Road, there has been an overall reduction in the concentration of these contaminants in sediments at most sites (Table 4, Figure 4). The site that most notably flies against this trend

is Wickliffe Street which shows increases all contaminant levels apart from cadmium, zinc and PAHs. Arsenic levels are generally higher than last year except at Orari Street, Portobello Road, Shore Street, Cove Drainage and Boatshed where there have been moderate to marked decreases (Table 4, Figure 4). Chromium is higher at Shore Street than it has been since 2007. Lead shows modest increases at Wickliffe Street, Kitchener Street and Shore Street (Table 4, Figure 4). Zinc levels in sediment have decreased dramatically at White Street and more modestly at all other sites. ANZECC low trigger values are exceeded by lead, zinc and PAHs at the majority of sites (Table 4) with arsenic (at Retaining Wall) and copper (at White Street and Portobello Road) also breaching guidelines.

As observed in previous investigations PAHs are to be found at moderate to high levels in much of the Upper Harbour Basin, with the highest levels adjacent to the Portobello Road outfall (Table 4, Figure 4). Stormwater inputs of PAHs were lower this year than last year at Portobello Road, but very slightly higher at Orari Street and Kitchener Street indicating that, while PAHs are still being added to the upper harbour, the amount varies through time and with site. The extremely high levels of PAHs in older sediments off Portobello Road are believed to have been sourced from the now defunct gas works. The levels of PAHs off Portobello Road observed this year are much lower than those from last year and lower than those observed in any sampling round to date. Wave action disturbing surface sediments around the time of sampling will undoubtedly have a bearing on PAH levels at any particular site. This year, sampling occurred on a relatively calm day, but wind strength was not markedly different to that on the sampling day last year. Perhaps unexpected was the slight increase in PAH levels at Retaining Wall.

Microbial contamination in sediment is relatively low at most outfalls with just Shore Street having moderate numbers of enterococci and both Shore and Wickliffe Streets having moderate numbers of faecal coliforms (Table 4). Numbers are, however, slightly higher than last year, but lower than in 2007 or 2008.

Trends in contaminant levels at the various sites through time remain unclear with just four years of sampling revealing high variability among contaminants and among sites (Figure 4). However, levels of chromium, copper, nickel, lead zinc and PAHs are generally lower this year and show a reducing trend at some sites. It

will be of interest to see if this trend becomes more apparent with the addition of further data from future monitoring rounds.

Table 4. *Contaminant levels in sediments at various locations within 20m of stormwater outfalls and within the Upper Otago Harbour Basin with 2007 (yellow) and 2008 (green) values compared with 2009 values (blue) and 2010 values (grey). Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

Sediments within 20m of outfall																												
	As				Cd				Cr				Cu				Ni				Pb				Zn			
Units	mg/kg dry wt				mg/kg dry wt				mg/kg dry wt				mg/kg dry wt				mg/kg dry wt				mg/kg dry wt				mg/kg dry wt			
Parameter	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
Rowing Club	10.6	9.8	7.3	13.0	0.2	0.2	0.1	0.2	17.6	12.0	16.0	14.0	14	13	14	9	11.3	14.0	13.0	11.0	18.9	27	27	28	101	130	160	149
Wickliffe Street	17.3	11.0	6.9	9.0	0.6	0.7	0.8	0.7	38.0	34.0	16.0	27.0	121	68	50	58	19.2	23.0	13.0	17.0	76.1	140	77	92	412	740	810	740
White Street	11.6	18.0	5.4	6.0	0.3	0.2	0.2	0.1	68.5	56.0	26.0	19.0	433	160	170	78	29.5	21.0	11.0	8.0	147.0	180	170	124	4450	2500	2400	1280
Kitchener Street	4.6	7.5	7.0	9.0	0.4	0.4	0.3	0.3	22.6	18.0	98.0	22.0	70	56	90	37	10.6	12.0	15.0	12.0	117.9	97	130	155	249	280	300	280
Orari Street	18.6	4.3	20.0	5.0	63.0	0.1	0.9	0.2	0.3	16.0	37.0	16.0	25	13	61	11	23.6	8.1	16.0	8.0	12.8	39	120	35	68	130	680	157
Portobello Road	29.0	23.0	24.0	15.0	48.5	1.8	2.0	1.5	1.8	54.0	50.0	36.0	60	160	190	123	169.3	18.0	26.0	19.0	20.4	330	290	193	306	1400	1600	1040
Shore Street	9.5	7.1	6.2	6.0	0.4	0.3	0.3	0.3	21.8	16.0	18.0	19.0	51	44	41	35	10.7	9.0	11.0	10.0	113.0	110	79	85	484	300	330	350
Boatshed	27.4	16.0	17.0	15.0	0.3	0.2	0.2	0.3	41.7	19.0	26.0	31.0	108	33	49	35	24.5	16.0	17.0	16.0	112.0	800	170	86	339	370	360	290
Cove Drainage	21.5	17.0	19.0	13.0	0.1	0.1	0.4	<0.1	15.8	35.0	32.0	19.0	11	19	38	11	23.5	44.0	23.0	19.0	19.7	20	55	18	99	150	270	125
Retaining Wall	25.3	36.0	24.0	36.0	0.1	0.2	<0.1	<0.1	23.6	31.0	39.0	23.0	13	19	17	10	15.9	25.0	26.0	18.0	26.9	27	42	24	141	170	150	152
ANZECC Low trigger value	20				1.5				80				65				21				50				200			
ANZECC high trigger value	70				10				370				270				52				220				410			

Sediments within 20m of outfall												
	PAH				Enterococci				Faecal coliforms			
Units	mg/kg dry wt				MPN/g				MPN/g			
Parameter	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
Rowing Club	7.0	5.8	0.5	3.7	2	11	<2	<3	<2	17	5	2
Wickliffe Street	9.2	1.2	7.3	7.2	580	>1600	330	<3	2	540	33	540
White Street	13.0	11.1	15.9	6.5	4	2	<2	23	<2	<2	<2	5
Kitchener Street	8.9	140.5	4.8	5.0	66	920	5	<3	20	13	70	<2
Orari Street	10.2	12.6	28.3	9.3	<2	8	23	<3	23000	4	33	33
Portobello Road	436.3	250.3	525.2	194.1	727	170	<2	<3	23	43	2	21
Shore Street	9.6	21.0	8.6	10.5	90	>1600	<2	460	<2	540	<2	130
Boatshed	6.7	5.5	38.8	7.9	34	33	33	<3	<2	2	79	5
Cove Drainage	0.4	0.0	0.1	0.1	8	17	<2	<3	2	8	<2	<2
Retaining Wall	0.3	3.9	0.0	9.4	<2	8	<18	<3	2	<2	33	<2
ANZECC Low trigger value	4											
ANZECC high trigger value	45											

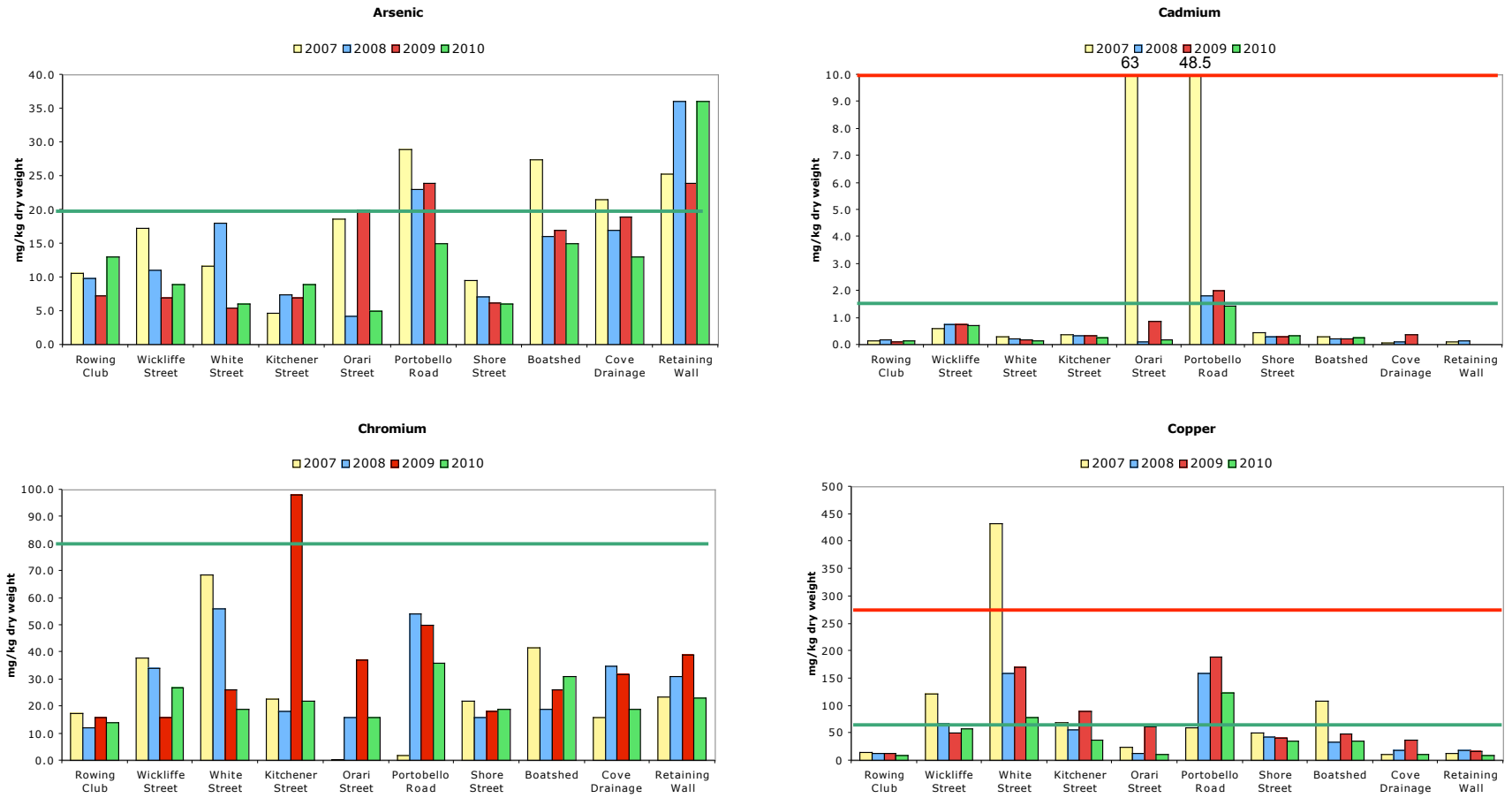


Figure 4. *Graphical representation of contaminant levels in sediment at sampling sites around upper Otago Harbour in 2007, 2008, 2009 and 2010. Green line indicates ANZECC low trigger level, red line is high trigger level.*

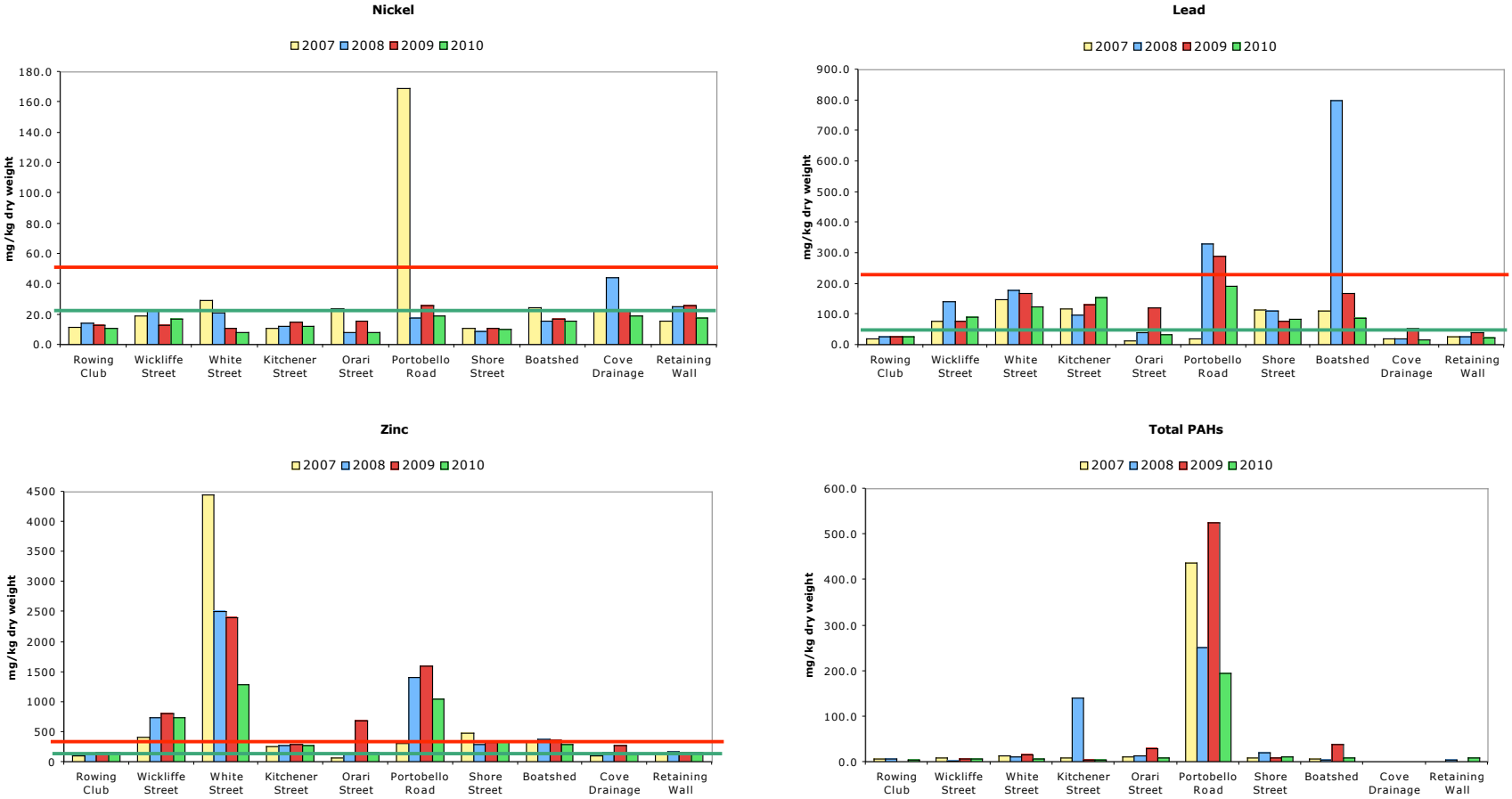


Figure 4 (continued). *Graphical representation of contaminant levels in sediment at sampling sites around upper Otago Harbour in 2007, 2008, 2009 and 2010. Green line indicates ANZECC low trigger level, red line is high trigger level.*

3.3 Biological Monitoring

On 28 April 2010 biological sampling was carried out at the Portobello Road, Orari Street and Kitchener Street outfalls. The tide was reasonably low at 1.0m below mean sea level.

There was a reasonable diversity of mainly red algae at all three sites. Just a single species was present at Portobello Road in 2008. Despite the diversity, percentage cover was generally low near the Kitchener Street outfall except at one quadrat >50m from the outfall Table 5). Cover was higher at both sites near the Orari Street outfall with occasional quite large clumps of *Ceramium uncinatum* and *Ulva lactuca* present (Table 6). Cover at Portobello Road generally sparse. Overall, cover at all sites was similar to previous years with the exception of >50m from the Kitchener Street outfall where cover was lower than last year, but similar to 2008 and 2007 (Stewart 2007a, Stewart 2008c, Stewart 2009).

Table 5. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Kitchener Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis			3.0			
Ulva lactuca						
Ceramium uncinatum	2	7	40	45	40	40
Euptilota formosissima						
Gracilaria chilensis						
Lenormandia chauvinii		2	2	1	3	2
Lomentaria umbellata			1	4	2	3

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis		1				4
Ulva lactuca	2	1	1			
Ceramium uncinatum	2	7	85	7	12	15
Euptilota formosissima						
Gracilaria chilensis						
Lenormandia chauvinii	2	2	2	1	1	2
Lomentaria umbellata			3			2

Table 6. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Orari Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca	40	30	35	60	40	25
Ceramium uncinatum	10	7	35	7	30	10
Euptilota formosissima	2	2	2	4	3	5
Gracilaria chilensis	5	7	10	15	7	6
Lenormandia chauvinii						1
Lomentaria umbellata						

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa	2	3			5	
Codium fragilis						1
Ulva lactuca	12	10	18	30	18	12
Ceramium uncinatum	40	35	45	25	25	15
Euptilota formosissima	2	1	2	1	2	3
Gracilaria chilensis	5	2	4	7	5	7
Lenormandia chauvinii	3	2	2	1	2	2
Lomentaria umbellata						

Table 7. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Portobello Rd outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis		2				
Ulva lactuca	2		1	2	3	4
Ceramium uncinatum	17	15	8	2	2	6
Euptilota formosissima					2	1
Gracilaria chilensis						
Lenormandia chauvinii			2			1
Lomentaria umbellata	5	2	2	1		

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca	1	3	1	3		2
Ceramium uncinatum	20	10	5	7	15	10
Euptilota formosissima			1			
Gracilaria chilensis						
Lenormandia chauvinii		1				
Lomentaria umbellata						

Epifauna was moderately abundant at all three outfalls (Tables 8-10) with the small topshell *Micrelenchus tenebrosus* and cockles, *Austrovenus stutchburyi*, comprising the majority of animals. Numbers of animals per square metre was lower at more than 50m distant from the Kitchener Street outfall than within 20m of the outfall, as for 2008 and 2009. For both Orari Street and Portobello Road, numbers were much more similar at each distance. This is similar to previous years for Orari Street but differs for Portobello Road, which showed higher abundance further from the outfall last year (Tables 8-10).

Diversity within animal communities was variable with Portobello Road showing greater diversity further from the outfall while Kitchener Street showed the converse (Table 11). Diversity at Orari Street was very similar at both sites. Overall diversity has not changed from that observed in 2007, 2008 and 2009 ($F_{3,8}$ = 0.221, p = 0.879 for <20m sites; $F_{3,8}$ = 0.271, p = 0.845 for >50m sites). Neither is there a significant difference in epifaunal diversity among sites <20m from the outfalls and sites >50m from the outfalls ($F_{1,4}$ = 0.131, p = 0.736).

Table 8. *Epifauna within 20m (top) and greater than 50m (bottom) of the Kitchener Street outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus		146	14							15	18		18	24	1
Spirorbis spp															
Crabs															
Macrophthalmus hirtipes															
Barnacles															
Eminius modestus		22	38	35	18	29		23	64	31	53	37	2	2	
Chamaesipho columna														1	
Snails and Chitons															
Chiton glaucus													2		
Melagraphis aethiops			1												
Micrelenchus tenebrosus	12	35	46	5	2	7	2	4	8	23	41	26	8	7	28
Notoacmea spp		2													
Bivalves															
Austrovenus stutchburyi						1						1			
Ostrea heffordi	1	6			1				1	5	2	1	1	1	

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Barnacles															
Eminius modestus						3	2	2					2		
Snails and Chitons															
Micrelenchus tenebrosus	4	8	4	5	3	10	5	5	23	8	16	8	12	7	47
Notoacmea spp	1	1	1		1			1			1	1	1		
Bivalves															
Ostrea heffordi													2		1

Table 9. *Epifauna within 20m (top) and greater than 50m (overleaf) of the Orari Street outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Snails and Chitons															
Acanthochitona zelandica													1		
Micrelenchus tenebrosus				2		1		1		1		1			1
Bivalves															
Austrovenus stutchburyi	5	7	2	8	6	6	2	12	9	8	6	7	7	12	11

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Snails and Chitons															
Acanthochitona zelandica								1		1					
Buccinulum vittatum													1		1
Cominella glandiformis						1									
Melagraphis aethiops															
Micrelenchus tenebrosus	1	2	2	1	1	3	1				1				2
Bivalves															
Austrovenus stutchburyi	2	5	6	14	1	13	10	16	13	19	31	13	17	23	11

Table 10. *Epifauna within 20m (top) and greater than 50m (bottom) of the Portobello Rd outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus			1	4											
Barnacles															
Chamaesipho columna				4						2					
Snails and Chitons															
Cominella glandiformis								1					1		
Chiton glaucus		1													
Melagraphis aethiops						1									
Micrelenchus tenebrosus	1		1	3	7	3		2	1	4		1		3	1
Notoacmea spp					2	1	2								
Zeacumantus subcarinata			1	1	1										
Bivalves															
Austrovenus stutchburyi	11	23	13	12	8	5	5	7	7	6	2	6	1	3	2
Mytilus galloprovincialis				1											
Ostrea heffordi			3	7						4					2
Echinoderms															
Ophiuroid		1													

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus	3			2				15							
Barnacles															
Eminius modestus															
Chamaesipho columna														1	
Snails and Chitons															
Notoacmea spp												5	3	2	1
Chiton glaucus													1		
Acanthochitona zelandica												1			
Melagraphis aethiops			1	2									1		
Micrelenchus tenebrosus	2	1	5	3	1			5	3		2	1	7	5	2
Bivalves															
Austrovenus stutchburyi	4	5	7	1		6	5	3	12	7	18	8	5	2	1
Ostrea heffordi			6					3			1		1		

As in 2007, 2008 and 2009 cockles became noticeably smaller and less abundant as one moved from Kitchener Street to Portobello Road (Table 12). However, when

compared using ANOVA at a significance level of 0.05 the overall size of cockles at each site has not changed significantly from year to year ($F_{3,8}$ = 0.284, p = 0.836).

Table 11. *Diversity (H') of epifauna within 20m and greater than 50m of the Kitchener Street, Orari Street and Portobello Road outfalls. 2010 data compared with 2007, 2008 and 2009 data.*

	<20m				>50m			
Site	2007	2008	2009	2010	2007	2008	2009	2010
Kitchener Street	0.48	0.48	0.55	0.53	0.71	0.57	0.42	0.2
Orari Street	0.36	0.37	0.3	0.12	0.05	0.25	0.31	0.16
Portobello Road	0.53	0.33	0.62	0.58	0.5	0.63	0.84	0.64

Table 12. *Size of cockles collected at Kitchener Street, Orari Street and Portobello Road in 2007, 2008, 2009 and 2010.*

	2007			2008			2009			2010		
	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)
Kitchener Street	59	18.8	37.1	54	16.36	35.5	80	19.6	38.1	63	17.73	36.6
Orari Street	62	12.3	32.4	74	8.65	29.8	80	12.3	33.0	82	10.18	30.2
Portobello Road	64	9.4	30.1	74	7.87	28.3	80	10	30.1	80	7.7	28.2

A suggestion was made at the discussion of the 2008 report that growth rings should be measured on cockles to determine how age and size were related at the different sites. This was attempted for the 2009 sampling round and again this year but, due to most cockles having ill-defined and very closely spaced growth rings, results were considered to be too inaccurate to be meaningful and were disregarded. It would be fair to say, however, that at all sites cockles are much slower growing than at prime cockle sites further down harbour or in Papanui and Waitati Inlets (Stewart 2006b, 2008d).

Infauna at all three sites was dominated by polychaete worms with glyceriids being the most abundant at all sites (Tables 14-16). Spionid worms were common at Kitchener Street and Portobello Road both close to and further away from the outfall. Phoxocephalid amphipods were reasonably common at both locations near the Kitchener Street outfall, but were not common elsewhere. Cockles (*Austrovenus stutchburyi*) were most common at both the <20m and >50m sites near the Orari Street outfall (Tables 14-16). Tanaid crustaceans, which have not been common in the past, were found in moderate numbers at most sites, but were absent from >50m at Portobello Road. Numbers of animals per square metre were generally higher than in the past and ranged from 2420 at replicate 3, Site 2 at <20mm from the Orari Street outfall to 12,320 at replicate 1, Site 1 at <20m from the Portobello Road outfall. This high number was largely due to high abundance

of polychaetes and nemertean worms. Despite the variability in overall numbers of animals at the various sites, diversity has not changed significantly from year to year for the <20m sites ($F_{3,8}$ = 2.404, p = 0.143). For >50m sites, however, there was a significant difference observed this year ($F_{3,8}$ = 6.747, p = 0.014), with diversity being higher in this survey than in previous years at each of the three sites. That being said, there is no significant difference in diversity between the <20m locations and the >50m locations at any of the sites. ($F_{1,4}$ = 0.199, p = 0.679) (Table 13).

Table 13. *Diversity (H') of infauna within 20m and greater than 50m of the Kitchener Street, Orari Street and Portobello Road outfalls. 2009 data compared with 2007and 2008 data.*

	<20m				>50m			
Site	2007	2008	2009	2010	2007	2008	2009	2010
Kitchener Street	0.67	0.53	0.44	0.9	0.98	0.73	0.56	0.9
Orari Street	1.01	0.86	0.74	0.98	0.88	0.87	0.74	1.03
Portobello Road	0.74	0.67	0.8	1.04	0.84	0.68	0.76	1.08

Table 14. *Abundance of species of infauna collected <20m and >50m from the Kitchener Street outfall.*

Kitchener Street			Location	<20m							>50m						
2010			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**														
Annelida																	
	Polychaeta	Cirratulidae				1				1							
		Capitellidae			3		2		3	8							
		Glyceridae		14	7	5	16	10	8	60	3	4		7	5	9	28
		Maldanidae										1					1
		Nephtyidae		3	1	1	3			8		1					1
		Nereidae							2	2					1		1
		Nereididae		1	3		2		1	7	1	2		1		1	5
		Spionidae		3	4		5	8	4	24	1	2		10	3	5	21
Nemertea															1		1
Crustacea																	
	Decapoda	Malacostraca	*Elamena producta*													1	1
			Macrophthalmus hirtipes					1		1							
	Amphipoda	Haustoriidae					1			1							
		Lysianassidae				2	3	1		6	1	1	3				5
		Oedicerotidae		1		1	1		1	4	1		1	2	1		5
		Phoxocephalidae		4	4	1	4	3	1	17	3	2	3	1	2	1	12
	Isopoda		*Isocladus armatus*												1		1
	Tanaidacea				1	1	2	2		6		1					1
	Ostracoda				1	3		1		5	2		1				3
Mollusca																	
	Bivalvia	Veneridae	*Austrovenus stutchburyi*	1	1	1			1	4	2		1			2	5
			Puyseguria spp.														
		Tellinidae	*Macomona liliana*		1					1							
		Animals per core		28	28	19	40	28	24	155	15	16	12	22	16	22	91
		Animals per m^2		6160	6160	4180	8800	6160	5280	5695	3300	3520	2640	4840	3520	4840	3343
		Species per site								16							15

3.4 Analyses of Cockle, Mussels, Fish and Octopus flesh

Unlike last year when levels of heavy metals in the cockle flesh were highest at Portobello Road, there is no clear trend for contamination in moving from Kitchener Street to Portobello Road (Table 17). PAHs on the other hand, are still highest at Portobello Road (Table 17).

Table 15. *Abundance of species of infauna collected <20m and >50m from the Orari Street outfall.*

Orari Street			Location	<20m							>50m						
2010			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Glyceridae		10	7	4	7	8	3	39	6	3	2	3	2	3	19
		Lumbrineridae		2				1		3							
		Maldanidae				2	1			3	2		1		1		4
		Nereidae		2						2	1		1	1			3
		Nereididae		3						3	1			3			4
		Cirratulidae				1				1							
		Capitellikdae									3						3
		Spionidae		4	2	1	4		1	12	2	1	2	1		3	9
Hemichordata																	
	Enteropneusta										1						1
Nemertea				1	2	1	1		1	6							
Sipuncula						1	3			4							
Crustacea																	
	Decapoda																
			Macrophthalmus hirtipes									1					1
	Amphipoda	Jassidae										1				1	2
		Lysianassidae			2	4		2		8	1	1	3			2	7
		Oedicerotidae															
		Phoxocephalidae			1	2		1		4	1			2	1	1	5
	Tanaidacea			6	3	1			1	11	1				1	3	5
Mollusca																	
	Gastropoda	Cominellidae	*Cominella glandiformis*		1					1							
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi	1	10	2		4	1	18	3	4	3	3	3	5	21
			Puyseguria spp.	1	1			1		3	2		2	2	1	2	9
		Tellinidae															
			Macomona liliana			1		1	1	3	1		1	1	1	1	5
		Animals per core		31	31	23	17	20	11	121	26	13	18	17	12	24	98
		Animals per m^2		6820	6820	5060	3740	4400	2420	4446	5720	2860	3960	3740	2640	5280	3601
		Species per site								16							15

Table 16. *Abundance of species of infauna collected <20m and >50m from the Portobello Road outfall.*

Portobello Rd			Location	<20m							>50m						
2010				Site 1			Site 2				Site 1			Site 2			
			Sample	1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta	Capitellidae										1		1		2	4
		Eunicidae												1		1	2
		Glyceridae		13	6	6	6	2	12	45	3	5	8	7	4	11	38
		Lumbrineridae		1						1		1			3		4
		Maldanidae		8	2		1			11							
		Nephtyidae		4					2	6	2	2	3	2			9
		Nereidae		3			1		1	5	2	1	1	1		2	7
		Nereididae		3	3	4	4	1	3	18	1	1		1	1	3	7
		Cirratulidae							3	3					1		1
		Orbiniidae						1		1				1	1		2
		Sabellidae												1			1
		Serpulidae												1			1
		Spionidae		8	3	7			3	21	2	5	4	3	2	3	19
Hemichordata																	
	Enteropneusta							1		1					3		3
Nemertea				8	7	6	8		16	45							
Crustacea																	
	Decapoda		*Macrophthalmus hirtipes*									2					2
	Amphipoda	Jassidae			2					2		1					1
		Lysianassidae			4					4							
		Oedicerotidae		3						3			1		1		2
		Phoxocephalidae					1	1		2			2	2			4
	Isopoda		*Isocladus armatus*		1					1							
	Malacostraca		*Macrophthalmus hirtipes*									1					1
	Tanaidacea					2		2		4							
	Ostracoda			2						2							
Mollusca																	
	Polyplacophora		*Chiton glaucus*									1					1
	Gastropoda	Amphibolidae	*Amphibola crenata*														
		Cominellidae	*Cominella glandiformis*		1	1				2							
		Batilliidae	*Zeacumantus subcarinatus*				1		1	2							
		Nacellidae	*Notoacmea* spp.								2			1	1		4
	Bivalvia	Veneridae	*Austrovenus stutchburyi*					1	1	2	2	2	5		2	3	14
			Puyseguria spp.					1		1							
		Tellinidae	*Macomona liliana*					1		1	3		2		1		6
Nematoda				3	2	6	2	5	7	25							
		Animals per core		56	31	32	24	16	49	208	17	23	26	22	20	25	133
		Animals per m^2		12320	6820	7040	5280	3520	10780	7642	3740	5060	5720	4840	4400	5500	4886
		Species per site								24							22

All heavy metals were at concentrations two orders of magnitude below accepted food standards (Table 18). There are no specific guidelines for PAH in shellfish flesh for New Zealand, but food standards for British Columbia recommend an upper limit for benzo[a]pyrene (Table 19).

It should be noted that, as already stated, and as found in previous surveys, cockles became smaller as one nears the Portobello Road outfall. Whether this is due to PAH contamination or exposure at low tides and to fresh water, or some other factor, remains to be determined. Perhaps an investigation of cockle sizes at a site with similar fresh water and tidal exposure is merited. Faecal coliform levels in cockle flesh were highest at Kitchener St. and moderate at Orari St. and Portobello Road. This differs from last year when they were highest at Portobello Road but were not detected at Orari and Kitchener Streets. Highest overall FC levels in cockles were in 2008 but FCs were not detected in any cockle samples in 2007.

Table 17. *Contaminant concentrations in cockle flesh from within 20m of the Kitchener Street, Orari Street and Portobello Road stormwater outfalls in 2007, 2008, 2009 and 2010. Green shading indicates a decrease in contaminant level, pink indicates an increase, white = no change. BDL = below detectable limits.*

	Parameter	Units		Portobello Rd	Orari Street	Kitchener St
Cockles	As	mg/kg	2007	2.5	2.5	3.5
			2008	4.0	2.8	3.3
			2009	2.9	4.9	3.8
			2010	2.0	2.3	2.2
	Cd	mg/kg	2007	0.014	0.011	0.016
			2008	0.023	0.010	0.015
			2009	0.021	0.024	0.017
			2010	0.014	0.013	0.010
	Cr	mg/kg	2007	0.32	0.32	0.34
			2008	0.65	0.15	0.27
			2009	0.22	0.30	0.31
			2010	BDL	0.18	0.13
	Cu	mg/kg	2007	0.64	0.70	0.81
			2008	1.20	0.85	0.67
			2009	0.82	1.10	0.89
			2010	0.43	0.46	0.66
	Ni	mg/kg	2007	0.71	1.00	0.64
			2008	1.30	1.10	1.30
			2009	0.89	0.93	1.00
			2010	0.72	1.24	1.30
	Pb	mg/kg	2007	0.17	0.11	0.08
			2008	0.42	0.07	0.08
			2009	0.099	0.110	0.082
			2010	0.151	0.082	0.089
	Zn	mg/kg	2007	6.3	6.4	8.0
			2008	11.0	7.7	8.6
			2009	7.4	10.0	9.0
			2010	5.5	5.3	6.7
	PAH	mg/kg	2007	4.912	0.018	0.009
			2008	0.640	0.047	0.028
			2009	0.613	0.038	0.028
			2010	1.714	0.035	0.044
	Faecal coliforms	MPN/100g	2007	<18	<18	<18
			2008	1300	230	78
			2009	78	<18	<18
			2010	68	68	220

Table 18. *Heavy metal concentrations for NZ and US FDA guidelines for adults (expressed as mg/kg dry weight). '-' means no guideline is available.*

	Cu	Zn	Pb	Cd	Cr	Ni
Food Regs/NZ DoH	150.0	2000.0	10.0	5.0	-	-
US FDA	-	-	4.2	-	11.0	80.0
Australia NZ food standards code	-	-	2.0	2.0	-	-

Table 19. *British Columbian guidelines for B[a]P concentration in shellfish for human consumption*

B[a]P concentration in the edible portion of fish/shellfish (µg B[a]P/kg wet weight)	Safe quantity for weekly consumption* on a regular basis (g wet weight)	B[a]P Portobello Road cockles 2007 (µg B[a]P/kg wet weight)	B[a]P Portobello Road cockles 2008 (µg B[a]P/kg wet weight)
4	50	249	34
2	100		
1	200		

*low and moderate consumption levels, according to the State of Washington, are 45 g/wk (or 6.5 g/d) and 140 g/wk (or 20 g/d).

As for cockles in the upper harbour basin, mussels from Second Beach showed levels of contamination that were well below accepted food guidelines (Table 20). Concentrations of most contaminants were not dissimilar to those observed in cockles (Table 17), with the exception of nickel, which is lower in Second Beach mussels than in cockles, and lead and cadmium, both of which are higher in mussels. Overall, however, there is little evidence of contamination of shellfish by stormwater at this site.

Nine triplefins and one spotty were caught in baited fish traps set off the Mason Street wharf on 5 May 2010. The triplefins were small (Table 20), but representative of the size classes commonly seen amongst variable triplefins. The spotty was of moderate to small size. Sizes and weights of the triplefins were slightly up on those caught in 2007 and 2008 but lower than last year (Table 21). Levels of all contaminants were generally lower in fish this year than they were last year. Overall, levels PAHs and of all metals except zinc were lower in fish than in cockles. Levels of chromium were lowest in fish and Portobello Road cockles (Tables 17 & 22).

It could, therefore, be argued that the concentration of most contaminants in the fish, with the exception of zinc, were similar to or lower than in cockles (Table 22). This is similar to the situation in 2007, 2008 and 2009. At first glance one is tempted to say that this is not unexpected, given that the cockles are filter feeders while the fish are predators. However, contaminants tend to become more

concentrated as one moves up the food chain. Triplefins do not prey on shellfish, but do eat smaller fish and a variety of other invertebrates. The fact that contaminant levels are relatively low in fish flesh suggests that heavy metal and PAH contamination around the Mason Street stormwater outfall is low.

Table 20. *Contaminant concentrations in mussel flesh from within 20m of the Second Beach stormwater outfall.*

	Parameter	Units		Second Beach
Mussels	As	mg/kg	2007	1.6
			2008	1.9
			2009	1.9
			2010	1.5
	Cd	mg/kg	2007	0.078
			2008	0.083
			2009	0.084
			2010	0.094
	Cr	mg/kg	2007	0.33
			2008	0.20
			2009	0.11
			2010	0.19
	Cu	mg/kg	2007	1.00
			2008	0.69
			2009	1.50
			2010	0.94
	Ni	mg/kg	2007	0.4
			2008	0.3
			2009	0.3
			2010	0.5
	Pb	mg/kg	2007	0.14
			2008	0.11
			2009	0.20
			2010	0.18
	Zn	mg/kg	2007	12.0
			2008	9.4
			2009	14.0
			2010	9.8
	Faecal coliforms	CFU/100ml	2007	<18
			2008	20
			2009	45
			2010	<18

A single large octopus (*Pinnoctopus cordiformis* – formerly *Octopus maorum*) was found on the foreshore adjacent to the Orari Street outfall on 14 June 2010. As in previous years subsamples of flesh and digestive gland were collected and sent to Hill Laboratories in Hamilton for analysis. In 2008 a single animals was found approximately 200m south of the Orari Street outfall. In 2009 two octopus, one from 10m to the north of the Orari Street stormwater outfall and one from in front of the Portobello Road outfall were found. For reference the results for analysis of the flesh from the 2007, 2008 and 2009 animals are presented in Table 23. Contaminant concentrations in octopus were quite low and certainly well below all food guidelines (Table 23).

Table 21. *Size and weight of triplefins captured near the Mason Street Stormwater outfall in 2007, 2008, 2009 and 2010. Spotty values in blue shaded cells.*

	2007	2008	2009	2010	2007	2008	2009	2010
	Fish Sizes (mm)				Weight (g)			
	75	70	101	151	4.7	4	13.1	41.3
	71	67	88	72	3.9	2.9	9.8	4.9
	73	46	96	75	4.4	0.9	10.6	5.2
	61	65	71	88	2.2	3	4.5	7.0
	49	63	62	83	1.1	2.7	2.8	7.3
	78	75	81	80	5.3	5.5	6.9	6.5
	77	58	70	78	5.6	2.4	4.1	4.8
	79	67	78	62	6.1	3.4	6.6	2.5
	75	72	79	79	4.1	4.5	6	6.5
	46	83	59	76	0.9	6.4	2.1	5.1
	52	71			1.6	4.8		
	74	68			4.6	3.8		
		72				4.8		
		65				2.8		
		59				2.7		
		56				2.2		
		60				2.4		
Mean =	67.5	65.71	78.50	84.40	3.7	3.48	6.65	9.11
Mean (excluding spotty) =				77.0				5.5

Table 22. *Contaminant concentrations in the flesh of triplefins captured near the Mason Street Stormwater outfall. BDL = below detectable limits.*

	Parameter	Units		Mason Street
Fish	As	mg/kg	2007	1.9
			2008	1.6
			2009	1.9
			2010	1.6
	Cd	mg/kg	2007	0.0047
			2008	0.0047
			2009	0.0110
			2010	0.0091
	Cr	mg/kg	2007	0.05
			2008	BDL
			2009	0.14
			2010	BDL
	Cu	mg/kg	2007	0.54
			2008	0.52
			2009	1.20
			2010	0.38
	Ni	mg/kg	2007	BDL
			2008	BDL
			2009	<0.095
			2010	BDL
	Pb	mg/kg	2007	0.140
			2008	0.120
			2009	0.43
			2010	0.14
	Zn	mg/kg	2007	21
			2008	20
			2009	21
			2010	18
	PAH	mg/kg	2007	0.0056
			2008	0.0023
			2009	0.0060
			2010	0.0150
	Mean Size	(mm)	2007	67.5
			2008	65.7
			2009	78.5
			2010	84.4
	Mean Weight	(g)	2007	3.7
			2008	3.5
			2009	6.65
			2010	9.11

Arsenic levels were once again much higher than those found in either fish or shellfish and similar to levels found in previous years. An octopus sampled in the autumn of 2006 from near Orari Street also had high arsenic levels. Copper levels in digestive glands are much lower than last year, but similar to levels found in an octopus from the same area in 2008. Octopus are higher on the food web than shellfish, but results of analyses for cockles, fish and octopus [in 2006-2009] obtained so far do not give any clear indication as to where an organism lies with respect to trophic level.

Table 23. *Contaminant concentrations in the flesh (left) and digestive glands (right) of octopus collected near the Orari Street and Portobello Road Stormwater outfalls.*

Parameter	Units		Portobello Road	Orari Street	Parameter	Units		Portobello Road	Orari Street
As	mg/kg	2007	12.0	7.7	As	mg/kg	2007	12.0	7.7
		2008	-	20.0			2008	-	13.0
		2009	4.9	24.0			2009	5.7	22
		2010	-	21.0			2010	-	12.6
Cd	mg/kg	2007	0.001	0.008	Cd	mg/kg	2007	0.260	3.300
		2008	-	0.0012			2008	-	0.066
		2009	0.019	0.010			2009	1.4	9.6
		2010	-	0.006			2010	-	0.21
Cr	mg/kg	2007	<0.02	<0.02	Cr	mg/kg	2007	<0.2	9.2
		2008	-	<0.02			2008	-	<0.02
		2009	0.15	0.62			2009	<0.12	<0.20
		2010	-	<0.10			2010	-	<0.10
Cu	mg/kg	2007	3.30	3.90	Cu	mg/kg	2007	44.0	740.0
		2008	-	2.60			2008	-	27.0
		2009	7.30	2.60			2009	230.0	520.0
		2010	-	5.50			2010	-	49.0
Ni	mg/kg	2007	0.1	0.1	Ni	mg/kg	2007	0.5	5.2
		2008	-	0.023			2008	-	2.8
		2009	<0.10	<0.10			2009	1.7	0.66
		2010	-	<0.10			2010	-	<0.10
Pb	mg/kg	2007	0.023	0.220	Pb	mg/kg	2007	0.074	0.440
		2008	-	0.029			2008	-	0.026
		2009	0.23	0.11			2009	0.25	0.25
		2010	-	0.03			2010	-	0.06
Zn	mg/kg	2007	13.0	14.0	Zn	mg/kg	2007	26.0	160.0
		2008	-	19.0			2008	-	26.0
		2009	20.0	23.0			2009	87.0	310.0
		2010	-	16.6			2010	-	47.0
PAH	mg/kg	2007	0.0043	-	PAH	mg/kg	2007	0.0599	-
		2008	-	0.0127			2008	-	0.0251
		2009	0.754	0.026			2009	0.26	0.116
		2010	-	0.0115			2010	-	0.0291
Arm span	(mm)	2007	2603	680	Arm span	(mm)	2007	2603	680
		2008	-	2154			2008	-	2154
		2009	547	2168			2009	547	2168
		2010	-	1684			2010	-	1684
Weight	(g)	2007	11784	197	Weight	(g)	2007	11784	197
		2008	-	10562			2008	-	10562
		2009	218	11252			2009	218	11252
		2010	-	3562			2010	-	3562

4. Discussion and Conclusion

In 2010 water samples were colleted from a total of 14 major Dunedin City stormwater outfalls. In addition, sediments were sampled from near 5 of these outfalls and from an additional 5 sites located some distance from the outfalls to gain a clearer picture of the distribution of contaminants in sediment in the upper Otago Harbour. Flesh from fish, cockles, mussels and octopus was also collected for contaminant analysis. For interest sake historical data for some of the same sites have been included for comparison (Tables 24 and 25). Any trends observed in these data for historical sediment values should be viewed with extreme caution as sampling in some previous years may have used entirely different protocols. For example, sediments may have been collected from different depths within the substrate and by different methods meaning that results are not directly comparable. Stormwater sampling, however, should be comparable assuming previous investigators targeted the first flush.

There has been a decline in the levels of some contaminants at stormwater outfalls for which historic data are provided. This is perhaps to be expected for lead as it has been removed from paint and petrol and levels in the environment are very gradually declining. The reduction in the levels of some other contaminants is very slight, but gratifying, although such fluctuations may be merely a function of the intensity of the storm events when sampling occurred. However, it should be recognised that there are currently some contaminants (e.g. arsenic) for which levels appear to be increasing or, fluctuating (Tables 24 and 25). The increased levels of most metals at Wickliffe Street suggests that some investigation into sources within the catchment may be warranted, especially if the trend is continued in the next round of sampling.

The high levels of FWAs at Bauchop Street observed in both 2007 and 2008 suggested that there is some gross cross contamination by wastewater somewhere in this catchment. Investigations up-pipe in 2008 year pinpointed this discharge and remedial action was taken. As a consequence the FWA levels at Bauchop Street this year and in 2009 are comparable with other locations. It is expected that the implementation of the long-term stormwater catchment management plans currently under development through the DCC's Three Waters Strategy will contribute to addressing the issue of future contaminants in stormwater. It will be

of interest to see if any long-term trends in contaminant levels can be discerned as monitoring continues.

Benthic and infaunal communities in the vicinity of the Portobello Road, Orari Street and Kitchener Street outfalls have reasonably low diversity, but this is generalised and not associated with any one outfall and is likely symptomatic of a large proportion the upper harbour basin. As in past years there is a trend towards smaller cockles as one nears the Portobello Road outfall. This may be as a result of historic PAH contamination, which is extremely high beneath the surface at this site, but a number of other factors, not least of which are freshwater exposure and exposure at low tide, must also be considered.

Rainer (1981) and Grove (1995) certainly found less diversity in soft-bottom macrofaunal communities as one moves from harbour mouth to the head of Otago Harbour. It should be pointed out that much of the shoreline around the upper harbour has been extensively modified and as such cannot be regarded as an inlet typical of those found throughout the region. Despite this the communities sampled in the upper Otago Harbour near stormwater outfalls are numerically dominated by polychaete worms and amphipods, as is usual for sheltered soft shores around New Zealand (Morton and Miller 1973), and show distinct similarities to communities found in other moderately impacted inlets in Otago (Stewart 2007b, 2008a,b).

While not pristine, the upper harbour and the communities associated with the intertidal areas adjacent to major stormwater outfalls appear not to be undergoing any significant further degradation as a result of stormwater inputs. It is to be hoped that if the trend towards lower contaminant levels in stormwater is continued, both water quality and community health in the harbour will gradually improve over time.

Only after problem areas and problem contaminants have been identified can measures be taken to mitigate any effects. No additional mitigation measures have been undertaken by the DCC at this stage, apart from investigations into the remediation of PAH contamination at the Portobello Road outfall (Stewart 2006), the elimination of the source of FWAs at Bauchop Street, and the usual street sweeping and mud tank clearance. As already stated, the South Dunedin (Portobello Road) catchment has been investigated as the pilot catchment for the

development of the Three Waters Strategy catchment management plans. It is expected that further stormwater monitoring over time and concurrent investigations under the Three Waters strategy will define problem areas such that mitigation measures may be undertaken.

Table 24. *Contaminants in stormwater being discharged to the upper Otago harbour basin through time. BDL = below detectable limits. Pink cells denote levels higher than at any past sampling event; green cells denote levels lower than at any past sampling event.*

	Parameter	Suspended Solids					Cd					Cr					Cu				
	units	g/m^3					g/m^3					g/m^3					g/m^3				
		Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010
Catchement	Second Beach		BDL	37.0	41	BDL		BDL	0.00006	0.00006	0.00007		0.0007	0.0028	0.0035	0.00086		0.0027	0.012	0.019	0.0054
	Pt Chalmers George St		87.0	150.0	26	170		0.00028	0.00140	0.00011	0.00033		0.005	0.012	0.0031	0.00136		0.0213	0.039	0.025	0.0148
	Pt Chalmers Watson Pk		37.0	39.0	7.4	240		BDL	BDL	BDL	BDL		BDL	0.0064	BDL	BDL		0.009	0.0025	BDL	BDL
	Shore Street	75.4	41.0	24.0	20	9.5		BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		0.01	0.014	0.02	0.0118
	Portobello Road	28.0	18.0	46.0	30	8.1	0.0003	BDL	0.00023	BDL	BDL	0.0029	BDL	0.002	BDL	BDL	0.03	BDL	0.026	0.01	0.0057
	Teviot Street		25.0	33.0	12	84		BDL	0.00008	BDL	0.00026		BDL	0.0018	BDL	BDL		BDL	0.0094	BDL	0.0136
	Midland Street		30.0	19.0	30	52		BDL	0.00013	BDL	BDL		BDL	0.0035	0.0031	BDL		0.02	0.031	0.057	0.021
	Orari Street	38.1	28.0	77.0	16	130	0.0005	BDL	BDL	BDL	0.000164	0.002	BDL	0.0032	BDL	0.00183	0.0132	BDL	0.014	BDL	0.0096
	Kitchener Street		104.0	41.0	45	50		BDL	BDL	BDL	BDL		0.004	0.002	BDL	BDL		0.034	0.0056	0.023	0.0118
	Mason Street		62.0	37.0	37	138		BDL	BDL	0.0077	0.00051		BDL	BDL	BDL	BDL		0.022	0.012	0.021	0.0157
	Ravensbourne Road			8.5	18	61			BDL	BDL	BDL			0.00061	BDL	BDL			0.0023	BDL	0.0031
	Bauchop Street		44.0	16.0	13	53		BDL	BDL	BDL	0.00049		BDL	0.0015	BDL	BDL		0.029	0.0096	0.021	0.0026
	Halsey Street		119.0	35.0	27	50		BDL	0.00022	BDL	0.00026		BDL	BDL	BDL	BDL		0.024	0.0043	BDL	0.00162
	Wickliffe Street		35.0	27.0	100	86		BDL	BDL	0.00052	0.00078		BDL	0.0017	0.0076	0.00157		0.01	0.013	0.059	0.0058

	Parameter	Ni					Pb					Zn					PAH				
	units	g/m^3					g/m^3					g/m^3					g/m^3				
		Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010
Catchement	Second Beach		0.0009	0.0021	0.0022	0.00133		0.001	0.011	0.013	0.00021		0.038	0.16	0.15	0.092					
	Pt Chalmers George St		0.0029	0.0093	0.0026	0.006		0.0342	0.041	0.018	0.0048		0.288	0.66	0.19	0.42					
	Pt Chalmers Watson Pk		BDL	BDL	BDL	0.0035		0.0141	0.0018	BDL	BDL		0.231	0.027	BDL	0.29					
	Shore Street		0.01	BDL	BDL	BDL		0.003	0.0085	0.0069	BDL		0.02	0.44	0.21	0.115					
	Portobello Road	0.002	BDL	0.0035	0.0028	0.0035	0.021	BDL	0.019	0.0067	0.00055	0.895	0.08	0.94	0.64	0.153	0.0031	BDL	328	0.00017	0.00016
	Teviot Street		BDL	0.0019	BDL	0.0033		BDL	0.0066	BDL	BDL		BDL	0.13	BDL	1.79					
	Midland Street		BDL	0.0016	BDL	0.0075		0.005	0.0054	0.0083	BDL		0.1	0.35	0.18	0.22					
	Orari Street	0.002	BDL	0.0033	BDL	0.00108	0.022	BDL	0.023	BDL	0.00015	0.191	BDL	0.22	0.031	0.3	0.0026	0.0001	318	BDL	0.0005
	Kitchener Street		0.003	BDL	0.0036	0.0035		0.0442	0.007	0.018	0.00196		0.445	0.036	0.38	0.62		BDL	327	BDL	0.0001
	Mason Street		0.004	BDL	0.0055	BDL		0.0258	0.0089	0.014	0.00102		0.25	0.16	0.35	0.43					
	Ravensbourne Road			0.00066	BDL	0.00148			0.0015	0.0029	0.00023			0.053	0.047	0.144					
	Bauchop Street		0.01	BDL	0.0035	BDL		0.01	0.0035	0.0097	BDL		0.23	0.12	0.3	0.121					
	Halsey Street		0.009	BDL	BDL	BDL		0.021	0.0022	BDL	0.0021		0.12	0.033	0.13	0.136					
	Wickliffe Street		0.01	BDL	0.0042	BDL		0.006	0.0084	0.033	BDL		0.1	0.2	0.53	0.24					

Table 25. *Contaminants in sediments in the upper Otago harbour basin in the vicinity of selected stormwater outfalls through time. Pink cells denote levels higher than at any past sampling event; green cells denote levels lower than at any past sampling event.*

	Arsenic					Cadmium					Chromium					Copper					Nickel					Lead					Zinc					PAH					Enterococci				
	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010
Rowing Club		10.6	9.8	7.3	13.0	0.0	0.2	0.2	0.1	0.2	16.8	17.6	12	16.0	14.0	9.8	14.2	13	14	9		11.3	14	13.0	11.0		18.9	27	27	28	80.8	101	130	160	149		6.97	5.78	0.5	3.7		200	11	<2	
Wickliffe		17.3	11.0	6.9	9.0		0.6	0.74	0.8	0.7		38	34	16.0	27.0		121.0	68	50	58		19.2	23	13.0	17.0		76.1	140	77	92		412	740	810	740		9.21	1.18	7.3	7.2		58000	>1600	330	<3
White St		11.6	18.0	5.4	6.0		0.3	0.22	0.2	0.1		68.5	56	26.0	19.0		433.0	160	170	78		29.5	21	11.0	8.0		147	180	170	124		4450	2500	2400	1280		12.96	11.05	15.9	6.5		400	2	<2	
Kitchener St		4.6	7.5	7.0	9.0		0.4	0.35	0.3	0.3	7.1	22.6	18	98.0	22.0		69.5	56	90	37	5.8	10.6	12	15.0	12.0		117.9	97	130	155	170	249.33	280	300	280		8.88	140.49	4.8	5.0	130	6633	920	5	<3
Orari St		18.6	4.3	20.0	5.0	0.5	63.0	0.13	0.9	0.2	17.5	0.27	16	37.0	16.0	20	25.1	13	61	11	10.4	23.6	8.1	16.0	8.0	185	12.8	39	120	35	239	68.27	130	680	157	13.41	10.23	12.59	28.3	9.3	557	12.67	8	23	<3
Orari 100		13.7				0.3	0.4				16	26.3				28	25.9				8.8	12.6				170	170				230	227					6.67				1300	3600			
Midland 200		15.4				0.4	0.3				22	22.4				24	19.0				8.3	10.7				36	36				190	165					7.24				130	20000			
Portobello Rd		29.0	23.0	24.0	15.0	2.0	1.8	1.8	2.0	1.5	41	60.1	54	50.0	36.0	210	169.3	160	190	123	15	20.4	18	26.0	19.0	410	306.33	330	290	193	1300	1493	1400	1600	1040	425.83	382.90	250.30	525.2	194.1	1120	72667	170	<2	
PR 200		17.4				1.0	0.5				32	41.8				100	52.6				13	17.3				130	81.3				430	309				12.29	8.97				40	66000			
Shore St		9.5	7.1	6.2	6.0	0.5	0.4	0.32	0.3	0.3	9.6	21.8	16	18.0	19.0	30	50.9	44	41	35	5.4	10.7	9	11.0	10.0	130	113	110	79	85	300	484	300	330	350		9.56	21.01	8.6	10.5	2400	9000	>1600	<2	
Boatshed		27.4	16.0	17.0	15.0		0.3	0.21	0.2	0.3		41.7	19	26.0	31.0		108.0	33	49	35		24.5	16	17.0	16.0		112	800	170	86		339	370	360	290		6.67	5.54	38.8	7.9		3400	33	33	<3
Cove Drainage		21.5	17.0	19.0	13.0		0.1	0.13	0.4	<0.1		15.8	35	32.0	19.0		11.3	19	38	11		23.5	44	23.0	19.0		19.7	20	55	18		99.2	150	270	125		0.37	0.00	0.1	0.1		800	17	<2	<3
Retaining wall		25.3	36.0	24.0	36.0		0.1	0.15	<0.1	<0.1		23.6	31	39.0	23.0		13.3	19	17	10		15.9	25	26.0	18.0		26.9	27	42	24		141	170	150	152		0.30	3.91	0.0	9.4		<100	8	<18	
RW 300		16.2				0.1	0.3				28.33	0.27				16.3	15.2				13.3	12.4				40	6.7				149	131					0.30					<2			
W/W centre		11.1					0.2				2.75	30.8					15.3				3.63	14.6				25	5.6					168					0.34					<2			
UHB Centre		10.5				0.3	0.2				26.8	24.3				15.2	15.2				10	11.3				27	23				118	119					0.65					24000			

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Compliance Monitoring 2011

Stormwater Discharges from Dunedin City

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Prepared for

Dunedin City Council

by

Ryder Consulting Ltd.

June 2011



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Stormwater Discharges from Dunedin City

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Cover photo: Tide gates at the Orari Street stormwater outfall

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Executive Summary

This report presents the findings for the fourth annual monitoring of Dunedin's stormwater outfalls since discharge consents were granted.

The survey comprised assessment of benthic communities, of contamination of stormwater and of contamination of sediments and benthic fauna, including fish, cockles and mussels.

Stormwater from all outfalls monitored showed variable levels of contamination, with numerous parameters being present at concentrations above recommended ANZECC guidelines or trigger values.

Sediments too showed varying levels of contamination from outfall to outfall with levels of contaminants breaching ANZECC trigger values for lead, zinc and PAHs at the majority of sites. However, overall sediment contaminant levels appear to be falling through time

Contaminant levels were similar to those observed in previous surveys carried out in 2007, 2008, 2009 and 2010 with no clear trends in contaminant levels in stormwater discernible at this juncture.

1. Introduction

1.1 Background

As with all urban centres throughout New Zealand and indeed most of the world, Dunedin's stormwater is reticulated to receiving environments via networks of gutters, open channels and pipes. The principal receiving water environments for Dunedin's reticulated stormwater are the upper basin of Otago Harbour, Second Beach/St. Clair Beach on the open coast, Kaikorai Stream and the Water of Leith. Dunedin City Council (DCC) was, on 29th November 2007, granted resource consents for its major urban stormwater discharges into the coastal marine environment (i.e. Otago Harbour, Sawyers Bay. Port Chalmers and Second Beach).

Conditions under which consents have been granted include compliance monitoring. Specifically:

Condition 2.

(a) *The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.*

(b) *The sampling shall be undertaken during storms, preceded by at least 72 hours of no measurable precipitation, with an intensity of at least 2.5 millimetres (depth) of rain in a 24 hour period. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:*

(i) pH
(ii) suspended solids
(iii) faecal coliforms and Escherichia coli
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel

(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease
(xiii) Polycyclic aromatic hydrocarbons ***(Portobello Road, Orari and Kitchener Street consents only)***

(c) *The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b).*

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road catchment discharge consent only

(a) *The consent holder shall undertake to determine the source and extent of the high levels of polycyclic aromatic hydrocarbons in the historic sediment deposits associated with discharge from the Portobello Road stormwater outlet.*

(b) *Updates on the progress of the investigation in condition 3(a) shall be provided in writing to the Consent Authority by 1 September each year.*

(c) *No later than six months prior to the expiry of this consent, the consent holder shall provide a report to the Consent Authority stating the outcomes of the investigation in condition 3(a) and outlining the best practicable option(s) to mitigate the effects of these contaminated sediments.*

For the Portobello Road, Orari and Kitchener Street discharge consents only

(a) *The consent holder shall undertake biological monitoring annually between the months of January to June inclusive. The monitoring shall be undertaken at four sites at the waters edge at low tide; two within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide and two a minimum of 50 metres of the confluence of the stormwater outlet and the waters edge at low tide.*

(b) *At each site, three randomly spaced $5m^2$ quadrats shall be sampled. For epifauna within each $5m^2$ quadrat, the number of each species shall be recorded in five $0.1m^2$ quadrats. For infauna a sediment core shall be taken in three $0.1m^2$ quadrats and the number of each species shall be recorded. For macroflora, the percentage cover of each species shall be estimated in*

three 1.0m^2 quadrats.

(c) *Results shall be reported to the Consent Authority in accordance with condition 8(e).*

For the Portobello Road, Orari and Kitchener Street discharge consents only

The consent holder shall undertake sampling of the flesh of cockles (Austrovenus stutchburyi) annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide. The size of each cockle sampled shall be recorded. The cockle flesh samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
(i) faecal coliforms

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road and Orari Street discharge consents only

The consent holder shall undertake sampling of deceased octopus annually, between the months of January to June inclusive (to align with the autumn die-off of octopus). Samples will include flesh and, if available, digestive gland. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The total arm span and weight of each octopus sampled shall be recorded. The samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons

Results shall be reported to the Consent Authority in accordance with condition 8(e). Should no deceased octopus be present, the consent holder shall notify the Consent Authority that sampling is unable to be undertaken.

For the Mason Street discharge consents only

The consent holder shall undertake sampling of spotties (Notolabrus celidotus) or triplefin (*Tripterygion varium*) *annually. This sampling is to be carried out within the months of January to June inclusive. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The length and weight of each fish sampled shall be recorded. The samples shall be analysed for:*

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road, Orari and Kitchener Street discharge consents only

The consent holder shall undertake sediment quality sampling using three replicate sediment samples that shall be collected at each site as marked on the plans attached as Appendix 1 to this consent. Sampling shall be undertaken:

(a) annually between January and June at the locations marked by large orange stars; and

(b) between January and June 2007, and between January and June 2010, at the locations marked by large pink stars. The samples will comprise the top 20mm of sediment and shall be analysed for:

(i) total copper
(ii) total lead
(iii) total zinc
(iv) total arsenic
(v) total nickel
(vi) total cadmium

(vii) total chromium
(viii) faecal coliforms and enterococci
(ix) polycyclic aromatic hydrocarbons
Results shall be reported to the Consent Authority in accordance with condition 8(e).

Condition 3. *The biological sampling of epifauna, infauna, macroflora, cockles, octopus, spotties or triplefins and sediment quality sampling required by Coastal Permits etc, shall be undertaken within a 14 day period (within the months of January to June), unless it is not practicable to do so due to the absence of any fauna to be sampled.*

Condition 4. *All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder and be acceptable to the Consent Authority.*

Condition 5. *Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.*

Second Beach

Condition 2.

(a) *The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of the rainfall event means that sampling in the manner described in condition 2(b) is not possible.*

(b) *The sampling shall be undertaken during storms, preceded by at least 72 hours of no measurable precipitation, with an intensity of at least 2.5 millimetres (depth) of rain in a 24 hour period. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:*
(i) pH
(ii) suspended solids
(iii) faecal coliforms and Escherichia coli
(iv) total copper
(v) total lead
(vi) total zinc

(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) HEM, oil and grease
(xii) UV fluorescent (whitening agent)

(c) *The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b). Results shall be reported in accordance with condition 8(e).*

Condition 3.

(a) *The consent holder shall undertake sampling of mussels annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, 50 metres to the east of the outlet. The shell length of each mussel sampled shall be recorded.*

(b) *The sampling of mussels shall be undertaken within a 14 day period (within the months of January to June) associated with the sampling rounds for Green Island and Tahuna WWTP discharge consents, unless it is not practicable to do so due to the absence of any fauna to be sampled.*

(c) *The samples shall be analysed for:*
(i) faecal coliforms
(ii) total copper
(iii) total lead
(iv) total zinc
(v) total arsenic
(vi) total nickel
(vii) total cadmium
(viii) total chromium

(d) *Results shall be reported in accordance with condition 8(e).*

Condition 4. *All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder and be acceptable to the Consent Authority.*

Condition 5. *Unless specifically approved otherwise by the Consent Authority, all*

analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.

The following report presents the results of the latest round of sampling/monitoring carried out between January and June 2011.

1.2 Stormwater Outfalls

Stormwater is discharged from Dunedin City to the Upper Otago Harbour, Second Beach and Port Chalmers from fourteen reasonably large and permanent stormwater outfalls (Figures 1a, 1b and 1c), and from a number of smaller outfalls and non-point sources (Table 1). Many of the outfalls have very long histories dating back to the days of the early settlement of Dunedin and a numbers were dual-purpose outfalls, discharging both wastewater and stormwater. All current outfalls, however, are designated to discharge stormwater.



Figure 1a. *Major stormwater outfalls, labeled by catchment name, discharging from Dunedin City to the Upper Otago Harbour Basin.*

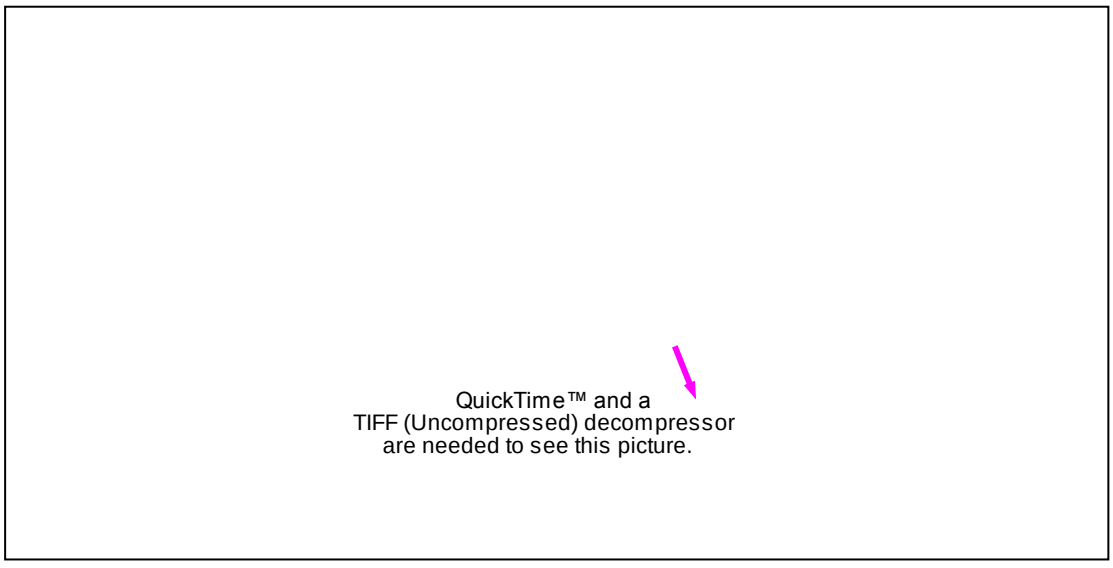


Figure 1b. *Location of the Second Beach stormwater outfall.*

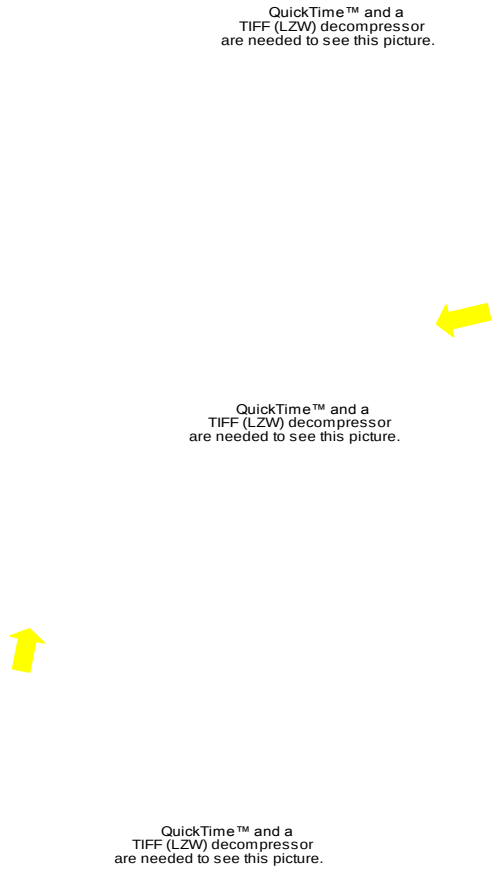


Figure 1c. *Location of major outfalls discharging stormwater from Port Chalmers.*

A total of 31 consents have been granted for the individual stormwater outfalls listed in Table 1.

Table 1. *List of stormwater outfalls for which discharge permits have been granted.*

Consent ref	DCC ref	Location	Catchment	Description	Max flow rate (l/s)	Outlet structure
2002.080	4	Shore St	Shore St	1500mm dia	2,380	Yes
2002.081	5	Portobello Rd	Portobello Rd	twin 1500mm dia conduits	pump rate 6,300	Yes
2002.082	6	Teviot St	Foreshore	375mm dia.	105	Yes
2002.083	7	Midland St	Foreshore	450mm dia	143	No
2002.084	8(a)	Orari St	Orari St	375mm dia	101	No
2002.085	8(b)	Orari St	Orari St	2700mm dia	10,350	Yes
2002.086	9(a)	Kitchener St	Kitchener St	600mm dia	310	Yes
2002.087	9(b)	Kitchener St	Kitchener St	1500mmdia	3,880	Yes
2002.088	10	French St	Foreshore	450mm dia	185	No
2002.089	11	Kitchener St	Foreshore	300 mm dia.	78	No
2002.090	12(a)	Birch St	Foreshore	225 mm dia.	37	No
2002.091	12(b)	Birch St	Foreshore	225 mm dia.	55	No
2002.092	12(c)	Wharf St	Foreshore	225 mm dia.	52	No
2002.093	13(a)	Fryatt St	Foreshore	150 mm dia.	40	No
2002.094	13(b)	Fryatt St	Foreshore	450mm dia	180	No
2002.095	13(c)	Fryatt St	Foreshore	300mm dia	54	No
2002.096	14	Fryatt St	Foreshore	300mm dia	116	No
2002.097	15(a)	Mason St	Mason St	2175mm dia. conduit	5,000	Yes
2002.098	15(b)	Mason St	Bauchop St	450mm dia	90	No
2002.099	15(c)	Mason St	Bauchop St	1350mm dia. culvert	1,500	No
2002.100	16(a)	Halsey St	Halsey St	1950mm conduit	3,800	No
2002.101	16(b)	Halsey St	Wickliffe St	1950mm conduit	2,600	No
2002.102	16(c)	Halsey St	Wickliffe St	300mm dia	113	Yes
2002.103	17	Wickliffe St	Wickliffe St	1,050 mm dia.	1,660	No
2002.104	18(a)	Magnet St	Magnet St	300mm dia	73	No
2002.105	18(b)	Magnet St	Magnet St	300mm dia	66	No
2002.106	19	Ravensbourne Rd	Gas Works	300 mm dia.	117	Yes
2002.108		George St (Port Otago)	Port Chalmers	750 mm dia.	1,000	No
2002.109		George St/SH88	Port Chalmers	1,250 mm dia.	1,200	Yes
2002.110		Second Beach Rd	St. Clair	1,050 x 1,050 mm tunnel	7,000	Yes
2006.222		Sawyers Bay, western side of Watson Park, Port Chalmers	Port Chalmers	150 mm dia.	20	Yes

2. Methods

2.1 Stormwater

A number of the outfalls listed in Table 1 do not have outfall structures or are located in places that are inaccessible. Consequently it is neither practical nor possible to sample from the entire 31 outfalls listed, as agreed by the ORC. However, the monitoring programme undertaken samples all major Dunedin stormwater catchments and gives a comprehensive picture of the state of contaminants in Dunedin's stormwater. Catchment names have been altered slightly from those used in 2009 to reflect the naming used under the DCCs Three Waters Strategy (See Table 2, page16). Grab samples of stormwater were collected from each stormwater outfall within 1 hour of the commencement of a rain event (>0.5mm) in an endeavour to ensure that first flush water was gathered. Collections took place only if there was an antecedent period of at least 72 hours with no rain before the target rain event. Samples were sent to Hill Laboratories in Hamilton to be analysed for arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn), faecal coliforms and *E. coli*. Samples collected from the Kitchener Street, Orari Street and Portobello Road outfalls were additionally analysed for polycyclic aromatic hydrocarbons (PAHs). Samples were also collected during a period of low flow a week after the targeted rainfall event and sent to ESR in Christchurch for analysis of fluorescent whitening agents (FWAs). FWAs are used in laundry detergents and indicate possible sewage infiltration to the stormwater system (Petch 1996). Gilpin *et al*., (2004) recommend that stormwater be sampled at low flows to get a more accurate picture of sewage infiltration because the FWAs are usually present in only very low concentrations and are more readily detected at low flows.

2.2 Sediments

Three replicate 250cm^3 samples were collected from the top 20mm of sediment

within 20m from each of the Kitchener Street, Orari Street and Portobello Road Outfalls. To gain a clear picture of sediment contamination within the upper harbour basin, further replicate sediment samples were collected at each of the sites indicated by orange stars in Figure 2. Samples were chilled and sent to Hill laboratories in Hamilton for analysis for total arsenic, total cadmium, total chromium, total copper, total nickel, total lead, total zinc, faecal coliforms, enterococci and PAHs.

2.3 Biological Monitoring

At the Portobello Road, Orari Street and Kitchener Street outfalls two sites within 20m of each outfall and at the waters edge at low tide were sampled for flora and fauna according to the protocols outlined in Kingsford and Battershill (1998). An additional two sites were sampled at no less than 50m from each outfall at the waters edge. At each site, three randomly spaced $5m^2$ quadrats were sampled, giving a total of 12 quadrats at each outfall. For epifauna within each $5m^2$ quadrat, the number of each species was recorded in five $0.1m^2$ quadrats. For infauna a sediment core was taken in three $0.1m^2$ quadrats per site, giving 12 cores per outfall. Sediment was returned to the laboratory, washed through a 500µm sieve and animals retained identified to at least family level (Bates *et al.* 2007). The abundance of each species was then recorded. For macroflora, the percentage cover of each species was estimated in three $1.0m^2$ quadrats per site, giving 12 quadrats per outfall. For both epifauna and infauna a Shannon Weiner diversity index (Zar 1996) was calculated to enable community diversity to be compared from year to year.

2.4 Cockle, Mussel, Fish and Octopus Flesh

Daily patrols of the shoreline at low tide adjacent to the Portobello Road and Orari Street stormwater outfalls were made, beginning in late March, to seek mature octopus (*Pinnoctopus cordiformis* – formerly *Octopus maorum* or *Octopus huttoni* – formerly *Robsonella australis*) during the annual autumn die-off.

For shellfish a minimum of 15-20 large cockles (*Austrovenus stutchburyi*) were collected from within 20m of the confluence of the stormwater outlet and the waters edge at low tide at each of the Portobello Road, Orari Street and Kitchener Street outfalls. Cockles were individually measured, bagged, and chilled and sent to Hill Laboratories for analysis for As, Cd, Cr, Cu, Ni, Pb and Zn. A further 15-20 cockles were collected at each site and sent for PAH analysis, and a further 15-20 to Hill Laboratories in Christchurch for analysis for faecal coliforms.

Within the same period that cockles were collected variable triplefins (*Tripterygion varium*) were caught using baited fish traps off the Mason Street wharf no more than 50m from the Mason Street stormwater outfall. Fish were weighed and measured, then chilled, bagged, and sent to Hill Laboratories for analysis for As, Cd, Cr, Cu, Ni, Pb and Zn and for PAHs.

At Second Beach a minimum of twelve mussels (*Perna canaliculus*) were collected from the rock reef to the east of the Second Beach stormwater outfall at a distance of no more than 50m from the outfall. Only mussels of mature size (≥80mm) were collected. Mussels were bagged and chilled and sent to Hill Laboratories in Hamilton for analysis for, As, Cd, Cr, Cu, Ni, Pb and Zn. A further 12-15 mussels were collected and sent to Hill Laboratories, Christchurch, for analysis for faecal coliforms.

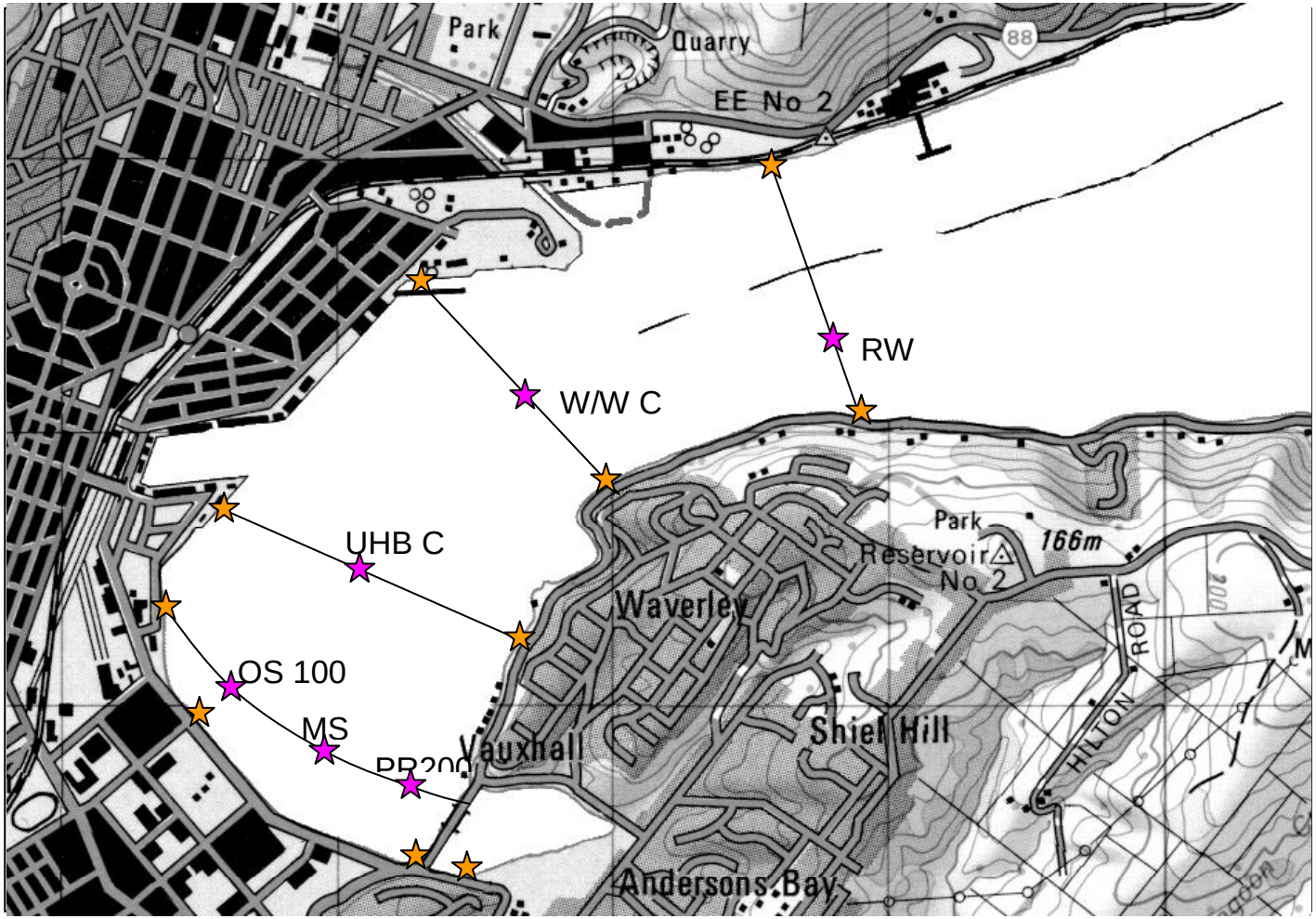


Figure 2. *Upper Harbour Basin sediment sampling sites. Orange stars sampled annually; pink stars sampled 5 yearly. Anticlockwise, starting at top, orange sites are: Rowing Club, Wickliffe St, White St, Kitchener St, Orari St, Portobello Rd, Shore St, Boatshed, Cove Drainage and Retaining Wall. Pink sites are coded according to location (see Table 4).*

3. Results

3.1 Stormwater

During the first two hours of a storm event that produced 7.4mm rainfall on 3 May 2011 water samples were collected from stormwater outfalls at Second Beach, Shore Street, Portobello Road, Teviot Street, Midland Street, Orari Street, Kitchener Street, Mason Street, Bauchop Street, Halsey Street, Wickliffe Street and Ravensbourne Road in Dunedin and from Watson Park and east George Street in Port Chalmers. This storm event had an antecedent dry period of 180 hours.

Stormwater at all sites was only moderately discoloured, testimony to the relatively gradual onset of the rain event. Contaminant levels are compared with levels in stormwater collected during a preliminary survey conducted in 2007 and the first, second and third annual surveys conducted in 2008, 2009 and 2010 (Table 2, Figure 3). This year all contaminants, with the exception of lead, zinc and copper were below ANZECC (2000) guidelines for protection of 80% of species (Table 2). Zinc was, however, not detected in stormwater at the Shore Street, Midland Street, Orari Street, Kitchener Street and Bauchop Street outfalls (Table 2). This is an improvement over results in 2010, 2009 and 2008. Lead levels this year were higher than last year, but similar to levels in 2007, 2008 and 2009 (Table 2, Figure 3). Copper levels show an improvement over 2010 with copper detected at just seven outfalls rather than the eleven outfalls seen in 2010. It should be noted that Orari Street and Portobello Road both operate with sump systems and it is not clear if, in fact, the first flush had reached the outfall for these sites at the time of sampling. However, these sumps were operating at the time of sampling so it is assumed the first flush for these two outfalls was sampled.

Like last year there was no outfall this year that was clearly "worse" than others. However, there were a number of outfalls (Shore Street, Midland Street, Orari Street, Kitchener Street and Bauchop Street) for which all heavy metal contaminants were below detectable levels. Wickliffe Street had the highest levels of arsenic, cadmium and chromium; Mason Street had the highest levels of copper and nickel; and Portobello Road had the highest levels of lead and zinc. Generally speaking, contaminant levels showed considerable variability with location when compared with results from 2007, 2008, 2009 and 2010. Lead at Mason Street, Ravensbourne and Portobello Road, zinc at Mason Street, Wickliffe Street and Portobello Road, and copper at Mason Street, Halsey Street, Wickliffe Street, Portobello Road and Teviot Street all stand out as being at levels higher than might be expected based on previous results (Figure 3). If such levels continue in future sampling it will be worthwhile carrying out further investigations in these catchments to determine possible sources, but, based on past results, this is just as likely to be a one-off occurrence.

Microbiological levels were high to very high at nine sites this year with values exceeding the guidelines for secondary contact recreation for both faecal coliforms and *E. Coli* at Second Beach, Portobello Road, Mason Street, Halsey Street and Wickliffe Street (Table 2, Figure 3) and for *E. coli* alone at Bauchop Street, Kitchener Street, Midland Street and Shore Street. Second Beach, Watson Park, Halsey Street and Wickliffe Street all show increases in *E. coli* levels compared with 2010, with Watson Park also showing an increase in faecal coliforms. However, bacterial levels at Portobello Road, Kitchener Street and Mason Street all show a marked decrease over the 2010 figures (Table 2, Figure 3). High microbial counts are not unexpected for first flush samples with a considerable amount of

animal faeces and decaying vegetable matter being washed into the stormwater system from streets and pavements. There are no clearly discernible trends in bacterial levels through time for any of the monitored stormwater outfalls.

FWAs were detected at low flows at all sites again this year, albeit at low levels for all but Shore Street, Teviot Street and Orari Street outfalls (Table 2). The levels at these three outfalls suggest there may be some contamination by human sewage. Overall, levels were generally comparable with previous years with values at some sites increasing slightly while those at others decreased slightly. As in 2009, Midland Street had the highest values, but well short of the extreme levels seen at Bauchop Street in 2007 and 2008 (Figure 3). There are no standards for FWAs in New Zealand but, as stated, levels above 0.1µg/L suggest some contamination and levels above 0.2µg/L are cause for concern (Brent Gilpin, ESR, pers. comm.). It is expected that contaminants of this nature will continue to be investigated as part of the development and implementation of the long-term stormwater catchment management plans and DCC's Three Waters strategy.

PAHs were not detected at Kitchener Street or Orari Street this year, but were detected at Portobello Road, albeit at very low levels. This differs from last year where PAHs were detected at all three outfalls, but is similar to 2009 when, once again, PAHs were detected at just the Portobello Road outfall. In 2007 PAHs were detected only in Orari Street stormwater (just Pyrene at very low levels) (Table 3), and in 2008 PAH levels were high at all three outfalls (Table 3). Total PAH levels were higher at Portobello Road than in 2010 and 2009, but much lower than in 2008 (Table 3). Anthracene, acepaphthylene, fluorene and biphenyl-d10, the four PAHs that contributed the major component of the 2008 total, were present at only

very low levels this year. Anthracene and biphenyl-d10 are components of coal tar and, as has been previously suggested, it may be that the input of these substances (a by-product of gas production) to the upper harbour via stormwater is tailing off. It will be of interest to note trends in PAH input at Portobello road over future years.

The one result that stood out last year was the high level of oil and grease at Teviot Street. This year no oil and grease was detected at Teviot Street but there were moderate levels at George Street, Midland Street, Orari Street, Kitchener Street and Wickliffe Street, with Orari and Kitchener Street values being particularly high and exceeding levels seen at any time in the past (Table 2; Figure 3).

Table 2. *Levels of contaminants detected in stormwater from outfalls in and around Dunedin during a storm events on 11 April 2007, 17 June 2008, 12 May 2009, 23 April 2010 and 3 May 2011. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

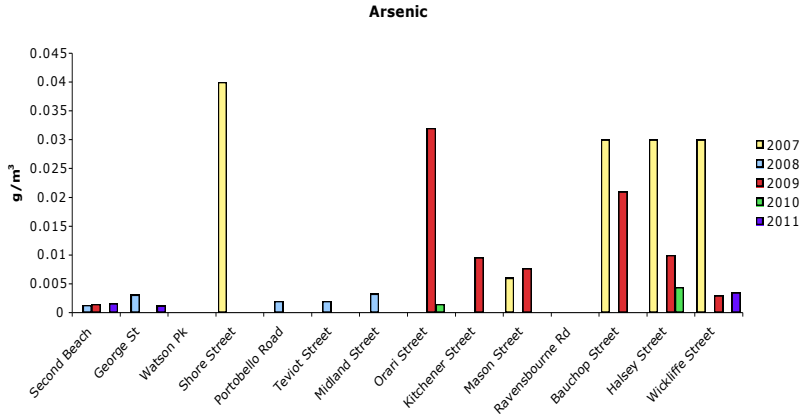
	Stormwater																				
Three Waters Project ICMP Catchment	Parameter	As					Cd					Cr					Cu				
	units	g/m^3					g/m^3					g/m^3					g/m^3				
	Outfall	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
St Clair	Second Beach	BDL	0.0013	0	BDL	0.002	BDL	0.00006	0.00006	0.00007	0.000075	0.0007	0.0028	0.0035	0.00086	0.0038	0.003	0.012	0.019	0.005	0.017
Port Chalmers	George St	BDL	0.0031	BDL	BDL	0.001	0.00028	0.00140	0.00011	0.00033	0.000168	0.005	0.012	0.0031	0.00136	0.0045	0.021	0.039	0.025	0.015	0.02
Port Chalmers	Watson Pk	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0064	BDL	BDL	BDL	0.009	0.003	BDL	BDL	
Shore Street	Shore Street	0.04	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01	0.014	0.02	0.012	
South Dunedin	Portobello Road	BDL	0.002	BDL	BDL	BDL	BDL	0.00023	BDL	BDL	BDL	BDL	0.002	BDL	BDL	BDL	BDL	0.026	0.01	0.006	0.029
Andersons Bay	Teviot Street	BDL	0.002	BDL	BDL	BDL	BDL	0.00008	BDL	0.00026	BDL	BDL	0.0018	BDL	BDL	BDL	BDL	0.009	BDL	0.014	0.031
Andersons Bay	Midland Street	BDL	0.0033	BDL	BDL	BDL	BDL	0.00013	BDL	BDL	BDL	BDL	0.0035	0.0031	BDL	BDL	0.02	0.031	0.057	0.021	
Orari Street	Orari Street	BDL	BDL	0.03	0.00149	BDL	BDL	BDL	BDL	0.00016	BDL	BDL	0.0032	BDL	0.00183	BDL	BDL	0.014	BDL	0.01	
Kitchener Street	Kitchener Street	BDL	BDL	0.01	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.004	0.002	BDL	BDL	BDL	0.034	0.006	0.023	0.012	
Mason Street	Mason Street	0.01	BDL	0.01	BDL	BDL	BDL	BDL	0.0077	0.00051	BDL	BDL	BDL	BDL	BDL	BDL	0.022	0.012	0.021	0.016	0.043
Ravensbourne	Ravensbourne Rd		BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		0.00061	BDL	BDL	BDL		0.002	BDL	0.003	
Halsey Street	Bauchop Street	0.03	BDL	0.02	BDL	BDL	BDL	BDL	BDL	0.00049	BDL	BDL	0.0015	BDL	BDL	BDL	0.029	0.01	BDL	0.003	
Halsey Street	Halsey Street	0.03	BDL	0.01	0.0044	BDL	BDL	0.00022	BDL	0.00026	BDL	BDL	BDL	BDL	BDL	BDL	0.024	0.004	0.021	0.002	0.029
Halsey Street	Wickliffe Street	0.03	BDL	0	BDL	0.004	BDL	BDL	0.00052	0.00078	0.00092	BDL	0.0017	0.0076	0.00157	0.0046	0.01	0.013	0.059	0.006	0.022
	Protection for 80% of species																				
	ANZECC guidelines	0.36					0.0008					0.04					0.0025				

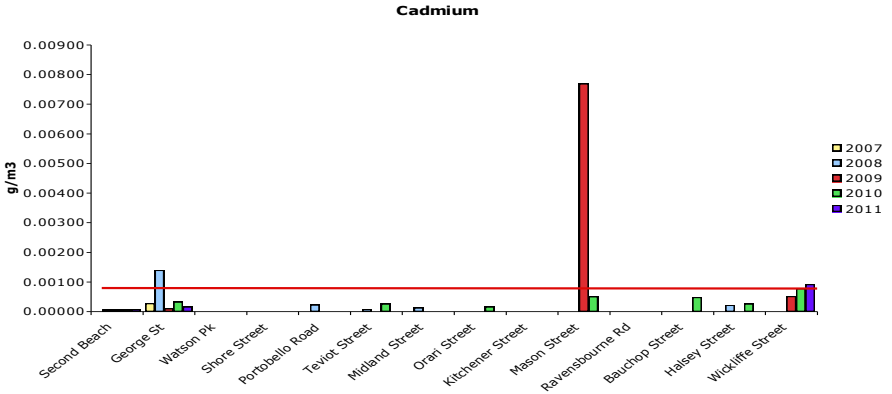
Three Waters Project ICMP Catchment	Parameter	Stormwater Ni					Pb					Zn				
	units	g/m^3					g/m^3					g/m^3				
	Outfall	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
St Clair	Second Beach	0.0009	0.0021	0.0022	0.0013	0.0026	0.001	0.011	0.013	2E-04	0.013	0.038	0.16	0.15	0.092	0.25
Port Chalmers	George St	0.0029	0.0093	0.0026	0.006	0.0037	0.0342	0.041	0.018	0.005	0.004	0.288	0.66	0.19	0.42	0.25
Port Chalmers	Watson Pk	BDL	BDL	BDL	0.0035	BDL	0.0141	0.0018	BDL	BDL	0.004	0.231	0.027	BDL	0.29	0.24
Shore Street	Shore Street	0.01	BDL	BDL	BDL	BDL	0.003	0.0085	0.0069	BDL	BDL	0.02	0.44	0.21	0.115	BDL
South Dunedin	Portobello Road	BDL	0.0035	0.0028	0.0035	BDL	BDL	0.019	0.0067	6E-04	0.026	0.08	0.94	0.64	0.153	0.87
Andersons Bay	Teviot Street	BDL	0.0019	BDL	0.0033	BDL	BDL	0.0066	BDL	BDL	0.007	BDL	0.13	BDL	1.79	0.61
Andersons Bay	Midland Street	BDL	0.0016	BDL	0.0075	BDL	0.005	0.0054	0.0083	BDL	BDL	0.1	0.35	0.18	0.22	BDL
Orari Street	Orari Street	BDL	0.0033	BDL	0.0011	BDL	BDL	0.023	BDL	2E-04	BDL	BDL	0.22	0.03	0.3	BDL
Kitchener Street	Kitchener Street	0.003	BDL	0.0036	0.0035	BDL	0.0442	0.007	0.018	0.002	BDL	0.445	0.036	0.38	0.62	BDL
Mason Street	Mason Street	0.004	BDL	0.0055	BDL	0.0039	0.0258	0.0089	0.014	0.001	0.019	0.25	0.16	0.35	0.43	0.63
Ravensbourne	Ravensbourne Rd		0.0007	BDL	0.0015	BDL		0.0015	0.0029	2E-04	0.025		0.053	0.05	0.144	0.27
Halsey Street	Bauchop Street	0.01	BDL	BDL	BDL	BDL	0.01	0.0035	BDL	BDL	BDL	0.23	0.12	0.13	0.121	BDL
Halsey Street	Halsey Street	0.009	BDL	0.0035	BDL	BDL	0.021	0.0022	0.0097	0.002	0.009	0.12	0.033	0.3	0.136	0.36
Halsey Street	Wickliffe Street	0.01	BDL	0.0042	BDL	0.0021	0.006	0.0084	0.033	BDL	0.013	0.1	0.2	0.53	0.24	0.82
	Protection for 80% of species															
	ANZECC guidelines			0.017					0.0094					0.031		

Table 2. *continued…*

Three Waters Project ICMP Catchment	Parameter	Stormwater pH					Suspended Solids					Oil & Grease					FWA				
	units						g/m^3					g/m^3					µg/L				
	Outfall	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
St Clair	Second Beach	7.7	7.3	7.4	7.3	7.4	BDL	37	41	BDL	57	5	BDL	BDL	BDL	BDL	0.147	0.19	0.098	0.04	0.075
Port Chalmers	George St	6.9	7.1	7.3	6.8	6.8	87	150	26	170	140	10	8.7	BDL	BDL	8	BDL	BDL	0.03	0.079	0.082
Port Chalmers	Watson Pk	6.8	7.9	8.2	7.1	7.5	37	39	7.4	240	24	8	BDL	BDL	BDL	BDL	0.002	0.003	0.124	0.105	0.092
Shore Street	Shore Street	7.9	7.2	7.3	7.4	7.9	41	24	20	9.5	12	BDL	BDL	BDL	BDL	BDL	0.081	0.031	0.142	0.98	0.142
South Dunedin	Portobello Road	7.9	7.3	7.6	7.6	7.4	18	46	30	8.1	53	4	9.7	BDL	BDL	BDL	0.003	0.049	0.177	0.151	0.045
Andersons Bay	Teviot Street	7.9	7.1	7.9	7	8	25	33	12	84	66	8	4.4	BDL	6.4	BDL	BDL	0.006	0.096	0.135	0.117
Andersons Bay	Midland Street	7.7	7.7	7.7	7.5	7.8	30	19	30	52	14	BDL	BDL	BDL	BDL	4	BDL	0.004	0.132	0.218	0.197
Orari Street	Orari Street	7.8	7.4	8.1	7.1	7.9	28	77	16	130	4	BDL	11	BDL	BDL	17	BDL	0.005	0.11	0.052	0.081
Kitchener Street	Kitchener Street	7.1	7.7	7.4	6.9	8	104	41	45	50	BDL	9	BDL	BDL	BDL	22	0.18	0.029	0.072	0.023	0.047
Mason Street	Mason Street	7.1	7	7.4	7	7	62	37	37	138	30	5	7.9	BDL	BDL	BDL	0.007	0.07	0.051	0.156	0.026
Ravensbourne	Ravensbourne Rd		7	8.1	7.3	8		8.5	18	61	5		8.8	BDL	BDL	BDL		BDL	0.096	0.136	0.014
Halsey Street	Bauchop Street	7.6	7.8	8.1	7.4	8	44	16	13	53	5	4	BDL	BDL	BDL	BDL	2.028	4.92	0.031	0.067	0.017
Halsey Street	Halsey Street	7.3	7.9	7.2	6.8	7.1	119	35	27	50	24	9	BDL	BDL	BDL	BDL	BDL	0.004	0.011	0.061	0.025
Halsey Street	Wickliffe Street	7.7	7.5	8.0	7.3	9.7	35	27	100	86	46	6	9.5	9.5	BDL	7	0.024	0.003	0.021	0.048	0.094
	Protection for 80% of species																				
	ANZECC guidelines			7.2-7.8																	

Three Waters Project ICMP Catchment	Parameter	Stormwater E. coli					Stormwater Faecal Coliforms					
	units	MPN/100ml					cfu/100ml					
	Outfall	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	
St Clair	Second Beach	560	6800	14000	4800	9000	560	8300	14000	92000	9000	
Port Chalmers	George St	1400	930	1000	1100	600	1400	1400	1000	1100	600	
Port Chalmers	Watson Pk	14000	150	10	>1600	1000	39000	150	10	>1600	1000	
Shore Street	Shore Street	300	5100	16000	7000	110	300	5100	16000	9400	110	
South Dunedin	Portobello Road	460	5000	2800	54000	6000	590	5000	2800	54000	6000	
Andersons Bay	Teviot Street	7	120000	210	16000	300	7	240000	210	16000	300	
Andersons Bay	Midland Street	290	130	6000	3500	600	290	130	6000	5400	600	
Orari Street	Orari Street	50	6000	210	1700	BDL	80	7000	210	3500	BDL	
Kitchener Street	Kitchener Street	13000	70	10000	92000	110	13000	70	10000	160000	110	
Mason Street	Mason Street	22000	26000	50000	350000	48000	22000	26000	50000	350000	48000	
Ravensbourne	Ravensbourne Rd		120	90	11000	130	150	130	90	11000	130	
Halsey Street	Bauchop Street	2200	400	3000	7900	450	2200	400	3000	35000	450	
Halsey Street	Halsey Street	9000	1700	70000	17000	78000	9000	1700	70000	92000	78000	
Halsey Street	Wickliffe Street	25000	10000	220000	35000	43000	30000	10000	220000	54000	43000	
	Primary	Amber	>260				>150					Primary
	Secondary	Red	>550				>1000					Secondary





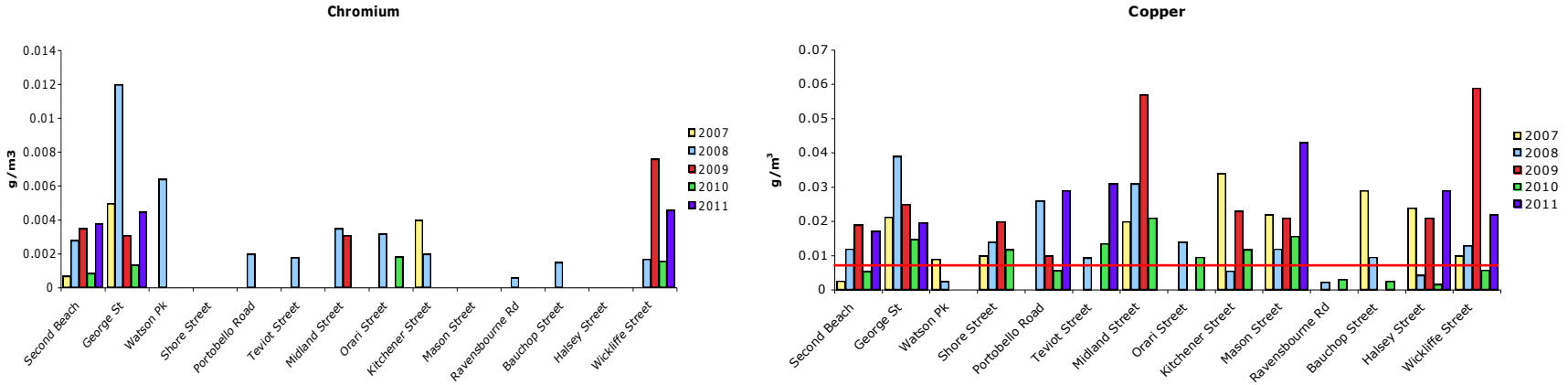


Figure 3. *Graphical representation of contaminant levels in stormwater at outfalls around upper Otago Harbour in 2007, 2008, 2009, 2010 and 2011. Red line indicates ANZECC trigger level for protection of 80% of species.*

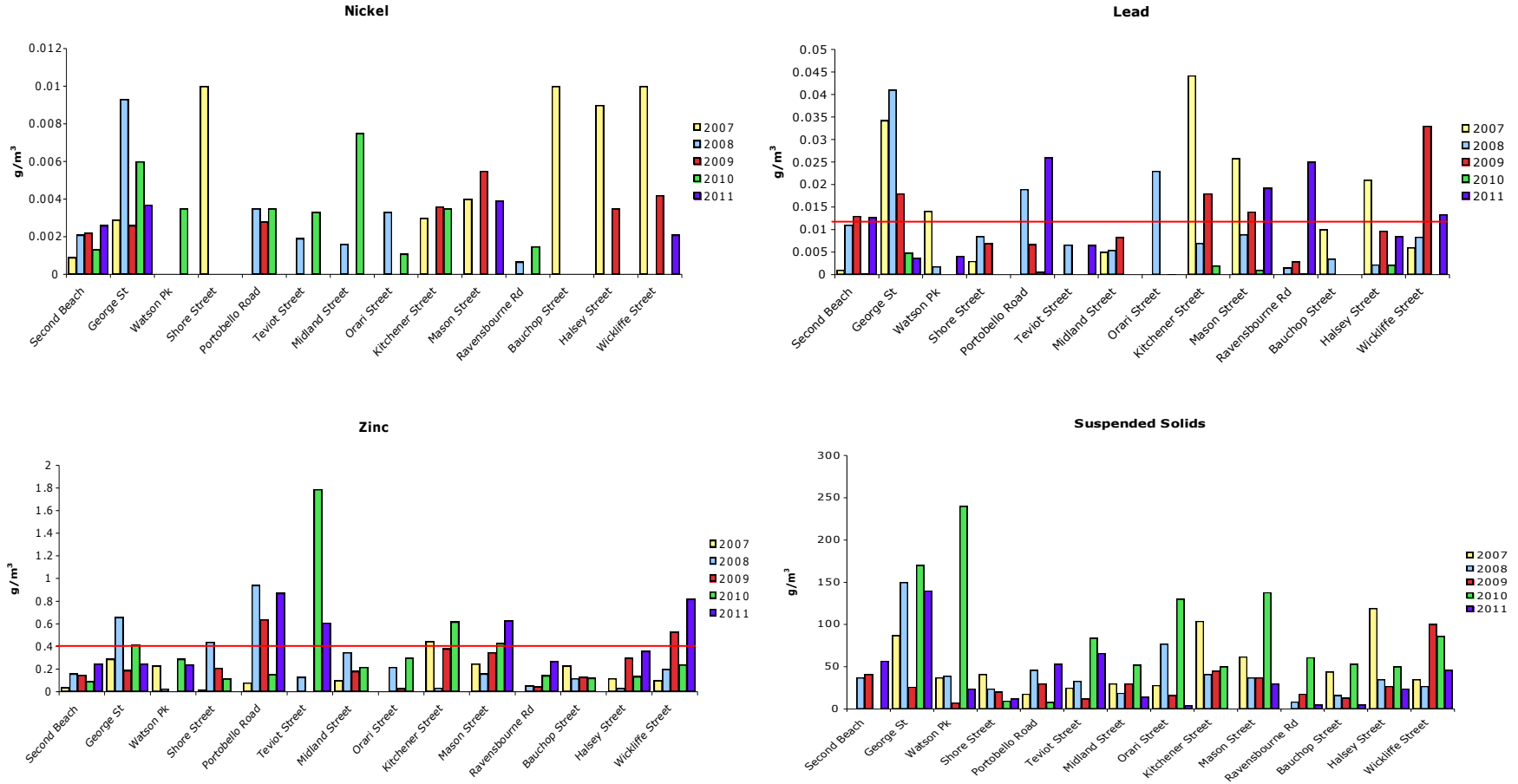
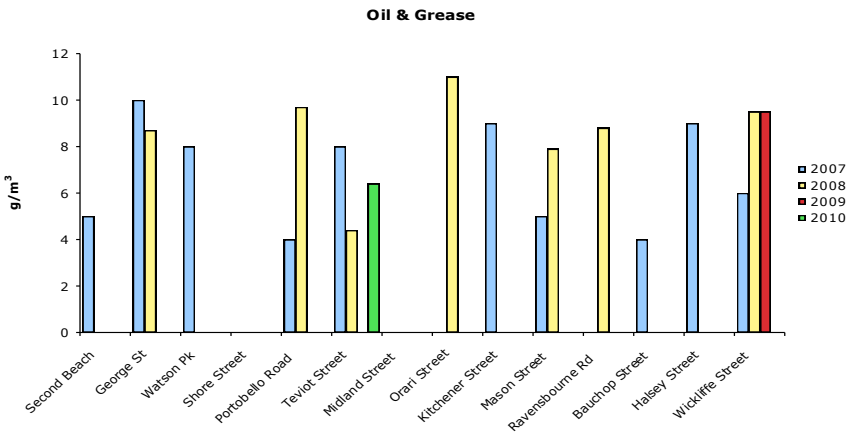
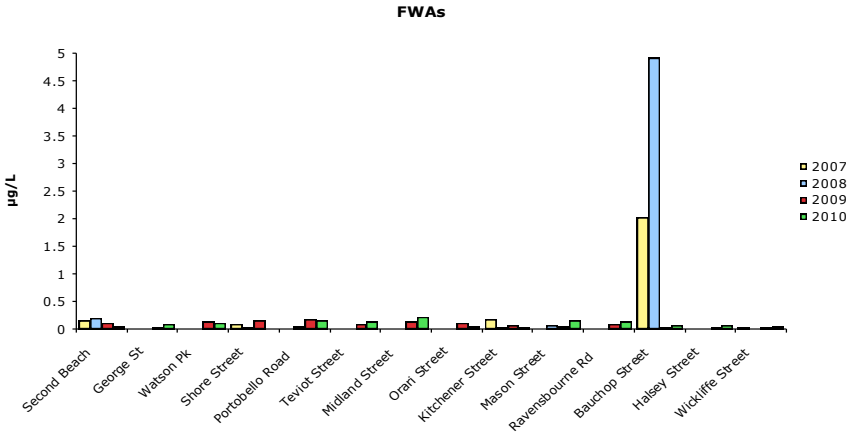
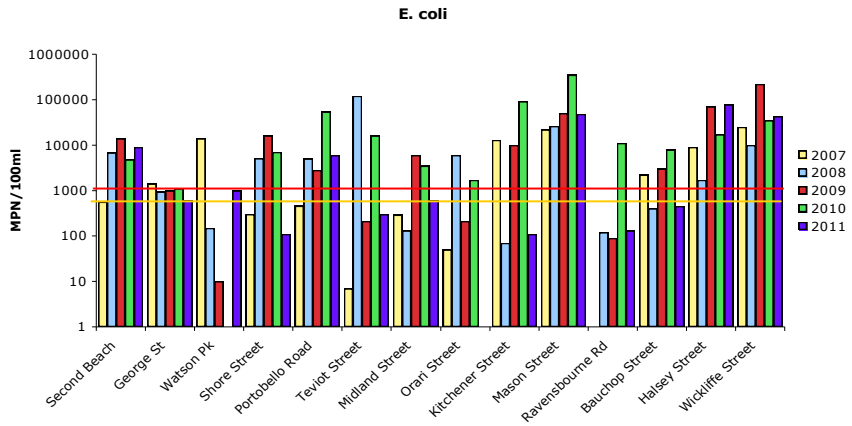


Figure 3. (continued….)


Oil & Grease
g/m³
0
2
4
6
8
10
12
Second Beach
George St
Watson Pk
Shore Street
Portobello Road
Teviot Street
Midland Street
Orari Street
Kitchener Street
Mason Street
Ravensbourne Rd
Bauchop Street
Halsey Street
Wickliffe Street
2007
2008
2009
2010


FWAs
µg/L
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Second Beach
George St
Watson Pk
Shore Street
Portobello Road
Teviot Street
Midland Street
Orari Street
Kitchener Street
Mason Street
Ravensbourne Rd
Bauchop Street
Halsey Street
Wickliffe Street
2007
2008
2009
2010


E. coli
MPN/100ml
1
10
100
1000
10000
100000
1000000
Second Beach
George St
Watson Pk
Shore Street
Portobello Road
Teviot Street
Midland Street
Orari Street
Kitchener Street
Mason Street
Ravensbourne Rd
Bauchop Street
Halsey Street
Wickliffe Street
2007
2008
2009
2010
2011

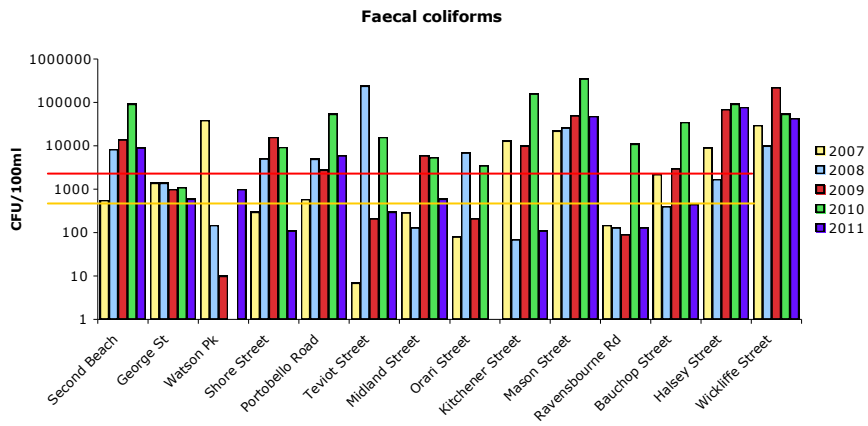

Faecal coliforms
CFU/100ml
1
10
100
1000
10000
100000
1000000
Second Beach
George St
Watson Pk
Shore Street
Portobello Road
Teviot Street
Midland Street
Orari Street
Kitchener Street
Mason Street
Ravensbourne Rd
Bauchop Street
Halsey Street
Wickliffe Street
2007
2008
2009
2010
2011

Figure 3. ***(continued)*** *Graphical representation of contaminant levels in stormwater at outfalls around upper Otago Harbour in 2007, 2008, 2009, 2010 and 2011. For microbiological graphs amber line indicates guideline for primary contact, red line indicates guideline for secondary contact.* ***Note log scale on Y axis of microbiological graphs.***

Table 3. *PAHs (g/m^3) detected in stormwater from the Kitchener Street, Orari Street and Portobello Road outfalls in 2007, 2008, and 2009, 2010 and 2011. BDL indicates Below Detectable Limits.*

	Kitchener St					Orari St					Portobello Rd				
	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
Acenaphthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00034	0.000024	BDL	0.000015
Acepaphthylene	BDL	100	BDL	BDL	BDL	BDL	92	BDL	BDL	BDL	BDL	100	0.000029	BDL	0.00016
Anthracene	BDL	87	BDL	BDL	BDL	BDL	89	BDL	BDL	BDL	BDL	87	0.000008	BDL	0.000044
Benzo[a]anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00015	0.000014	BDL	0.000105
Benzo[a]pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000017	BDL	0.000167
Benzo[a]fluorathene + Benzo[j]fluorathene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00012	BDL	BDL	0.00018	0.000033	0.000158	0.00024
Benzo[g,h,i]perylene	BDL	BDL	BDL	BDL	BDL	BDL	0.00014	BDL	BDL	BDL	BDL	BDL	0.000014	BDL	0.000147
Benzo[k]fluorathene	-	67	BDL	BDL	BDL	-	67	BDL	BDL	BDL	-	67	BDL	BDL	0.000094
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000093
Dibenzo[a,h]anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000026
Fluoranthene	BDL	BDL	BDL	0.00015	BDL	BDL	0.00011	BDL	0.00017	BDL	BDL	0.00028	0.00001	BDL	0.000182
Fluorene	BDL	73	BDL	BDL	BDL	BDL	70	BDL	BDL	BDL	BDL	74	BDL	BDL	0.000017
Indeno[1,2,3-c,d]pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000013	BDL	0.000107
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00008
Phenanthrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000041
Pyrene	BDL	BDL	BDL	BDL	BDL	0.0001	BDL	BDL	0.00023	BDL	BDL	0.00037	0.000011	BDL	0.00016
Total PAH	0.00	327.00	BDL	0.0001	BDL	0.00	318.00	BDL	0.0005	BDL	BDL	328.00	0.00017	0.00016	0.00168

3.2 Sediments

Sediments were sampled on 17th May 2011 at sites detailed in Figure 2. Surface sediments were generally clean at most sites with little surface detritus apart from a thick layer of organic particles (wood, leaves and bark fragments) at Portobello Road. Additionally, at Portobello Road, sediments were very dark and smelled strongly of petro-carbons with a visible oil slick forming in footprints and depressions dug to remove sediments. At Wickliffe Street, sediments were dark and smelled strongly of hydrogen sulphide, indicating anoxic conditions. Investigations into PAH levels at the Portobello Road outfall are detailed in Stewart (2005, 2006). Note that the South Dunedin (Portobello Road) catchment was used as the pilot for the stormwater catchment management plan development for the DCC's Three Waters Strategy and a complete ICMP has been finalised for this catchment. The ICMP contained recommendations for addressing problems and issues highlighted in this catchment that will be considered and programmed for action where practicable.

Generally speaking, levels of contaminants in sediments near outfalls are similar to previous years. The exceptions are White Street, where almost all metals occur at higher levels than last year, and at Portobello Road where all levels of all contaminants exceeded the levels observed last year (Table 4, Figure 4). The sites that most notably fly against this trend are Orari Street and Shore Street which both show decreases in all contaminant levels this year. Cadmium and chromium levels are higher than they have ever been at Portobello Road as are PAH levels at Wickliffe Street. Conversely, a number of outfalls show lower levels than seen previously of arsenic, cadmium copper and nickel (Orari Street and Shore Street) and chromium, lead and zinc at Shore Street. This year, ANZECC low trigger values are exceeded only by arsenic, nickel, zinc and copper at Portobello Road (Table 4) and by lead and zinc at most other outfalls.

As observed in previous investigations PAHs are to be found at moderate to high levels in much of the Upper Harbour Basin, with the highest levels adjacent to the Portobello Road outfall (Table 4, Figure 4). PAHs in sediments were lower this year than last year at the White Street, Orari Street and Shore Street outfalls and also at the Rowing Club site. Conversely PAH levels were higher than in the past at Wickliffe Street outfall and at the Boatshed and Cove Drainage sites indicating that, while PAHs are still being added to the upper harbour, the amount varies through time and with site. The extremely high levels of PAHs in older sediments off Portobello Road are believed to have been sourced from the now defunct gas works. The levels of PAHs off Portobello Road observed this year are higher than those from last year but similar to those observed in 2008 and 2009. Wave action disturbing surface sediments around the time of sampling will undoubtedly have a

bearing on PAH levels at any particular site. This year, sampling occurred on a very calm day.

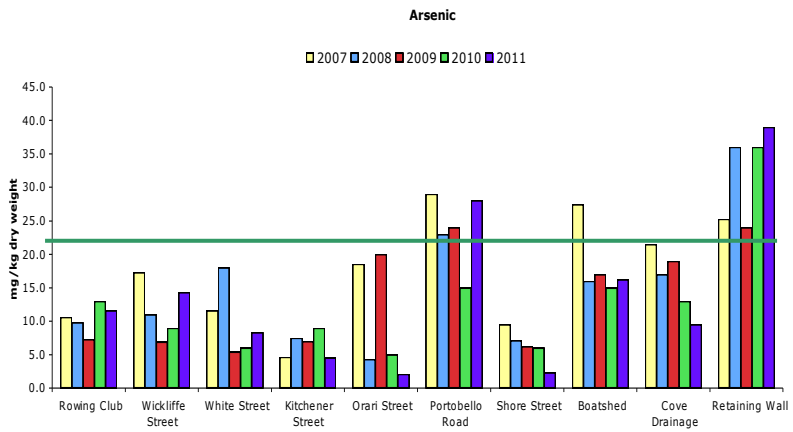
Microbial contamination in sediment is relatively low at most outfalls with just Wickliffe Street and Kitchener Street having high numbers of enterococci and Wickliffe Streets having moderate numbers of faecal coliforms (Table 4). Numbers are, however, not as high as they were in 2007 or 2008.

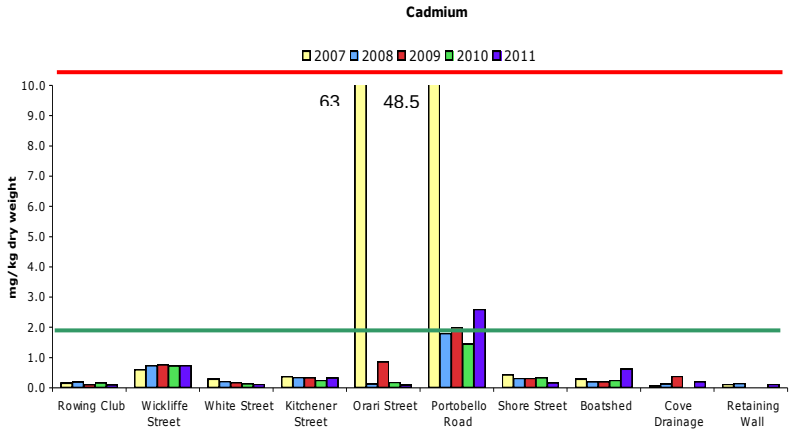
Trends in contaminant levels at the various sites through time remain unclear with five years of sampling revealing high variability among contaminants and among sites (Figure 4). However, as already stated, levels of some contaminants are lower this year at some sites than they have ever been. It will be of interest to see if this trend becomes more apparent with the addition of further data from future monitoring rounds.

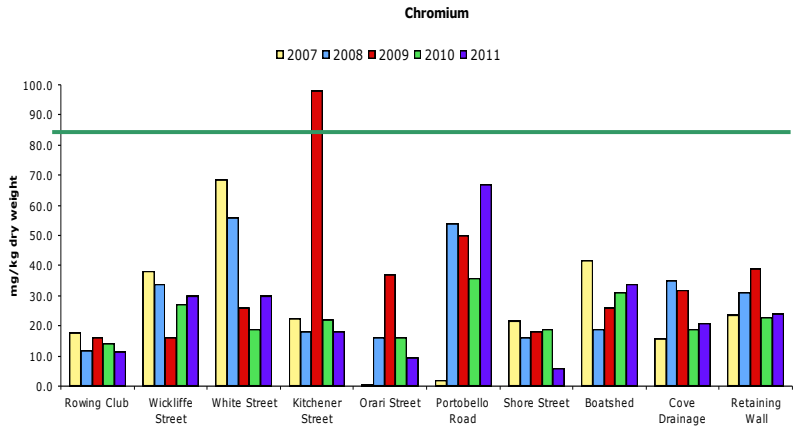
Table 4. *Contaminant levels in sediments at various locations within 20m of stormwater outfalls and within the Upper Otago Harbour Basin with 2007 (yellow) and 2008 (green) values compared with 2009 values (blue), 2010 values (grey) and 2011 values (purple). Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

Sediments within 20m of outfall																										
	As					Cd					Cr					Cu					Ni				
Units	mg/kg dry wt					mg/kg dry wt					mg/kg dry wt					mg/kg dry wt					mg/kg dry wt				
Parameter	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
Rowing Club	10.6	9.8	7.3	13.0	11.6	0.2	0.2	0.1	0.2	0.1	17.6	12.0	16.0	14.0	11.6	14	13	14	9	12	11.3	14.0	13.0	11.0	12.1
Wickliffe Street	17.3	11.0	6.9	9.0	14.3	0.6	0.7	0.8	0.7	0.7	38.0	34.0	16.0	27.0	30.0	121	68	50	58	86	19.2	23.0	13.0	17.0	15.9
White Street	11.6	18.0	5.4	6.0	8.3	0.3	0.2	0.2	0.1	0.1	68.5	56.0	26.0	19.0	30.0	433	160	170	78	98	29.5	21.0	11.0	8.0	14.5
Kitchener Street	4.6	7.5	7.0	9.0	4.5	0.4	0.4	0.3	0.3	0.3	22.6	18.0	98.0	22.0	18.3	70	56	90	37	54	10.6	12.0	15.0	12.0	10.6
Orari Street	18.6	4.3	20.0	5.0	2.1	63.0	0.1	0.9	0.2	0.1	0.3	16.0	37.0	16.0	9.4	25	13	61	11	7	23.6	8.1	16.0	8.0	5.3
Portobello Road	29.0	23.0	24.0	15.0	28.0	48.5	1.8	2.0	1.5	2.6	1.8	54.0	50.0	36.0	67.0	60	160	190	123	176	169.3	18.0	26.0	19.0	24.0
Shore Street	9.5	7.1	6.2	6.0	2.3	0.4	0.3	0.3	0.3	0.2	21.8	16.0	18.0	19.0	5.8	51	44	41	35	11	10.7	9.0	11.0	10.0	5.2
Boatshed	27.4	16.0	17.0	15.0	16.2	0.3	0.2	0.2	0.3	0.6	41.7	19.0	26.0	31.0	34.0	108	33	49	35	53	24.5	16.0	17.0	16.0	18.5
Cove Drainage	21.5	17.0	19.0	13.0	9.5	0.1	0.1	0.4	<0.1	0.2	15.8	35.0	32.0	19.0	21.0	11	19	38	11	14	23.5	44.0	23.0	19.0	12.8
Retaining Wall	25.3	36.0	24.0	36.0	39.0	0.1	0.2	<0.1	<0.1	0.1	23.6	31.0	39.0	23.0	24.0	13	19	17	10	11	15.9	25.0	26.0	18.0	13.2
ANZECC Low trigger value	20					1.5					80					65					21				
ANZECC high trigger value	70					10					370					270					52				

Sediments within 20m of outfall																										
	Pb					Zn					PAH					Enterococci					Faecal coliforms				
Units	mg/kg dry wt					mg/kg dry wt					mg/kg dry wt					MPN/g					MPN/g				
Parameter	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
Rowing Club	18.9	27	27	28	19	101	130	160	149	109	7.0	5.8	0.5	3.7	0.1	2	11	<2	<3	8	<2	17	5	2	<2
Wickliffe Street	76.1	140	77	92	127	412	740	810	740	700	9.2	1.2	7.3	7.2	11.3	580	>1600	330	<3	>160	2	540	33	540	110
White Street	147.0	180	170	124	147	4450	2500	2400	1280	1650	13.0	11.1	15.9	6.5	5.4	4	2	<2	23	35	<2	<2	<2	5	<2
Kitchener Street	117.9	97	130	155	132	249	280	300	280	260	8.9	140.5	4.8	5.0	5.5	66	920	5	<3	>160	20	13	70	<2	49
Orari Street	12.8	39	120	35	17	68	130	680	157	69	10.2	12.6	28.3	9.3	4.3	<2	8	23	<3	54	23000	4	33	33	17
Portobello Road	20.4	330	290	193	310	306	1400	1600	1040	1410	436.3	250.3	525.2	194.1	482.0	727	170	<2	<3	16	23	43	2	21	2
Shore Street	113.0	110	79	85	36	484	300	330	350	210	9.6	21.0	8.6	10.5	4.1	90	>1600	<2	460	35	<2	540	<2	130	49
Boatshed	112.0	800	170	86	89	339	370	360	290	300	6.7	5.5	38.8	7.9	40.4	34	33	33	<3	54	<2	2	79	5	22
Cove Drainage	19.7	20	55	18	44	99	150	270	125	119	0.4	0.0	0.1	0.1	1.0	8	17	<2	<3	35	2	8	<2	<2	6
Retaining Wall	26.9	27	42	24	23	141	170	150	152	138	0.3	3.9	0.0	9.4	0.2	<2	8	<18	<3	8	2	<2	33	<2	2
ANZECC Low trigger value	50					200					4														
ANZECC high trigger value	220					410					45														


Arsenic
2007 2008 2009 2010 2011
mg/kg dry weight
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Rowing Club
Wickliffe Street
White Street
Kitchener Street
Orari Street
Portobello Road
Shore Street
Boatshed
Cove Drainage
Retaining Wall


Cadmium
2007 2008 2009 2010 2011
mg/kg dry weight
63
48.5
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Rowing Club
Wickliffe Street
White Street
Kitchener Street
Orari Street
Portobello Road
Shore Street
Boatshed
Cove Drainage
Retaining Wall


Chromium
2007 2008 2009 2010 2011
mg/kg dry weight
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Rowing Club
Wickliffe Street
White Street
Kitchener Street
Orari Street
Portobello Road
Shore Street
Boatshed
Cove Drainage
Retaining Wall

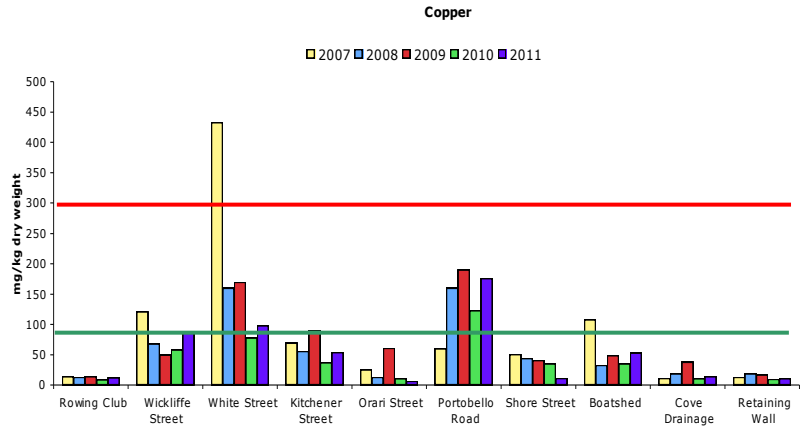
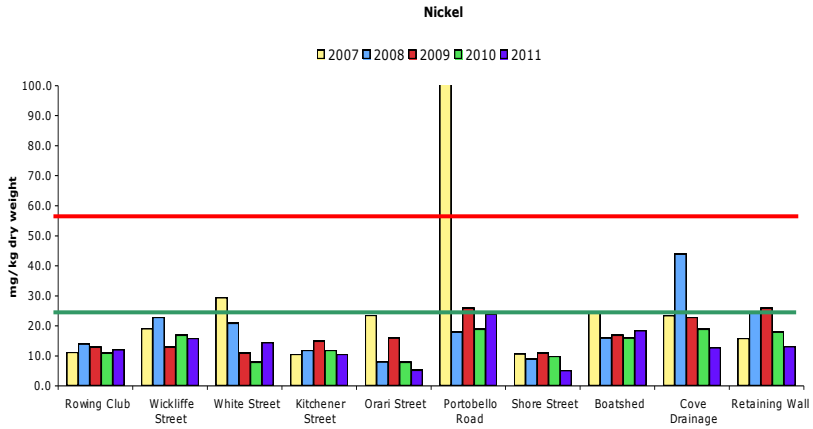
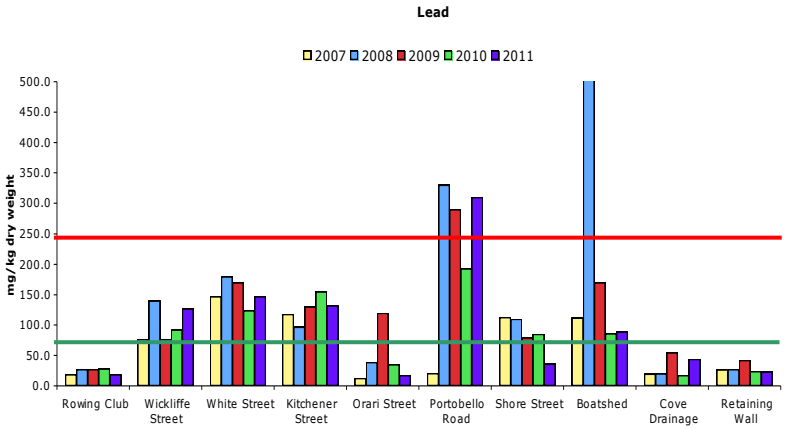
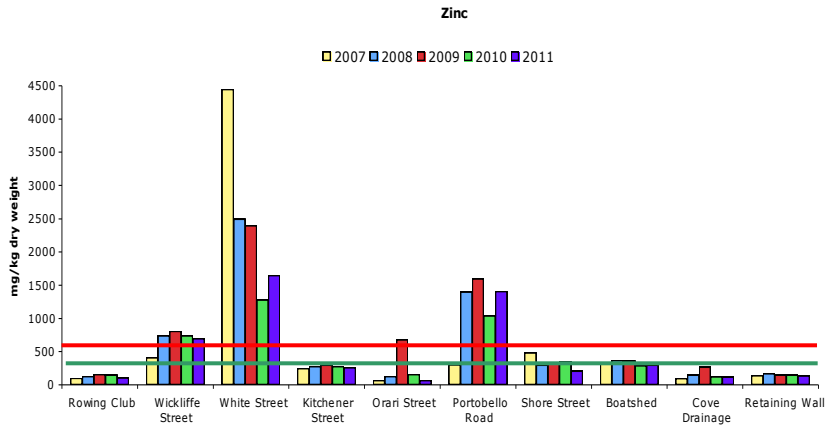

Copper
2007 2008 2009 2010 2011
mg/kg dry weight
500
450
400
350
300
250
200
150
100
50
0
Rowing Club
Wickliffe Street
White Street
Kitchener Street
Orari Street
Portobello Road
Shore Street
Boatshed
Cove Drainage
Retaining Wall

Figure 4. *Graphical representation of contaminant levels in sediment at sampling sites around upper Otago Harbour in 2007, 2008, 2009, 2010 and 2011. Green line indicates ANZECC low trigger level, red line is high trigger level.*







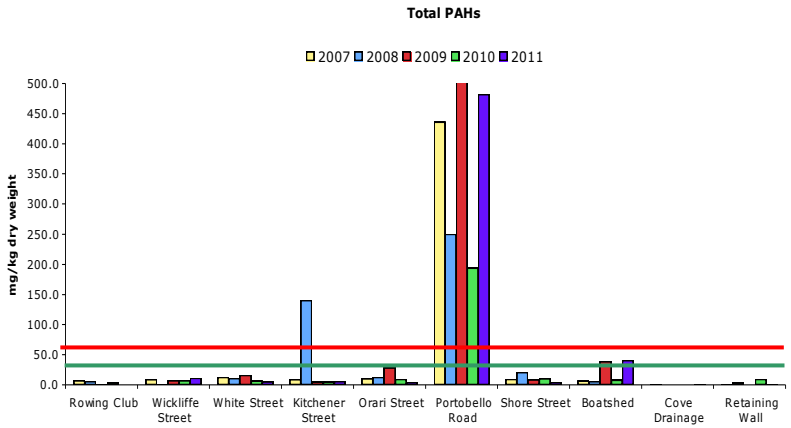


Figure 4 (continued). *Graphical representation of contaminant levels in sediment at sampling sites around upper Otago Harbour in 2007, 2008, 2009, 2010 and 2011. Green line indicates ANZECC low trigger level, red line is high trigger level.*

3.3 Biological Monitoring

On 18th and 19th May 2011 biological sampling was carried out at the Orari Street, Kitchener Street and Portobello Road, outfalls. The tide was reasonably low at 1.1m below mean sea level.

There was a low diversity of mainly red algae at all three sites with Orari Street having the highest diversity (7 taxa) and Portobello Road having the lowest diversity (3 taxa) (Table 5-7). Percentage cover was generally low at all sites with >50m from the Portobello Road outfall having on algae at all (Table 7). Cover was highest at both sites near the Orari Street outfall with occasional quite large clumps of *Ceramium uncinatum* and *Gracilaria chilensis* present (Table 6). Overall, cover at all sites was similar to previous years with the exception of the Portobello Road outfall sites where cover was lower than in previous surveys (Stewart 2007a, Stewart 2008c, Stewart 2009, Stewart 2010).

Table 5. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Kitchener Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca						
Ceramium uncinatum						
Euptilota formosissima	10		1	10		
Gracilaria chilensis						
Lenormandia chauvinii	2					
Lomentaria umbellata						

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis			1			
Ulva lactuca						
Ceramium uncinatum	1	1		1		
Euptilota formosissima				1		
Gracilaria chilensis				1		
Lenormandia chauvinii	10	3	3	12	5	7
Lomentaria umbellata	1	1				2

Table 6. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Orari Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis					6	
Ulva lactuca		1	2	1	6	
Ceramium uncinatum			1	15	12	
Euptilota formosissima			4			
Gracilaria chilensis	1		4		2	2
Lenormandia chauvinii	1	1	1		2	
Lomentaria umbellata					1	

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						8
Ulva lactuca		1				
Ceramium uncinatum					3	8
Euptilota formosissima	2	2	1	1	1	
Gracilaria chilensis	10	15	2	4	3	1
Lenormandia chauvinii			1	1	1	1
Lomentaria umbellata						

Table 7. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Portobello Rd outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca						
Ceramium uncinatum						
Euptilota formosissima		2	1			
Gracilaria chilensis	2	1				
Lenormandia chauvinii		1				
Lomentaria umbellata						

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca						
Ceramium uncinatum						
Euptilota formosissima						
Gracilaria chilensis						
Lenormandia chauvinii						
Lomentaria umbellata						

Epifauna was moderately abundant at all three outfalls (Tables 8-10), although slightly less so than in 2010. As in previous years the small topshell *Micrelenchus tenebrosus* and cockles, *Austrovenus stutchburyi*, comprise the majority of animals. Numbers of animals per square metre was lower at more than 50m distant from the Kitchener Street outfall than within 20m of the outfall. This echoes the results observed in 2008, 2009 and 2010. For both Orari Street and Portobello Road numbers differed from last year in that at Orari Street the highest density was close to the outfall while the opposite applied at Portobello Road. In 2010 numbers were similar irrespective of distance at both outfalls. Overall density of epifaunal animals was lowest at Orari Street and highest at Kitchener Street, due mainly to the higher abundance of tubeworms at this site (Tables 8-10).

Diversity within animal communities was variable with Kitchener Street showing slightly greater diversity closer to the outfall while Orari Street and Portobello Road showed the no difference in diversity with distance (Table 11). Diversity was lowest at Orari Street. Overall diversity has not changed from that observed in 2007, 2008, 2009 and 2010 ($F_{4,10} = 0.123$, $p = 0.744$ for <20m sites; $F_{4,10} = 0.229$, $p = 0.926$ for >50m sites). Neither is there a significant difference in epifaunal diversity among sites <20m from the outfalls and sites >50m from the outfalls ($F_{1,4} = 0.048$, $p = 0.838$).

Table 8. *Epifauna within 20m (top) and greater than 50m (bottom) of the Kitchener Street outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus		6	14	62		28	21		19	15	11		6		2
Barnacles															
Eminius modestus			18		4			10							
Snails and Chitons															
Melagraphis aethiops						1							1		
Micrelenchus tenebrosus	21	18	26	3	9	24	9	3	6	9	13	17	21	9	11
Notoacmea spp			3												
Bivalves															
Mytilus galloprovincialis											1				
Austrovenus stutchburyi												1		3	
Ostrea heffordi		1		8			2		15	11	7		4		3

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus	6						5		11	12	12		19	5	8
Barnacles															
Eminius modestus			6	3									13	4	1
Snails and Chitons															
Micrelenchus tenebrosus	3	18	8	12	9	18	3	8	9	8		3	4	9	16
Melagraphis aethiops		1		1											
Chiton glaucus								1							
Bivalves															
Austrovenus stutchburyi	1														
Ostrea heffordi	1						14		5	4	4	1	8	1	5

Table 9. *Epifauna within 20m (top) and greater than 50m (overleaf) of the Orari Street outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Snails and Chitons															
Notoacmea spp					1										
Acanthochitona zelandica															
Micrelenchus tenebrosus	1	5	3	6	5	11	6	6	6	2	2	1	4	3	1
Zeacumantus subcarinatus			1												
Cominella galndiformis								1							
Bivalves															
Austrovenus stutchburyi	5	7	12	10	9	9	13	11	10	16	9	7	10	9	4
Ostrea heffordi															

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Spirorbis spp															
Snails and Chitons															
Acanthochitona zelandica															
Buccinulum vittatum															
Cominella glandiformis				1											
Melagraphis aethiops															
Micrelenchus tenebrosus	2	1	1		1					1		1			1
Crustaceans															
Macrophthalmus hirtipes				1											
Bivalves															
Austrovenus stutchburyi	10	6	14	7	7	6	9	5	4	4	6	7	4	11	9

Table 10. *Epifauna within 20m (top) and greater than 50m (bottom) of the Portobello Rd outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus	30	8						7	16			5			12
Snails and Chitons															
Melagraphis aethiops												1			1
Micrelenchus tenebrosus		1			1			3	8	1	1	7	6	1	16
Zeacumantus subcarinata	1														
Bivalves															
Austrovenus stutchburyi				1		1		8	4	3	2	7	3	3	1
Mytilus galloprovincialis												2			
Ostrea heffordi	1														8

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus	28	7	47	31	12	5				63	2			13	37
Spirorbis spp															
Barnacles															
Eminius modestus	7		42												7
Snails and Chitons															
Notoacmea spp		1	1			5		1		2					2
Melagraphis aethiops	1	1			1					1			1		1
Micrelenchus tenebrosus		12	1	9	8	4			1	5			2		4
Bivalves															
Austrovenus stutchburyi															
Mytilus galloprovincialis			1						1						3
Ostrea heffordi	2		13	14	4	4				24				2	8

Table 11. *Diversity (H') of epifauna within 20m and greater than 50m of the Kitchener Street, Orari Street and Portobello Road outfalls. 2011 data compared with 2007, 2008, 2009 and 2010 data.*

	<20m					>50m				
Site	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
Kitchener Street	0.67	0.53	0.44	0.9	0.55	0.98	0.73	0.56	0.9	0.57
Orari Street	1.01	0.86	0.74	0.98	0.29	0.88	0.87	0.74	1.03	0.15
Portobello Road	0.74	0.67	0.8	1.04	0.57	0.84	0.68	0.76	1.08	0.58

As in previous surveys cockles became noticeably smaller and less abundant as one moved from Kitchener Street to Portobello Road (Table 12). However, when compared using ANOVA at a significance level of 0.05 the overall size of cockles at each site has not changed significantly from year to year ($F_{1,10}$ = 0.201, p = 0.932).

Table 12. *Size of cockles collected at Kitchener Street, Orari Street and Portobello Road in 2007, 2008, 2009, 2010 and 2011.*

	2007			2008			2009			2010			2011		
	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)
Kitchener Street	59	18.8	37.1	54	16.36	35.5	80	19.6	38.1	63	17.73	36.6	106	19.47	37.5
Orari Street	62	12.3	32.4	74	8.65	29.8	80	12.3	33.0	82	10.18	30.2	73	9.62	30.0
Portobello Road	64	9.4	30.1	74	7.87	28.3	80	10	30.1	80	7.7	28.2	103	8.77	28.8

A suggestion was made at the discussion of the 2008 report that growth rings should be measured on cockles to determine how age and size were related at the different sites. This was attempted for the 2009 sampling round and again last year but, due to most cockles having ill-defined and very closely spaced growth rings, results were considered to be too inaccurate to be meaningful and were disregarded. No attempt to count rings was made this year. It would be fair to say, however, that at all sites at the head of the harbour cockles are much slower growing than at prime cockle sites further down harbour or in Papanui and Waitati Inlets (Stewart 2006b, 2008d).

Infauna at all three sites was dominated by polychaete worms with glyceriids being the most abundant at all sites (Tables 14-16). Next most common were nereidid worms which were reasonably abundant both close to and further away from the Kitchener Street and Orari Street outfalls, but less so at Portobello Road. Spionid worms were present, but less common than last year. Phoxocephalid amphipods were far less common at all sites than they were in 2010. Cockles (*Austrovenus stutchburyi*) were most common at both the <20m and >50m sites near the Orari Street outfall and at the <20m site at Kitchener Street (Tables 14-16), with overall abundance similar to previous years. Tanaid crustaceans, which were found in moderate numbers at most sites last year, were observed at just the <20m site at

Orari Street this year. Numbers of animals per square metre were generally lower than last year, but similar to other surveys, and ranged from 669 at replicate 2, Site 1 at >50mm from the Portobello Road outfall to 7359 at replicate 4, Site 2 at <20m from the Orari Street outfall. The higher value was largely due to high abundance of polychaetes worms in that core. Despite the variability in overall numbers of animals at the various sites, diversity has not changed significantly from year to year for the <20m sites ($F_{4,10}$ = 1.898, p = 0.187). For >50m sites, however, there was a significant difference observed this year and in 2010 ($F_{4,10}$ = 7.65, p = 0.004), with diversity being higher over the past two years than in previous surveys at each of the three sites. That being said, there is no significant difference in diversity among the past two years for >50m ($F_{1,4}$ = 0.357, p = 0.582) or between the <20m locations and the >50m locations at any of the sites. ($F_{1,4}$ = 2.502, p = 0.189) (Table 13).

Table 13. *Diversity (H') of infauna within 20m and greater than 50m of the Kitchener Street, Orari Street and Portobello Road outfalls. 2011 data compared with 2007, 2008, 2009 and 2010 data.*

	<20m					>50m				
Site	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
Kitchener Street	0.67	0.53	0.44	0.9	0.81	0.98	0.73	0.56	0.9	0.94
Orari Street	1.01	0.86	0.74	0.98	0.99	0.88	0.87	0.74	1.03	0.98
Portobello Road	0.74	0.67	0.8	1.04	0.69	0.84	0.68	0.76	1.08	0.99

Table 14. *Abundance of species of infauna collected <20m and >50m from the Kitchener Street outfall.*

Kitchener Street			Location	<20m							>50m						
2011				Site 1			Site 2				Site 1			Site 2			
			Sample	1	2	3	4	5	6	sum	1	2	3	4	5	6	sum
Phylum		**Family**	**Genus/species**														
Annelida																	
	Polychaeta																
		Eunicidae														1	1
		Glyceridae		4	5	2	2	6	5	24		3	3	2	1	3	12
		Maldanidae									1	1					2
		Nephtyidae			1					1		1					1
		Nereididae		3	9	4	3	7	3	29	3	3	1	2	3	2	14
		Orbiniidae		1		1				2						1	1
		Spionidae		4	2	1		2	2	11	1			1		1	3
Hemichordata																	
	Enteropneusta													1			1
Crustacea																	
	Amphipoda																
		Jassidae		1						1							
		Lysianassidae			1					1		1	1			1	3
		Oedicerotidae		2						2							
		Phoxocephalidae			1		1	1		3	1		1		1	3	6
Mollusca																	
	Gastropoda																
		Trochidae															
			Micrelenchus tenebrosus			1	1	1		3		2	1		1		4
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi	3	5	6	6	4	5	29	3		2	3	2	2	12
		Tellinidae															
			Macomona liliana			1	1	1	1	4		1		1			2
		Animals per core		18	24	16	14	22	16	110	9	12	9	10	8	14	62
		Animals per m^2		4014	5352	3568	3122	4906	3568	24530	2007	2676	2007	2230	1784	3122	13826
		Species per site		7	7	7	6	7	5	12	5	7	6	6	5	8	13

Table 15. *Abundance of species of infauna collected <20m and >50m from the Orari Street outfall.*

Orari Street			Location	<20m							>50m						
2011				Site 1			Site 2				Site 1			Site 2			
			Sample	1	2	3	4	5	6	sum	1	2	3	4	5	6	sum
Phylum		**Family**	**Genus/species**														
Annelida																	
	Polychaeta																
		Glyceridae		5	2	3	8	4	2	24	2		5	2	3	4	16
		Maldanidae				1	3	2	1	7			2	2	1		5
		Nephtyidae					1			1		2		2	1	1	6
		Nereidae			2	1	2		1	6	1	1					2
		Nereididae		6	4	4	6	3	5	28	1	4	6	3	6	3	23
		Spionidae		2	1	2			1	6		3	3		5	1	12
Hemichordata																	
	Enteropneusta				1		1	1		3					1		1
Sipuncula							1			1					1		1
Crustacea																	
	Amphipoda	Haustoriidae															
		Jassidae											1			1	2
		Lysianassidae				1	2			3							
		Oedicerotidae					1			1							
		Phoxocephalidae		1	1	1				3		1	1				2
	Isopoda																
			Isocladus armatus												1		1
	Malacostraca		*Macrophthalmus hirtipes*		1					1							
	Tanaidacea						1			1							
	Ostracoda								1	1							
Mollusca																	
	Gastropoda																
		Trochidae															
			Micrelenchus tenebrosus	1			1	1		3				1	1		2
		Nacellidae															
			Cellana ornata				1	1		2							
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi	6	5	1	4	7	5	28	4	3	1	4	4	5	21
			Nucula spp.				1		1	2	2	1	2	3		1	9
		Tellinidae															
			Macomona liliana	1	1	1		1	1	5	1	1	1			2	5
		Animals per core		22	18	15	33	20	18		11	16	22	17	24	18	108
		Animals per m^2		4906	4014	3345	7359	4460	4014	0	2453	3568	4906	3791	5352	4014	24084
		Species per site		7	9	9	14	8	9	19	6	8	9	7	10	8	15

Table 16. *Abundance of species of infauna collected <20m and >50m from the Portobello Road outfall.*

Portobello Rd			Location	<20m							>50m						
2011				Site 1			Site 2				Site 1			Site 2			
			Sample	1	2	3	4	5	6	sum	1	2	3	4	5	6	sum
Phylum		**Family**	**Genus/species**														
Annelida																	
	Polychaeta																
		Glyceridae		5	3	7	11	3	7	36		1			1	2	4
		Maldanidae		2	1	2	3		4	12	1						1
		Nephtyidae				3	4	1	5	13			1			1	2
		Nereididae		1		3	2			6			1				1
		Spionidae														1	1
		Syllidae				2	1	1		4		1	1				2
Hemichordata											1					1	2
	Enteropneusta					1				1							
Crustacea																	
	Amphipoda																
		Lysianassidae										1					1
		Phoxocephalidae			1	1		3	1	6			5				5
	Malacostraca		*Macrophthalmus hirtipes*											1			1
Mollusca																	
	Gastropoda																
		Nacellidae															
			Cellana ornata												1		1
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi		1					1	3		1	2	2		8
			Puyseguria spp.														
		Tellinidae															
			Macomona liliana											1	1		2
		Animals per core		8	6	19	21	8	17	79	5	3	9	4	5	5	31
		Animals per m^2		1784	1338	4237	4683	1784	3791	17617	1115	669	2007	892	1115	1115	6913
		Species per site		3	4	7	5	4	4	8	3	3	5	3	4	4	13

3.4 Analyses of Cockle, Mussels, Fish and Octopus flesh

st year, levels of heavy metals in cockle flesh showed no clear trend for contamination in moving from Kitchener Street to Portobello Road (Table 17). This differs from 2008 and 2009 when levels were highest at Portobello Road. PAHs on the other hand, remain by far the highest at Portobello Road (Table 17).

All heavy metals were at concentrations two orders of magnitude below accepted food standards (Table 18). There are no specific guidelines for PAH in shellfish flesh for New Zealand, but food standards for British Columbia recommend an upper limit for benzo[a]pyrene (Table 19).

It should be noted that, as already stated, and as found in previous surveys, cockles became smaller as one nears the Portobello Road outfall. Whether this is due to

PAH contamination or exposure at low tides and to fresh water, or some other factor, remains to be determined. As suggested last year, perhaps an investigation of cockle sizes at a site with similar fresh water and tidal exposure is merited.

Faecal coliform levels in cockle flesh were highest at Portobello Road and below detectable limits at Orari Street and Kitchener Street, much the same as in 2009. Last year they were highest at Kitchener Street and moderate at Orari Street and Portobello Road. Highest overall FC levels in cockles were in 2008 but FCs were not detected in any cockle samples in 2007.

To my knowledge, cockles are not gathered by recreational harvesters in the upper harbour basin as they are perceived to be contaminated and too small to be worthwhile.

Table 17. *Contaminant concentrations in cockle flesh from within 20m of the Kitchener Street, Orari Street and Portobello Road stormwater outfalls in 2007, 2008, 2009, 2010 and 2011. Green shading indicates a decrease in contaminant level, pink indicates an increase, white = no change. BDL = below detectable limits.*

	Parameter	Units		Portobello Rd	Orari Street	Kitchener St
Cockles	As	mg/kg	2007	2.5	2.5	3.5
			2008	4.0	2.8	3.3
			2009	2.9	4.9	3.8
			2010	2.0	2.3	2.2
			2011	2.5	2.5	2.8
	Cd	mg/kg	2007	0.014	0.011	0.016
			2008	0.023	0.010	0.015
			2009	0.021	0.024	0.017
			2010	0.014	0.013	0.010
			2011	0.015	0.014	0.015
	Cr	mg/kg	2007	0.32	0.32	0.34
			2008	0.65	0.15	0.27
			2009	0.22	0.30	0.31
			2010	BDL	0.18	0.13
			2011	0.02	0.17	0.22
	Cu	mg/kg	2007	0.64	0.70	0.81
			2008	1.20	0.85	0.67
			2009	0.82	1.10	0.89
			2010	0.43	0.46	0.66
			2011	0.77	0.65	0.71
	Ni	mg/kg	2007	0.71	1.00	0.64
			2008	1.30	1.10	1.30
			2009	0.89	0.93	1.00
			2010	0.72	1.24	1.30
			2011	0.69	1.02	1.10
	Pb	mg/kg	2007	0.17	0.11	0.08
			2008	0.42	0.07	0.08
			2009	0.099	0.110	0.082
			2010	0.151	0.082	0.089
			2011	0.130	0.094	0.082
	Zn	mg/kg	2007	6.3	6.4	8.0
			2008	11.0	7.7	8.6
			2009	7.4	10.0	9.0
			2010	5.5	5.3	6.7
			2011	6.8	5.8	7.1
	PAH	mg/kg	2007	4.912	0.018	0.009
			2008	0.640	0.047	0.028
			2009	0.613	0.038	0.028
			2010	1.714	0.035	0.044
			2011	0.772	0.034	0.027
	Faecal coliforms	MPN/100g	2007	<18	<18	<18
			2008	1300	230	78
			2009	78	<18	<18
			2010	68	68	220
			2011	45	<18	<18

Table 18. *Heavy metal concentrations for NZ and US FDA guidelines for adults (expressed as mg/kg dry weight). '-' means no guideline is available.*

	Cu	Zn	Pb	Cd	Cr	Ni
Food Regs/NZ DoH	150.0	2000.0	10.0	5.0	-	-
US FDA	-	-	4.2	-	11.0	80.0
Australia NZ food standards code	-	-	2.0	2.0	-	-

Table 19. *British Columbian guidelines for B[a]P concentration in shellfish for human consumption*

B[a]P concentration in the edible portion of fish/shellfish (µg B[a]P/kg wet weight)	Safe quantity for weekly consumption* on a regular basis (g wet weight)	B[a]P Portobello Road cockles 2007 (µg B[a]P/kg wet weight)	B[a]P Portobello Road cockles 2008 (µg B[a]P/kg wet weight)
4	50	249	34
2	100		
1	200		

*low and moderate consumption levels, according to the State of Washington, are 45 g/wk (or 6.5 g/d) and 140 g/wk (or 20 g/d).

As for cockles in the upper harbour basin, mussels from Second Beach showed levels of contamination that were well below accepted food guidelines (Table 20). Concentrations of most contaminants were not dissimilar to those observed in cockles (Table 17), but with nickel and arsenic slightly lower and copper and zinc slightly higher. Overall, however, there is little evidence of contamination of shellfish by stormwater at this site.

Seven triplefins were caught in baited fish traps set off the Mason Street wharf on 31st May 2011. The triplefins were small (Table 20), but representative of the size classes commonly seen amongst variable triplefins. Sizes and weights of the triplefins were slightly up on those caught in 2007 and 2008 but lower than last year and 2009 (Table 21). Levels of all contaminants in fish this year were generally similar to those observed in previous surveys. Overall, levels PAHs and of all metals except zinc were lower in fish than in cockles. Levels of chromium continue to be lowest in fish and Portobello Road cockles (Tables 17 & 22).

It could, therefore, be argued that the concentration of most contaminants in the fish, with the exception of zinc, were similar to or lower than in cockles (Table 22). This is similar to the situation in 2007, 2008, 2009 and 2010. At first glance one is tempted to say that this is not unexpected, given that the cockles are filter feeders while the fish are predators. However, contaminants tend to become more concentrated as one moves up the food chain. Triplefins do not prey on shellfish, but do eat smaller fish and a variety of other invertebrates. The fact that contaminant levels are relatively low in fish flesh suggests that heavy metal and PAH contamination around the Mason Street stormwater outfall is low.

Despite numerous patrols along the foreshore no octopus were found for collection of samples this year.

Table 20. *Contaminant concentrations in mussel flesh from within 20m of the Second Beach stormwater outfall.*

	Parameter	Units		Second Beach
Mussels	As	mg/kg	2007	1.6
			2008	1.9
			2009	1.9
			2010	1.5
			2011	1.7
	Cd	mg/kg	2007	0.078
			2008	0.083
			2009	0.084
			2010	0.094
			2011	0.014
	Cr	mg/kg	2007	0.33
			2008	0.20
			2009	0.11
			2010	0.19
			2011	0.21
	Cu	mg/kg	2007	1.00
			2008	0.69
			2009	1.50
			2010	0.94
			2011	1.03
	Ni	mg/kg	2007	0.4
			2008	0.3
			2009	0.3
			2010	0.5
			2011	0.4
	Pb	mg/kg	2007	0.14
			2008	0.11
			2009	0.20
			2010	0.18
			2011	0.16
	Zn	mg/kg	2007	12.0
			2008	9.4
			2009	14.0
			2010	9.8
			2011	11.3
	Faecal coliforms	CFU/100ml	2007	<18
			2008	20
			2009	45
			2010	<18
			2011	170

Table 21. *Size and weight of triplefins captured near the Mason Street Stormwater outfall in 2007, 2008, 2009, 2010 and 2011. Spotty values in blue shaded cells.*

2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
Fish Sizes (mm)					Weight (g)				
75	70	101	151	74	4.7	4	13.1	41.3	5.12
71	67	88	72	53	3.9	2.9	9.8	4.9	1.52
73	46	96	75	64	4.4	0.9	10.6	5.2	2.71
61	65	71	88	68	2.2	3	4.5	7.0	3.24
49	63	62	83	87	1.1	2.7	2.8	7.3	7.28
78	75	81	80	77	5.3	5.5	6.9	6.5	5.1
77	58	70	78	90	5.6	2.4	4.1	4.8	9.88
79	67	78	62		6.1	3.4	6.6	2.5	
75	72	79	79		4.1	4.5	6	6.5	
46	83	59	76		0.9	6.4	2.1	5.1	
52	71				1.6	4.8			
74	68				4.6	3.8			
	72					4.8			
	65					2.8			
	59					2.7			
	56					2.2			
	60					2.4			
Mean = 67.5	65.71	78.50	84.40	73.29	3.7	3.48	6.65	9.11	4.98
Mean (excluding spotty) =			77.0					5.5	

Table 22. *Contaminant concentrations in the flesh of triplefins captured near the Mason Street Stormwater outfall. BDL = below detectable limits.*

	Parameter	Units		Mason Street
Fish	As	mg/kg	2007	1.90
			2008	1.60
			2009	1.90
			2010	1.56
			2011	1.24
	Cd	mg/kg	2007	0.0047
			2008	0.0047
			2009	0.0110
			2010	0.0091
			2011	0.0060
	Cr	mg/kg	2007	0.05
			2008	BDL
			2009	0.14
			2010	BDL
			2011	BDL
	Cu	mg/kg	2007	0.54
			2008	0.52
			2009	1.20
			2010	0.38
			2011	0.49
	Ni	mg/kg	2007	BDL
			2008	BDL
			2009	<0.095
			2010	BDL
			2011	0.13
	Pb	mg/kg	2007	0.140
			2008	0.120
			2009	0.43
			2010	0.14
			2011	0.14
	Zn	mg/kg	2007	21.00
			2008	20.00
			2009	21.00
			2010	18.10
			2011	19.70
	PAH	mg/kg	2007	7.0000
			2008	0.0023
			2009	0.0060
			2010	0.0150
			2011	0.0015
	Mean Size	(mm)	2007	67.5
			2008	65.7
			2009	78.5
			2010	84.4
			2011	73.3
	Mean Weight	(g)	2007	3.7
			2008	3.5
			2009	6.65
			2010	9.11
			2011	4.98

4. Discussion and Conclusion

In 2011 water samples were colleted from a total of 14 major Dunedin City stormwater outfalls. In addition, sediments were sampled from near 5 of these outfalls and from an additional 5 sites located some distance from the outfalls to

gain a clearer picture of the distribution of contaminants in sediment in the upper Otago Harbour. Flesh from fish, cockles and mussels was also collected for contaminant analysis. For interest sake historical data for some of the same sites have been included for comparison (Tables 23 and 24). Any trends observed in these data for historical sediment values should be viewed with extreme caution as sampling in some previous years may have used entirely different protocols. For example, sediments may have been collected from different depths within the substrate and by different methods meaning that results are not directly comparable. Stormwater sampling, however, should be comparable assuming previous investigators targeted the first flush.

There has been a decline in the levels of some contaminants at stormwater outfalls for which historic data are provided, but a rise in others. The reduction in lead levels continues at George Street and Kitchener Street, and is perhaps to be expected as it has been removed from paint and petrol and levels in the environment are very gradually declining. The reduction in the levels of other contaminants is very slight (e.g. Zn and Cu at four sites) and there is a slight increase in levels of all metals a few sites (Table 23). Such fluctuations are relatively small and may be merely a function of the intensity of the storm events when sampling occurred.

Overall levels of contaminants in sediment, however, appear to continue to fall slightly, suggesting build-up of contaminants in the environment may have plateaued, or is declining, and existing contaminants may be being buried (Tables

23 and 24). The increased levels of most metals seen at Wickliffe Street in the past is not apparent this year.

It is expected that the implementation of the long-term stormwater catchment management plans currently under development through the DCC's Three Waters Strategy will contribute to addressing the issue of future contaminants in stormwater. It will be of interest to see if any long-term trends in contaminant levels can be discerned as monitoring continues.

Benthic and infaunal communities in the vicinity of the Portobello Road, Orari Street and Kitchener Street outfalls have reasonably low diversity, but this is generalised and not associated with any one outfall and is likely symptomatic of a large proportion the upper harbour basin. As in past years there is a trend towards smaller cockles as one nears the Portobello Road outfall. This may be as a result of historic PAH contamination, which is extremely high beneath the surface at this site, but a number of other factors, not least of which are freshwater exposure and exposure at low tide, must also be considered.

Rainer (1981) and Grove (1995) certainly found less diversity in soft-bottom macrofaunal communities as one moves from harbour mouth to the head of Otago Harbour. It should be pointed out that much of the shoreline around the upper harbour has been extensively modified and as such cannot be regarded as an inlet typical of those found throughout the region. Despite this the communities sampled in the upper Otago Harbour near stormwater outfalls are numerically dominated by polychaete worms and amphipods, as is usual for sheltered soft shores around New Zealand (Morton and Miller 1973), and show distinct

similarities to communities found in other moderately impacted inlets in Otago (Stewart 2007b, 2008a,b).

While not pristine, the upper harbour and the communities associated with the intertidal areas adjacent to major stormwater outfalls appear not to be undergoing any significant further degradation as a result of stormwater inputs. It is to be hoped that if the trend towards lower contaminant levels in stormwater is continued, both water quality and community health in the harbour will gradually improve over time.

Only after problem areas and problem contaminants have been identified can measures be taken to mitigate any effects. No additional mitigation measures have been undertaken by the DCC at this stage, apart from investigations into the remediation of PAH contamination at the Portobello Road outfall (Stewart 2006), the elimination of the source of FWAs at Bauchop Street in 2008, and the usual street sweeping and mud tank clearance. As already stated, the South Dunedin (Portobello Road) catchment has been investigated as the pilot catchment for the development of the Three Waters Strategy catchment management plans. It is expected that further stormwater monitoring over time and concurrent investigations under the Three Waters strategy will define problem areas such that mitigation measures may be undertaken.

It should be noted that the current stormwater monitoring programme is under review and a modified programme may help pinpoint areas of concern with more accuracy in future.

Table 23. *Contaminants in stormwater being discharged to the upper Otago harbour basin through time. BDL = below detectable limits. Pink cells denote levels higher than at any past sampling event; green cells denote levels lower than at any past sampling event.*

Parameter	Suspended Solids						Cd						Cr						Cu					
units	g/m^3						g/m^3						g/m^3						g/m^3					
	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011
Second Beach		BDL	37.0	41	BDL	57		BDL	0.00006	0.00006	0.00007	0.000075		0.0007	0.0028	0.0035	0.00086	0.0038		0.0027	0.012	0.019	0.0054	0.0172
Pt Chalmers George St		87.0	150.0	26	170	140		0.00028	0.00140	0.00011	0.00033	0.000168		0.005	0.012	0.0031	0.00136	0.0045		0.0213	0.039	0.025	0.0148	0.0197
Pt Chalmers Watson Pk		37.0	39.0	7.4	240	24		BDL	BDL	BDL	BDL	BDL		BDL	0.0064	BDL	BDL	BDL		0.009	0.0025	BDL	BDL	BDL
Shore Street	75.4	41.0	24.0	20	9.5	12		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL	BDL		0.01	0.014	0.02	0.0118	BDL
Portobello Road	28.0	18.0	46.0	30	8.1	53	0.0003	BDL	0.00023	BDL	BDL	BDL	0.0029	BDL	0.002	BDL	BDL	BDL	0.03	BDL	0.026	0.01	0.0057	0.029
Teviot Street		25.0	33.0	12	84	66		BDL	0.00008	BDL	0.00026	BDL		BDL	0.0018	BDL	BDL	BDL		BDL	0.0094	BDL	0.0136	0.031
Midland Street		30.0	19.0	30	52	14		BDL	0.00013	BDL	BDL	BDL		BDL	0.0035	0.0031	BDL	BDL		0.02	0.031	0.057	0.021	BDL
Orari Street	38.1	28.0	77.0	16	130	4	0.0005	BDL	BDL	BDL	0.000164	BDL	0.002	BDL	0.0032	BDL	0.00183	BDL	0.0132	BDL	0.014	BDL	0.0096	BDL
Kitchener Street		104.0	41.0	45	50	BDL		BDL	BDL	BDL	BDL	BDL		0.004	0.002	BDL	BDL	BDL		0.034	0.0056	0.023	0.0118	BDL
Mason Street		62.0	37.0	37	138	30		BDL	BDL	0.0077	0.00051	BDL		BDL	BDL	BDL	BDL	BDL		0.022	0.012	0.021	0.0157	0.043
Ravensbourne Road			8.5	18	61	5			BDL	BDL	BDL	BDL			0.00061	BDL	BDL	BDL			0.0023	BDL	0.0031	BDL
Bauchop Street		44.0	16.0	13	53	5		BDL	BDL	BDL	0.00049	BDL		BDL	0.0015	BDL	BDL	BDL		0.029	0.0096	0.021	0.0026	BDL
Halsey Street		119.0	35.0	27	50	24		BDL	0.00022	BDL	0.00026	BDL		BDL	BDL	BDL	BDL	BDL		0.024	0.0043	BDL	0.00162	0.029
Wickliffe Street		35.0	27.0	100	86	46		BDL	BDL	0.00052	0.00078	0.00092		BDL	0.0017	0.0076	0.00157	0.0046		0.01	0.013	0.059	0.0058	0.022

Parameter	Ni						Pb						Zn						PAH					
units	g/m^3						g/m^3						g/m^3						g/m^3					
	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011
Second Beach		0.0009	0.0021	0.0022	0.00133	0.0026		0.001	0.011	0.013	0.00021	0.0127		0.038	0.16	0.15	0.092	0.25						
Pt Chalmers George St		0.0029	0.0093	0.0026	0.006	0.0037		0.0342	0.041	0.018	0.0048	0.0037		0.288	0.66	0.19	0.42	0.25						
Pt Chalmers Watson Pk		BDL	BDL	BDL	0.0035	BDL		0.0141	0.0018	BDL	BDL	0.0041		0.231	0.027	BDL	0.29	0.24						
Shore Street		0.01	BDL	BDL	BDL	BDL		0.003	0.0085	0.0069	BDL	BDL		0.02	0.44	0.21	0.115	BDL						
Portobello Road	0.002	BDL	0.0035	0.0028	0.0035	BDL	0.021	BDL	0.019	0.0067	0.00055	0.026	0.895	0.08	0.94	0.64	0.153	0.87	0.0031	BDL	328	0.00017	0.00016	0.00168
Teviot Street		BDL	0.0019	BDL	0.0033	BDL		BDL	0.0066	BDL	BDL	0.0065		BDL	0.13	BDL	1.79	0.61						
Midland Street		BDL	0.0016	BDL	0.0075	BDL		0.005	0.0054	0.0083	BDL	BDL		0.1	0.35	0.18	0.22	BDL						
Orari Street	0.002	BDL	0.0033	BDL	0.00108	BDL	0.022	BDL	0.023	BDL	0.00015	BDL	0.191	BDL	0.22	0.031	0.3	BDL	0.0026	0.0001	318	BDL	0.0005	BDL
Kitchener Street		0.003	BDL	0.0036	0.0035	BDL		0.0442	0.007	0.018	0.00196	BDL		0.445	0.036	0.38	0.62	BDL		BDL	327	BDL	0.0001	BDL
Mason Street		0.004	BDL	0.0055	BDL	0.0039		0.0258	0.0089	0.014	0.00102	0.0192		0.25	0.16	0.35	0.43	0.63						
Ravensbourne Road			0.00066	BDL	0.00148	BDL			0.0015	0.0029	0.00023	0.025			0.053	0.047	0.144	0.27						
Bauchop Street		0.01	BDL	0.0035	BDL	BDL		0.01	0.0035	0.0097	BDL	BDL		0.23	0.12	0.3	0.121	BDL						
Halsey Street		0.009	BDL	BDL	BDL	BDL		0.021	0.0022	BDL	0.0021	0.0085		0.12	0.033	0.13	0.136	0.36						
Wickliffe Street		0.01	BDL	0.0042	BDL	0.0021		0.006	0.0084	0.033	BDL	0.0134		0.1	0.2	0.53	0.24	0.82						

Table 24. *Contaminants in sediments in the upper Otago harbour basin in the vicinity of selected stormwater outfalls through time. Pink cells denote levels higher than at any past sampling event; green cells denote levels lower than at any past sampling event.*

	Arsenic						Cadmium						Chromium						Copper						Nickel					
	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011
Rowing Club		10.6	9.8	7.3	13.0	11.6	0.0	0.2	0.2	0.1	0.2	0.1	16.8	17.6	12	16.0	14.0	11.6	9.8	14.2	13	14	9	12		11.3	14	13.0	11.0	12.1
Wickliffe		17.3	11.0	6.9	9.0	14.3		0.6	0.74	0.8	0.7	0.7		38	34	16.0	27.0	30.0		121.0	68	50	58	86		19.2	23	13.0	17.0	15.9
White St		11.6	18.0	5.4	6.0	8.3		0.3	0.22	0.2	0.1	0.1		68.5	56	26.0	19.0	30.0		433.0	160	170	78	98		29.5	21	11.0	8.0	14.5
Kitchener St		4.6	7.5	7.0	9.0	4.5		0.4	0.35	0.3	0.3	0.3	7.1	22.6	18	98.0	22.0	18.3		69.5	56	90	37	54	5.8	10.6	12	15.0	12.0	10.6
Orari St		18.6	4.3	20.0	5.0	2.1	0.5	63.0	0.13	0.9	0.2	0.1	17.5	0.27	16	37.0	16.0	9.4	20	25.1	13	61	11	7	10.4	23.6	8.1	16.0	8.0	5.3
Orari 100		13.7					0.3	0.4					16	26.3					28	25.9					8.8	12.6				
Midland 200		15.4					0.4	0.3					22	22.4					24	19.0					8.3	10.7				
Portobello Rd		29.0	23.0	24.0	15.0	28.0	2.0	1.8	1.8	2.0	1.5	2.6	41	60.1	54	50.0	36.0	67.0	210	169.3	160	190	123	176	15	20.4	18	26.0	19.0	24.0
PR 200		17.4					1.0	0.5					32	41.8					100	52.6					13	17.3				
Shore St		9.5	7.1	6.2	6.0	2.3	0.5	0.4	0.32	0.3	0.3	0.2	9.6	21.8	16	18.0	19.0	5.8	30	50.9	44	41	35	11	5.4	10.7	9	11.0	10.0	5.2
Boatshed		27.4	16.0	17.0	15.0	16.2		0.3	0.21	0.2	0.3	0.6		41.7	19	26.0	31.0	34.0		108.0	33	49	35	53		24.5	16	17.0	16.0	18.5
Cove Drainage		21.5	17.0	19.0	13.0	9.5		0.1	0.13	0.4	<0.1	0.2		15.8	35	32.0	19.0	21.0		11.3	19	38	11	14		23.5	44	23.0	19.0	12.8
Retaining wall		25.3	36.0	24.0	36.0	39.0		0.1	0.15	<0.1	<0.1	0.1		23.6	31	39.0	23.0	24.0		13.3	19	17	10	11		15.9	25	26.0	18.0	13.2
RW 300		16.2					0.1	0.3					28.33	0.27					16.3	15.2					13.3	12.4				
W/W centre		11.1						0.2					2.75	30.8						15.3					3.63	14.6				
UHB Centre		10.5					0.3	0.2					26.8	24.3					15.2	15.2					10	11.3				

	Lead						Zinc						PAH						Enterococci					
	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011	Historic	2007	2008	2009	2010	2011
Rowing Club		18.9	27	27	28	19	80.8	101	130	160	149	109		6.97	5.78	0.5	3.7	0.1		200	11	<2		8
Wickliffe		76.1	140	77	92	127		412	740	810	740	700		9.21	1.18	7.3	7.2	11.3		58000	>1600	330	<3	>160
White St		147	180	170	124	147		4450	2500	2400	1280	1650		12.96	11.05	15.9	6.5	5.4		400	2	<2		35
Kitchener St		117.9	97	130	155	132	170	249.33	280	300	280	260		8.88	140.49	4.8	5.0	5.5	130	6633	920	5	<3	>160
Orari St	185	12.8	39	120	35	17	239	68.27	130	680	157	69	13.41	10.23	12.59	28.3	9.3	4.3	557	12.67	8	23	<3	54
Orari 100	170	170					230	227						6.67					1300	3600				
Midland 200	36	36					190	165						7.24					130	20000				
Portobello Rd	410	306.33	330	290	193	310	1300	1493	1400	1600	1040	1410	425.83	382.90	250.30	525.2	194.1	482.0	1120	72667	170	<2		16
PR 200	130	81.3					430	309					12.29	8.97					40	66000				
Shore St	130	113	110	79	85	36	300	484	300	330	350	210		9.56	21.01	8.6	10.5	4.1	2400	9000	>1600	<2		35
Boatshed		112	800	170	86	89		339	370	360	290	300		6.67	5.54	38.8	7.9	40.4		3400	33	33	<3	54
Cove Drainage		19.7	20	55	18	44		99.2	150	270	125	119		0.37	0.00	0.1	0.1	1.0		800	17	<2	<3	35
Retaining wall		26.9	27	42	24	23		141	170	150	152	138		0.30	3.91	0.0	9.4	0.2		<100	8	<18		8
RW 300	40	6.7					149	131						0.30						<2				
W/W centre	25	5.6						168						0.34						<2				
UHB Centre	27	23					118	119						0.65						24000				

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Stormwater Compliance Monitoring 2012

Stormwater Discharges from Dunedin City

(ORC Resource Consents 2002.080-2002.110 and 2006.222)



Prepared for

Dunedin City Council

by

Ryder Consulting Ltd.

May 2012

ryderconsulting
environment + planning + project management

Stormwater Compliance Monitoring 2012

Stormwater Discharges from Dunedin City
(ORC Resource Consents 2002.080-2002.110 and 2006.222)

prepared by

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May 2012

Cover photo: Low tide near the Orari Street stormwater outfall

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Executive Summary

This report presents the findings for the fifth annual monitoring of Dunedin's stormwater outfalls since discharge consents were granted.

The survey comprised assessment of benthic communities, of contamination of stormwater and of contamination of sediments and benthic fauna, including fish, cockles, octopus and mussels.

Stormwater from all outfalls monitored showed variable levels of contamination, with numerous parameters being present at concentrations above recommended ANZECC guidelines or trigger values at a variety of outfalls.

Sediments too showed varying levels of contamination from outfall to outfall with levels of contaminants breaching ANZECC trigger values for lead, zinc and PAHs at many sites. However, overall sediment contaminant levels at sites remote from the outfalls appear to be falling through time.

Contaminant levels in both stormwater and sediment were within the ranges observed in previous surveys carried out in 2007, 2008, 2009 2010 and 2011 with no clear trends in contaminant levels discernible at this juncture.

However, it appears the ecology of the upper harbour basin is not being appreciably degraded as a result of the discharge of stormwater to Otago harbour.

1. Introduction

1.1 Background

As with all urban centres throughout New Zealand and indeed most of the world, Dunedin's stormwater is reticulated to receiving environments via networks of gutters, open channels and pipes. The principal receiving water environments for Dunedin's reticulated stormwater are the upper basin of Otago Harbour, Second Beach/St. Clair Beach on the open coast, Kaikorai Stream and the Water of Leith. Dunedin City Council (DCC) was, on 29th November 2007, granted resource consents for its major urban stormwater discharges into the coastal marine environment (i.e. Otago Harbour, Sawyers Bay. Port Chalmers and Second Beach).

Conditions under which consents have been granted include compliance monitoring. Specifically:

Condition 2.

(a) *The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of rainfall events means that sampling in the manner described in condition 2(b) is not possible.*

(b) *The sampling shall be undertaken during storms, preceded by at least 72 hours of no measurable precipitation, with an intensity of at least 2.5 millimetres (depth) of rain in a 24 hour period. Sampling shall be undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:*
(i) pH
(ii) suspended solids
(iii) faecal coliforms and Escherichia coli
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) UV fluorescent (whitening agent)
(xii) HEM, oil and grease
(xiii) Polycyclic aromatic hydrocarbons ***(Portobello Road, Orari and Kitchener Street consents only)***

(c) *The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b).*

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road catchment discharge consent only

(a) *The consent holder shall undertake to determine the source and extent of the high levels of polycyclic aromatic hydrocarbons in the historic sediment deposits associated with discharge from the Portobello Road stormwater outlet.*

(b) *Updates on the progress of the investigation in condition 3(a) shall be*

provided in writing to the Consent Authority by 1 September each year.

(c) *No later than six months prior to the expiry of this consent, the consent holder shall provide a report to the Consent Authority stating the outcomes of the investigation in condition 3(a) and outlining the best practicable option(s) to mitigate the effects of these contaminated sediments.*

For the Portobello Road, Orari and Kitchener Street discharge consents only

(a) *The consent holder shall undertake biological monitoring annually between the months of January to June inclusive. The monitoring shall be undertaken at four sites at the waters edge at low tide; two within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide and two a minimum of 50 metres of the confluence of the stormwater outlet and the waters edge at low tide.*

(b) *At each site, three randomly spaced 5m^2 quadrats shall be sampled. For epifauna within each 5m^2 quadrat, the number of each species shall be recorded in five 0.1m^2 quadrats. For infauna a sediment core shall be taken in three 0.1m^2 quadrats and the number of each species shall be recorded. For macroflora, the percentage cover of each species shall be estimated in three 1.0m^2 quadrats.*

(c) *Results shall be reported to the Consent Authority in accordance with condition 8(e).*

For the Portobello Road, Orari and Kitchener Street discharge consents only

The consent holder shall undertake sampling of the flesh of cockles (Austrovenus stutchburyi) annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, within 20 metres of the confluence of the stormwater outlet and the waters edge at low tide. The size of each cockle sampled shall be recorded. The cockle flesh samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
(i) faecal coliforms

Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road and Orari Street discharge consents only

The consent holder shall undertake sampling of deceased octopus annually, between the months of January to June inclusive (to align with the autumn die-off of octopus). Samples will include flesh and, if available, digestive gland. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The total arm span and weight of each octopus sampled shall be recorded. The samples shall be analysed for:

(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons

Results shall be reported to the Consent Authority in accordance with condition 8(e). Should no deceased octopus be present, the consent holder shall notify the Consent Authority that sampling is unable to be undertaken.

For the Mason Street discharge consents only

The consent holder shall undertake sampling of spotties (Notolabrus

celidotus) or triplefin (Tripterygion varium) annually. This sampling is to be carried out within the months of January to June inclusive. Sampling shall be carried out within 50 metres of the confluence of the outlet and the waters edge at low tide. The length and weight of each fish sampled shall be recorded. The samples shall be analysed for:
(a) total copper
(b) total lead
(c) total zinc
(d) total arsenic
(e) total nickel
(f) total cadmium
(g) total chromium
(h) polycyclic aromatic hydrocarbons
Results shall be reported to the Consent Authority in accordance with condition 8(e).

For the Portobello Road, Orari and Kitchener Street discharge consents only

The consent holder shall undertake sediment quality sampling using three replicate sediment samples that shall be collected at each site as marked on the plans attached as Appendix 1 to this consent. Sampling shall be undertaken:

(a) annually between January and June at the locations marked by large orange stars; and

(b) between January and June 2007, and between January and June 2010, at the locations marked by large pink stars. The samples will comprise the top 20mm of sediment and shall be analysed for:
(i) total copper
(ii) total lead
(iii) total zinc
(iv) total arsenic
(v) total nickel
(vi) total cadmium
(vii) total chromium
(viii) faecal coliforms and enterococci
(ix) polycyclic aromatic hydrocarbons
Results shall be reported to the Consent Authority in accordance with condition 8(e).

Condition 3. *The biological sampling of epifauna, infauna, macroflora, cockles, octopus, spotties or triplefins and sediment quality sampling required by Coastal Permits etc, shall be undertaken within a 14 day period (within the months of January to June), unless it is not practicable to do so due to the absence of any fauna to be sampled.*

Condition 4. *All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder and be acceptable to the Consent Authority.*

Condition 5. *Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.*

Second Beach
Condition 2.

(a) *The consent holder shall undertake water quality sampling of the discharge following one storm event annually, unless the size and frequency of the rainfall event means that sampling in the manner described in condition 2(b) is not possible.*

(b) *The sampling shall be undertaken during storms, preceded by at least 72 hours of no measurable precipitation, with an intensity of at least 2.5 millimetres (depth) of rain in a 24 hour period. Sampling shall be*

undertaken within the first hour of the storm discharge in order to obtain the maximum concentration of a pollutant. The samples shall be analysed for:
(i) pH
(ii) suspended solids
(iii) faecal coliforms and Escherichia coli
(iv) total copper
(v) total lead
(vi) total zinc
(vii) total arsenic
(viii) total nickel
(ix) total cadmium
(x) total chromium
(xi) HEM, oil and grease
(xii) UV fluorescent (whitening agent)

(c) *The consent holder shall also undertake targeted sampling of any visual slicks seen during the stormwater discharge sampling in conditions 2 (a) and (b). Results shall be reported in accordance with condition 8(e).*

Condition 3.
(a) *The consent holder shall undertake sampling of mussels annually, between the months of January to June inclusive. Sampling shall be carried out at the waters edge at low tide, 50 metres to the east of the outlet. The shell length of each mussel sampled shall be recorded.*

(b) *The sampling of mussels shall be undertaken within a 14 day period (within the months of January to June) associated with the sampling rounds for Green Island and Tahuna WWTP discharge consents, unless it is not practicable to do so due to the absence of any fauna to be sampled.*

(c) *The samples shall be analysed for:*
(i) faecal coliforms
(ii) total copper
(iii) total lead
(iv) total zinc
(v) total arsenic
(vi) total nickel
(vii) total cadmium
(viii) total chromium
(d) *Results shall be reported in accordance with condition 8(e).*

Condition 4. *All sampling techniques employed in respect of the conditions of this consent shall follow a written standard operating procedure to be developed by the consent holder and be acceptable to the Consent Authority.*

Condition 5. *Unless specifically approved otherwise by the Consent Authority, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that meets ISO17025 standards.*

The following report presents the results of the latest round of sampling/monitoring carried out between January and June 2012. It should be noted that the DCC is currently in the process of applying for new resource consents to cover the discharge of stormwater into Otago Harbour.

1.2 Stormwater Outfalls

Stormwater is discharged from Dunedin City to the Upper Otago Harbour, Second Beach and Port Chalmers from fourteen reasonably large and permanent stormwater outfalls (Figures 1a, 1b and 1c), and from a number of smaller outfalls

and non-point sources (Table 1). Many of the outfalls have very long histories dating back to the days of the early settlement of Dunedin and a numbers were dual-purpose outfalls, discharging both wastewater and stormwater. All current outfalls, however, are designated to discharge stormwater.



Figure 1a. *Major stormwater outfalls, labeled by catchment name, discharging from Dunedin City to the Upper Otago Harbour Basin.*

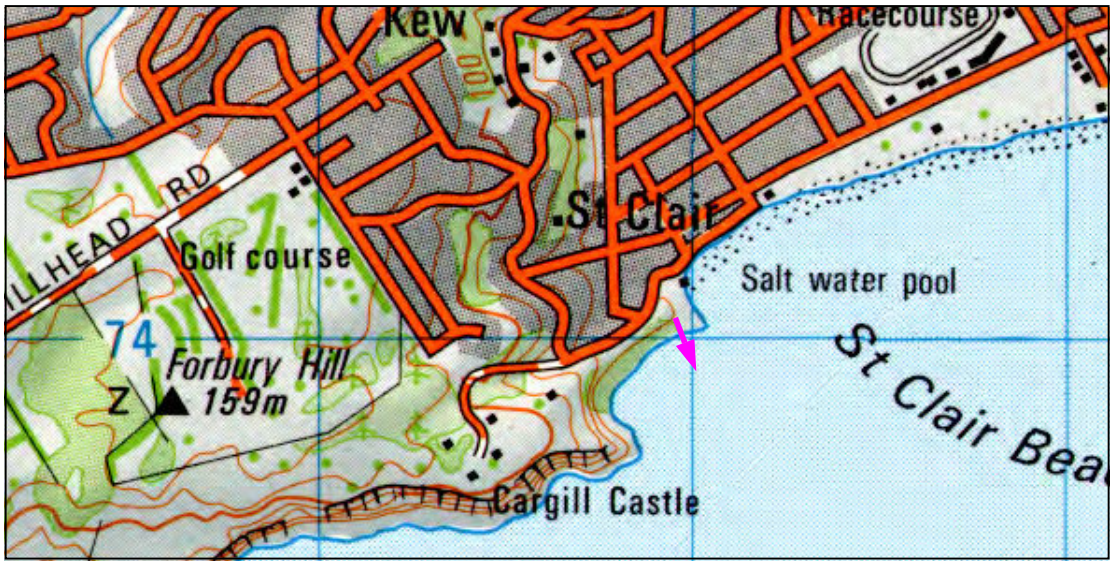


Figure 1b. *Location of the Second Beach stormwater outfall.*

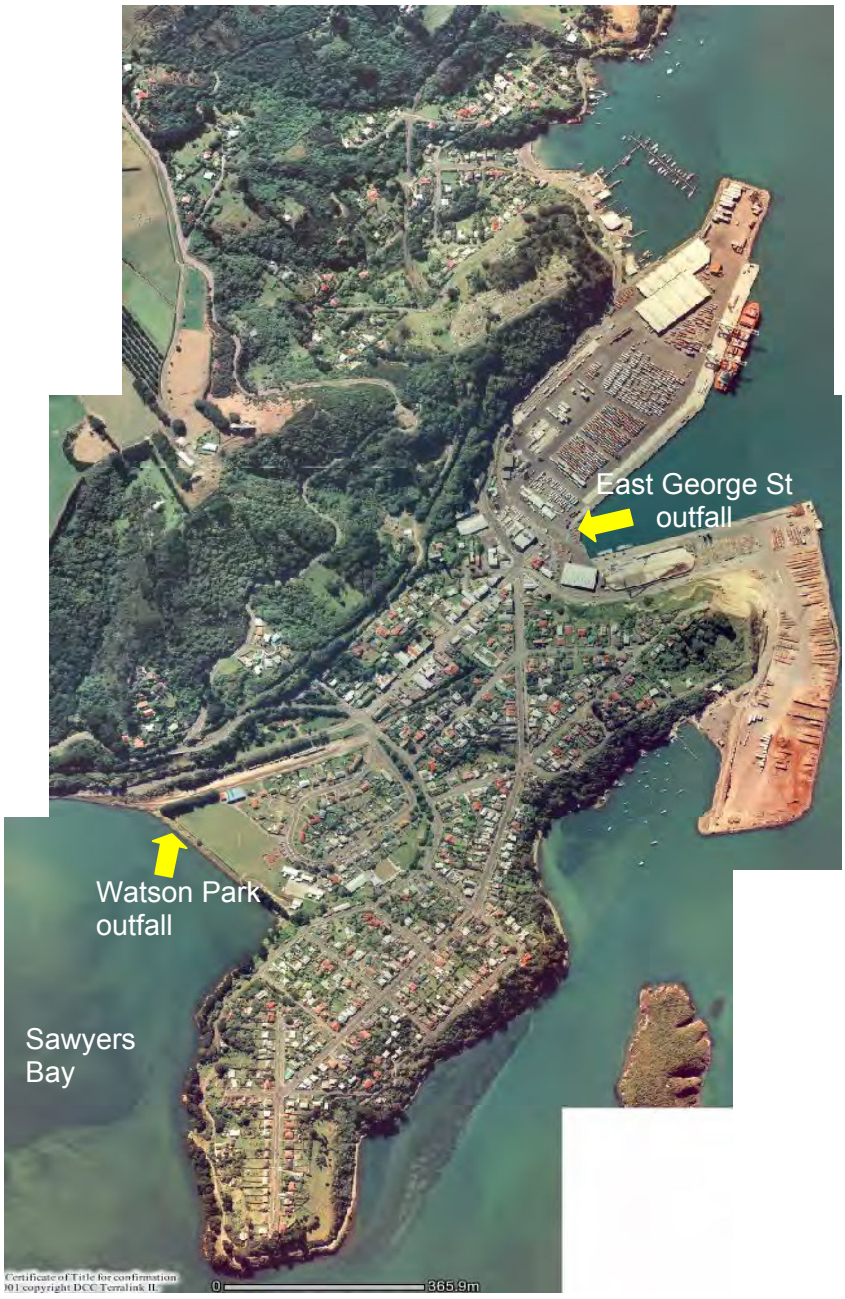


Figure 1c. *Location of major outfalls discharging stormwater from Port Chalmers.*

A total of 31 consents have been granted for the individual stormwater outfalls listed in Table 1.

Table 1. *List of stormwater outfalls for which discharge permits have been granted.*

Consent ref	DCC ref	Location	Catchment	Description	Max flow rate (l/s)	Outlet structure
2002.080	4	Shore St	Shore St	1500mm dia	2,380	Yes
2002.081	5	Portobello Rd	Portobello Rd	twin 1500mm dia conduits	pump rate 6,300	Yes
2002.082	6	Teviot St	Foreshore	375mm dia.	105	Yes
2002.083	7	Midland St	Foreshore	450mm dia	143	No
2002.084	8(a)	Orari St	Orari St	375mm dia	101	No
2002.085	8(b)	Orari St	Orari St	2700mm dia	10,350	Yes
2002.086	9(a)	Kitchener St	Kitchener St	600mm dia	310	Yes
2002.087	9(b)	Kitchener St	Kitchener St	1500mmdia	3,880	Yes
2002.088	10	French St	Foreshore	450mm dia	185	No
2002.089	11	Kitchener St	Foreshore	300 mm dia.	78	No
2002.090	12(a)	Birch St	Foreshore	225 mm dia.	37	No
2002.091	12(b)	Birch St	Foreshore	225 mm dia.	55	No
2002.092	12(c)	Wharf St	Foreshore	225 mm dia.	52	No
2002.093	13(a)	Fryatt St	Foreshore	150 mm dia.	40	No
2002.094	13(b)	Fryatt St	Foreshore	450mm dia	180	No
2002.095	13(c)	Fryatt St	Foreshore	300mm dia	54	No
2002.096	14	Fryatt St	Foreshore	300mm dia	116	No
2002.097	15(a)	Mason St	Mason St	2175mm dia. conduit	5,000	Yes
2002.098	15(b)	Mason St	Bauchop St	450mm dia	90	No
2002.099	15(c)	Mason St	Bauchop St	1350mm dia. culvert	1,500	No
2002.100	16(a)	Halsey St	Halsey St	1950mm conduit	3,800	No
2002.101	16(b)	Halsey St	Wickliffe St	1950mm conduit	2,600	No
2002.102	16(c)	Halsey St	Wickliffe St	300mm dia	113	Yes
2002.103	17	Wickliffe St	Wickliffe St	1,050 mm dia.	1,660	No
2002.104	18(a)	Magnet St	Magnet St	300mm dia	73	No
2002.105	18(b)	Magnet St	Magnet St	300mm dia	66	No
2002.106	19	Ravensbourne Rd	Gas Works	300 mm dia.	117	Yes
2002.108		George St (Port Otago)	Port Chalmers	750 mm dia.	1,000	No
2002.109		George St/SH88	Port Chalmers	1,250 mm dia.	1,200	Yes
2002.110		Second Beach Rd	St. Clair	1,050 x 1,050 mm tunnel	7,000	Yes
2006.222		Sawyers Bay, western side of Watson Park, Port Chalmers	Port Chalmers	150 mm dia.	20	Yes

2. Methods

2.1 Stormwater

A number of the outfalls listed in Table 1 do not have outfall structures or are located in places that are inaccessible. Consequently it is neither practical nor possible to sample from the entire 31 outfalls listed, as agreed by the ORC. However, the monitoring programme undertaken samples all major Dunedin stormwater catchments and gives a comprehensive picture of the state of contaminants in Dunedin's stormwater. Catchment names have been altered slightly from those used in 2009 to reflect the naming used under the DCCs Three

Waters Strategy (See Table 2, page16). Grab samples of stormwater were collected from each stormwater outfall within 1 hour of the commencement of a rain event (>0.5mm) in an endeavour to ensure that first flush water was gathered. Collections took place only if there was an antecedent period of at least 72 hours with no rain before the target rain event. Samples were sent to Hill Laboratories in Hamilton to be analysed for arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn), faecal coliforms and *E. coli.* Samples collected from the Kitchener Street, Orari Street and Portobello Road outfalls were additionally analysed for polycyclic aromatic hydrocarbons (PAHs). Samples were also collected during a period of low flow a week after the targeted rainfall event and sent to ESR in Christchurch for analysis of fluorescent whitening agents (FWAs). FWAs are used in laundry detergents and indicate possible sewage infiltration to the stormwater system (Petch 1996). Gilpin *et al*., (2004) recommend that stormwater be sampled at low flows to get a more accurate picture of sewage infiltration because the FWAs are usually present in only very low concentrations and are more readily detected at low flows.

2.2 Sediments

Three replicate 250cm^3 samples were collected from the top 20mm of sediment within 20m from each of the Kitchener Street, Orari Street and Portobello Road Outfalls. To gain a clear picture of sediment contamination within the upper harbour basin, further replicate sediment samples were collected at each of the sites indicated by orange and pink stars in Figure 2. Samples were chilled and sent to Hill laboratories in Hamilton for analysis for total arsenic, total cadmium, total chromium, total copper, total nickel, total lead, total zinc, faecal coliforms, enterococci and PAHs.

2.3 Biological Monitoring

At the Portobello Road, Orari Street and Kitchener Street outfalls two sites within 20m of each outfall and at the waters edge at low tide were sampled for flora and fauna according to the protocols outlined in Kingsford and Battershill (1998). An additional two sites were sampled at no less than 50m from each outfall at the waters edge. At each site, three randomly spaced 5m^2 quadrats were sampled, giving a total of 12 quadrats at each outfall. For epifauna within each 5m^2 quadrat, the number of each species was recorded in five 0.1m^2 quadrats. For infauna a sediment core was taken in three 0.1m^2 quadrats per site, giving 12 cores per outfall. Sediment was returned to the laboratory, washed through a 500μm sieve

and animals retained identified to at least family level (Bates *et al*. 2007). The abundance of each species was then recorded. For macroflora, the percentage cover of each species was estimated in three 1.0m^2 quadrats per site, giving 12 quadrats per outfall. For both epifauna and infauna a Shannon Weiner diversity index (Zar 1996) was calculated to enable community diversity to be compared from year to year.

2.4 Cockle, Mussel, Fish and Octopus Flesh

Daily patrols of the shoreline at low tide adjacent to the Portobello Road and Orari Street stormwater outfalls were made, beginning in late March, to seek mature octopus (*Pinnoctopus cordiformis* – formerly *Octopus maorum;* or *Octopus huttoni* – formerly *Robsonella australis*) during the annual autumn die-off.

For shellfish a minimum of 15-20 large cockles (*Austrovenus stutchburyi*) were collected from within 20m of the confluence of the stormwater outlet and the waters edge at low tide at each of the Portobello Road, Orari Street and Kitchener Street outfalls. Cockles were individually measured, bagged, and chilled and sent to Hill Laboratories for analysis for As, Cd, Cr, Cu, Ni, Pb and Zn. A further 15-20 cockles were collected at each site and sent for PAH analysis, and a further 15-20 to Hill Laboratories in Christchurch for analysis for faecal coliforms.

Within the same period that cockles were collected variable triplefins (*Tripterygion varium*) were caught using baited fish traps off the Mason Street wharf no more than 50m from the Mason Street stormwater outfall. Fish were weighed and measured, then chilled, bagged, and sent to Hill Laboratories for analysis for As, Cd, Cr, Cu, Ni, Pb and Zn and for PAHs.

At Second Beach a minimum of twelve mussels (*Perna canaliculus*) were collected from the rock reef to the east of the Second Beach stormwater outfall at a distance of no more than 50m from the outfall. Only mussels of mature size (≥80mm) were collected. Mussels were bagged and chilled and sent to Hill Laboratories in Hamilton for analysis for, As, Cd, Cr, Cu, Ni, Pb and Zn. A further 12-15 mussels were collected and sent to Hill Laboratories, Christchurch, for analysis for faecal coliforms.

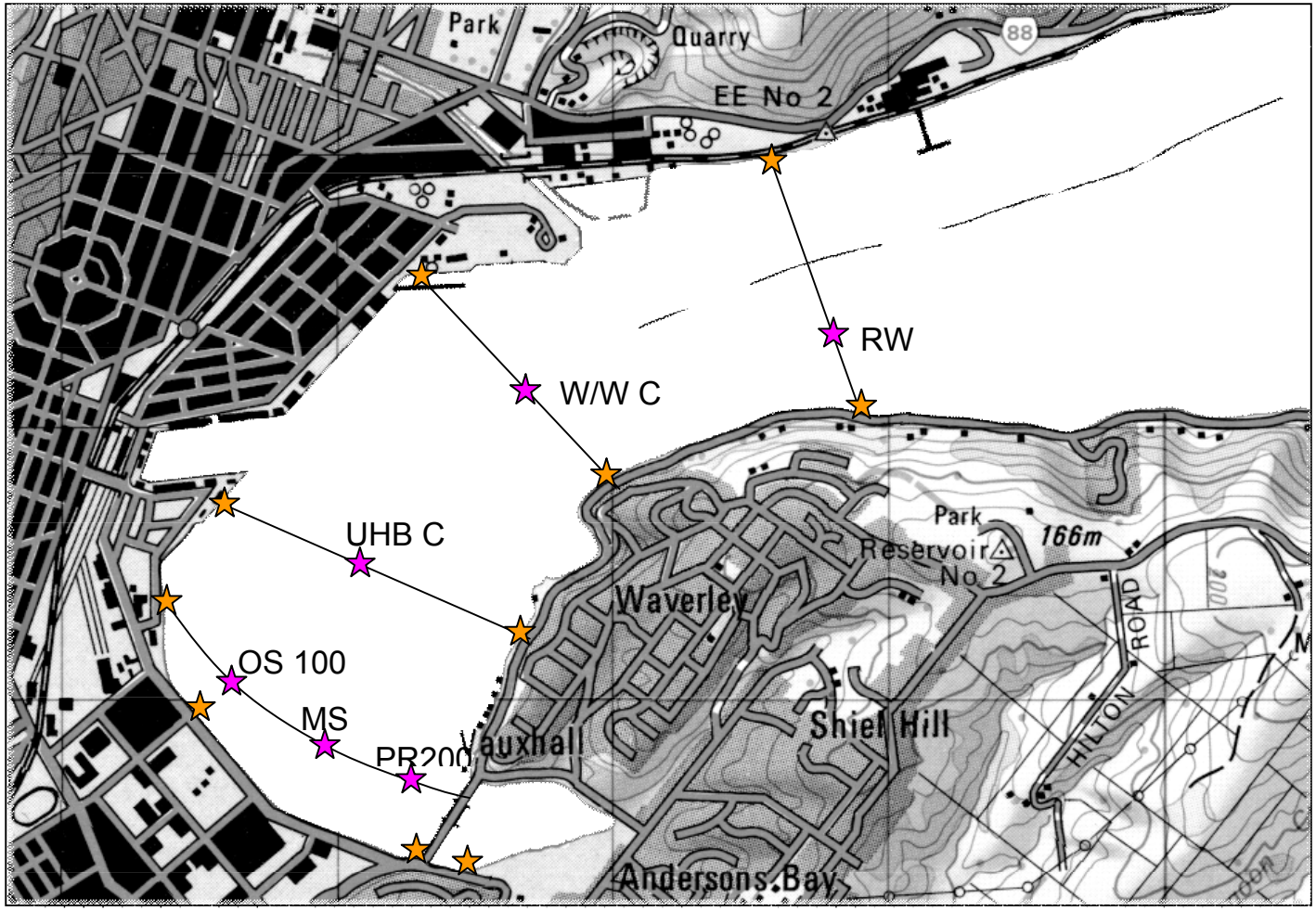


Figure 2. *Upper Harbour Basin sediment sampling sites. Orange stars sampled annually; pink stars sampled 5 yearly. Anticlockwise, starting at top, orange sites are: Rowing Club, Wickliffe St, White St, Kitchener St, Orari St, Portobello Rd, Shore St, Boatshed, Cove Drainage and Retaining Wall. Pink sites are coded according to location (see Table 4).*

3. Results

3.1 Stormwater

During the first two hours of a storm event that produced 10.6 mm rainfall on 29 February 2012 water samples were collected from stormwater outfalls at Second Beach, Shore Street, Portobello Road, Teviot Street, Midland Street, Orari Street, Kitchener Street, Mason Street, Bauchop Street, Halsey Street, Wickliffe Street and Ravensbourne Road in Dunedin and from Watson Park and east George Street in Port Chalmers. This storm event had an antecedent dry period of 118 hours.

Stormwater at most sites was only very lightly discoloured, testimony to the relatively gradual onset of the rain event. At Portobello Road, Kitchener Street and Mason Street, however, stormwater was more noticeably discoloured (Figure 3).



Figure 3 *Discoloured stormwater discharging from (a) Kitchener Street; (b) Portobello Road; (c) Mason Street; and (d) hydrocarbon sheen on sea surface at Mason Street.*

Contaminant levels are compared with levels in stormwater collected during a preliminary survey conducted in 2007 and all subsequent surveys (Table 2, Figure 4). As for last year all contaminants, with the exception of lead, zinc and copper were below ANZECC (2000) guidelines for protection of 80% of species (Table 2). However, there are no trends in the levels of these contaminants evident, with levels at some outfalls being higher than last year while others are lower (Table 2, Figure 4). It should be noted that Orari Street and Portobello Road both operate with sump systems and it is not clear if, in fact, the first flush had reached the outfall for these sites at the time of sampling. However, these sumps were operating at the time of sampling so it is assumed the first flush for these two outfalls was sampled.

Unlike last year, when there was no outfall that was clearly "worse" than others, Wickliffe Street, Bauchop Street and George Street all show high levels of some contaminants this year, notably lead, copper, nickel and zinc (Table 2, Figure 4). In fact George Street had the highest levels of nickel, cadmium, copper and chromium while Wickliffe Street had the highest levels of arsenic and zinc. Orari Street was the only outfall this year for which all heavy metal contaminants were below ANZECC guidelines. Generally speaking, contaminant levels showed considerable variability with location when compared with results from previous surveys. Lead at George Street, Bauchop Street and Wickliffe Street, zinc at George Street, Wickliffe Street and Teviot Street, nickel at George Street and Wickliffe Street and copper at George Street and Wickliffe Street all stand out as being at levels higher than might be expected based on previous results (Figure 4). If such levels continue in future sampling it will be worthwhile carrying out further investigations in these catchments to determine possible sources, but, based on past results, this is just as likely to be a one-off occurrence and is likely a function of rainfall intensity and antecedent dry period as much as other factors.

Microbiological levels were high to very high at all sites except Kitchener Street this year, with values exceeding the guidelines for secondary contact recreation for both faecal coliforms and *E. Coli* at George Street, Watson Park, Shore Street, Teviot Street, Midland Street, Orari Street, Mason Street, Halsey Street, Bauchop Street, Ravensbourne Road and Wickliffe Street (Table 2, Figure 4). All sites except Second Beach, Portobello Road, Mason Street and, Halsey Street show increases in *E. coli* and faecal coliform levels compared with 2011. However, bacterial levels at Portobello Road show a marked decrease over the 2010 and 2011

figures (Table 2, Figure 4). High microbial counts are not unexpected for first flush samples, with a considerable amount of animal faeces and decaying vegetable matter being washed into the stormwater system from streets and pavements. There are no clearly discernible trends in bacterial levels through time for any of the monitored stormwater outfalls (Figure 4).

FWAs were detected at low flows at all sites again this year, albeit at low levels for all but George Street, Watson Park, Shore Street, Teviot Street, Midland Street, and Wickliffe Street (Table 2). The levels at these three outfalls suggest there may be some contamination by human sewage. Overall, levels were generally comparable with previous years with values at some sites increasing slightly while those at others decreased slightly. As in 2009 and 2011, Midland Street had the highest values, but well short of the extreme levels seen at Bauchop Street in 2007 and 2008 (Figure 4). There are no standards for FWAs in New Zealand but, as stated, levels above 0.1µg/L suggest some contamination and levels above 0.2µg/L are cause for concern (Brent Gilpin, ESR, pers. comm.).

PAHs were not detected at Kitchener Street or Orari Street again this year, but were detected at Portobello Road, albeit at very low levels. This differs from 2010 where PAHs were detected at all three outfalls, but is similar to 2009 when, once again, PAHs were detected at just the Portobello Road outfall. In 2007 PAHs were detected only in Orari Street stormwater (just Pyrene at very low levels) (Table 3), and in 2008 PAH levels were high at all three outfalls (Table 3). Total PAH levels were lower at Portobello Road than in 2011 and 2009, and much lower than in 2008 (Table 3). Anthracene, acepaphthylene, fluorene and benzo[k]fluoranthene, the four PAHs that contributed the major component of the 2008 total, were either undetectable or present at only very low levels this year. Anthracene and benzo[k]fluoranthene are components of coal tar and, as has been previously suggested, it may be that the input of these substances (a by-product of gas production) to the upper harbour via stormwater is tailing off.

The high levels of oil and grease present last year at Orari Street and Kitchener Street were not so evident this year, although Kitchener Street remains quite high. There was an increase in the level of oil and grease at George Street, with levels at Second Beach, Shore Street and Teviot Street also being moderately high. (Table 2; Figure 4).

Table 2. *Levels of contaminants detected in stormwater from outfalls in and around Dunedin during a storm events on 11 April 2007, 17 June 2008, 12 May 2009, 23 April 2010, 3 May 2011 and 29 February 2012. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species.*

		Stormwater																	
Three Waters Project ICMP Catchment	Parameter	As						Cd						Cr					
	units	g/m^3						g/m^3						g/m^3					
	Outfall	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
St Clair	Second Beach	BDL	0.0013	0.0015	BDL	0.002	BDL	BDL	0.00006	0.00006	0.00007	8E-05	BDL	0.0007	0.0028	0.0035	0.00086	0.0038	0.00148
Port Chalmers	George St	BDL	0.0031	BDL	BDL	0.001	0.0016	0.00028	0.00140	0.00011	0.00033	0.0002	0.0006	0.005	0.012	0.0031	0.00136	0.0045	0.0053
Port Chalmers	Watson Pk	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0064	BDL	BDL	BDL	0.0016
Shore Street	Shore Street	0.04	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
South Dunedin	Portobello Road	BDL	0.002	BDL	BDL	BDL	BDL	BDL	0.00023	BDL	BDL	BDL	BDL	BDL	0.002	BDL	BDL	BDL	BDL
Andersons Bay	Teviot Street	BDL	0.002	BDL	BDL	BDL	BDL	BDL	0.00008	BDL	0.00026	BDL	0.0001	BDL	0.0018	BDL	BDL	BDL	0.0019
Andersons Bay	Midland Street	BDL	0.0033	BDL	BDL	BDL	BDL	BDL	0.00013	BDL	BDL	BDL	BDL	BDL	0.0035	0.0031	BDL	BDL	BDL
Orari Street	Orari Street	BDL	BDL	0.032	0.00149	BDL	BDL	BDL	BDL	BDL	0.000164	BDL	BDL	BDL	0.0032	BDL	0.00183	BDL	BDL
Kitchener Street	Kitchener Street	BDL	BDL	0.0096	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.004	0.002	BDL	BDL	BDL	BDL
Mason Street	Mason Street	0.006	BDL	0.0077	BDL	BDL	BDL	BDL	BDL	0.0077	0.00051	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Ravensbourne	Ravensbourne Rd		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL	BDL		0.00061	BDL	BDL	BDL	BDL
Halsey Street	Bauchop Street	0.03	BDL	0.021	BDL	BDL	BDL	BDL	BDL	BDL	0.00049	BDL	BDL	BDL	0.0015	BDL	BDL	BDL	BDL
Halsey Street	Halsey Street	0.03	BDL	0.01	0.0044	BDL	BDL	BDL	0.00022	BDL	0.00026	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Halsey Street	Wickliffe Street	0.03	BDL	0.003	BDL	0.004	0.0027	BDL	BDL	0.00052	0.00078	0.0009	0.0002	BDL	0.0017	0.0076	0.00157	0.0046	0.0028
	Protection for 80% of species																		
	ANZECC guidelines	0.36						0.0008						0.04					

		Stormwater																	
Three Waters Project ICMP Catchment	Parameter	Cu						Ni						Pb					
	units	g/m^3						g/m^3						g/m^3					
	Outfall	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
St Clair	Second Beach	0.0027	0.012	0.019	0.0054	0.0172	0.0026	0.0009	0.0021	0.0022	0.0013	0.0026	0.0011	0.001	0.011	0.013	2E-04	0.013	0.00101
Port Chalmers	George St	0.0213	0.039	0.025	0.0148	0.0197	0.027	0.0029	0.0093	0.0026	0.006	0.0037	0.0061	0.0342	0.041	0.018	0.005	0.004	0.029
Port Chalmers	Watson Pk	0.009	0.0025	BDL	BDL	BDL	0.008	BDL	BDL	BDL	0.0035	BDL	0.0019	0.0141	0.0018	BDL	BDL	0.004	0.0057
Shore Street	Shore Street	0.01	0.014	0.02	0.0118	BDL	BDL	0.01	BDL	BDL	BDL	BDL	BDL	0.003	0.0085	0.0069	BDL	BDL	BDL
South Dunedin	Portobello Road	BDL	0.026	0.01	0.0057	0.029	0.012	BDL	0.0035	0.0028	0.0035	BDL	BDL	BDL	0.019	0.0067	6E-04	0.026	0.0081
Andersons Bay	Teviot Street	BDL	0.0094	BDL	0.0136	0.031	0.0104	BDL	0.0019	BDL	0.0033	BDL	0.0017	BDL	0.0066	BDL	BDL	0.007	0.0028
Andersons Bay	Midland Street	0.02	0.031	0.057	0.021	BDL	0.0134	BDL	0.0016	BDL	0.0075	BDL	BDL	0.005	0.0054	0.0083	BDL	BDL	0.0023
Orari Street	Orari Street	BDL	0.014	BDL	0.0096	BDL	0.0024	BDL	0.0033	BDL	0.0011	BDL	0.0008	BDL	0.023	BDL	2E-04	BDL	0.00118
Kitchener Street	Kitchener Street	0.034	0.0056	0.023	0.0118	BDL	BDL	0.003	BDL	0.0036	0.0035	BDL	BDL	0.0442	0.007	0.018	0.002	BDL	0.0028
Mason Street	Mason Street	0.022	0.012	0.021	0.0157	0.043	0.026	0.004	BDL	0.0055	BDL	0.0039	BDL	0.0258	0.0089	0.014	0.001	0.019	0.0101
Ravensbourne	Ravensbourne Rd		0.0023	BDL	0.0031	BDL	0.0032		0.0007	BDL	0.0015	BDL	0.0007		0.0015	0.0029	2E-04	0.025	0.0039
Halsey Street	Bauchop Street	0.029	0.0096	BDL	0.0026	BDL	0.021	0.01	BDL	BDL	BDL	BDL	BDL	0.01	0.0035	BDL	BDL	BDL	0.021
Halsey Street	Halsey Street	0.024	0.0043	0.021	0.00162	0.029	0.0043	0.009	BDL	0.0035	BDL	BDL	BDL	0.021	0.0022	0.0097	0.002	0.009	0.0043
Halsey Street	Wickliffe Street	0.01	0.013	0.059	0.0058	0.022	0.025	0.01	BDL	0.0042	BDL	0.0021	0.0046	0.006	0.0084	0.033	BDL	0.013	0.0153
	Protection for 80% of species																		
	ANZECC guidelines	0.0025						0.017						0.0094					

Table 2. *continued…*

Three Waters Project ICMP Catchment	Parameter	Stormwater Zn						Stormwater pH						Stormwater Suspended Solids					
	units	g/m^3												g/m^3					
	Outfall	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
St Clair	Second Beach	0.038	0.16	0.15	0.092	0.25	0.026	7.7	7.3	7.4	7.3	7.4	8	BDL	37	41	BDL	57	5
Port Chalmers	George St	0.288	0.66	0.19	0.42	0.25	0.43	6.9	7.1	7.3	6.8	6.8	6.3	87	150	26	170	140	180
Port Chalmers	Watson Pk	0.231	0.027	BDL	0.29	0.24	0.27	6.8	7.9	8.2	7.1	7.5	7.5	37	39	7.4	240	24	24
Shore Street	Shore Street	0.02	0.44	0.21	0.115	BDL	0.071	7.9	7.2	7.3	7.4	7.9	7.5	41	24	20	9.5	12	10
South Dunedin	Portobello Road	0.08	0.94	0.64	0.153	0.87	0.15	7.9	7.3	7.6	7.6	7.4	8.1	18	46	30	8.1	53	43
Andersons Bay	Teviot Street	BDL	0.13	BDL	1.79	0.61	1.22	7.9	7.1	7.9	7	8	7.1	25	33	12	84	66	32
Andersons Bay	Midland Street	0.1	0.35	0.18	0.22	BDL	0.21	7.7	7.7	7.7	7.5	7.8	7.6	30	19	30	52	14	12
Orari Street	Orari Street	BDL	0.22	0.031	0.3	BDL	0.0157	7.8	7.4	8.1	7.1	7.9	7.9	28	77	16	130	4	BDL
Kitchener Street	Kitchener Street	0.445	0.036	0.38	0.62	BDL	0.082	7.1	7.7	7.4	6.9	8	7.6	104	41	45	50	BDL	27
Mason Street	Mason Street	0.25	0.16	0.35	0.43	0.63	0.43	7.1	7	7.4	7	7	7.1	62	37	37	138	30	31
Ravensbourne	Ravensbourne Rd		0.053	0.047	0.144	0.27	0.32		7	8.1	7.3	8	7.8		8.5	18	61	5	6
Halsey Street	Bauchop Street	0.23	0.12	0.13	0.121	BDL	0.94	7.6	7.8	8.1	7.4	8	7.4	44	16	13	53	5	38
Halsey Street	Halsey Street	0.12	0.033	0.3	0.136	0.36	0.089	7.3	7.9	7.2	6.8	7.1	7.8	119	35	27	50	24	22
Halsey Street	Wickliffe Street	0.1	0.2	0.53	0.24	0.82	1.57	7.7	7.5	8.0	7.3	9.7	7.0	35	27	100	86	46	30
	Protection for 80% of species																		
	ANZECC guidelines	0.031						7.2-7.8											

Three Waters Project ICMP Catchment	Parameter	Stormwater Oil & Grease						Stormwater FWA					
	units	g/m^3						µg/L					
	Outfall	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
St Clair	Second Beach	5	BDL	BDL	BDL	BDL	11	0.147	0.19	0.098	0.04	0.075	0.069
Port Chalmers	George St	10	8.7	BDL	BDL	8	13	BDL	BDL	0.03	0.079	0.082	0.124
Port Chalmers	Watson Pk	8	BDL	BDL	BDL	BDL	BDL	0.002	0.003	0.124	0.105	0.092	0.147
Shore Street	Shore Street	BDL	BDL	BDL	BDL	BDL	10	0.081	0.031	0.142	0.98	0.142	0.156
South Dunedin	Portobello Road	4	9.7	BDL	BDL	BDL	BDL	0.003	0.049	0.177	0.151	0.045	0.096
Andersons Bay	Teviot Street	8	4.4	BDL	6.4	BDL	7	BDL	0.006	0.096	0.135	0.117	0.103
Andersons Bay	Midland Street	BDL	BDL	BDL	BDL	4	BDL	BDL	0.004	0.132	0.218	0.197	0.174
Orari Street	Orari Street	BDL	11	BDL	BDL	17	BDL	BDL	0.005	0.11	0.052	0.081	0.094
Kitchener Street	Kitchener Street	9	BDL	BDL	BDL	22	11	0.18	0.029	0.072	0.023	0.047	0.052
Mason Street	Mason Street	5	7.9	BDL	BDL	BDL	BDL	0.007	0.07	0.051	0.156	0.026	0.043
Ravensbourne	Ravensbourne Rd		8.8	BDL	BDL	BDL	BDL		BDL	0.096	0.136	0.014	0.23
Halsey Street	Bauchop Street	4	BDL	BDL	BDL	BDL	BDL	2.028	4.92	0.031	0.067	0.017	0.019
Halsey Street	Halsey Street	9	BDL	BDL	BDL	BDL	BDL	BDL	0.004	0.011	0.061	0.025	0.038
Halsey Street	Wickliffe Street	6	9.5	9.5	BDL	7	BDL	0.024	0.003	0.021	0.048	0.094	0.121

Table 2. *continued… For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

		Stormwater												
Three Waters Project ICMP Catchment	Parameter	E. coli						Faecal Coliforms						
	units	MPN/100ml						cfu/100ml						
	Outfall	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012	
St Clair	Second Beach	560	6800	14000	4800	9000	300	560	8300	14000	92000	9000	300	
Port Chalmers	George St	1400	930	1000	1100	600	6000	1400	1400	1000	1100	600	6000	
Port Chalmers	Watson Pk	14000	150	10	>1600	1000	5900	39000	150	10	>1600	1000	5900	
Shore Street	Shore Street	300	5100	16000	7000	110	11000	300	5100	16000	9400	110	11000	
South Dunedin	Portobello Road	460	5000	2800	54000	6000	280	590	5000	2800	54000	6000	280	
Andersons Bay	Teviot Street	7	120000	210	16000	300	3000	7	240000	210	16000	300	3000	
Andersons Bay	Midland Street	290	130	6000	3500	600	3700	290	130	6000	5400	600	4900	
Orari Street	Orari Street	50	6000	210	1700	BDL	1800	80	7000	210	3500	BDL	1800	
Kitchener Street	Kitchener Street	13000	70	10000	92000	110	150	13000	70	10000	160000	110	230	
Mason Street	Mason Street	22000	26000	50000	350000	48000	32000	22000	26000	50000	350000	48000	32000	
Ravensbourne	Ravensbourne Rd		120	90	11000	130	1300	150	130	90	11000	130	1300	
Halsey Street	Bauchop Street	2200	400	3000	7900	450	17000	2200	400	3000	35000	450	17000	
Halsey Street	Halsey Street	9000	1700	70000	17000	78000	26000	9000	1700	70000	92000	78000	26000	
Halsey Street	Wickliffe Street	25000	10000	220000	35000	43000	96000	30000	10000	220000	54000	43000	96000	
	Primary	Amber	>260					>150						Primary
	Secondary	Red	>550					>1000						Secondary

Table 3. *PAHs (g/m^3) detected in stormwater from the Kitchener Street, Orari Street and Portobello Road outfalls in 2007, 2008, and 2009, 2010, 2011 and 2012. BDL indicates Below Detectable Limits.*

	Kitchener St						Orari St						Portobello Rd					
	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
Acenaphthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00034	0.000024	BDL	0.000015	BDL
Acepaphthylene	BDL	100	BDL	BDL	BDL	BDL	BDL	92	BDL	BDL	BDL	BDL	BDL	100	0.000029	BDL	0.00016	0.000014
Anthracene	BDL	87	BDL	BDL	BDL	BDL	BDL	89	BDL	BDL	BDL	BDL	BDL	87	0.000008	BDL	0.000044	BDL
Benzo[a]anthracen	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00015	0.000014	BDL	0.000105	0.000012
Benzo[a]pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000017	BDL	0.000167	0.000021
ne + Benzo[j]fluorathen	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00012	BDL	BDL	BDL	0.00018	0.000033	0.000158	0.00024	0.000027
Benzo[g,h,i]peryler	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00014	BDL	BDL	BDL	BDL	BDL	BDL	0.000014	BDL	0.000147	0.000015
Benzo[k]fluorather	-	67	BDL	BDL	BDL	BDL	-	67	BDL	BDL	BDL	BDL	-	67	BDL	BDL	0.000094	0.000009
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000093	0.00001
Dibenzo[a,h]anthra	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000026	BDL
Fluoranthene	BDL	BDL	BDL	0.00015	BDL	BDL	BDL	0.00011	BDL	0.00017	BDL	BDL	BDL	0.00028	0.00001	BDL	0.000182	0.000024
Fluorene	BDL	73	BDL	BDL	BDL	BDL	BDL	70	BDL	BDL	BDL	BDL	BDL	74	BDL	BDL	0.000017	BDL
Indeno[1,2,3-c,d]p	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000013	BDL	0.000107	0.000012
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00008	BDL
Phenanthrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000041	BDL
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	0.0001	BDL	BDL	0.00023	BDL	BDL	BDL	0.00037	0.000011	BDL	0.00016	0.000022
Total PAH	0.00	327.00	BDL	0.0001	BDL	BDL	0.00	318.00	BDL	0.0005	BDL	BDL	BDL	328.00	0.00017	0.00016	0.00168	0.000166

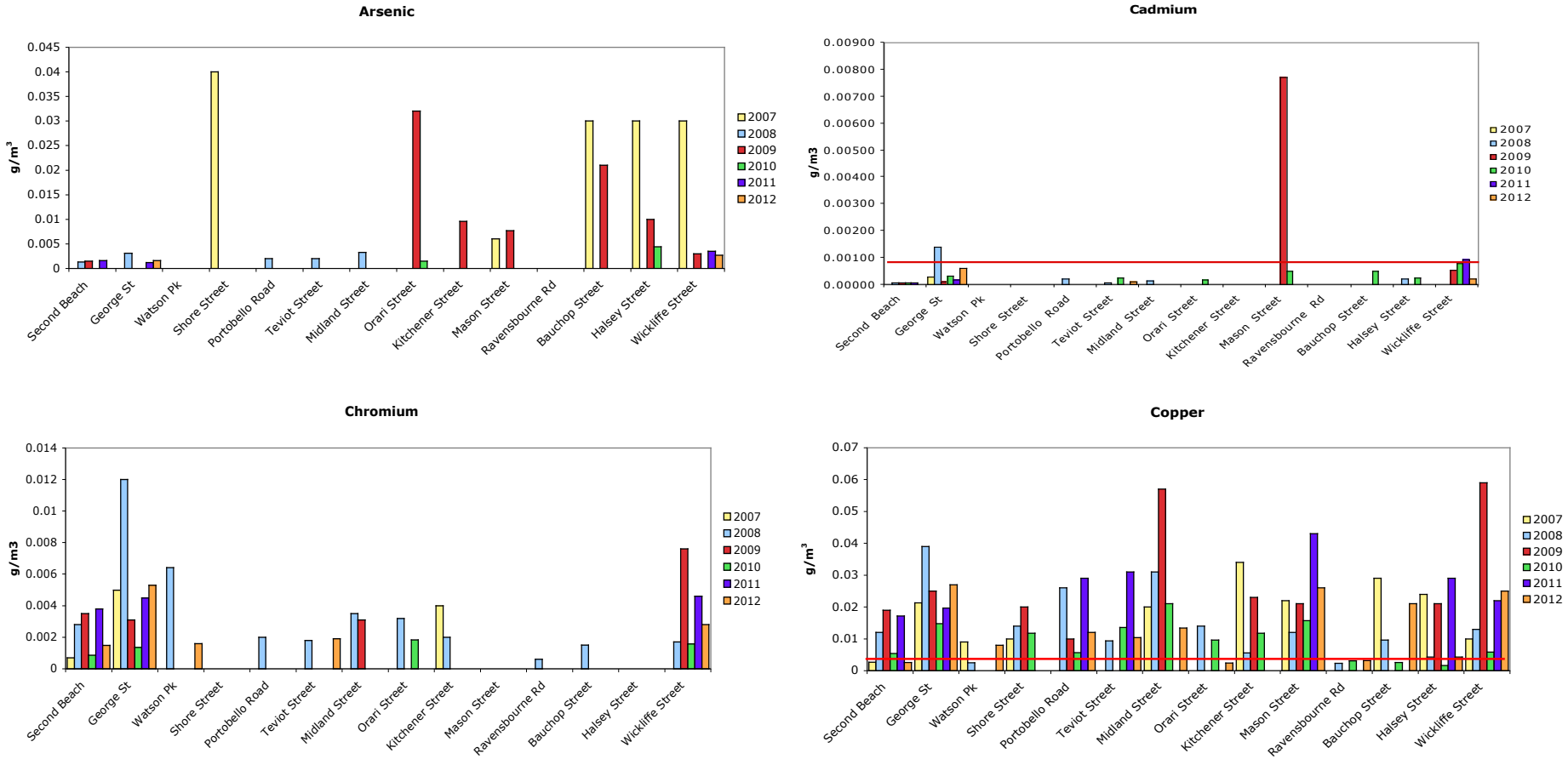


Figure 4. *Graphical representation of contaminant levels in stormwater at outfalls around upper Otago Harbour in 2007, 2008, 2009, 2010, 2011 and 2012. Red line indicates ANZECC trigger level for protection of 80% of species.*

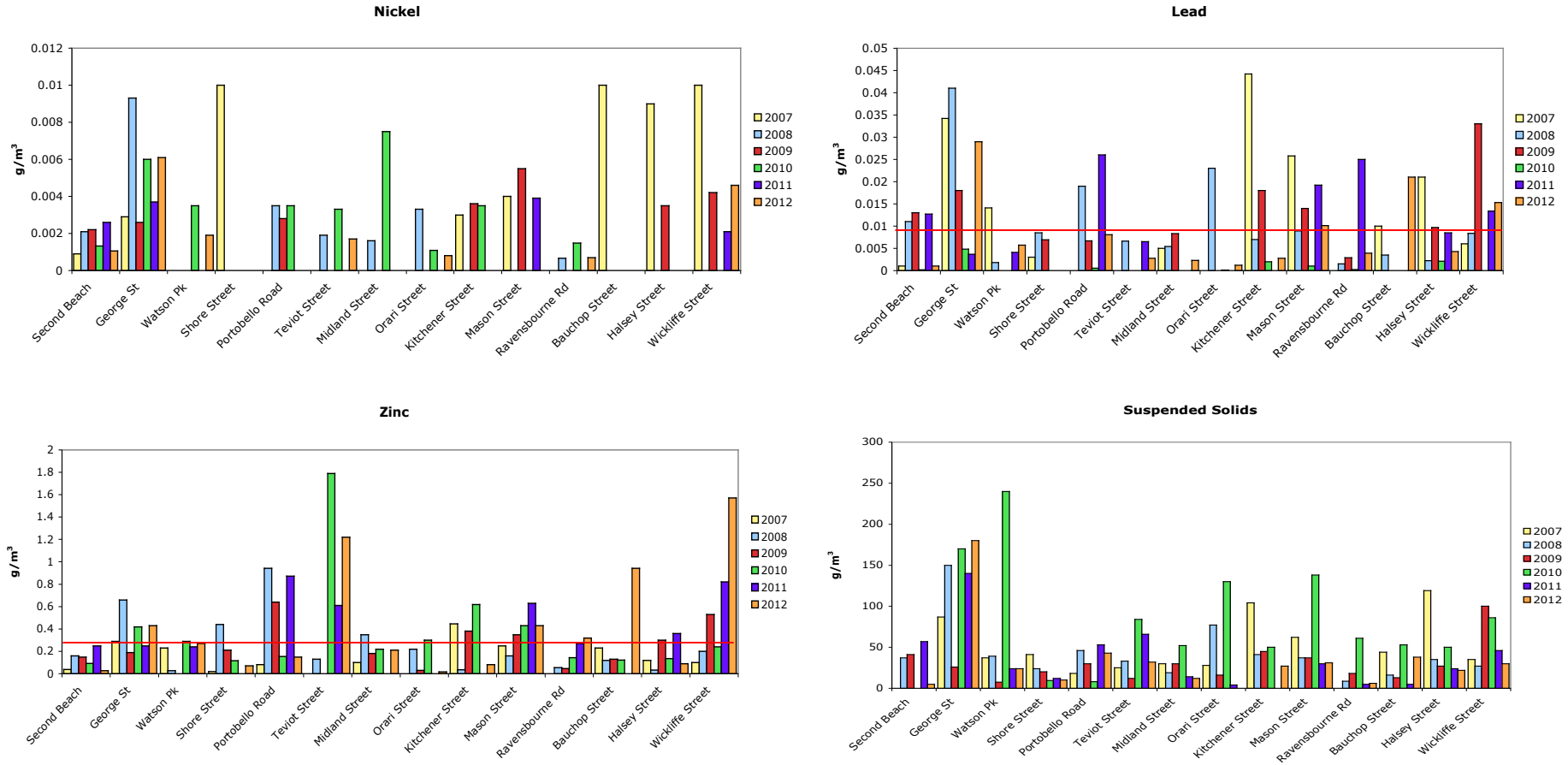


Figure 4. (continued….)

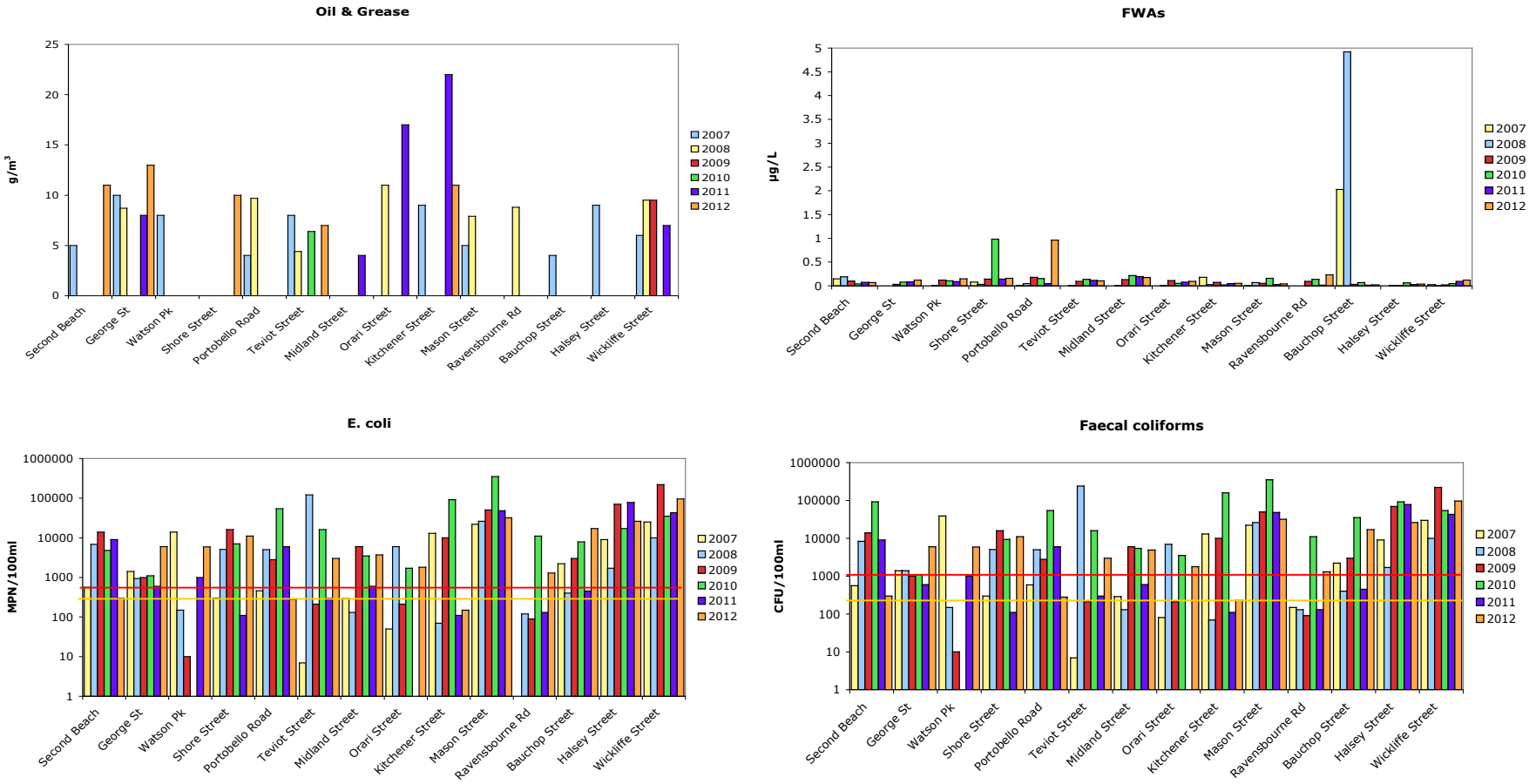


Figure 4. ***(continued)*** *Graphical representation of contaminant levels in stormwater at outfalls around upper Otago Harbour in 2007, 2008, 2009, 2010, 2011 and 2012. For microbiological graphs amber line indicates guideline for primary contact, red line indicates guideline for secondary contact.* ***Note log scale on Y axis of microbiological graphs.***

3.2 Sediments

Sediments were sampled on 10th March and 20th April at sites detailed in Figure 2. As in the past, surface sediments were generally clean at most sites with little surface detritus apart from a thick layer of organic particles (wood, leaves and bark fragments) at Portobello Road. Additionally, as in past years at Portobello Road, sediments were very dark and smelled strongly of petro-carbons with a visible oil slick forming in footprints and depressions dug to remove sediments. At Wickliffe Street, sediments were dark and smelled strongly of hydrogen sulphide, indicating anoxic conditions. Investigations into PAH levels at the Portobello Road outfall are detailed in Stewart (2005, 2006). Note that the South Dunedin (Portobello Road) catchment was used as the pilot for the stormwater catchment management plan development for the DCC's Three Waters Strategy and a complete ICMP has been finalised for this catchment. The ICMP contained recommendations for addressing problems and issues highlighted in this catchment that will be considered and programmed for action where practicable.

Generally speaking, levels of contaminants in sediments near outfalls are within the range observed for previous years. Portobello Road, Orari Street and Kitchener Street where the levels of all contaminants, except nickel at Portobello Road and Kitchener Street, exceeded the levels observed last year (Table 4, Figure 5). In fact levels of most contaminants at Portobello Road are higher than recorded at any time in the past. The site that most notably flies against this trend is Shore Street, which appears to show an overall decrease in contaminants through time. A number of sites show lower levels of contaminants than seen previously, especially those sites at more remote locations (e.g. <100m from outfalls), suggesting that overall levels of contaminants in the upper harbour basin may be falling or that contaminated sediment is slowly being buried. This year, ANZECC high trigger values are exceeded only by lead, zinc and PAHs at Portobello Road, by lead at Kitchener Street and by zinc at Wickliffe Street, White Street and Kitchener Street (Table 4). Copper, lead, zinc and PAHS exceed the ANZECC low trigger value at most sites other than Rowing Club, Cove Drainage, Retaining wall and centre of harbour sites.

As observed in previous investigations PAHs are to be found at moderate to high levels in much of the Upper Harbour Basin, with the highest levels adjacent to

the Portobello Road outfall (Table 4, Figure 5). PAHs in sediments were lower this year than last year at the Wickliffe Street outfall and also at the Boat Shed site. Conversely PAH levels were higher than in the past at Portobello Road and the Cove Drainage site indicating that, while PAHs are still being added to the upper harbour, the amount varies through time and with site. The extremely high levels of PAHs in older sediments off Portobello Road are believed to have been sourced from the now defunct gas works. The reason for the particularly high level of PAHs this sampling round is unknown but the core may have stuck a localised area of high contamination. Wave action disturbing surface sediments around the time of sampling will undoubtedly have a bearing on PAH levels at any particular site. This year, sampling occurred on a calm day.

Microbial contamination in sediment is relatively low at most outfalls with very low numbers of enterococci at all sites and just Kitchener Street having appreciable numbers of faecal coliforms (Table 4). Numbers overall are much lower than they were in 2007 or 2008.

Trends in contaminant levels at the various sites through time remain unclear with six years of sampling revealing high variability among contaminants and among sites (Figure 4). However, as already stated, levels of some contaminants exhibit a reducing trend at Shore Street but a possible increasing trend at Wickliffe Street. It will be of interest to see if this trend becomes more apparent with the addition of further data from future monitoring rounds.

Table 4. *Contaminant levels in sediments at various locations within 20m of stormwater outfalls and within the Upper Otago Harbour Basin. Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels. Sites that are sampled only 5 yearly are not graphed, but green shading indicates where these sites are lower than at any time in the past.*

Sediments within 20m of outfall																								
	As						Cd						Cr						Cu					
Units	mg/kg dry wt						mg/kg dry wt						mg/kg dry wt						mg/kg dry wt					
Parameter	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
Rowing Club	10.6	9.8	7.3	13.0	11.6	8.0	0.2	0.2	0.1	0.2	0.1	0.2	17.6	12.0	16.0	14.0	11.6	20.0	14	13	14	9	12	16
Wickliffe	17.3	11.0	6.9	9.0	14.3	11.0	0.6	0.7	0.8	0.7	0.7	0.8	38.0	34.0	16.0	27.0	30.0	31.0	121	68	50	58	86	75
White St	11.6	18.0	5.4	6.0	8.3	8.0	0.3	0.2	0.2	0.1	0.1	0.2	68.5	56.0	26.0	19.0	30.0	43.0	433	160	170	78	98	149
Kitchener St	4.6	7.5	7.0	9.0	4.5	12.0	0.4	0.4	0.3	0.3	0.3	0.5	22.6	18.0	98.0	22.0	18.3	34.0	70	56	90	37	54	81
Orari St	18.6	4.3	20.0	5.0	2.1	4.0	63.0	0.1	0.9	0.2	0.1	0.3	0.3	16.0	37.0	16.0	9.4	26.0	25	13	61	11	7	28
Orari 100	13.7					10.7	0.4					0.32	26.3					22.0	25.9					20.0
Midland 200	15.4					11.2	0.3					0.42	22.4					21.0	19.0					20.0
Portobello Rd	29.0	23.0	24.0	15.0	28.0	42.0	48.5	1.8	2.0	1.5	2.6	3.1	1.8	54.0	50.0	36.0	67.0	82.0	60	160	190	123	176	220
PR 200	17.4					18.3	0.5					0.43	41.8					41.0	19.0					20.0
Shore St	9.5	7.1	6.2	6.0	2.3	5.0	0.4	0.3	0.3	0.3	0.2	0.3	21.8	16.0	18.0	19.0	5.8	12.0	51	44	41	35	11	25
Boatshed	27.4	16.0	17.0	15.0	16.2	20.0	0.3	0.2	0.2	0.3	0.6	0.3	41.7	19.0	26.0	31.0	34.0	38.0	108	33	49	35	53	55
Cove Drainage	21.5	17.0	19.0	13.0	9.5	17.0	0.1	0.1	0.4	<0.1	0.2	<.1	15.8	35.0	32.0	19.0	21.0	27.0	11	19	38	11	14	20
Retaining wall	25.3	36.0	24.0	36.0	39.0	24.0	0.1	0.2	<0.1	<0.1	0.1	0.1	23.6	31.0	39.0	23.0	24.0	27.0	13	19	17	10	11	11
RW 300	16.2					15.2	0.3					0.15	27					28.0	15.2					14.7
W/W centre	11.1					15.1	0.2					0.11	30.8					25.0	15.3					13.0
UHB Centre	10.5					9.1	0.2					0.21	24.3					25.0	15.2					21.0
ANZECC Low trigger value	20						1.5						80						65					
ANZECC high trigger value	70						10						370						270					

	Ni						Pb						Zn					
Units	mg/kg dry wt						mg/kg dry wt						mg/kg dry wt					
Parameter	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
Rowing Club	11.3	14.0	13.0	11.0	12.1	14.0	18.9	27	27	28	19	27	101	130	160	149	109	127
Wickliffe	19.2	23.0	13.0	17.0	15.9	17.0	76.1	140	77	92	127	130	412	740	810	740	700	770
White St	29.5	21.0	11.0	8.0	14.5	18.0	147.0	180	170	124	147	95	4450	2500	2400	1280	1650	2700
Kitchener St	10.6	12.0	15.0	12.0	10.6	16.0	117.9	97	130	155	132	220	249	280	300	280	260	530
Orari St	23.6	8.1	16.0	8.0	5.3	16.0	12.8	39	120	35	17	72	68	130	680	157	69	350
Orari 100	12.6					11.5	170					37	227					197
Midland 200	10.7					10.2	36					38	165					270
Portobello Rd	169.3	18.0	26.0	19.0	24.0	19.0	20.4	330	290	193	310	470	306	1400	1600	1040	1410	2400
PR 200	17.3					18.0	81.3					79	309					310
Shore St	10.7	9.0	11.0	10.0	5.2	7.0	113.0	110	79	85	36	78	484	300	330	350	210	290
Boatshed	24.5	16.0	17.0	16.0	18.5	19.0	112.0	800	170	86	89	91	339	370	360	290	300	340
Cove Drainage	23.5	44.0	23.0	19.0	12.8	34.0	19.7	20	55	18	44	32	99	150	270	125	119	156
Retaining wall	15.9	25.0	26.0	18.0	13.2	16.0	26.9	27	42	24	23	27	141	170	150	152	138	112
RW 300	12.4					25.0	6.7					36	131					128
W/W centre	14.6					21.0	5.6					25	168					117
UHB Centre	11.3					16.0	23					40	119					157
ANZECC Low trigger value	21						50						200					
ANZECC high trigger value	52						220						410					

Table 4. *Continued…*

	PAH						Enterococci						Faecal coliforms					
Units	mg/kg dry wt						MPN/g						MPN/g					
Parameter	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
Rowing Club	7.0	5.8	0.5	3.7	0.1	0.7	2	11	<2	<3	8	BDL	<2	17	5	2	<2	BDL
Wickliffe	9.2	1.2	7.3	7.2	11.3	4.6	580	>1600	330	<3	>160	7	2	540	33	540	110	13
White St	13.0	11.1	15.9	6.5	5.4	10.7	4	2	<2	23	35	BDL	<2	<2	<2	5	<2	2
Kitchener St	8.9	140.5	4.8	5.0	5.5	10.0	66	920	5	<3	>160	12	20	13	70	<2	49	240
Orari St	10.2	12.6	28.3	9.3	4.3	10.4	<2	8	23	<3	54	9	23000	4	33	33	17	8
Orari 100	6.67					6.55	3600					BDL						BDL
Midland 200	7.24					7.12	20000					BDL						BDL
Portobello Rd	436.3	250.3	525.2	194.1	482.0	767.1	727	170	<2	<3	16	2	23	43	2	21	2	46
PR 200	8.97					9.16	66000					BDL						BDL
Shore St	9.6	21.0	8.6	10.5	4.1	14.2	90	>1600	<2	460	35	7	<2	540	<2	130	49	79
Boatshed	6.7	5.5	38.8	7.9	40.4	9.7	34	33	33	<3	54	BDL	<2	2	79	5	22	2
Cove Drainage	0.4	0.0	0.1	0.1	1.0	1.4	8	17	<2	<3	35	BDL	2	8	<2	<2	6	BDL
Retaining wall	0.3	3.9	0.0	9.4	0.2	0.2	<2	8	<18	<3	8	BDL	2	<2	33	<2	2	BDL
RW 300	0.30					0.28	<2					BDL						BDL
W/W centre	0.34					0.36	<2					BDL						BDL
UHB Centre	0.65					0.67	24000					BDL						BDL
ANZECC Low trigger value	4																	
ANZECC high trigger value	45																	

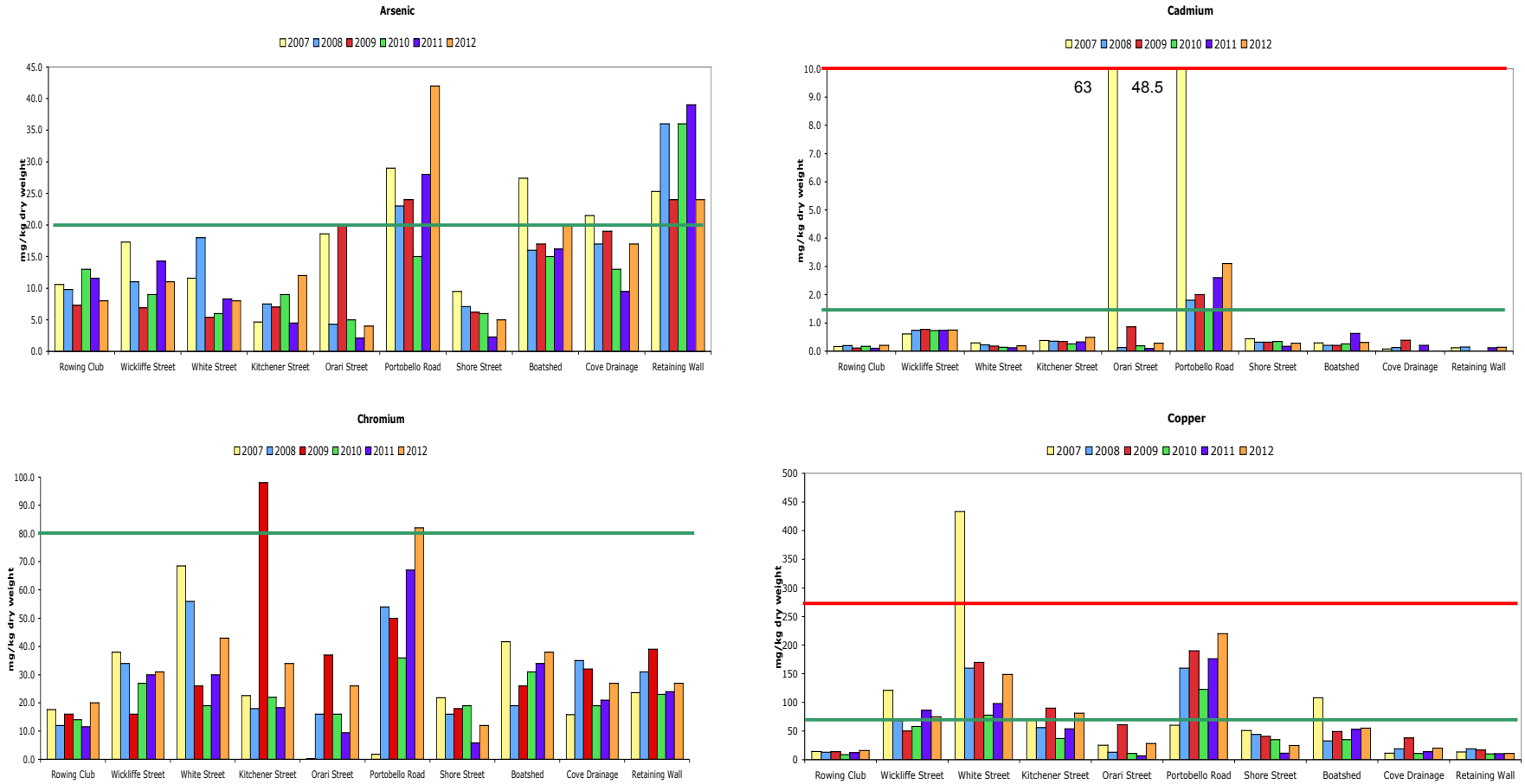


Figure 5. *Graphical representation of contaminant levels in sediment at sampling sites around upper Otago Harbour in 2007, 2008, 2009, 2010, 2011 and 2012. Green line indicates ANZECC low trigger level, red line is high trigger level.*

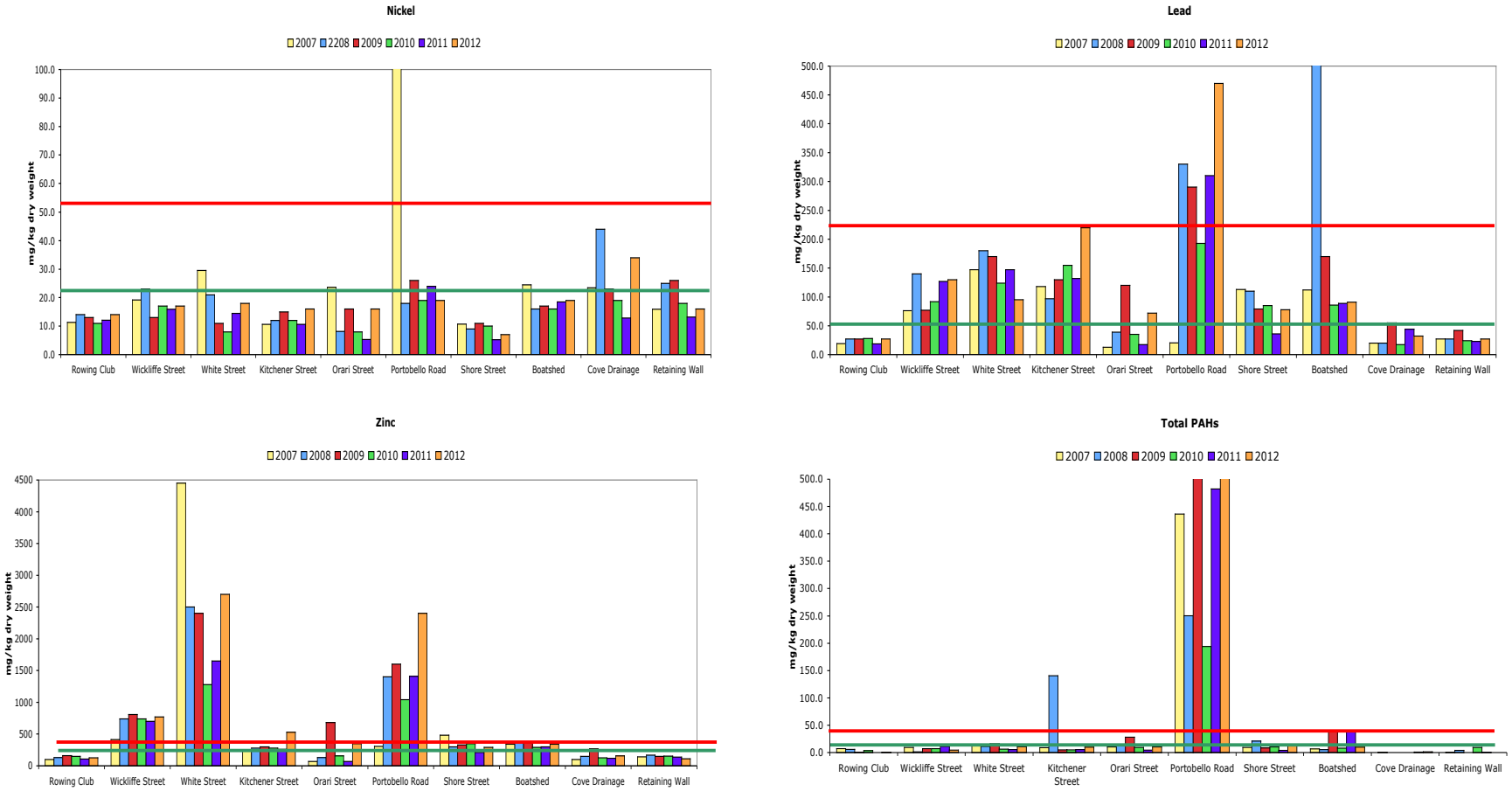


Figure 5 (continued). *Graphical representation of contaminant levels in sediment at sampling sites around upper Otago Harbour in 2007, 2008, 2009, 2010, 2011 and 2012. Green line indicates ANZECC low trigger level, red line is high trigger level.*

3.3 Biological Monitoring

On 12th and 13th March 2012 biological sampling was carried out at the Orari Street, Kitchener Street and Portobello Road, outfalls. The tide was moderately low at 0.97m below mean sea level.

There was a low diversity of green and red algae at all sites, with Orari Street having the highest diversity (7 taxa) and Kitchener Street having the lowest diversity (3 taxa) (Tables 5-7). Percentage cover was generally low at all sites with <20m from the Kitchener Street outfall and both sites at Portobello road having very little algal cover (Tables 5-7). Cover was highest at both sites near the Orari Street outfall with occasional quite large clumps of *Ulva lactuca* and *Gracilaria chilensis* present (Table 6). Overall, cover at all sites was similar to previous years (Stewart 2007a, Stewart 2008c, Stewart 2009, 2010, 2011).

Table 5. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Kitchener Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca	3	5	2	1	4	
Ceramium uncinatum						
Euptilota formosissima						
Gracilaria chilensis						
Lenormandia chauvinii	3	1	1			
Lomentaria umbellata					1	

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca	4	15	20	5	4	5
Ceramium uncinatum						
Euptilota formosissima						
Gracilaria chilensis						
Lenormandia chauvinii		3	6	1		2
Lomentaria umbellata						

Table 6. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Orari Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca	11	20	10	12	6	8
Ceramium uncinatum				1		
Euptilota formosissima	1			1		
Gracilaria chilensis	1	2	1	2		1
Lenormandia chauvinii						
Lomentaria umbellata					1	

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis		10				
Ulva lactuca	10	10	12	7	15	12
Ceramium uncinatum	1					
Euptilota formosissima			1	1	1	1
Gracilaria chilensis	2	1	1	8	1	1
Lenormandia chauvinii				1		
Lomentaria umbellata						

Table 7. *Macroalgal cover, expressed as a percentage, within 20m (left) and greater than 50m (right) of the Portobello Rd outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis			1			
Ulva lactuca	1		1	2	4	2
Ceramium uncinatum						
Euptilota formosissima				2	6	
Gracilaria chilensis		1				
Lenormandia chauvinii						
Lomentaria umbellata	1					

	Site 1			Site 2		
Algae (% cover) >50m	Q1	Q2	Q3	Q1	Q2	Q3
Enteromorpha intestinalis				2		
Codium fragilis				5		
Ulva lactuca			2		4	7
Ceramium uncinatum						
Euptilota formosissima	10	7			3	2
Gracilaria chilensis						
Lenormandia chauvinii						
Lomentaria umbellata						3

Epifauna was moderately abundant at all three outfalls (Tables 8-10), although somewhat less so than last year and in 2010. As in previous years the small topshell *Micrelenchus tenebrosus* and cockles, *Austrovenus stutchburyi*, comprise the majority of animals. Numbers of animals per square metre was higher at more than 50m distant from the Kitchener Street outfall than within 20m of the outfall. This is the opposite of what was found last year and is largely due to high numbers of tube worms and *Micrelenchus* in the >50m quadrats (Table 8). For both Orari Street and Portobello Road epifaunal numbers per square metre were slightly higher at <20m than at >50m. This echoes last years result for both sites. In 2010 numbers were similar irrespective of distance at both outfalls. Overall density of epifaunal animals was lowest at Orari Street and highest at Kitchener Street, due mainly to the higher abundance of tubeworms at this site (Tables 8-10).

Diversity within animal communities was variable with Kitchener and Orari Streets showing slightly greater diversity further from the outfall while Portobello Road showed higher diversity further away (Table 11). Diversity was lowest at Orari Street. Overall diversity has not changed from that observed in previous years ($F_{5,12}$ = 0.166, p = 0.970 for <20m sites; $F_{5,12}$ = 0.208, p = 0.952 for >50m sites). Neither is there a significant difference in epifaunal diversity among sites <20m from the outfalls and sites >50m from the outfalls ($F_{1,4}$ = 0.071, p = 0.803).

Table 8. *Epifauna within 20m (top) and greater than 50m (bottom) of the Kitchener Street outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus										7	11	9			
Barnacles															
Eminius modestus		3										12			
Snails and Chitons															
Melagraphis aethiops						1				1					
Micrelenchus tenebrosus	9	2	3	7	12	4	5	3	19	4	8	2	8	14	6
Notoacmea spp			3												
Bivalves															
Ostrea heffordi		3		2	1				4	3	6				

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus	26	49		6	2	7	62	15	34		3		6	9	6
Barnacles															
Eminius modestus	4	9		2		2	8	18						2	
Snails and Chitons															
Micrelenchus tenebrosus	5	10	5	4	5	1	4	12	17	21	7	3		5	8
Melagraphis aethiops			1												
Chiton glaucus															
Bivalves															
Mytilus galloprovincialis							1								
Austrovenus stutchburyi			2	3	2							2	3		2
Ostrea heffordi	2	1	4	8	7	5			3		13	1	7	5	4

Table 9. *Epifauna within 20m (top) and greater than 50m (overleaf) of the Orari Street outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Snails and Chitons															
Micrelenchus tenebrosus	2	1	1		2	1	1	3	4	1	5	4	1	2	4
Zeacumantus subcarinatus										1					
Cominella galndiformis														1	
Bivalves															
Austrovenus stutchburyi	2	5	4	9	7	2	5	8	11	6	4	4	8	9	3
Macomona liliana						1									

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Snails and Chitons															
Buccinulum vittatum															1
Cominella glandiformis	1			1				1							
Zeacumantus subcarinatus	1		1												
Micrelenchus tenebrosus	1			1	4	1	1	1	2	3	3	2	8	1	4
Crustaceans															
Macrophthalmus hirtipes															
Bivalves															
Austrovenus stutchburyi	3	3	2	3	2	8	4	10	11	5	4	2	6	4	4
Macomona liliana						1									

Table 10. *Epifauna within 20m (top) and greater than 50m (bottom) of the Portobello Rd outfall.*

<20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus				14	7	18			11	5					23
Barnacles															
Eminius modestus			1	6		2							1		2
Snails and Chitons															
Amphibola crenata							1								
Maoricolpus roseus					1										
Melagraphis aethiops		1			1	2				2			1	1	
Micrelenchus tenebrosus	2	5		6	3	4	4	1	4	8	3	2	1	3	1
Bivalves															
Austrovenus stutchburyi						1							1		
Ostrea heffordi			1												

>50m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Snails and Chitons															
Buccinulum vittatum			1												
Cominella glandiformis										1					
Melagraphis aethiops			1			1									
Micrelenchus tenebrosus			7			6		1	2	1					
Bivalves															
Austrovenus stutchburyi						1							1		
Ostrea heffordi			1												

Table 11. *Diversity (H') of epifauna within 20m and greater than 50m of the Kitchener Street, Orari Street and Portobello Road outfalls. 2012 data compared with 2007, 2008, 2009, 2010 and 2011 data.*

	<20m						>50m					
Site	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
Kitchener Street	0.48	0.48	0.55	0.53	0.55	0.51	0.71	0.57	0.42	0.2	0.57	0.57
Orari Street	0.36	0.37	0.3	0.12	0.29	0.31	0.05	0.25	0.31	0.16	0.15	0.39
Portobello Road	0.53	0.33	0.62	0.58	0.57	0.53	0.5	0.63	0.84	0.64	0.58	0.46

As in previous surveys cockles became noticeably smaller and less abundant as one moved from Kitchener Street to Portobello Road (Table 12). However, when compared using ANOVA at a significance level of 0.05 the overall size of cockles at each site has not changed significantly from year to year ($F_{5,121}$ = 0.167, p = 0.969). It should be pointed out that at all sites at the head of the harbour cockles are much slower growing than at prime cockle sites further down harbour or in Papanui and Waitati Inlets (Stewart 2006b, 2008d).

Table 12. *Size of cockles collected at Kitchener Street, Orari Street and Portobello Road in 2007, 2008, 2009, 2010, 2011 and 2012.*

	2007			2008			2009			2010			2011			2012		
	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)	n =	Mean weight (g)	Mean length (mm)
Kitchener	59	18.8	37.1	54	16.36	35.5	80	19.6	38.1	63	17.73	36.6	106	19.47	37.5	73	36.08	18.13
Orari St	62	12.3	32.4	74	8.65	29.8	80	12.3	33.0	82	10.18	30.2	73	9.62	30.0	83	31.45	11.17
Portobello	64	9.4	30.1	74	7.87	28.3	80	10	30.1	80	7.7	28.2	103	8.77	28.8	92	28.92	8.96

Infauna at all three sites was dominated by polychaete worms with glyceriids being the most abundant at Portobello Road and glyceriids and nereidids most common at Kitchener and Orari Street (Tables 14-16). Spionid worms were present at Orari and Kitchener Streets, but less common than last year, and totally absent from the Portobello Road sites. Phoxocephalid amphipods were about as common at all sites as they were last year but less common than they were in 2010. Cockles (*Austrovenus stutchburyi*) were most common at both the <20m and >50m sites near the Orari Street outfall and at the <20m site at Kitchener Street (Tables 14-16), with overall abundance similar to previous years. Cockle density was moderate at the >50m site at Kitchener Street and at both Portobello Road sites. Tanaid crustaceans, which were found in moderate numbers at most sites in 2010, were observed at just the <20m site at Orari Street this year. This echoes the results for last year.

Table 13. *Diversity (H') of infauna within 20m and greater than 50m of the Kitchener Street, Orari Street and Portobello Road outfalls. 2012 data compared with 2007, 2008, 2009, 2010 and 2011 data.*

	<20m						>50m					
Site	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
Kitchener Street	0.67	0.53	0.44	0.9	0.81	0.9	0.98	0.73	0.56	0.9	0.94	1.08
Orari Street	1.01	0.86	0.74	0.98	0.99	1.14	0.88	0.87	0.74	1.03	0.98	1
Portobello Road	0.74	0.67	0.8	1.04	0.69	0.7	0.84	0.68	0.76	1.08	0.99	0.9

Table 14. *Abundance of species of infauna collected <20m and >50m from the Kitchener Street outfall.*

Kitchener Street			Location	<20m							>50m						
2012			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**														
Annelida																	0
	Polychaeta																0
		Glyceridae		2	2	2	1	3	1	11		3	1	1	1		6
		Maldanidae									1	1		1			3
		Nephtyidae			1		1			2			1	1			2
		Nereididae		1	2	1	1	3	5	13	2	1	2	1	3	1	10
		Orbiniidae										1	1			1	3
		Spionidae		2	2	4	5	1	1	15	1	2			3	1	7
Hemichordata																	
	Enteropneusta													1		1	2
Crustacea																	
	Amphipoda																
		Lysianassidae			1		1			2	1	1	1	2		1	6
		Oedicerotidae			1		1			2							
		Phoxocephalidae		2	1	1	1	1		6	1	2	1	1	1	3	9
	Isopoda																
			Isocladus armatus														
	Malacostraca		*Macrophthalmus hirtipes*														
	Tanaidacea				1					1						1	1
Mollusca																	
	Gastropoda	Amphibolidae	*Amphibola crenata*														
		Trochidae	*Melagraphia aethiops*														
			Micrelenchus tenebrosus					1		1		1	1		1	1	4
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi	2	1	6	1	1		11	2	1	2	1		2	8
		Mesodesmatidae															
			Paphies subtriangulata														8
		Tellinidae															
			Macomona liliana		2			1	1	4		1		1	1		3
		Animals per core		9	14	14	12	11	8	68	8	14	10	10	10	12	72
		Animals per m^2		1980	3080	3080	2640	2420	1760	2498	1760	3080	2200	2200	2200	2640	2645
		Species per site		5	10	5	8	7	4	11	6	10	8	9	6	9	16

Numbers of animals per square metre were slightly higher than last year, but similar to other surveys, and ranged from 880 at replicate 1, Site 1 at >50mm from the Portobello Road outfall, to 5940 at replicate 2, Site 1 at <20m from the Orari Street outfall. The higher value was largely due to high abundance of polychaetes worms in that core. Despite the variability in overall numbers of animals at the various sites, diversity has not changed significantly from year to year for the <20m sites ($F_{5,12}$ = 1.569, p = 0.242). For >50m sites, however, there has been a significant difference observed over the past three years ($F_{5,12}$ = 7.13, p = 0.003), with diversity being higher recently than in previous surveys at each of the three sites. That being said, there is no significant difference in diversity among the past

two years for the <20m site ($F_{1,4}$ = 0.292, p = 0.618) or for the >50m ($F_{1,4}$ = 0.185, p = 0.689), or between the <20m locations and the >50m locations at any of the sites. ($F_{1,4}$ = 339, p = 0.592) (Table 13).

Table 15. *Abundance of species of infauna collected <20m and >50m from the Orari Street outfall.*

Orari Street			Location	<20m							>50m						
2012			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Opheliidae	*Armandia*		1					1							
		Eunicidae												1			1
		Glyceridae		2	3	1	4	2	3	15	1	1	3	1	4	4	14
		Lumbrineridae			1					1							
		Maldanidae		1	2		1	1	3	8			1	2	1		4
		Nephtyidae			2		1			3				1	1	1	3
		Nereidae		1	1	1	1	2	1	7	1	1			1		3
		Nereididae		3	4	2	1	1	3	14	2	2	3	2	4	1	14
		Spionidae		1	1	2	2		1	7	1	1	2	1	3	1	9
Hemichordata	Enteropneusta			2	1			1	1	5				1	1		2
Sipuncula					1					1		1			1		2
Crustacea	Decapoda		*Helice crassa*									1					1
	Amphipoda																
		Jassidae															
		Lysianassidae		2	1	1	1		2	7							
		Oedicerotidae				1	1			2							
		Phoxocephalidae		2	2	1	1		1	7		1	1		2		4
	Isopoda		*Isocladus armatus*									1					1
	Malacostraca		*Macrophthalmus hirtipes*		1			1		2							
	Tanaidacea					1	1			2							
Mollusca																	
	Gastropoda	Amphibolidae															
		Trochidae	*Micrelenchus tenebrosus*		2					2					1		1
	Bivalvia	Veneridae	*Austrovenus stutchburyi*	3	4	2	1	5	2	17	3	5	4	1	2	7	22
			Nucula spp.			2	1			3	2	2	1	2	1	1	9
		Tellinidae															
			Macomona liliana	2			2		1	5	2	1	1		1	2	7
		Animals per core		19	27	14	18	13	18		12	17	16	12	23	17	97
		Animals per m^2		4180	5940	3080	3960	2860	3960	3997	2640	3740	3520	2640	5060	3740	3557
		Species per site		10	15	10	13	7	10	19	7	11	8	9	13	7	16

Table 16. *Abundance of species of infauna collected <20m and >50m from the Portobello Road outfall.*

Portobello Rd			Location	<20m							>50m						
2012				Site 1			Site 2				Site 1			Site 2			
			Sample	1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Glyceridae		3	3	6	4	9	8	33	3	1	2		3	2	11
		Maldanidae		1	2	2		3	1	9		1	1				2
		Nephtyidae			2		3	1	3	9		2	1			1	4
		Nereididae		1	2	2	1		1	7					1	1	2
		Syllidae			1		1		1	3		1			1		2
Hemichordata																	
	Enteropneusta								1	1	2		1			1	4
Crustacea																	
	Amphipoda																
		Lysianassidae										1		2			3
		Phoxocephalidae		3		1	2	1	2	9			1	1	3		5
Mollusca																	
	Bivalvia																
		Veneridae	*Austrovenus stutchburyi*			1		1		2	2	1	2	1	1	2	9
		Tellinidae	*Macomona liliana*									1					1
		Animals per core		8	10	12	11	15	17	73	7	8	8	4	9	7	43
		Animals per m^2		1760	2200	2640	2420	3300	3740	16060	1540	1760	1760	880	1980	1540	9460
		Species per site		4	5	5	5	5	7	8	3	7	6	3	5	5	10

3.4 Analyses of Cockle, Mussels, Fish and Octopus flesh

Like last year and in 2010, levels of heavy metals in cockle flesh showed no clear trend for contamination in moving from Kitchener Street to Portobello Road (Table 17). This differs from 2008 and 2009 when levels were highest at Portobello Road. PAHs on the other hand, remain by far the highest at Portobello Road (Table 17).

All heavy metals were at concentrations two orders of magnitude below accepted food standards (Table 18). There are no specific guidelines for PAH in shellfish flesh for New Zealand, but food standards for British Columbia recommend an upper limit for benzo[a]pyrene (Table 19).

It should be noted that, as already stated, and as found in previous surveys, cockles became smaller as one nears the Portobello Road outfall. Whether this is due to PAH contamination or exposure at low tides and to fresh water, or some other factor, remains to be determined. As suggested last year, perhaps an investigation of cockle sizes at a site with similar fresh water and tidal exposure is merited.

Unlike last year when faecal coliforms (FCs) were detected at moderate levels in the Portobello Road samples, this year no faecal coliforms were detected in any of the samples. In 2010 FCs were highest at Kitchener Street and moderate at Orari Street and Portobello Road. Highest overall FC levels in cockles were in 2008 but FCs were not detected in any cockle samples in 2007 (Table 17).

To my knowledge, cockles are not gathered by recreational harvesters in the upper harbour basin as they are perceived to be contaminated and too small to be worthwhile.

As with cockles in the upper harbour basin, mussels from Second Beach showed levels of contamination that were well below accepted food guidelines (Table 20). Concentrations of most contaminants were not dissimilar to those observed in cockles (Table 17), but with cadmium slightly higher and chromium lower. Faecal coliform levels were higher than expected and likely derived from stormwater contamination (Table 20). Overall, however, there is little evidence of heavy metal contamination of shellfish by stormwater at the Second Beach site.

Table 17. *Contaminant concentrations in cockle flesh from within 20m of the Kitchener Street, Orari Street and Portobello Road stormwater outfalls in 2007, 2008, 2009, 2010, 2011 and 2012. Green shading indicates a decrease in contaminant level, pink indicates an increase, white = no change. BDL = below detectable limits.*

	Parameter	Units		Portobello Rd	Orari Street	Kitchener St
Cockles	As	mg/kg	2007	2.5	2.5	3.5
			2008	4.0	2.8	3.3
			2009	2.9	4.9	3.8
			2010	2.0	2.3	2.2
			2011	2.5	2.5	2.8
			2012	8.0	8.8	5.3
	Cd	mg/kg	2007	0.014	0.011	0.016
			2008	0.023	0.010	0.015
			2009	0.021	0.024	0.017
			2010	0.014	0.013	0.010
			2011	0.015	0.014	0.015
			2012	0.053	0.027	0.025
	Cr	mg/kg	2007	0.32	0.32	0.34
			2008	0.65	0.15	0.27
			2009	0.22	0.30	0.31
			2010	BDL	0.18	0.13
			2011	0.02	0.17	0.22
			2012	0.33	0.41	0.33
	Cu	mg/kg	2007	0.64	0.70	0.81
			2008	1.20	0.85	0.67
			2009	0.82	1.10	0.89
			2010	0.43	0.46	0.66
			2011	0.77	0.65	0.71
			2012	1.29	1.24	1.29
	Ni	mg/kg	2007	0.71	1.00	0.64
			2008	1.30	1.10	1.30
			2009	0.89	0.93	1.00
			2010	0.72	1.24	1.30
			2011	0.69	1.02	1.10
			2012	0.46	0.55	0.51
	Pb	mg/kg	2007	0.17	0.11	0.08
			2008	0.42	0.07	0.08
			2009	0.099	0.110	0.082
			2010	0.151	0.082	0.089
			2011	0.130	0.094	0.082
			2012	0.35	0.11	0.20
	Zn	mg/kg	2007	6.3	6.4	8.0
			2008	11.0	7.7	8.6
			2009	7.4	10.0	9.0
			2010	5.5	5.3	6.7
			2011	6.8	5.8	7.1
			2012	12.8	10.6	12.1
	PAH	mg/kg	2007	4.912	0.018	0.009
			2008	0.640	0.047	0.028
			2009	0.613	0.038	0.028
			2010	1.714	0.035	0.044
			2011	0.772	0.034	0.027
			2012	2.750	0.031	0.024
	Faecal coliforms	MPN/100g	2007	<18	<18	<18
			2008	1300	230	78
			2009	78	<18	<18
			2010	68	68	220
			2011	45	<18	<18
			2012	<18	<18	<18

Table 18. *Heavy metal concentrations for NZ and US FDA guidelines for adults (expressed as mg/kg dry weight). '-' means no guideline is available.*

	Cu	Zn	Pb	Cd	Cr	Ni
Food Regs/NZ DoH	150.0	2000.0	10.0	5.0	-	-
US FDA	-	-	4.2	-	11.0	80.0
Australia NZ food standards code	-	-	2.0	2.0	-	-

Table 19. *British Columbian guidelines for B[a]P concentration in shellfish for human consumption*

B[a]P concentration in the edible portion of fish/shellfish (µg B[a]P/kg wet weight)	Safe quantity for weekly consumption* on a regular basis (g wet weight)	B[a]P Portobello Road cockles 2007 (µg B[a]P/kg wet weight)	B[a]P Portobello Road cockles 2008 (µg B[a]P/kg wet weight)
4	50	249	34
2	100		
1	200		

*low and moderate consumption levels, according to the State of Washington, are 45 g/wk (or 6.5 g/d) and 140 g/wk (or 20 g/d).

Twenty triplefins were caught in baited fish traps set off the Mason Street wharf on 22nd March 2012. The triplefins were small (Table 20), but representative of the size classes commonly seen amongst variable triplefins. Sizes and weights of the triplefins were slightly lower than those caught last year and lower than in 2007 and 2008. However, size and weight ranges were similar overall to fish caught in past surveys (Table 21). Levels of all contaminants in fish this year were generally similar to those observed in previous surveys. Overall, levels of PAHs and of all metals except lead and zinc were lower in fish than in cockles. Levels of chromium continue to be low in fish and in Portobello Road cockles (Tables 17 & 22).

This is consistent with the results of surveys in previous years, with the concentration of most contaminants in the fish, with the exception of zinc, being similar to or lower than levels observed in cockles (Table 22). At first glance one is tempted to say that this is not unexpected, given that the cockles are filter feeders while the fish are predators. However, contaminants tend to become more concentrated as one moves up the food chain. Triplefins do not prey on shellfish, but do eat smaller fish and a variety of other invertebrates. The fact that contaminant levels are relatively low in fish flesh suggests that heavy metal and PAH contamination around the Mason Street stormwater outfall is low.

Despite numerous patrols along the foreshore just a single octopus was found near the Orari Street outfall for collection of samples this year. Contaminants in octopus flesh were much the same as in previous surveys where octopus have been analysed and are well below levels for concern (Table 23).

Table 20. *Contaminant concentrations in mussel flesh from within 20m of the Second Beach stormwater outfall.*

	Parameter	Units		Second Beach
Mussels	As	mg/kg	2007	1.60
			2008	1.90
			2009	1.90
			2010	1.45
			2011	1.71
			2012	1.65
	Cd	mg/kg	2007	0.078
			2008	0.083
			2009	0.084
			2010	0.094
			2011	0.014
			2012	0.105
	Cr	mg/kg	2007	0.33
			2008	0.20
			2009	0.11
			2010	0.19
			2011	0.21
			2012	BDL
	Cu	mg/kg	2007	1.00
			2008	0.69
			2009	1.50
			2010	0.94
			2011	1.03
			2012	0.89
	Ni	mg/kg	2007	0.40
			2008	0.29
			2009	0.28
			2010	0.48
			2011	0.36
			2012	0.31
	Pb	mg/kg	2007	0.140
			2008	0.110
			2009	0.200
			2010	0.179
			2011	0.157
			2012	0.103
	Zn	mg/kg	2007	12.0
			2008	9.4
			2009	14.0
			2010	9.8
			2011	11.3
			2012	12.2
	Faecal coliforms	MPN/100g	2007	<18
			2008	20
			2009	45
			2010	<18
			2011	170
			2012	1300

Table 21. *Size and weight of triplefins captured near the Mason Street Stormwater outfall in 2007, 2008, 2009, 2010, 2011 and 2012. Spotty values in blue shaded cells.*

	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
	Fish Sizes (mm)						Weight (g)					
	75	70	101	151	74	0	4.7	4	13.1	41.3	5.12	4.2
	71	67	88	72	53	78	3.9	2.9	9.8	4.9	1.52	6.5
	73	46	96	75	64	76	4.4	0.9	10.6	5.2	2.71	5.5
	61	65	71	88	68	66	2.2	3	4.5	7.0	3.24	3.6
	49	63	62	83	87	74	1.1	2.7	2.8	7.3	7.28	4.8
	78	75	81	80	77	88	5.3	5.5	6.9	6.5	5.1	8.7
	77	58	70	78	90	70	5.6	2.4	4.1	4.8	9.88	3.9
	79	67	78	62		44	6.1	3.4	6.6	2.5		1.2
	75	72	79	79		72	4.1	4.5	6	6.5		4.2
	46	83	59	76		78	0.9	6.4	2.1	5.1		4.9
	52	71				64	1.6	4.8				3.1
	74	68				62	4.6	3.8				3.2
		72				62		4.8				2.8
		65				58		2.8				2
		59				70		2.7				4.4
		56				66		2.2				3.6
		60				60		2.4				2.5
						64						3
						60						2.5
						48						1
Mean =	67.5	65.71	78.50	84.40	73.29	64.00	3.7	3.48	6.65	9.11	4.98	4.06
Mean (excluding spotty) =				77.0						5.5		

Table 22. *Contaminant concentrations in the flesh of triplefins captured near the Mason Street Stormwater outfall. BDL = below detectable limits.*

	Parameter	Units		Mason Street
Fish	As	mg/kg	2007	1.90
			2008	1.60
			2009	1.90
			2010	1.56
			2011	1.24
			2012	1.09
	Cd	mg/kg	2007	0.0047
			2008	0.0047
			2009	0.0110
			2010	0.0091
			2011	0.0060
			2012	0.0020
	Cr	mg/kg	2007	0.05
			2008	BDL
			2009	0.14
			2010	BDL
			2011	BDL
			2012	BDL
	Cu	mg/kg	2007	0.54
			2008	0.52
			2009	1.20
			2010	0.38
			2011	0.49
			2012	0.57
	Ni	mg/kg	2007	BDL
			2008	BDL
			2009	BDL
			2010	BDL
			2011	0.13
			2012	BDL
	Pb	mg/kg	2007	0.140
			2008	0.120
			2009	0.43
			2010	0.14
			2011	0.14
			2012	0.29
	Zn	mg/kg	2007	21.00
			2008	20.00
			2009	21.00
			2010	18.10
			2011	19.70
			2012	25.00
	PAH	mg/kg	2007	7.0000
			2008	0.0023
			2009	0.0060
			2010	0.0150
			2011	0.0015
			2012	0.0052
	Mean Size	(mm)	2007	67.5
			2008	65.7
			2009	78.5
			2010	84.4
			2011	73.3
			2012	64.0
	Mean Weight	(g)	2007	3.7
			2008	3.5
			2009	6.65
			2010	9.11
			2011	4.98
			2012	4.06

Table 23. *Contaminant concentrations in the flesh (left) and digestive glands (right) of octopus collected near the Orari Street and Portobello Road Stormwater outfalls.*

	Parameter	Units		Portobello Road	Orari Street
Octopus	As	mg/kg	2007	12.0	7.7
			2008	-	20.0
			2009	4.9	24.0
			2010	-	21.0
			2011	-	-
			2012	-	4.3
	Cd	mg/kg	2007	0.001	0.008
			2008	-	0.0012
			2009	0.019	0.010
			2010	-	0.006
			2011	-	-
			2012	-	0.1
	Cr	mg/kg	2007	<0.02	<0.02
			2008	-	<0.02
			2009	0.15	0.62
			2010	-	<0.10
			2011	-	-
			2012	-	<0.10
	Cu	mg/kg	2007	3.30	3.90
			2008	-	2.60
			2009	7.30	2.60
			2010	-	5.50
			2011	-	-
			2012	-	30.0
	Ni	mg/kg	2007	0.1	0.1
			2008	-	0.023
			2009	<0.10	<0.10
			2010	-	<0.10
			2011	-	-
			2012	-	0.3
	Pb	mg/kg	2007	0.023	0.220
			2008	-	0.029
			2009	0.23	0.11
			2010	-	0.03
			2011	-	-
			2012	-	0.05
	Zn	mg/kg	2007	13.0	14.0
			2008	-	19.0
			2009	20.0	23.0
			2010	-	16.6
			2011	-	-
			2012	-	26.0
	PAH	mg/kg	2007	0.0043	-
			2008	-	0.0127
			2009	0.754	0.026
			2010	-	0.0115
			2011	-	-
			2012	-	0.0057
	Arm span	(mm)	2007	2603	680
			2008	-	2154
			2009	547	2168
			2010	-	1684
			2011	-	-
			2012	-	325
	Weight	(g)	2007	11784	197
			2008	-	10562
			2009	218	11252
			2010	-	3562
			2011	-	-
			2012	-	187

	Parameter	Units		Portobello Road	Orari Street
Octopus (digestive gland)	As	mg/kg	2007	12.0	7.7
			2008	-	13.0
			2009	5.7	22
			2010	-	12.6
			2011	-	-
			2012	-	6.1
	Cd	mg/kg	2007	0.260	3.300
			2008	-	0.066
			2009	1.4	9.6
			2010	-	0.21
			2011	-	-
			2012	-	1.6
	Cr	mg/kg	2007	<0.2	9.2
			2008	-	<0.02
			2009	<0.12	<0.20
			2010	-	<0.10
			2011	-	-
			2012	-	<0.10
	Cu	mg/kg	2007	44.0	740.0
			2008	-	27.0
			2009	230.0	520.0
			2010	-	49.0
			2011	-	-
			2012	-	368.0
	Ni	mg/kg	2007	0.5	5.2
			2008	-	2.8
			2009	1.7	0.66
			2010	-	<0.10
			2011	-	-
			2012	-	2.6
	Pb	mg/kg	2007	0.074	0.440
			2008	-	0.026
			2009	0.25	0.25
			2010	-	0.06
			2011	-	-
			2012	-	0.15
	Zn	mg/kg	2007	26.0	160.0
			2008	-	26.0
			2009	87.0	310.0
			2010	-	47.0
			2011	-	-
			2012	-	284.0
	PAH	mg/kg	2007	0.0599	-
			2008	-	0.0251
			2009	0.26	0.116
			2010	-	0.0291
			2011	-	-
			2012	-	0.0243
	Arm span	(mm)	2007	2603	680
			2008	-	2154
			2009	547	2168
			2010	-	1684
			2011	-	-
			2012	-	325
	Weight	(g)	2007	11784	197
			2008	-	10562
			2009	218	11252
			2010	-	3562
			2011	-	-
			2012	-	187

4. Discussion and Conclusion

In 2012 water samples were colleted from a total of 14 major Dunedin City stormwater outfalls. In addition, sediments were sampled from near 5 of these outfalls and from an additional 11 sites located some distance from the outfalls to

gain a clearer picture of the distribution of contaminants in sediment in the upper Otago Harbour. Flesh from fish, cockles, octopus and mussels was also collected for contaminant analysis. For interest sake historical data for some of the same sites have been included for comparison (Tables 24 and 25). Any trends observed in these data for historical sediment values should be viewed with extreme caution as sampling in some previous years may have used entirely different protocols. For example, sediments may have been collected from different depths within the substrate and by different methods meaning that results are not directly comparable. Stormwater sampling, however, should be comparable assuming previous investigators targeted the first flush.

There has been a decline in the levels of some contaminants at stormwater outfalls for which historic data are provided, but a rise in others. The reduction in lead levels continues at many outfalls, but has risen at George Street, Bauchop Street and Wickliffe Street. This is a little surprising as one would expect that with the removal of lead from paint and petrol, levels in the environment should be very gradually declining. Any reduction in the levels of other contaminants is extremely inconsistent (e.g. Cu has risen at three sites, but fallen at the remainder) and there is a slight increase in levels of all metals a few sites (Table 24). Such fluctuations are generally relatively small and may be merely a function of the intensity of the storm events when sampling occurred.

Overall levels of contaminants in sediment appeared to have been falling slightly or to have plateaued. However, this year levels of most contaminants at most outfall sites have risen slightly. Of some comfort is the fact that contaminant levels at sites more remote from the outfalls show a continued decline, suggesting that existing contaminants may be declining, being buried, or being flushed out of the harbour (Tables 24 and 25). The increased levels of most metals seen in sediment at Wickliffe Street in the past is not apparent this year.

It is expected that the implementation of the long-term stormwater catchment management plans currently under development through the DCC's Three Waters Strategy will contribute to addressing the issue of future contaminants in stormwater. It will be of interest to see if any long-term trends in contaminant levels can be discerned as monitoring continues.

Benthic and infaunal communities in the vicinity of the Portobello Road, Orari Street and Kitchener Street outfalls have reasonably low diversity, but this is generalised and not associated with any one outfall and is likely symptomatic of a large proportion the upper harbour basin. As in past years there is a trend towards smaller cockles as one nears the Portobello Road outfall. This may be as a result of historic PAH contamination, which is extremely high beneath the surface at this site, but a number of other factors, not least of which are freshwater exposure and exposure at low tide, must also be considered.

Rainer (1981) and Grove (1995) certainly found less diversity in soft-bottom macrofaunal communities as one moves from harbour mouth to the head of Otago Harbour. It should be pointed out that much of the shoreline around the upper harbour has been extensively modified and as such cannot be regarded as an inlet typical of those found throughout the region. Despite this the communities sampled in the upper Otago Harbour near stormwater outfalls are numerically dominated by polychaete worms and amphipods, as is usual for sheltered soft shores around New Zealand (Morton and Miller 1973), and show distinct similarities to communities found in other moderately impacted inlets in Otago (Stewart 2007b, 2008a,b).

While not pristine, the upper harbour and the communities associated with the intertidal areas adjacent to major stormwater outfalls appear not to be undergoing any significant further degradation as a result of stormwater inputs. It is to be hoped that if any slight trends towards lower contaminant levels in stormwater are continued, both water quality and community health in the harbour will gradually improve over time.

Only after problem areas and problem contaminants have been identified can measures be taken to mitigate any effects. No additional mitigation measures have been undertaken by the DCC at this stage, apart from investigations into the remediation of PAH contamination at the Portobello Road outfall (Stewart 2006), the elimination of the source of FWAs at Bauchop Street in 2008, and the usual street sweeping and mud tank clearance. As already stated, the South Dunedin (Portobello Road) catchment has been investigated as the pilot catchment for the development of the Three Waters Strategy catchment management plans. It is expected that further stormwater monitoring over time and concurrent investigations under the Three Waters strategy will define problem areas such that

mitigation measures may be undertaken.

It should be noted that the current stormwater monitoring programme is under review and a modified programme may help pinpoint areas of concern with more accuracy in future.

Table 24. *Contaminants in stormwater being discharged to the upper Otago harbour basin through time. BDL = below detectable limits. Pink cells denote levels higher than at any past sampling event; green cells denote levels lower than at any past sampling event.*

	Parameter	Suspended Solids							Cd							Cr						
	units	g/m^3							g/m^3							g/m^3						
		Historic	2007	2008	2009	2010	2011	2012	Historic	2007	2008	2009	2010	2011	2012	Historic	2007	2008	2009	2010	2011	2012
Catchement	Second Beach		BDL	37.0	41	BDL	57	5		BDL	0.00006	0.00006	0.00007	0.000075	BDL		0.0007	0.0028	0.0035	0.00086	0.0038	0.00148
	Pt Chalmers George St		87.0	150.0	26	170	140	180		0.00028	0.00140	0.00011	0.00033	0.000168	0.0006		0.005	0.012	0.0031	0.00136	0.0045	0.0053
	Pt Chalmers Watson Pk		37.0	39.0	7.4	240	24	24		BDL	BDL	BDL	BDL	BDL	BDL		BDL	0.0064	BDL	BDL	BDL	0.0016
	Shore Street	75.4	41.0	24.0	20	9.5	12	10		BDL	BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL	BDL	BDL
	Portobello Road	28.0	18.0	46.0	30	8.1	53	43	0.0003	BDL	0.00023	BDL	BDL	BDL	BDL	0.0029	BDL	0.002	BDL	BDL	BDL	BDL
	Teviot Street		25.0	33.0	12	84	66	32		BDL	0.00008	BDL	0.00026	BDL	0.00012		BDL	0.0018	BDL	BDL	BDL	0.0019
	Midland Street		30.0	19.0	30	52	14	12		BDL	0.00013	BDL	BDL	BDL	BDL		BDL	0.0035	0.0031	BDL	BDL	BDL
	Orari Street	38.1	28.0	77.0	16	130	4	BDL	0.0005	BDL	BDL	BDL	0.000164	BDL	BDL	0.002	BDL	0.0032	BDL	0.00183	BDL	BDL
	Kitchener Street		104.0	41.0	45	50	BDL	27		BDL	BDL	BDL	BDL	BDL	BDL		0.004	0.002	BDL	BDL	BDL	BDL
	Mason Street		62.0	37.0	37	138	30	31		BDL	BDL	0.0077	0.00051	BDL	BDL		BDL	BDL	BDL	BDL	BDL	BDL
	Ravensbourne Road			8.5	18	61	5	6			BDL	BDL	BDL	BDL	BDL			0.00061	BDL	BDL	BDL	BDL
	Bauchop Street		44.0	16.0	13	53	5	38		BDL	BDL	BDL	0.00049	BDL	BDL		BDL	0.0015	BDL	BDL	BDL	BDL
	Halsey Street		119.0	35.0	27	50	24	22		BDL	0.00022	BDL	0.00026	BDL	BDL		BDL	BDL	BDL	BDL	BDL	BDL
	Wickliffe Street		35.0	27.0	100	86	46	30		BDL	BDL	0.00052	0.00078	0.00092	0.00022		BDL	0.0017	0.0076	0.00157	0.0046	0.0028

	Parameter	Cu							Ni							Pb						
	units	g/m^3							g/m^3							g/m^3						
		Historic	2007	2008	2009	2010	2011	2012	Historic	2007	2008	2009	2010	2011	2012	Historic	2007	2008	2009	2010	2011	2012
Catchement	Second Beach		0.0027	0.012	0.019	0.0054	0.0172	0.0026		0.0009	0.0021	0.0022	0.00133	0.0026	0.00105		0.001	0.011	0.013	0.00021	0.0127	0.00101
	Pt Chalmers George St		0.0213	0.039	0.025	0.0148	0.0197	0.027		0.0029	0.0093	0.0026	0.006	0.0037	0.0061		0.0342	0.041	0.018	0.0048	0.0037	0.029
	Pt Chalmers Watson Pk		0.009	0.0025	BDL	BDL	BDL	0.008		BDL	BDL	BDL	0.0035	BDL	0.0019		0.0141	0.0018	BDL	BDL	0.0041	0.0057
	Shore Street		0.01	0.014	0.02	0.0118	BDL	BDL		0.01	BDL	BDL	BDL	BDL	BDL		0.003	0.0085	0.0069	BDL	BDL	BDL
	Portobello Road	0.03	BDL	0.026	0.01	0.0057	0.029	0.012	0.002	BDL	0.0035	0.0028	0.0035	BDL	BDL	0.021	BDL	0.019	0.0067	0.00055	0.026	0.0081
	Teviot Street		BDL	0.0094	BDL	0.0136	0.031	0.0104		BDL	0.0019	BDL	0.0033	BDL	0.0017		BDL	0.0066	BDL	BDL	0.0065	0.0028
	Midland Street		0.02	0.031	0.057	0.021	BDL	0.0134		BDL	0.0016	BDL	0.0075	BDL	BDL		0.005	0.0054	0.0083	BDL	BDL	0.0023
	Orari Street	0.0132	BDL	0.014	BDL	0.0096	BDL	0.0024	0.002	BDL	0.0033	BDL	0.00108	BDL	0.00081	0.022	BDL	0.023	BDL	0.00015	BDL	0.00118
	Kitchener Street		0.034	0.0056	0.023	0.0118	BDL	BDL		0.003	BDL	0.0036	0.0035	BDL	BDL		0.0442	0.007	0.018	0.00196	BDL	0.0028
	Mason Street		0.022	0.012	0.021	0.0157	0.043	0.026		0.004	BDL	0.0055	BDL	0.0039	BDL		0.0258	0.0089	0.014	0.00102	0.0192	0.0101
	Ravensbourne Road			0.0023	BDL	0.0031	BDL	0.0032			0.00066	BDL	0.00148	BDL	0.00069			0.0015	0.0029	0.00023	0.025	0.0039
	Bauchop Street		0.029	0.0096	0.021	0.0026	BDL	0.021		0.01	BDL	0.0035	BDL	BDL	BDL		0.01	0.0035	0.0097	BDL	BDL	0.021
	Halsey Street		0.024	0.0043	BDL	0.00162	0.029	0.0043		0.009	BDL	BDL	BDL	BDL	BDL		0.021	0.0022	BDL	0.0021	0.0085	0.0043
	Wickliffe Street		0.01	0.013	0.059	0.0058	0.022	0.025		0.01	BDL	0.0042	BDL	0.0021	0.0046		0.006	0.0084	0.033	BDL	0.0134	0.0153

	Parameter	Zn							PAH						
	units	g/m^3							g/m^3						
		Historic	2007	2008	2009	2010	2011	2012	Historic	2007	2008	2009	2010	2011	2012
Catchement	Second Beach		0.038	0.16	0.15	0.092	0.25	0.026							
	Pt Chalmers George St		0.288	0.66	0.19	0.42	0.25	0.43							
	Pt Chalmers Watson Pk		0.231	0.027	BDL	0.29	0.24	0.27							
	Shore Street		0.02	0.44	0.21	0.115	BDL	0.071							
	Portobello Road	0.895	0.08	0.94	0.64	0.153	0.87	0.15	0.0031	BDL	328	0.00017	0.00016	0.00168	0.000166
	Teviot Street		BDL	0.13	BDL	1.79	0.61	1.22							
	Midland Street		0.1	0.35	0.18	0.22	BDL	0.21							
	Orari Street	0.191	BDL	0.22	0.031	0.3	BDL	0.0157	0.0026	0.0001	318	BDL	0.0005	BDL	BDL
	Kitchener Street		0.445	0.036	0.38	0.62	BDL	0.082		BDL	327	BDL	0.0001	BDL	BDL
	Mason Street		0.25	0.16	0.35	0.43	0.63	0.43							
	Ravensbourne Road			0.053	0.047	0.144	0.27	0.32							
	Bauchop Street		0.23	0.12	0.3	0.121	BDL	0.94							
	Halsey Street		0.12	0.033	0.13	0.136	0.36	0.089							
	Wickliffe Street		0.1	0.2	0.53	0.24	0.82	1.57							

Table 25. *Contaminants in sediments in the upper Otago harbour basin in the vicinity of selected stormwater outfalls through time. Pink cells denote levels higher than at any past sampling event; green cells denote levels lower than at any past sampling event.*

	Arsenic							Cadmium							Chromium						
	Historic	2007	2008	2009	2010	2011	2012	Historic	2007	2008	2009	2010	2011	2012	Historic	2007	2008	2009	2010	2011	2012
Rowing Club		10.6	9.8	7.3	13.0	11.6	8.0	0.0	0.2	0.2	0.1	0.2	0.1	0.2	16.8	17.6	12	16.0	14.0	11.6	20.0
Wickliffe		17.3	11.0	6.9	9.0	14.3	11.0		0.6	0.74	0.8	0.7	0.7	0.8		38	34	16.0	27.0	30.0	31.0
White St		11.6	18.0	5.4	6.0	8.3	8.0		0.3	0.22	0.2	0.1	0.1	0.2		68.5	56	26.0	19.0	30.0	43.0
Kitchener St		4.6	7.5	7.0	9.0	4.5	12.0		0.4	0.35	0.3	0.3	0.3	0.5	7.1	22.6	18	98.0	22.0	18.3	34.0
Orari St		18.6	4.3	20.0	5.0	2.1	4.0	0.5	63.0	0.13	0.9	0.2	0.1	0.3	17.5	0.27	16	37.0	16.0	9.4	26.0
Orari 100		13.7					10.7	0.3	0.4					0.32	16	26.3					22.0
Midland 200		15.4					11.2	0.4	0.3					0.42	22	22.4					21.0
Portobello Rd		29.0	23.0	24.0	15.0	28.0	42.0	2.0	1.8	1.8	2.0	1.5	2.6	3.1	41	60.1	54	50.0	36.0	67.0	82.0
PR 200		17.4					18.3	1.0	0.5					0.43	32	41.8					41.0
Shore St		9.5	7.1	6.2	6.0	2.3	5.0	0.5	0.4	0.32	0.3	0.3	0.2	0.3	9.6	21.8	16	18.0	19.0	5.8	12.0
Boatshed		27.4	16.0	17.0	15.0	16.2	20.0		0.3	0.21	0.2	0.3	0.6	0.3		41.7	19	26.0	31.0	34.0	38.0
Cove Drainage		21.5	17.0	19.0	13.0	9.5	17.0		0.1	0.13	0.4	<0.1	0.2	<.1		15.8	35	32.0	19.0	21.0	27.0
Retaining wall		25.3	36.0	24.0	36.0	39.0	24.0		0.1	0.15	<0.1	<0.1	0.1	0.1		23.6	31	39.0	23.0	24.0	27.0
RW 300		16.2					15.2	0.1	0.3					0.15	28.33	27					28.0
W/W centre		11.1					15.1		0.2					0.11	2.75	30.8					25.0
UHB Centre		10.5					9.1	0.3	0.2					0.21	26.8	24.3					25.0

	Copper							Nickel							Lead						
	Historic	2007	2008	2009	2010	2011	2012	Historic	2007	2008	2009	2010	2011	2012	Historic	2007	2008	2009	2010	2011	2012
Rowing Club	9.8	14.2	13	14	9	12	16.0		11.3	14	13.0	11.0	12.1	14.0		18.9	27	27	28	19	27
Wickliffe		121.0	68	50	58	86	75.0		19.2	23	13.0	17.0	15.9	17.0		76.1	140	77	92	127	130
White St		433.0	160	170	78	98	149.0		29.5	21	11.0	8.0	14.5	18.0		147	180	170	124	147	95
Kitchener St		69.5	56	90	37	54	81.0	5.8	10.6	12	15.0	12.0	10.6	16.0		117.9	97	130	155	132	220
Orari St	20	25.1	13	61	11	7	28.0	10.4	23.6	8.1	16.0	8.0	5.3	16.0	185	12.8	39	120	35	17	72
Orari 100	28	25.9					20.0	8.8	12.6					11.5	170	170					37
Midland 200	24	19.0					20.0	8.3	10.7					10.2	36	36					38
Portobello Rd	210	169.3	160	190	123	176	220.0	15	20.4	18	26.0	19.0	24.0	19.0	410	306.33	330	290	193	310	470
PR 200	100	52.6					48.0	13	17.3					18.0	130	81.3					79
Shore St	30	50.9	44	41	35	11	25.0	5.4	10.7	9	11.0	10.0	5.2	7.0	130	113	110	79	85	36	78
Boatshed		108.0	33	49	35	53	55.0		24.5	16	17.0	16.0	18.5	19.0		112	800	170	86	89	91
Cove Drainage		11.3	19	38	11	14	20.0		23.5	44	23.0	19.0	12.8	34.0		19.7	20	55	18	44	32
Retaining wall		13.3	19	17	10	11	11.0		15.9	25	26.0	18.0	13.2	16.0		26.9	27	42	24	23	27
RW 300	16.3	15.2					14.7	13.3	12.4					25.0	40	6.7					36
W/W centre		15.3					13.0	3.63	14.6					21.0	25	5.6					25
UHB Centre	15.2	15.2					21.0	10	11.3					16.0	27	23					40

	Zinc							PAH							Enterococci						
	Historic	2007	2008	2009	2010	2011	2012	Historic	2007	2008	2009	2010	2011	2012	Historic	2007	2008	2009	2010	2011	2012
Rowing Club	80.8	101	130	160	149	109	127		6.97	5.78	0.5	3.7	0.1	0.7		200	11	<2		8	BDL
Wickliffe		412	740	810	740	700	770		9.21	1.18	7.3	7.2	11.3	4.6		58000	>1600	330	<3	>160	7
White St		4450	2500	2400	1280	1650	2700		12.96	11.05	15.9	6.5	5.4	10.7		400	2	<2		35	BDL
Kitchener St	170	249.33	280	300	280	260	530		8.88	140.49	4.8	5.0	5.5	10.0	130	6633	920	5	<3	>160	12
Orari St	239	68.27	130	680	157	69	350	13.41	10.23	12.59	28.3	9.3	4.3	10.4	557	12.67	8	23	<3	54	9
Orari 100	230	227					197		6.67					6.55	1300	3600					BDL
Midland 200	190	165					270		7.24					7.12	130	20000					BDL
Portobello Rd	1300	1493	1400	1600	1040	1410	2400	425.83	382.90	250.30	525.2	194.1	482.0	767.1	1120	72667	170	<2		16	2
PR 200	430	309					310	12.29	8.97					9.16	40	66000					BDL
Shore St	300	484	300	330	350	210	290		9.56	21.01	8.6	10.5	4.1	14.2	2400	9000	>1600	<2		35	7
Boatshed		339	370	360	290	300	340		6.67	5.54	38.8	7.9	40.4	9.7		3400	33	33	<3	54	BDL
Cove Drainage		99.2	150	270	125	119	156		0.37	0.00	0.1	0.1	1.0	1.4		800	17	<2	<3	35	BDL
Retaining wall		141	170	150	152	138	112		0.30	3.91	0.0	9.4	0.2	0.2		<100	8	<18		8	BDL
RW 300	149	131					128		0.30					0.28		<2					BDL
W/W centre		168					117		0.34					0.36		<2					BDL
UHB Centre	118	119					157		0.65					0.67		24000					BDL

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G

Appendix G Additional Monitoring Reports

Ecological Assessment of Dunedin's Marine Stormwater Outfalls

Dunedin 3 Waters Strategy



Prepared for

Dunedin City Council

by

Ryder Consulting Ltd.

June 2010

ryderconsulting
environment + planning + project management

Ecological Assessment of Dunedin's Marine Stormwater Outfalls

Dunedin 3 Waters Strategy

prepared by

Brian Stewart

Ryder Consulting

July 2010

Cover photo: St Clair stormwater outfall

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Executive Summary

This report presents the findings for the first monitoring of Dunedin's stormwater outfalls as part of catchment investigations for the DCCs' 3-Waters Strategy.

The survey comprised assessment of stormwater and sediments for possible anthropogenic contamination and assessment of benthic communities in the vicinity of 14 major Dunedin stormwater outfalls and compares results with past surveys and historical data.

Stormwater from all outfalls monitored showed variable levels of contamination, with numerous parameters being present at concentrations above recommended ANZECC guidelines or trigger values.

Sediment also showed variable levels of contamination but there appears to be a very slight trend towards diminishing levels for some contaminants at some sites through time.

Benthic communities show no significant difference between sites <5m from outfalls and sites >20m from the same outfalls.

It is expected that continued monitoring will provide a clearer picture which contaminants are associated with particular outfalls and of trends in contaminant levels.

1. Introduction

1.1 Background

The Dunedin City Council (DCC) recognises the need to manage its water resources. Such management applies not only to drinking water but also to wastewater and stormwater. Consequently, to provide direction for management in these areas the DCC has developed the Three Waters Strategy (TWS) which looks at the most effective and sustainable ways of meeting Dunedin's current and future needs with respect to drinking water, stormwater and wastewater.

A proposed way forward in the Three Waters Strategy with respect to stormwater is to develop separate catchment management plans for each of Dunedin's stormwater catchments. As with all urban centres throughout New Zealand, and indeed most of the world, Dunedin's stormwater is reticulated to receiving environments via networks of gutters, open channels and pipes. The principal receiving water environments for Dunedin's reticulated stormwater are the upper basin of Otago Harbour, Sawyers Bay and Port Chalmers, Second Beach/St Clair Beach on the open coast, Kaikorai Stream in Kaikorai Valley and the Water of Leith. As part of each catchment management plan the types of contaminants entering stormwater and the concentration of those contaminants in storm runoff need to be determined. Once this has been achieved effects, if any, that these contaminants are having on the receiving environment need to be determined.

To this end, OPUS engaged Ryder Consulting to carry out surveys of the receiving environment benthos in the vicinity of each major stormwater outfall and dovetail the findings with the annual stormwater monitoring carried out by the DCC.

The following report presents the results of these surveys and results of the latest round of DCC stormwater sampling/monitoring carried out between January and June 2010.

1.2 Stormwater Outfalls

Stormwater is discharged from Dunedin City to the Upper Otago Harbour, Second Beach and Port Chalmers from fourteen reasonably large and permanent stormwater outfalls (Figures 1a, 1b and 1c), and from a number of smaller outfalls and non-point sources (Table 1). Many of the outfalls have very long histories dating back to the days of the early settlement of Dunedin and a numbers were dual-purpose outfalls, discharging both wastewater and stormwater. All current outfalls, however, are

designated to discharge stormwater.

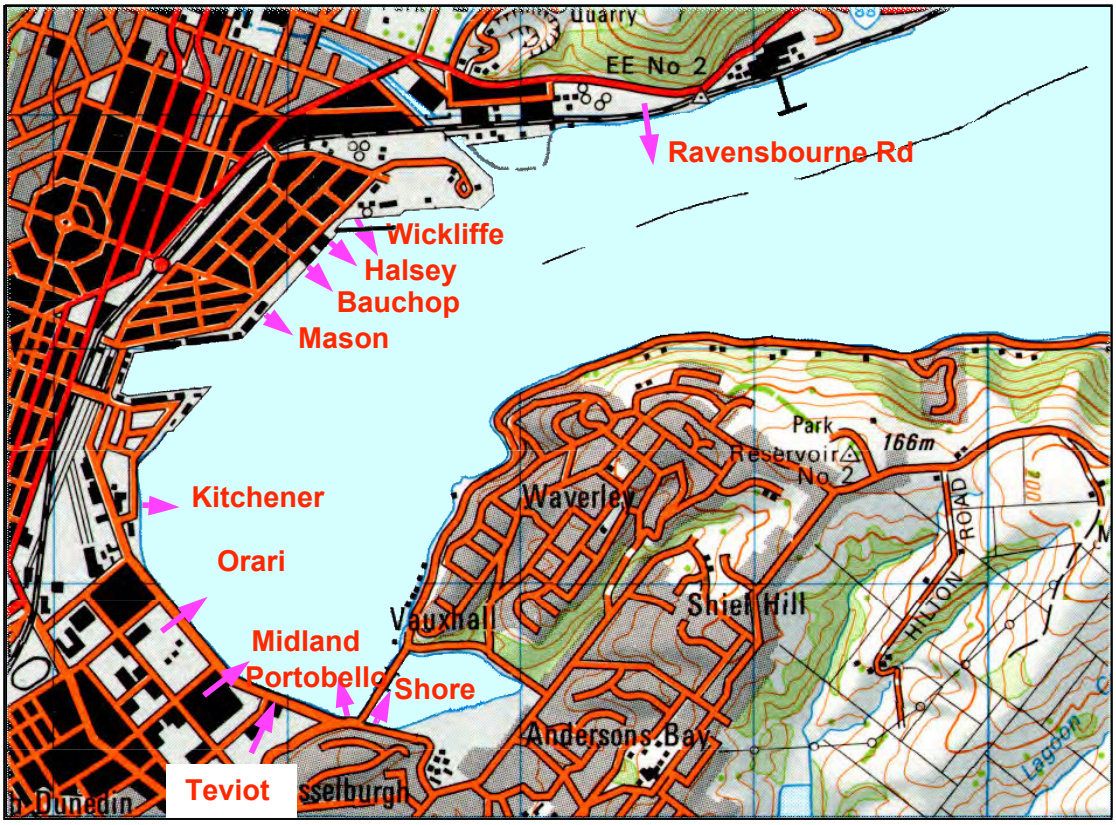


Figure 1a. *Major stormwater outfalls, labelled by catchment name, discharging from Dunedin City to the Upper Otago Harbour Basin.*



Figure 1b. *Location of the Second Beach (left) and St Clair (right) stormwater outfalls.*

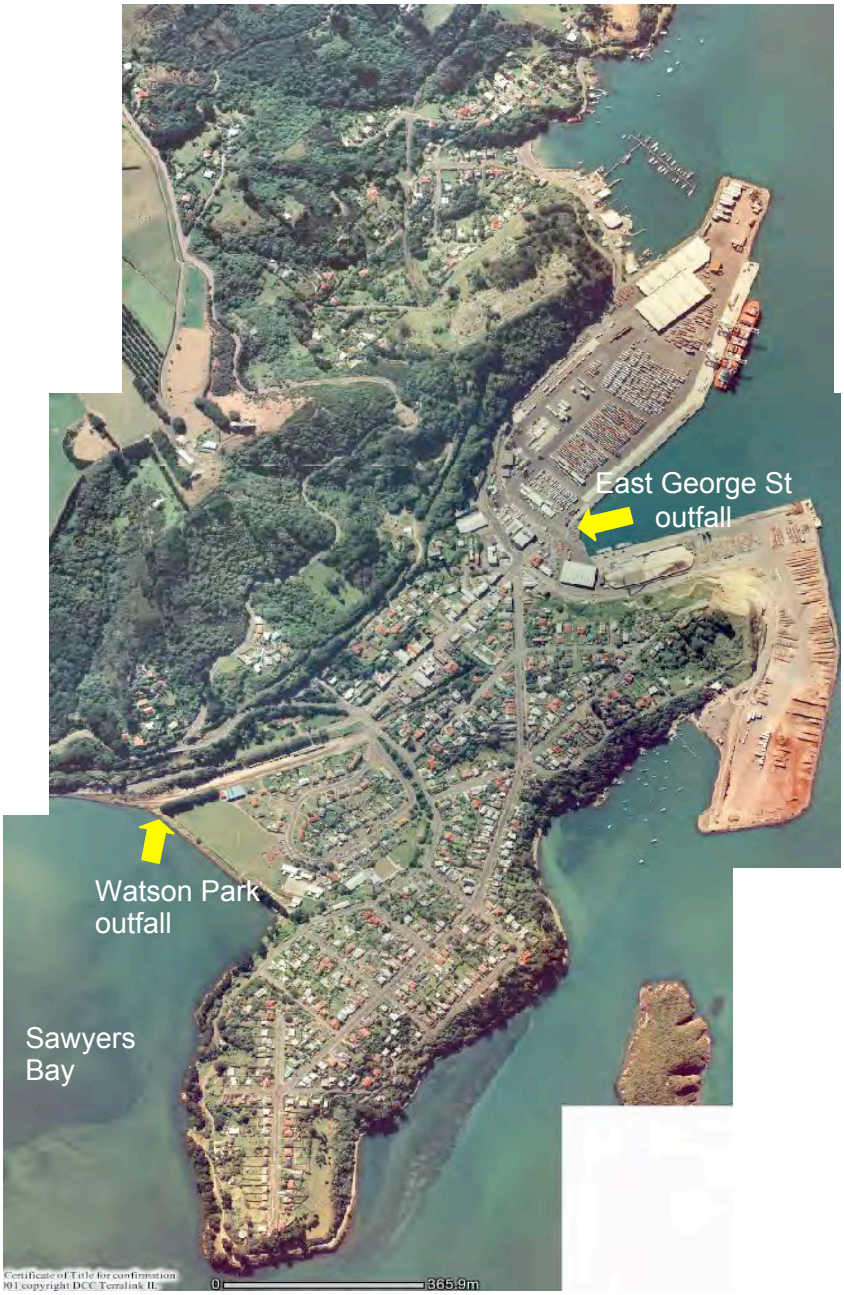


Figure 1c. *Location of major outfalls discharging stormwater from Port Chalmers.*

A total of 31 consents have been granted for the individual stormwater outfalls listed in Table 1. As can be seen in Table 1 a number of outfalls may drain a single catchment. The catchments in question are shown in Figure 2.

Table 1. *List of stormwater outfalls for which discharge permits have been granted.*

Consent ref	DCC ref	Location	Catchment	Description	Max flow rate (l/s)	Outlet structure
2002.080	4	Shore St	Shore St	1500mm dia concrete pipe with tide gate	2,380	Yes
2002.081	5	Portobello Rd	South Dunedin	twin 1500mm dia conduits in wingwall structure	pump rate 6,300	Yes
2002.082	6	Teviot St	Portsmouth Dr	375mm dia. concrete pipe	105	Yes
2002.083	7	Midland St	Portsmouth Dr	450mm dia concrete pipe	143	No
2002.084	8(a)	Orari St	Orari St	375mm dia concrete pipe	101	No
2002.085	8(b)	Orari St	Orari St	2700mm dia concrete pipes in wingwall structure with tide gates	10,350	Yes
2002.086	9(a)	Kitchener St	Kitchener St	600mm dia concrete pipe	310	Yes
2002.087	9(b)	Kitchener St	Kitchener St	1500mmdia	3,880	Yes
2002.088	10	French St	Portsmouth Dr	450mm dia concrete pipe	185	No
2002.089	11	Kitchener St	Kitchener St	300 mm dia concrete pipe	78	No
2002.090	12(a)	Birch St	Portsmouth Dr	225 mm dia concrete pipe	37	No
2002.091	12(b)	Birch St	Portsmouth Dr	225 mm dia concrete pipe	55	No
2002.092	12(c)	Wharf St	Portsmouth Dr	225 mm dia concrete pipe	52	No
2002.093	13(a)	Fryatt St	Portsmouth Dr	150 mm dia concrete pipe	40	No
2002.094	13(b)	Fryatt St	Portsmouth Dr	450mm dia concrete pipe	180	No
2002.095	13(c)	Fryatt St	Portsmouth Dr	300mm dia concrete pipe	54	No
2002.096	14	Fryatt St	Portsmouth Dr	300mm dia concrete pipe	116	No
2002.097	15(a)	Mason St	Mason St	2175mm dia concrete conduit	5,000	Yes
2002.098	15(b)	Mason St	Bauchop St	450mm dia concrete pipe	90	No
2002.099	15(c)	Mason St	Bauchop St	1350mm dia concrete culvert	1,500	No
2002.100	16(a)	Halsey St	Halsey St	1950mm concrete conduit	3,800	No
2002.101	16(b)	Halsey St	Wickliffe St	1950mm concrete conduit	2,600	No
2002.102	16(c)	Halsey St	Wickliffe St	300mm dia concrete pipe	113	Yes
2002.103	17	Wickliffe St	Wickliffe St	1,050 mm dia concrete pipe in wingwall structure	1,660	No
2002.104	18(a)	Magnet St	Ravensbourne	300mm dia concrete pipe	73	No
2002.105	18(b)	Magnet St	Ravensbourne	300mm dia concrete pipe	66	No
2002.106	19	Ravensbourne Rd	Ravensbourne	300 mm dia.	117	Yes
2002.108		George St (Port Otago)	Port Chalmers	750 mm dia concrete pipe	1,000	No
2002.109		George St/SH88	Port Chalmers	1,250 mm dia concrete pipe	1,200	Yes
2002.110		Second Beach Rd	St. Clair	1,050 x 1,050 mm tunnel and tower	7,000	Yes
2006.222		Sawyers Bay, west side of Watson Park	Port Chalmers	150 mm dia concrete pipe in wingwall structure	20	Yes

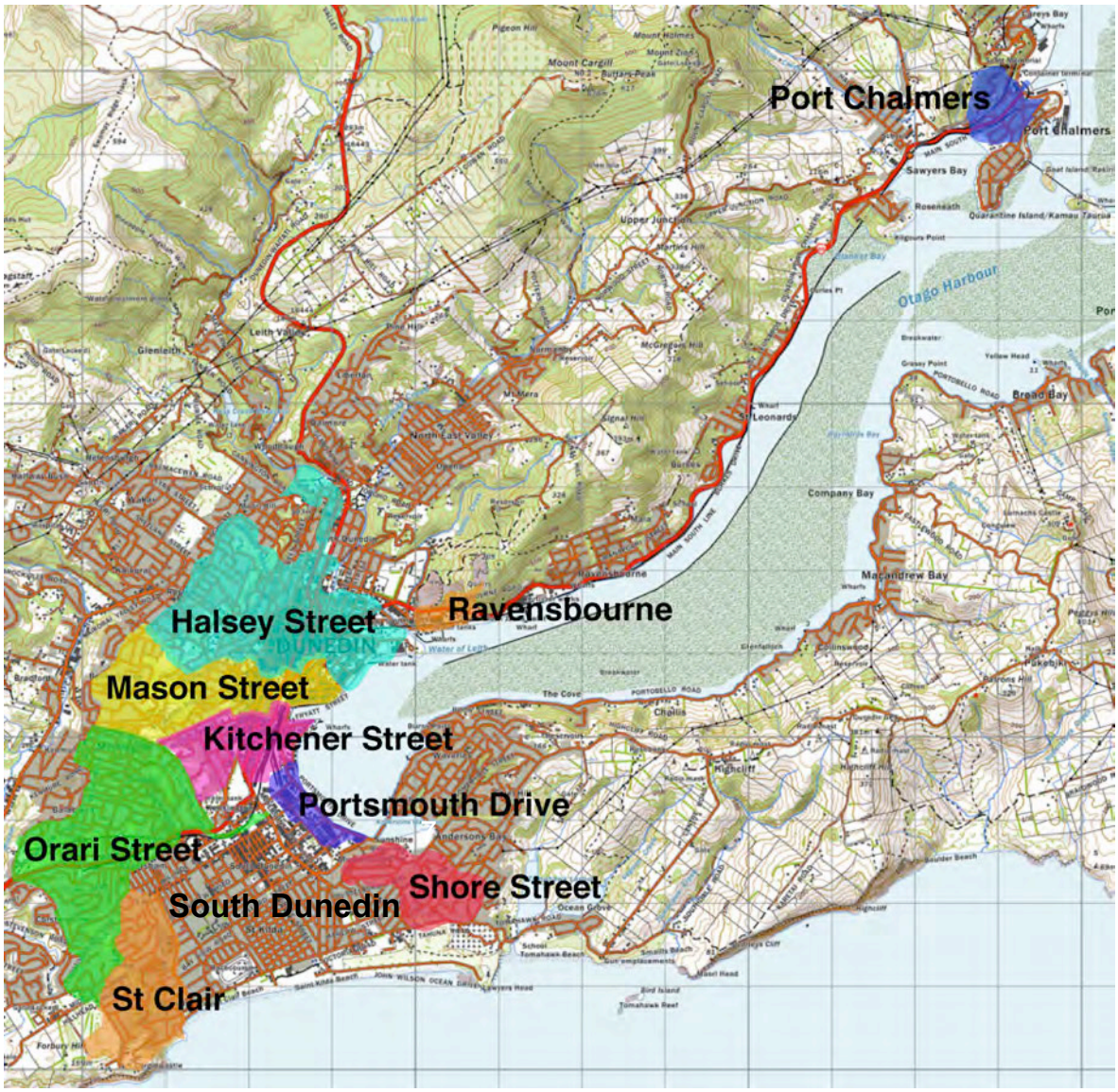


Figure 2. *Stormwater catchments within Dunedin.*

2. Methods

2.1 Annual stormwater monitoring

A number of the outfalls listed in Table 1 do not have outfall structures or are located in places that are inaccessible. Consequently, as agreed by the ORC, it is neither practical nor possible to sample from the entire 31 outfalls listed. However, the monitoring programme undertaken samples all major Dunedin stormwater catchments and gives a comprehensive picture of the state of contaminants in Dunedin's stormwater. Catchment names used reflect the naming used under the DCCs 3 Waters Strategy (See Table 2). Grab samples of stormwater were collected from each stormwater outfall within 1 hour of the commencement of a rain event (>0.5mm) in an endeavour to ensure that first flush water was gathered.

Collections took place only if there was an antecedent period of at least 72 hours with no rain before the target rain event. Samples were sent to Hill Laboratories in Hamilton to be analysed for arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn), faecal coliforms and *E. coli.* Samples collected from the Kitchener Street, Orari Street and Portobello Road outfalls were additionally analysed for polycyclic aromatic hydrocarbons (PAHs). Samples were also collected during a period of low flow a week after the targeted rainfall event and analysed for fluorescent whitening agents (FWAs). FWAs are used in laundry detergents and indicate possible sewage infiltration to the stormwater system (Petch 1996). Gilpin *et al*., (2004) recommend that stormwater be sampled at low flows to get a more accurate picture of sewage infiltration because the FWAs are usually present in only very low concentrations and are more readily detected at low flows.

2.2 Sediments

A 250cm^3 sediment sample was collected from the top 20mm of sediment within 5m from each of the St Clair, Watson Park, Ravensbourne, Kitchener Street, Orari Street, Midland Street, Shore Street and Portobello Road outfalls and a further replicate sediment sample was collected at >20m from the outfall for each site (Figure 3). Samples were chilled and sent to Hill laboratories in Hamilton for analysis for total arsenic, total cadmium, total chromium, total copper, total nickel, total lead, total zinc, faecal coliforms, enterococci and PAHs. The original proposal suggested a sample be collected from <1m from each outfall. This was replaced by the <5m sample due to the fact that at some sites (e.g. St Clair) it was impractical to collect at <1m, while at others (e.g. Portobello Rd and Orari Street) the sheer volume of stormwater issuing from the outfall ensured that settlement of sediments did not occur less than 3-5m from the outfall.

2.3 Biological Monitoring

In accordance with previous surveys and current monitoring programmes a quantitative sampling programme of a random block design was used in the proximity of each outfall that discharges to the intertidal zone (i.e. outfalls for all the above catchments except Halsey Street and Mason Street, both of which discharge to deep water, and the George Street outfall at Port Chalmers which is inaccessible). Thus, at the Watson Park, Ravensbourne, Kitchener Street, Orari Street, Midland Street, Portobello Road, Shore Street, and St Clair outfalls

macroalgae were identified and percentage cover estimated for three $1m^2$ quadrats at each of two sites <5m from the outfall and >20m from the outfall, giving a total of 12 quadrats per outfall. Macroinvertebrates were identified and recorded from 15 randomly placed $1.0m^2$ quadrats within 5m of each outfall at and at >20m from each outfall, according to the protocols outlined in Kingsford and Battershill (1998), giving a total of 30 samples at each site. Quadrats were randomly positioned at low tide, provided there was enough foreshore exposed.

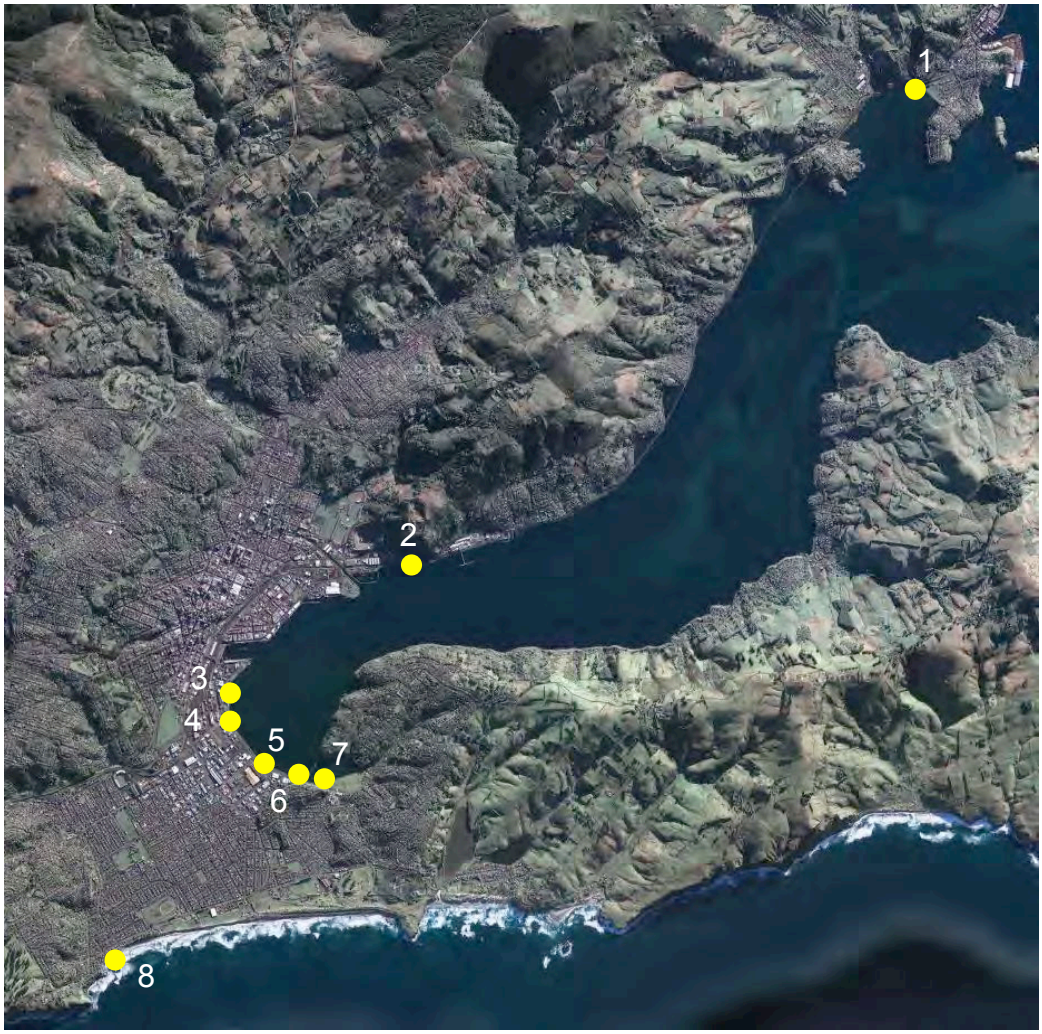


Figure 3. *Stormwater outfall sites at which soft sediment samples were collected. Sites are: 1. Watson Park, 2. Ravensbourne Rd, 3. Kitchener St, 4. Orari St, 5. Midland St, 6. Portobello Rd, 7. Shore St and 8. St Clair.*

The diversity and abundance of all visible animals was recorded for each quadrat, and then rocks greater than 100mm across, if present, were overturned and newly revealed animals counted. Where soft shore was encountered six random 200mm deep core samples were collected <5m from the outfall and six from >20m from each outfall using an 8cm diameter coring device. General

sediment characteristics (e.g., sand or mud colour, sulphide odour) were noted for each core sample. Core samples were sieved on site through a 0.5mm mesh Endecott® sieve. Infauna retained by the sieve was placed in labelled containers and returned to the laboratory for examination under a dissecting microscope. Animals were then identified to the lowest taxonomic level possible and counted (Bates *et al*. 2007). For both epifauna and infauna a Shannon Weiner diversity index (Zar 1996) was calculated to enable community diversity to be compared from year to year.

For outfalls that discharge where there is no intertidal shore available for study photographs were taken showing up to 5m either side of the outfall. These photographs were analysed for species abundance and diversity and may be used as comparisons for future surveys of the same areas. Additional photographs were taken of some minor outfalls for interest sake and comparison, although no monitoring of stormwater was carried out for these outfalls.

2.4 Cockle, Mussel, Fish and Octopus Flesh

Although not specifically required for this survey these organisms are assessed for metal contamination, PAHs and faecal coliforms annually as part of the annual stormwater monitoring programme. Results for analysis of the flesh of these animals is available in Stewart (2010).

2.5 Historic data

The existing literature containing data for stormwater discharges from Dunedin and contamination of sediments within the upper harbour basin was reviewed and relevant data extracted for comparison with more recent data. Overall there is a general paucity of data and much of what exists is not site specific to the locations used in this and other more recent surveys. However, the works of Purdie and Smith (1994), Grove (1995), Mosley (1995), Wells (1996), Grove and Probert (1997), Stevenson (1998), Bioresearches (2002), Brown (2002), Stewart and Ryder (2005), Stewart (2005, 2006) have contributed data that can be used for comparative purposes and these data are included where appropriate.

3. Results

3.1 General

During the first hour of a storm event that produced 2.6mm rainfall on 23 April 2010 water samples were collected from stormwater outfalls at Second Beach,

Shore Street, Portobello Road, Teviot Street, Midland Street, Orari Street, Kitchener Street, Mason Street, Bauchop Street, Halsey Street, Wickliffe Street and Ravensbourne Road in Dunedin and from Watson Park and east George Street in Port Chalmers. This storm event had an antecedent dry period of 192 hours.

Stormwater at Ravensbourne Road was flowing clear at sampling time but at all other sites was discoloured, particularly at Teviot Street, Midland Street, Orari Street, Kitchener Street, Wickliffe Street, Mason Street, Halsey Street and George Street. Second Beach, Portobello Road and Watson Park were all moderately discoloured.

Sediments were sampled within a week after rainfall on 27th April 2010 and 4th June 2010 at sites shown in Figure 3. Wickliffe Street was sampled as part of the annual stormwater monitoring but does not have an intertidal zone, the sediments there being subtidal. It is noted in Stewart (2010) that sediments at Wickliffe Street were dark and smelled strongly of hydrogen sulphide, indicating anoxic conditions.

On 28 April 2010 biological sampling was carried out at the Portobello Road, Orari Street and Kitchener Street outfalls and on 4 June 2010 biological sampling was carried out at the Watson Park, Midland Street, St Clair, Second Beach and Shore Street outfalls. The tide was reasonably low on both occasions at ~1.0m below mean sea level.

3.2 Port Chalmers

3.2.1 Stormwater

For the Port Chalmers catchment contaminant levels in the stormwater at both George Street and the Watson Park outfall are generally similar to levels observed in previous surveys (Table 2). Notable exceptions are copper which is lower this year at George Street, nickel which is higher at Watson Park and zinc which is higher at George Street. Microbial contamination is very high for both sites, but not significantly different to previous surveys (Table 2). All contaminants with the exception of copper at George Street, zinc at both sites and bacteria are below ANZECC (2000) or Mo/MfE trigger values.

3.2.2 Sediments

For the Port Chalmers catchment is not possible to collect sediment at the George Street outfall.

Table 2. *Levels of contaminants detected in stormwater from the Port Chalmers catchment outfalls during a storm event on 23 April 2010. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

				Port Chalmers	
	Parameter	units	Outfall	George St	Watson Pk
Stormwater	As	g/m^3	2007	BDL	BDL
			2008	0.0031	BDL
			2009	BDL	BDL
			2010	BDL	BDL
	Cd	g/m^3	2007	0.00028	BDL
			2008	0.00140	BDL
			2009	0.00011	BDL
			2010	0.00033	BDL
	Cr	g/m^3	2007	0.005	BDL
			2008	0.012	0.0064
			2009	0.0031	BDL
			2010	0.00136	BDL
	Cu	g/m^3	2007	0.0213	0.009
			2008	0.039	0.0025
			2009	0.025	BDL
			2010	0.0148	BDL
	Ni	g/m^3	2007	0.0029	BDL
			2008	0.0093	BDL
			2009	0.0026	BDL
			2010	0.006	0.0035
	Pb	g/m^3	2007	0.0342	0.0141
			2008	0.041	0.0018
			2009	0.018	BDL
			2010	0.0048	BDL
	Zn	g/m^3	2007	0.288	0.231
			2008	0.66	0.027
			2009	0.19	BDL
			2010	0.42	0.29
	pH		2007	6.9	6.8
			2008	7.1	7.9
			2009	7.3	8.2
			2010	6.8	7.1
	Suspended Solids	g/m^3	2007	87	37
			2008	150	39
			2009	26	7.4
			2010	170	240
	Oil & Grease	g/m^3	2007	10	8
			2008	8.7	BDL
			2009	BDL	BDL
			2010	BDL	BDL
	FWA	µg/L	2007	BDL	0.002
			2008	BDL	0.003
			2009	0.03	0.124
			2010	0.079	0.105
	E. coli	MPN/100ml	2007	1400	14000
			2008	930	150
			2009	1000	10
			2010	1100	>1600
	Faecal Coliforms	cfu/100ml	2007	1400	39000
			2008	1400	150
			2009	1000	10
			2010	1100	>1600

Sediments can, however, be collected at Watson Park, although this is the first year that this has been done. Sediments at Watson Park were generally clean and comprised mud, fins and coarse sand and small gravels.

Contaminant levels close to the outfall are below ANZECC (2000) trigger values apart from zinc and PAHs (Table 3). Further away from the outfall, just arsenic exceeds the trigger values. It must be remembered that the Watson Park outfall discharges to Sawyers Bay which was, in the past, the receiving environment for discharges from a tannery and wood treatment plant. As such, the sediments within the bay harbour a quite high level of historical contaminants (Grove 1995, Stewart and Ryder 2005) so this result is not entirely unexpected.

Table 3. *Contaminant levels in sediments within 5m of the Watson Park outfall and greater than 20m from the outfall. Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

Parameter	As	Cd	Cr	Cu	Ni	Pb	Zn	PAH	Enterococci	Faecal coliforms
Units	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	MPN/g	MPN/g
Year	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
Watson Park <5m	4.9	0.490	19.1	53.0	9.2	51	171	17.140	54	21
Watson park >20m	20.0	0.135	67.0	18.3	20.0	28	127	2.400	24	170
ANZECC Low trigger value	20	1.5	80	65	21	50	200	4		
ANZECC high trigger value	70	10	370	270	52	220	410	45		

3.2.3 Biota

For Watson Park macroalgae were virtually absent, with just a few very small patches of drift *Ulva* and *Lenormadia* evident (Table 4).

Table 4. *Macroalgal cover, expressed as a percentage, within 5m (left) and greater than 20m (right) of the Watson Park outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <5m	Q1	Q2	Q3	Q1	Q2	Q3
Ulva lactuca	3			5		
Lenormandia chauvinii		2				

	Site 1			Site 2		
Algae (% cover) >20m	Q1	Q2	Q3	Q1	Q2	Q3
Ulva lactuca			2			
Lenormandia chauvinii				4		

Epifauna was moderately abundant at Watson Park (Table 5) with the small barnacle *Elminius modestus* comprising the majority of animals both close to and further away from the outfall. The abundance of animals was, however, higher within 5m of the outfall than further away (Table 5). Diversity was relatively low with H' values of 0.5 at <5m from the outfall and 0.62 at >20m from the outfall.

Grove (1995) surveyed infauna within the soft sediments of Sawyers Bay. However, infauna were not assessed at Watson Park as suitable substrate was judged to be located too far away from the outfall to be directly influenced by the stormwater discharge.

Table 5. *Epifauna within 5m (top) and greater than 20m (bottom) of the Watson Park outfall.*

<5m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Amphipoda															
Gammaridae	2			3	2		4			2	1			3	
Barnacles															
Elminius modestus		8				64		13					52		
Snails and Chitons															
Cellana radians	1	1					2					1		3	
Cellana ornata		1	2			1			1		1	1			
Melagraphis aethiops		2		3		1		1					1	1	
Micrelenchus tenebrosus			2	1			1				1			2	
Notoacmea spp		1				1	1				2				1
Zeacumantus subcarinata			2			1									

>20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus		3												2	
Barnacles															
Eminius modestus			16				24			2				8	
Snails and Chitons															
Notoacmea spp	1						2				1	1			
Chiton glaucus				1			2		1						
Cellana radians		2													
Cellana ornata	1	1							1			1		2	
Melagraphis aethiops			2	1					1		2			1	2
Micrelenchus tenebrosus				1		2									

3.3 Ravensbourne

3.3.1 Stormwater

The Ravensbourne outfall discharges relatively low volumes of stormwater. Copper and zinc levels were above ANZECC (2000) trigger levels and bacterial contamination was well above MoH/MfE trigger values (Table 6). Both nickel and zinc levels are higher than in past surveys (Stewart 2010) but lead is an order of magnitude lower (Table 6). A moderate level of FWAs indicates there may be some sewage contamination and this is reflected in the high bacterial counts. There are no historic data for stormwater for Ravensbourne.

3.3.2 Sediments

Sediments adjacent to the Ravensbourne outfall are generally coarse sand, clean gravel and small to medium cobbles. Levels of contaminants in the sediments

are low with just arsenic exceeding ANZECC (2000) trigger values at >20m from the outfall (Table 7). Levels are similar to those observed in previous surveys (Stewart 2010). Historic data for sediments at Ravensbourne are scarce with values for just chromium (16.8mg/kg), copper (9.8 mg/kg) and zinc (80.8 mg/kg) (Stewart and Ryder 2005).

Table 6. *Levels of contaminants detected in stormwater from the Ravensbourne catchment outfall during a storm event on 23 April 2010. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

				Ravensbourne
	Parameter	units	Outfall	Ravensbourne Rd
Stormwater	As	g/m^3	2007	
			2008	BDL
			2009	BDL
			2010	BDL
	Cd	g/m^3	2007	
			2008	BDL
			2009	BDL
			2010	BDL
	Cr	g/m^3	2007	
			2008	0.00061
			2009	BDL
			2010	BDL
	Cu	g/m^3	2007	
			2008	0.0023
			2009	BDL
			2010	0.0031
	Ni	g/m^3	2007	
			2008	0.00066
			2009	BDL
			2010	0.00148
	Pb	g/m^3	2007	
			2008	0.0015
			2009	0.0029
			2010	0.00023
	Zn	g/m^3	2007	
			2008	0.053
			2009	0.047
			2010	0.144
	pH		2007	
			2008	7
			2009	8.1
			2010	7.3
	Suspended Solids	g/m^3	2007	
			2008	8.5
			2009	18
			2010	61
	Oil & Grease	g/m^3	2007	
			2008	8.8
			2009	BDL
			2010	BDL
	FWA	µg/L	2007	
			2008	BDL
			2009	0.096
			2010	0.136
	E. coli	MPN/100ml	2007	
			2008	120
			2009	90
			2010	11000
	Faecal Coliforms	cfu/100ml	2007	150
			2008	130
			2009	90
			2010	11000

Table 7. *Contaminant levels in sediments within 5m of the Ravensbourne outfall and greater than 20m from the outfall. Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

	Units	Parameter	<5m	>20m	ANZECC Low trigger value	ANZECC high trigger value
As	mg/kg dry wt	2007	10.6		20	70
		2008	9.8			
		2009	7.3			
		2010	13.0	20.0		
Cd	mg/kg dry wt	2007	0.2		1.5	10
		2008	0.2			
		2009	0.1			
		2010	0.2	0.135		
Cr	mg/kg dry wt	2007	17.6		80	370
		2008	12.0			
		2009	16.0			
		2010	14.0	67.0		
Cu	mg/kg dry wt	2007	14		65	270
		2008	13			
		2009	14			
		2010	9	18.3		
Ni	mg/kg dry wt	2007	11.3		21	52
		2008	14.0			
		2009	13.0			
		2010	11.0	20.0		
Pb	mg/kg dry wt	2007	18.9		50	220
		2008	27			
		2009	27			
		2010	28	28		
Zn	mg/kg dry wt	2007	101		200	410
		2008	130			
		2009	160			
		2010	149	127		
PAH	mg/kg dry wt	2007	7.0		4	45
		2008	5.8			
		2009	0.5			
		2010	3.7	2.400		
Enterococci	MPN/g	2007	2			
		2008	11			
		2009	<2			
		2010	<3	24		
Faecal coliforms	MPN/g	2007	<2			
		2008	17			
		2009	5			
		2010	2	170		

3.3.3 Biota

Ravensbourne had no algae evident in the intertidal zone, although there was a sparse coating of *Enteromorpha* on the adjacent boat-ramp.

Once again *Elminius modestus* comprised the majority of the epifauna at the Ravensbourne outfall, both at the <5m and >20 m sites, (Table 8). There were, however, a number of other animals, mainly molluscs sheltering under cobbles, to be found around the outfall. Overall diversity is very low with H' values of 0.24 at <5m from the outfall and 0.2 at >20m from the outfall.

Table 8. *Epifauna within 5m (top) and greater than 20m (bottom) of the Ravensbourne outfall.*

<5m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus				5											
Barnacles															
Eminius modestus		158	244		36				125			16	89		94
Snails and Chitons															
Chiton glaucus		1						1						2	
Melagraphia aethiops		2	3		1			1	1			4	2	1	
Micrelenchus tenebrosus	2	15		3		18		10			6	5		12	2
Notoacmea spp		1				1	2								1
Cellana radians	1			2		1				2	2			1	
Cellana ornata		1							1				1	1	

>20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus							2					7			
Crabs															
Macrophthalmus hirtipes				1			2								
Barnacles															
Eminius modestus	137					24		18	52			236	124	29	3
Snails and Chitons															
Chiton glaucus						1						1	1		
Melagraphia aethiops	2						1		1				1		
Micrelenchus tenebrosus	3		1	2	7		8			4			3		
Notoacmea spp	1					2					1	1			
Cellana radians		2					1	1						1	
Cellana ornata		1	1				1					1		1	

Substrate at the Ravensbourne outfall was unsuitable for the assessment of infauna.

3.4 Halsey Street

3.4.1 Stormwater

Stormwater from the Halsey Street catchment discharges via three main outfalls, Wickliffe Street, Halsey Street and Bauchop Street. Levels of contaminants in stormwater from this catchment have historically been reasonably high, especially for copper and zinc (Table 9). This year, copper exceeds the ANZECC (2000) trigger value at Wickliffe Street and zinc levels exceed trigger values at all three outfalls. Bacterial levels in stormwater from the Halsey Street catchment are historically very high and this year is no exception. MoH and MfE trigger values for secondary contact recreation are well exceeded at all three outfalls (Table 9) suggesting that cross connections with foul sewers may be common within this catchment. That being said, faecal coliform levels at Wickliffe Street are an order of magnitude lower than last year. Following investigations of high FWA levels and remedial action at Bauchop Street in 2008 whitening agents there have fallen to levels more in keeping with the other two Halsey Street outfalls.

Table 9. *Levels of contaminants detected in stormwater from the Halsey Street catchment outfall during a storm event on 23 April 2010. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

			Catchment	Halsey Street		
	Parameter	units	Outfall	Bauchop Street	Halsey Street	Wickliffe Street
Stormwater	As	g/m^3	2007	0.03	0.03	0.03
			2008	BDL	BDL	BDL
			2009	0.021	0.01	0.003
			2010	BDL	0.0044	BDL
	Cd	g/m^3	2007	BDL	BDL	BDL
			2008	BDL	0.00022	BDL
			2009	BDL	BDL	0.00052
			2010	0.00049	0.00026	0.00078
	Cr	g/m^3	2007	BDL	BDL	BDL
			2008	0.0015	BDL	0.0017
			2009	BDL	BDL	0.0076
			2010	BDL	BDL	0.00157
	Cu	g/m^3	2007	0.029	0.024	0.01
			2008	0.0096	0.0043	0.013
			2009	BDL	0.021	0.059
			2010	0.0026	0.00162	0.0058
	Ni	g/m^3	2007	0.01	0.009	0.01
			2008	BDL	BDL	BDL
			2009	BDL	0.0035	0.0042
			2010	BDL	BDL	BDL
	Pb	g/m^3	2007	0.01	0.021	0.006
			2008	0.0035	0.0022	0.0084
			2009	BDL	0.0097	0.033
			2010	BDL	0.0021	BDL
	Zn	g/m^3	2007	0.23	0.12	0.1
			2008	0.12	0.033	0.2
			2009	0.13	0.3	0.53
			2010	0.121	0.136	0.24
	pH		2007	7.6	7.3	7.7
			2008	7.8	7.9	7.5
			2009	8.1	7.2	8.0
			2010	7.4	6.8	7.3
	Suspended Solids	g/m^3	2007	44	119	35
			2008	16	35	27
			2009	13	27	100
			2010	53	50	86
	Oil & Grease	g/m^3	2007	4	9	6
			2008	BDL	BDL	9.5
			2009	BDL	BDL	9.5
			2010	BDL	BDL	BDL
	FWA	µg/L	2007	2.028	BDL	0.024
			2008	4.92	0.004	0.003
			2009	0.031	0.011	0.021
			2010	0.067	0.061	0.048
	E. coli	MPN/100ml	2007	2200	9000	25000
			2008	400	1700	10000
			2009	3000	70000	220000
			2010	7900	17000	35000
	Faecal Coliforms	cfu/100ml	2007	2200	9000	30000
			2008	400	1700	10000
			2009	3000	70000	220000
			2010	35000	92000	54000

3.4.2 Sediments

As stated earlier, the outfalls for the Halsey Street catchment discharge to deep water. Consequently sediments are difficult to obtain. However, sediments have

been collected from <5m from the outfall at Wickliffe Street when the tide is suitable. Sediments here are generally black and anoxic and smell strongly of hydrogen sulphide. Zinc continues to persist at high levels in Wickliffe Street sediment, which unsurprisingly, reflects the quite high input of zinc in stormwater rat this outfall. Copper levels, however, appear to be falling somewhat (Table 10). Lead and PAH levels exceed the ANZECC (2000) low trigger value.

Table 10. *Contaminant levels in sediments within 5m of the Wickliffe Street outfall, Halsey Street catchment. Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

	Units	Parameter	Wickliffe Street	ANZECC Low trigger value	ANZECC high trigger value
As	mg/kg dry wt	2007	17.3	20	70
		2008	11.0		
		2009	6.9		
		2010	9.0		
Cd	mg/kg dry wt	2007	0.6	1.5	10
		2008	0.7		
		2009	0.8		
		2010	0.7		
Cr	mg/kg dry wt	2007	38.0	80	370
		2008	34.0		
		2009	16.0		
		2010	27.0		
Cu	mg/kg dry wt	2007	121	65	270
		2008	68		
		2009	50		
		2010	58		
Ni	mg/kg dry wt	2007	19.2	21	52
		2008	23.0		
		2009	13.0		
		2010	17.0		
Pb	mg/kg dry wt	2007	76.1	50	220
		2008	140		
		2009	77		
		2010	92		
Zn	mg/kg dry wt	2007	412	200	410
		2008	740		
		2009	810		
		2010	740		
PAH	mg/kg dry wt	2007	9.2	4	45
		2008	1.2		
		2009	7.3		
		2010	7.2		
Enterococci	MPN/g	2007	580		
		2008	>1600		
		2009	330		
		2010	<3		
Faecal coliforms	MPN/g	2007	2		
		2008	540		
		2009	33		
		2010	540		

3.4.3 Biota

The three Halsey Street catchment outfalls discharge to deep water. Consequently there is little in the way of an intertidal zone to assess.

Photographs were taken to provide comparisons for future surveys. Epifauna comprised mainly small barnacles (*Elminius modestus*) and encrusting ascidians (Figures 4a, b, c). Abundance of these encrusting organisms was high at all sites with no perceptible change in abundance with distance either side of the outfall. On wharf piles <3m distance from the outfalls sea-tulips (*Pyura pachydermatina*) were common.



Figure 4a. *Wickliffe Street stormwater outfall densely encrusted by small barnacles and occasional ascidians.*



Figure 4b. *Halsey Street stormwater outfall densely encrusted by colonial ascidians.*



Figure 4c. *Wickliffe Street stormwater outfall densely encrusted by small barnacles and occasional ascidians.*

3.5 Mason Street

3.5.1 Stormwater

The stormwater from Mason Street catchment discharges to the upper harbour via a single large outfall and a number of very small outfalls under wharves in the Steamer Basin (Figures 5a-f).



Figure 5a. *Mason Street outfall.*



Figure 5b. *Fryatt Street 1 outfall.*



Figure 5c. *Fryatt Street 2 outfall.*



Figure 5d. *Wharf Street outfall.*



Figure 5e. *Birch Street 1 outfall.*



Figure 5f. *Birch Street 2 outfall.*

Contaminant levels are generally moderate with just copper and zinc exceeding the ANZECC (2000) trigger values for protection of 80% of species. Bacterial contamination, however, is extremely high with both *E. Coli* an d faecal coliforms well exceeding Moh/MfE alert levels for secondary contact recreation.

Table 11. *Levels of contaminants detected in stormwater from the Mason Street catchment outfall during a storm event on 23 April 2010. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

			Catchment	Mason Street
	Parameter	units	Outfall	Mason Street
Stormwater	As	g/m^3	2007	0.006
			2008	BDL
			2009	0.0077
			2010	BDL
	Cd	g/m^3	2007	BDL
			2008	BDL
			2009	0.0077
			2010	0.00051
	Cr	g/m^3	2007	BDL
			2008	BDL
			2009	BDL
			2010	BDL
	Cu	g/m^3	2007	0.022
			2008	0.012
			2009	0.021
			2010	0.0157
	Ni	g/m^3	2007	0.004
			2008	BDL
			2009	0.0055
			2010	BDL
	Pb	g/m^3	2007	0.0258
			2008	0.0089
			2009	0.014
			2010	0.00102
	Zn	g/m^3	2007	0.25
			2008	0.16
			2009	0.35
			2010	0.43
	pH		2007	7.1
			2008	7
			2009	7.4
			2010	7
	Suspended Solids	g/m^3	2007	62
			2008	37
			2009	37
			2010	138
	Oil & Grease	g/m^3	2007	5
			2008	7.9
			2009	BDL
			2010	BDL
	FWA	µg/L	2007	0.007
			2008	0.07
			2009	0.051
			2010	0.156
	E. coli	MPN/100ml	2007	22000
			2008	26000
			2009	50000
			2010	350000
	Faecal Coliforms	cfu/100ml	2007	22000
			2008	26000
			2009	50000
			2010	350000

3.5.2 Biota

The Mason Street catchment outfalls discharge to deep water. Consequently there is little in the way of an intertidal zone to assess. Photographs were taken to provide comparisons for future surveys (Figure 5a-f). Epifauna comprised mainly small barnacles (*Elminius modestus*) and encrusting ascidians (Figures 5a-f). Abundance of these encrusting organisms was high at all sites with no perceptible change in abundance with distance either side of the outfall. On wharf piles <3m distance from the outfalls sea-tulips (*Pyura pachydermatina*) were common.

On sheet piles at Mason Street and on rocky substrate at these smaller outfalls oysters (*Ostrea heffordi*) and tube worms (*Pomatoceros caerulaus*) were abundant (Figures 5a-f). Occasional blue mussel (*Mytilus galloprovincialis*) and limpets (*Cellana strigilis*) were present on wharf piles.

3.6 Kitchener Street

3.6.1 Stormwater

3.6.2

The Kitchener Street catchment is drained by one very large outfall and two considerably smaller ones. Just the main outfall has been assessed in this and previous surveys. Copper, lead and zinc levels all exceed the ANZECC (2000) trigger levels, with copper and zinc both being traditionally high (Table 12). Bacterial contamination too is well above guidelines with MoH/MfE guidelines for secondary contact recreation being well exceeded for both E. coli and faecal coliforms (Table 12). PAH levels are generally low apart from in 2008. There are no historic data prior to 2007 for the Kitchener Street outfall.

3.6.3 Sediments

Sediments at Kitchener Street range from fine silts to coarse gravel further away from the outfall. Sediments near the outfall were generally clean, but with a layer of dead leaves and drift algae further away from the outfall. Contaminant levels are moderately high with lead, zinc and PAHs all exceeding the ANZECC (2000) low trigger values close to the outfall and copper exceeding trigger values further away (Table 13). Zinc and PAHs exceed high trigger values at >20m from the outfall. There is a paucity of historic data for contaminants in

sediments at Kitchener Street with values available for just chromium, nickel zinc and enterococci (Table 13). All of these values are lower than more recent values but these historical sediment values should be viewed with extreme caution as sampling in some previous years may have used entirely different protocols. For example, sediments may have been collected from different depths within the substrate and by different methods meaning that results are not directly comparable. Sampling since 2007, however, has followed the same protocol.

3.6.4 Biota

There was a reasonable diversity of mainly red algae at the Kitchener Street site (Table 14) and a deep bed of drift algae at the >20m location.

Epifauna was moderately abundant at Kitchener Street with cockles, *Austrovenus stutchburyi*, comprising the majority of animals, although these are technically infauna. The abundance of animals was higher within 5m of the outfall than further away (Table 15). Taxonomic diversity differed with distance from the outfall at Kitchener Street with nine species present within 5m of the outfall but only 4 species present at the site >20m distant (Table 15). Diversity indices (H') for epifauna at Kitchener Street were 0.53 at <5m and 0.2 at >20m.

Table 12. *Levels of contaminants detected in stormwater from the Kitchener Street catchment outfall during a storm event on 23 April 2010. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

			Catchment	Kitchener St
	Parameter	units	Outfall	Kitchener St
Stormwater	As	g/m^3	2007	BDL
			2008	BDL
			2009	0.0096
			2010	BDL
	Cd	g/m^3	2007	BDL
			2008	BDL
			2009	BDL
			2010	BDL
	Cr	g/m^3	2007	0.004
			2008	0.002
			2009	BDL
			2010	BDL
	Cu	g/m^3	2007	0.034
			2008	0.0056
			2009	0.023
			2010	0.0118
	Ni	g/m^3	2007	0.003
			2008	BDL
			2009	0.0036
			2010	0.0035
	Pb	g/m^3	2007	0.0442
			2008	0.007
			2009	0.018
			2010	0.00196
	Zn	g/m^3	2007	0.445
			2008	0.036
			2009	0.38
			2010	0.62
	PAH	g/m^3	2007	0
			2008	327
			2009	BDL
			2010	0.0001
	pH		2007	7.1
			2008	7.7
			2009	7.4
			2010	6.9
	Suspended Solids	g/m^3	2007	104
			2008	41
			2009	45
			2010	50
	Oil & Grease	g/m^3	2007	9
			2008	BDL
			2009	BDL
			2010	BDL
	FWA	µg/L	2007	0.18
			2008	0.029
			2009	0.072
			2010	0.023
	E. coli	MPN/100ml	2007	13000
			2008	70
			2009	10000
			2010	92000
	Faecal Coliforms	cfu/100ml	2007	13000
			2008	70
			2009	10000
			2010	160000

Table 13. *Contaminant levels in sediments within 5m of and >20m from the Kitchener Street outfall and greater than 20m from the outfall. Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

	Units	Parameter	Kitchener Street <5m	Kitchener Street >20m	ANZECC Low trigger value	ANZECC high trigger value
As	mg/kg dry wt	Historic			20	70
		2007	4.6			
		2008	7.5			
		2009	7.0			
		2010	9.0	13.3		
Cd	mg/kg dry wt	Historic			1.5	10
		2007	0.4			
		2008	0.4			
		2009	0.3			
		2010	0.3	0.2		
Cr	mg/kg dry wt	Historic	7.0		80	370
		2007	22.6			
		2008	18.0			
		2009	98.0			
		2010	22.0	24.0		
Cu	mg/kg dry wt	Historic			65	270
		2007	70			
		2008	56			
		2009	90			
		2010	37	83		
Ni	mg/kg dry wt	Historic	6		21	52
		2007	10.6			
		2008	12.0			
		2009	15.0			
		2010	12.0	12.1		
Pb	mg/kg dry wt	Historic			50	220
		2007	117.9			
		2008	97			
		2009	130			
		2010	155	75		
Zn	mg/kg dry wt	Historic	170		200	410
		2007	249			
		2008	280			
		2009	300			
		2010	280	570		
PAH	mg/kg dry wt	Historic			4	45
		2007	8.9			
		2008	140.5			
		2009	4.8			
		2010	5.0	57.0		
Enterococci	MPN/g	Historic	130.0			
		2007	66			
		2008	920			
		2009	5			
		2010	<3	13		
Faecal coliforms	MPN/g	Historic				
		2007	20			
		2008	13			
		2009	70			
		2010	<2	2		

Table 14. *Macroalgal cover, expressed as a percentage, within 5m (left) and greater than 20m (right) of the Kitchener Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <5m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis			3.0			
Ulva lactuca						
Ceramium uncinatum	2	7	40	45	40	40
Euptilota formosissima						
Gracilaria chilensis						
Lenormandia chauvinii		2	2	1	3	2
Lomentaria umbellata			1	4	2	3

	Site 1			Site 2		
Algae (% cover) >20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis		1				4
Ulva lactuca	2	1	1			
Ceramium uncinatum	2	7	85	7	12	15
Euptilota formosissima						
Gracilaria chilensis						
Lenormandia chauvinii	2	2	2	1	1	2
Lomentaria umbellata			3			2

Table 15. *Epifauna within 5m (top) and greater than 20m (bottom) of the Kitchener Street outfall.*

<5m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus		146	14							15	18		18	24	1
Spirorbis spp															
Crabs															
Macrophthalmus hirtipes															
Barnacles															
Eminius modestus		22	38	35	18	29		23	64	31	53	37	2	2	
Chamaesipho columna														1	
Snails and Chitons															
Chiton glaucus													2		
Melagraphis aethiops			1												
Micrelenchus tenebrosus	12	35	46	5	2	7	2	4	8	23	41	26	8	7	28
Notoacmea spp		2													
Bivalves															
Austrovenus stutchburyi						1						1			
Ostrea heffordi	1	6			1				1	5	2	1	1	1	

>20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Barnacles															
Eminius modestus						3	2	2					2		
Snails and Chitons															
Micrelenchus tenebrosus	4	8	4	5	3	10	5	5	23	8	16	8	12	7	47
Notoacmea spp	1	1	1		1			1			1	1	1		
Bivalves															
Ostrea heffordi													2		1

Infauna at Kitchener Street was dominated by polychaete worms, with glyceriids being the most abundant (Table 16). Spionid worms were also common both close to and further away from the outfall.

Table 16. *Abundance of species of infauna collected <5m and >20m from the Kitchener Street outfall.*

Kitchener Street			Location	<5m							>20m						
2010			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**														
Annelida																	
	Polychaeta	Cirratulidae				1				1							
		Capitellidae			3		2		3	8							
		Glyceridae		14	7	5	16	10	8	60	3	4		7	5	9	28
		Maldanidae										1					1
		Nephtyidae		3	1	1	3			8		1					1
		Nereidae							2	2					1		1
		Nereididae		1	3		2		1	7	1	2		1		1	5
		Spionidae		3	4		5	8	4	24	1	2		10	3	5	21
Nemertea															1		1
Crustacea																	
	Decapoda	Malacostraca	*Elamena producta*													1	1
			Macrophthalmus hirtipes					1		1							
	Amphipoda	Haustoriidae					1			1							
		Lysianassidae				2	3	1		6	1	1	3				5
		Oedicerotidae		1		1	1		1	4	1		1	2	1		5
		Phoxocephalidae		4	4	1	4	3	1	17	3	2	3	1	2	1	12
	Isopoda		*Isocladus armatus*												1		1
	Tanaidacea				1	1	2	2		6		1					1
	Ostracoda				1	3		1		5	2		1				3
Mollusca																	
	Bivalvia	Veneridae	*Austrovenus stutchburyi*	1	1	1			1	4	2		1			2	5
			Puyseguria spp.														
		Tellinidae	*Macomona liliana*		1					1							
		Animals per core		28	28	19	40	28	24	155	15	16	12	22	16	22	91
		Animals per m^2		6160	6160	4180	8800	6160	5280	5695	3300	3520	2640	4840	3520	4840	3343
		Species per site								16							15

Phoxocephalid amphipods were reasonably common at both locations near the Kitchener Street outfall. Cockles (*Austrovenus stutchburyi*), although less common than some of the other animals, comprised by far the major portion of the biomass at both locations. Diversity indices (H') for infauna at Kitchener Street are presented in Table 17.

Table 17. *Diversity index (H') for infauna at the Kitchener Street outfall through time.*

	<5m				>20m			
Site	2007	2008	2009	2010	2007	2008	2009	2010
Kitchener Street	0.67	0.53	0.44	0.9	0.98	0.73	0.56	0.9

3.7 Orari Street

3.7.1 Stormwater

Stormwater from the Orari Street catchment drains to the harbour via one very large and one small outfall. Concentrations of contaminants in the stormwater are generally of the same order of magnitude as for previous surveys (Table 18). Copper and zinc levels exceed the ANZECC (2000) trigger values and bacterial contamination is above the alert level for secondary contact recreation. Historical values for contaminants are not dissimilar to current levels although copper and lead may show a diminishing trend.

3.7.2 Sediments

Sediments at Orari Street are generally fine silt and sand with a reasonably abundant organic matter content (e.g. decaying leaves and twigs). There is some evidence of anoxia but a barely noticeable smell of hydrogen sulphide. Just PAHs exceeded trigger levels (Table 19). Concentrations of nickel, lead and copper may be falling, but values vary considerably from year to year.

3.7.3 Biota

There was a moderate diversity of mainly red algae at the Kitchener Street site with occasional quite large patches of *Ulva lactuca* (Table 20). Abundance was reasonably high with up to 82% cover at some sites.

Epifauna was moderately abundant at Orari Street with cockles, *Austrovenus stutchburyi*, comprising the vast majority of animals and the major proportion of the biomass (Table 21). The abundance of animals was not significantly different at <5m of the outfall and >20m (Table 14).

Table 18. *Levels of contaminants detected in stormwater from the Orari Street catchment outfall during a storm event on 23 April 2010. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

			Catchment	Orari Street
	Parameter	units	Outfall	Orari Street
Stormwater	As	g/m^3	Historic	
			2007	BDL
			2008	BDL
			2009	0.032
			2010	0.00149
	Cd	g/m^3	Historic	0.0005
			2007	BDL
			2008	BDL
			2009	BDL
			2010	0.000164
	Cr	g/m^3	Historic	0.002
			2007	BDL
			2008	0.0032
			2009	BDL
			2010	0.00183
	Cu	g/m^3	Historic	0.0132
			2007	BDL
			2008	0.014
			2009	BDL
			2010	0.0096
	Ni	g/m^3	Historic	0.002
			2007	BDL
			2008	0.0033
			2009	BDL
			2010	0.00108
	Pb	g/m^3	Historic	0.022
			2007	BDL
			2008	0.023
			2009	BDL
			2010	0.00015
	Zn	g/m^3	Historic	0.191
			2007	BDL
			2008	0.22
			2009	0.031
			2010	0.3
	PAH	g/m^3	Historic	0.0026
			2007	0.0001
			2008	318
			2009	BDL
			2010	0.0005
	pH	g/m^3	Historic	
			2007	7.8
			2008	7.4
			2009	8.1
			2010	7.1
	Suspended Solids	g/m^3	Historic	
			2007	28
			2008	77
			2009	16
			2010	130
	Oil & Grease	g/m^3	Historic	
			2007	BDL
			2008	11
			2009	BDL
			2010	BDL
	FWA	µg/L	Historic	
			2007	BDL
			2008	0.005
			2009	0.11
			2010	0.052
	E. coli	MPN/100ml	Historic	
			2007	50
			2008	6000
			2009	210
			2010	1700
	Faecal Coliforms	cfu/100ml	Historic	
			2007	80
			2008	7000
			2009	210
			2010	3500

Table 19. *Contaminant levels in sediments within 5m of and >20m from the Orari Street outfall. Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

	Units	Parameter	Orari Street <5m	Orari Street >20m	ANZECC Low trigger value	ANZECC high trigger value
As	mg/kg dry wt	Historic			20	70
		2007	18.6			
		2008	4.3			
		2009	20.0			
		2010	5.0	3.1		
Cd	mg/kg dry wt	Historic	0.5		1.5	10
		2007	63.0			
		2008	0.1			
		2009	0.9			
		2010	0.2	0.096		
Cr	mg/kg dry wt	Historic	18.0		80	370
		2007	0.3			
		2008	16.0			
		2009	37.0			
		2010	16.0	11.7		
Cu	mg/kg dry wt	Historic	20.0		65	270
		2007	25			
		2008	13			
		2009	61			
		2010	11	6.1		
Ni	mg/kg dry wt	Historic	10.4		21	52
		2007	23.6			
		2008	8.1			
		2009	16.0			
		2010	8.0	5.1		
Pb	mg/kg dry wt	Historic	185.0		50	220
		2007	12.8			
		2008	39			
		2009	120			
		2010	35	13.5		
Zn	mg/kg dry wt	Historic	239		200	410
		2007	68			
		2008	130			
		2009	680			
		2010	157	73		
PAH	mg/kg dry wt	Historic			4	45
		2007	10.2			
		2008	12.6			
		2009	28.3			
		2010	9.3	0.730		
Enterococci	MPN/g	Historic				
		2007	<2			
		2008	8			
		2009	23			
		2010	<3	24		
Faecal coliforms	MPN/g	Historic				
		2007	23000			
		2008	4			
		2009	33			
		2010	33	17		

Table 20. *Macroalgal cover, expressed as a percentage, within 5m (left) and greater than 20m (right) of the Orari Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <5m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca	40	30	35	60	40	25
Ceramium uncinatum	10	7	35	7	30	10
Euptilota formosissima	2	2	2	4	3	5
Gracilaria chilensis	5	7	10	15	7	6
Lenormandia chauvinii						1
Lomentaria umbellata						

	Site 1			Site 2		
Algae (% cover) >20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa	2	3			5	
Codium fragilis						1
Ulva lactuca	12	10	18	30	18	12
Ceramium uncinatum	40	35	45	25	25	15
Euptilota formosissima	2	1	2	1	2	3
Gracilaria chilensis	5	2	4	7	5	7
Lenormandia chauvinii	3	2	2	1	2	2
Lomentaria umbellata						

Taxonomic diversity differed with distance from the outfall at Kitchener Street with 3 species present within 5m of the outfall and 5 species present at the site >20m distant (Table 21). Diversity indices (H') for epifauna at Orari Street were very low at 0.12 at <5m and 0.16 at >20m.

Table 21. *Epifauna within 5m (top) and greater than 20m (overleaf) of the Orari Street outfall.*

<5m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Snails and Chitons															
Notoacmea spp															
Acanthochitona zelandica													1		
Micrelenchus tenebrosus				2		1		1		1		1			1
Sigapatella novaezelandiae															
Bivalves															
Austrovenus stutchburyi	5	7	2	8	6	6	2	12	9	8	6	7	7	12	11
Ostrea heffordi															

>20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Spirorbis spp															
Snails and Chitons															
Acanthochitona zelandica								1		1					
Buccinulum vittatum													1		1
Cominella glandiformis						1									
Melagraphis aethiops															
Micrelenchus tenebrosus	1	2	2	1	1	3	1				1				2
Bivalves															
Austrovenus stutchburyi	2	5	6	14	1	13	10	16	13	19	31	13	17	23	11

Infauna at Orari Street was, as at Kitchener Street, dominated by polychaete worms, with glyceriids being the most abundant (Table 22). Spionid worms were reasonably common both close to and further away from the outfall. Amphipods, were moderately abundant at both locations and tanaids were relatively common both near to and further away from the outfall. Cockles were very abundant at both locations with up to 4400 animals per square metre.

Diversity was moderately high with 16 different species at the <5m site and 15 at the >20m site. Diversity indices (H') for infauna at Orari Street are presented in Table 23.

Table 22. *Abundance of species of infauna collected <5m and >20m from the Orari Street outfall.*

Orari Street			Location	<5m							>20m						
2010			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Glyceridae		10	7	4	7	8	3	39	6	3	2	3	2	3	19
		Lumbrineridae		2				1		3							
		Maldanidae				2	1			3	2		1		1		4
		Nereidae		2						2	1		1	1			3
		Nereididae		3						3	1			3			4
		Cirratulidae				1				1							
		Capitellikdae									3						3
		Spionidae		4	2	1	4		1	12	2	1	2	1		3	9
Hemichordata																	
	Enteropneusta										1						1
Nemertea				1	2	1	1		1	6							
Sipuncula						1	3			4							
Crustacea																	
	Decapoda																
			Macrophthalmus hirtipes									1					1
	Amphipoda	Jassidae										1				1	2
		Lysianassidae			2	4		2		8	1	1	3			2	7
		Oedicerotidae															
		Phoxocephalidae			1	2		1		4	1			2	1	1	5
	Tanaidacea			6	3	1			1	11	1				1	3	5
Mollusca																	
	Gastropoda	Cominellidae	*Cominella glandiformis*		1					1							
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi	1	10	2		4	1	18	3	4	3	3	3	5	21
			Puyseguria spp.	1	1			1		3	2		2	2	1	2	9
		Tellinidae															
			Macomona liliana			1		1	1	3	1		1	1	1	1	5
		Animals per core		31	31	23	17	20	11	121	26	13	18	17	12	24	98
		Animals per m^2		6820	6820	5060	3740	4400	2420	4446	5720	2860	3960	3740	2640	5280	3601
		Species per site								16							15

Table 23. *Diversity index (H') for infauna at the Orari Street outfall through time.*

	<5m				>20m			
Site	2007	2008	2009	2010	2007	2008	2009	2010
Orari Street	1.01	0.86	0.74	0.98	0.88	0.87	0.74	1.03

3.8 Portsmouth Drive

3.8.1 Stormwater

Stormwater from the Portsmouth Drive catchment Street is discharged via a number of small outfalls, but with two main ones at Midland Street and Teviot Street. Concentrations of contaminants in the stormwater are moderate but with copper and lead levels exceeding the ANZECC trigger values at both Teviot Street and Midland Street (Table 24). Concentrations of faecal coliforms and *E. coli* are well above MoH/MfE guideline values for secondary contact recreation.

3.8.2 Sediments

Sediments at Portsmouth Drive are similar to Orari Street with generally fine silt and sand and a reasonably abundant organic matter content (e.g. decaying leaves and twigs). There is little evidence of anoxia in surface sediments with no noticeable smell of hydrogen sulphide.

Table 24. *Levels of contaminants detected in stormwater from the Portsmouth Drive catchment outfalls during a storm event on 23 April 2010. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

		Catchment	Portsmouth Drive	
Parameter	units	Outfall	Teviot Street	Midland Street
As	g/m^3	2007	BDL	BDL
		2008	0.002	0.0033
		2009	BDL	BDL
		2010	BDL	BDL
Cd	g/m^3	2007	BDL	BDL
		2008	0.00008	0.00013
		2009	BDL	BDL
		2010	0.00026	BDL
Cr	g/m^3	2007	BDL	BDL
		2008	0.0018	0.0035
		2009	BDL	0.0031
		2010	BDL	BDL
Cu	g/m^3	2007	BDL	0.02
		2008	0.0094	0.031
		2009	BDL	0.057
		2010	0.0136	0.021
Ni	g/m^3	2007	BDL	BDL
		2008	0.0019	0.0016
		2009	BDL	BDL
		2010	0.0033	0.0075
Pb	g/m^3	2007	BDL	0.005
		2008	0.0066	0.0054
		2009	BDL	0.0083
		2010	BDL	BDL
Zn	g/m^3	2007	BDL	0.1
		2008	0.13	0.35
		2009	BDL	0.18
		2010	1.79	0.22
pH		2007	7.9	7.7
		2008	7.1	7.7
		2009	7.9	7.7
		2010	7	7.5
Suspended Solids	g/m^3	2007	25	30
		2008	33	19
		2009	12	30
		2010	84	52
Oil & Grease	g/m^3	2007	8	BDL
		2008	4.4	BDL
		2009	BDL	BDL
		2010	6.4	BDL
FWA	µg/L	2007	BDL	BDL
		2008	0.006	0.004
		2009	0.096	0.132
		2010	0.135	0.218
E. coli	MPN/100ml	2007	7	290
		2008	120000	130
		2009	210	6000
		2010	16000	3500
Faecal Coliforms	cfu/100ml	2007	7	290
		2008	240000	130
		2009	210	6000
		2010	16000	5400

Levels of contaminants in sediments along the Portsmouth Drive catchment are generally moderate to low with just lead, zinc and PAHs exceeding ANZECC low trigger values at the <5m site and zinc and PAHs exceeding these values at the >20m site (Table 25). There are no historic data available for sediment

contamination along the Portsmouth Drive catchment apart from two sampling rounds at 200m from the outfall in 2005 and 2007 (Table 26).

Table 25. *Contaminant levels in sediments within 5m of the Midland Street outfall. Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

Parameter	Units		Midland Street <5m	Midland Street >20m	ANZECC Low trigger value	ANZECC high trigger value
As	mg/kg dry wt	2010	10.1	8.6	20	70
Cd	mg/kg dry wt	2010	0.510	0.350	1.5	10
Cr	mg/kg dry wt	2010	29.0	21.0	80	370
Cu	mg/kg dry wt	2010	48.0	17.1	65	270
Ni	mg/kg dry wt	2010	13.0	8.8	21	52
Pb	mg/kg dry wt	2010	54	39	50	220
Zn	mg/kg dry wt	2010	280	210	200	410
PAH	mg/kg dry wt	2010	9.100	12.570	4	45
Enterococci	MPN/g	2010	>160	>160		
Faecal coliforms	MPN/g	2010	2	13		

Table 26. *Historic contaminant levels in sediments 200m from the Midland Street outfall.*

		Midland 200
Arsenic	Historic	
	2007	15.4
	2008	
	2009	
	2010	
Cadmium	Historic	0.4
	2007	0.3
	2008	
	2009	
	2010	
Chromium	Historic	22
	2007	22.4
	2008	
	2009	
	2010	
Copper	Historic	24
	2007	19.0
	2008	
	2009	
	2010	
Nickel	Historic	8.3
	2007	10.7
	2008	
	2009	
	2010	
Lead	Historic	36
	2007	36
	2008	
	2009	
	2010	
Zinc	Historic	190
	2007	165
	2008	
	2009	
	2010	
PAH	Historic	
	2007	7.24
	2008	
	2009	
	2010	
Enterococci	Historic	130
	2007	20000
	2008	
	2009	
	2010	

3.8.3 Biota

There was a relatively low diversity of macroalgae at the Portsmouth Drive catchment site with very sparse cover of red and green algae present in very small patches (Table 27).

Table 27. *Macroalgal cover, expressed as a percentage, within 5m (left) and greater than 20m (right) of the Midland Street outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <5m	Q1	Q2	Q3	Q1	Q2	Q3
Codium fragilis				2		
Ulva lactuca	1				2	
Ceramium uncinatum		3		5	1	
Lenormandia chauvinii	2					

	Site 1			Site 2		
Algae (% cover) >20m	Q1	Q2	Q3	Q1	Q2	Q3
Ulva lactuca		2				
Lenormandia chauvinii			1		1	3

Epifauna was moderately abundance and reasonably diverse with the dominant animals being gastropod snails and cockles (Table 28). Oysters were present wherever there were rocks available to cling to. Taxonomic diversity did not differ significantly with distance from the outfall with diversity indices (H') for epifauna at Portsmouth Drive being 0.7 at <5m and 0.76 at >20m.

Table 28. *Epifauna within 5m (top) and greater than 20m (bottom) of the Midland St outfall.*

<5m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus				6									13		
Snails and Chitons															
Cominella glandiformis				1	1										
Chiton glaucus		1									1		2		
Melagraphis aethiops						1					1				
Micrelenchus tenebrosus		2		1	4			5			2	1		3	
Notoacmea spp	1				1										
Zeacumantus subcarinata					1							1			
Bivalves															
Austrovenus stutchburyi	6	2	3	5	4	1	2	1	2	4	6	3	8	1	1
Ostrea heffordi				4				2				3	1		

>20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus									5						
Barnacles															
Eminius modestus							17				4				
Snails and Chitons															
Notoacmea spp			1				3					1		1	
Chiton glaucus				1									1		
Melagraphis aethiops		2	1	2			2	3		1			1		
Micrelenchus tenebrosus	3	2			3	2	1	1		1		4	1	2	
Bivalves															
Austrovenus stutchburyi	2	2	3	5	6	1	7	2	1	1	3	6	2	4	2
Ostrea heffordi		1		5	3			2	1			1	1		

Infauna at Portsmouth Drive was, as at Orari Street, dominated by polychaete worms, with glyceriids being the most abundant (Table 29). Spionid and nereid worms were also reasonably common both close to and further away from the outfall. Amphipods, were less abundant here than at the Orari Street or Kitchener Street outfalls. Cockles were very abundant at both locations with up to 4262 animals per square metre.

Diversity was moderately high with 13 different species at the <5m site and 15 at the >20m site. Diversity indices (H') for infauna at Portsmouth Drive are moderately high at 0.92 for the <5m site and 0.83 for the >20m site. There are no historical diversity data for the Portsmouth Drive site.

Table 29. *Abundance of species of infauna collected <5m and >20m from the Midland Street outfall.*

Midland Street			Location	<5m							>20m						
2010			Sample	Site 1			Site 2				Site 1			Site 2			
				1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Glyceridae		3	5		7	2	9	26	11	2	4	9	8	12	46
		Nephtyiae			2		1			3		1	1			1	3
		Maldanidae		1				2		3		1	1				2
		Nereidae			2		1	1		4	1	2	4		1		8
		Nereididae		3	2		1		1	7	2	1	1		4		8
		Capitellikdae				2	1			3			1		1		2
		Spionidae		2	2		3	1	1	9		2	1		1		4
Nemertea												1					1
Sipuncula					1					1							
Crustacea																	
	Amphipoda	Jassidae															
		Lysianassidae				1		2		3			1				1
		Oedicerotidae														1	1
		Phoxocephalidae			2			1		3		2	2			1	5
Mollusca																	
	Gastropoda	Cominellidae	*Cominella glandiformis*									1					1
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi	3	2	1	1	4	8	19	3	6		4	6	9	28
			Puyseguria spp.		2		1			3		1					1
		Tellinidae															
			Macomona liliana		1			1		2	2	1	1			1	5
		Animals per core		12	21	4	16	14	19	86	19	21	17	13	21	25	116
		Animals per m^2		2640	4620	880	3520	3080	4180	3160	4180	4620	3740	2860	4620	5500	4262
		Species per site								13							15

3.9 South Dunedin

3.9.1 Stormwater

Stormwater from the South Dunedin catchment drains to the harbour via one very large outfall at Portobello Road. Concentrations of contaminants in the stormwater this year are generally low apart from copper and zinc which have both been traditionally high, exceeding ANZECC trigger values on the majority of occasions in the past (Table 30). PAHs are low this year, and certainly well below the level recorded in 2008.

Table 30. *Levels of contaminants detected in stormwater from the South Dunedin catchment outfall at Portobello Road during a storm event on 23 April 2010. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

			Catchment	South Dunedin
	Parameter	units	Outfall	Portobello Road
Stormwater	As	g/m^3	Historic	
			2007	BDL
			2008	0.002
			2009	BDL
			2010	BDL
	Cd	g/m^3	Historic	0.0003
			2007	BDL
			2008	0.00023
			2009	BDL
			2010	BDL
	Cr	g/m^3	Historic	0.0029
			2007	BDL
			2008	0.002
			2009	BDL
			2010	BDL
	Cu	g/m^3	Historic	0.03
			2007	BDL
			2008	0.026
			2009	0.01
			2010	0.0057
	Ni	g/m^3	Historic	0.002
			2007	BDL
			2008	0.0035
			2009	0.0028
			2010	0.0035
	Pb	g/m^3	Historic	0.021
			2007	BDL
			2008	0.019
			2009	0.0067
			2010	0.00055
	Zn	g/m^3	Historic	0.895
			2007	0.08
			2008	0.94
			2009	0.64
			2010	0.153
	PAH	g/m^3	Historic	0.0031
			2007	BDL
			2008	328
			2009	0.00017
			2010	0.00016
	pH	g/m^3	Historic	
			2007	7.9
			2008	7.3
			2009	7.6
			2010	7.6
	Suspended Solids	g/m^3	Historic	
			2007	18
			2008	46
			2009	30
			2010	8.1
	Oil & Grease	g/m^3	Historic	
			2007	4
			2008	9.7
			2009	BDL
			2010	BDL
	FWA	µg/L	Historic	
			2007	0.003
			2008	0.049
			2009	0.177
			2010	0.151
	E. coli	MPN/100ml	Historic	
			2007	460
			2008	5000
			2009	2800
			2010	54000
	Faecal Coliforms	cfu/100ml	Historic	
			2007	590
			2008	5000
			2009	2800
			2010	54000

Faecal coliforms and *E. coli* both well exceed MoH/MfE guidelines for secondary contact recreation (Table 30).

3.9.2 Sediments

Sediments at Portobello Road are generally fine silt and sand with a high organic matter content (e.g. decaying leaves and twigs). At the <5m site sediments were very dark and smelled strongly of petro-carbons with a visible oil slick forming in footprints and depressions dug to remove sediments. Cadmium, copper and lead exceed ANZECC (2000) low trigger values close to the outfall, with copper and lead also exceeding trigger values >20m away (Table 31).

Table 31. *Contaminant levels in sediments within 5m of the Portobello Road outfall. Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

	Units	Parameter	Portobello Road <5m	Portobello Road >20m	ANZECC Low trigger value	ANZECC high trigger value
As	mg/kg dry wt	Historic			20	70
		2007	29.0			
		2008	23.0			
		2009	24.0			
		2010	15.0	15.6		
Cd	mg/kg dry wt	Historic	2.0		1.5	10
		2007	48.5			
		2008	1.8			
		2009	2.0			
		2010	1.5	0.800		
Cr	mg/kg dry wt	Historic	41.0		80	370
		2007	1.8			
		2008	54.0			
		2009	50.0			
		2010	36.0	25.0		
Cu	mg/kg dry wt	Historic	21.0		65	270
		2007	60			
		2008	160			
		2009	190			
		2010	123	72.0		
Ni	mg/kg dry wt	Historic	15		21	52
		2007	169.3			
		2008	18.0			
		2009	26.0			
		2010	19.0	14.3		
Pb	mg/kg dry wt	Historic	410.0		50	220
		2007	20.4			
		2008	330			
		2009	290			
		2010	193	99		
Zn	mg/kg dry wt	Historic	1300		200	410
		2007	306			
		2008	1400			
		2009	1600			
		2010	1040	520		
PAH	mg/kg dry wt	Historic	426		4	45
		2007	436.3			
		2008	250.3			
		2009	525.2			
		2010	194.1	189.060		
Enterococci	MPN/g	Historic	1120.0			
		2007	727			
		2008	170			
		2009	<2			
		2010	<3	24		
Faecal coliforms	MPN/g	Historic				
		2007	23			
		2008	43			
		2009	2			
		2010	21	22		

Zinc and PAHs exceed ANZECC (2000) low trigger values close to the outfall, with PAHs also exceeding trigger values >20m away (Table 31). PAHs have traditionally been extremely high at this site with the source apparently the now defunct gasworks in South Dunedin. Investigations into PAH distribution and possible remediation at the Portobello Road outfall are detailed in Stewart (2005, 2006). Perhaps surprisingly, bacterial contamination at this outfall has generally been low.

3.9.3 Biota

There was a moderate diversity of mainly red algae close to the Portobello Road site, with diversity further away somewhat less. *Ulva lactuca* was present in small patches at both locations (Table 32). Abundance was reasonably high with up to 82% cover at some sites.

Epifauna was, as at other sites along Portsmouth Drive, moderately abundant at with cockles again comprising the vast majority of animals and the major proportion of the biomass (Table 33). The small topshell, *Micrelenchus tenebrosus,* was quite common clinging to rocks at both the <5m site and the >20m sites. The abundance of animals was not significantly different at <5m of the outfall and >20m (Table 30).

Table 32. *Macroalgal cover, expressed as a percentage, within 5m (left) and greater than 20m (right) of the Portobello Rd outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <5m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis		2				
Ulva lactuca	2		1	2	3	4
Ceramium uncinatum	17	15	8	2	2	6
Euptilota formosissima					2	1
Gracilaria chilensis						
Lenormandia chauvinii			2			1
Lomentaria umbellata	5	2	2	1		

	Site 1			Site 2		
Algae (% cover) >20m	Q1	Q2	Q3	Q1	Q2	Q3
Bryopsis plumosa						
Codium fragilis						
Ulva lactuca	1	3	1	3		2
Ceramium uncinatum	20	10	5	7	15	10
Euptilota formosissima			1			
Gracilaria chilensis						
Lenormandia chauvinii		1				
Lomentaria umbellata						

Taxonomic diversity was only slightly different with distance from the outfall at Portobello Road with 12 species present within 5m of the outfall and 9 species present at the site >20m distant (Table 33). Diversity indices (H') for epifauna at Orari Street were moderate at 0.58 at <5m and 0.64 at >20m.

Infauna at Portobello Road was, as at Kitchener and Orari Streets, dominated by polychaete worms, with glyceriids once again being the most abundant at both the <5m and >20m sites (Table 34). Spionids too, were very common at both sites.

Amphipods were present at both locations, although not in any great abundance. Cockles were less abundant than at other sites along Portsmouth Drive and cockle sizes are noticeably smaller (Stewart 2010). Whether this is attributable to contaminants in the substrate here or to other factors such as exposure to fresh water and longer exposure at low tide is a moot point.

Table 33. *Epifauna within 5m (top) and greater than 20m (bottom) of the Portobello Rd outfall.*

<5m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus			1	4											
Barnacles															
Chamaesipho columna				4						2					
Snails and Chitons															
Cominella glandiformis								1					1		
Chiton glaucus		1													
Buccinulum vittatum															
Melagraphis aethiops						1									
Micrelenchus tenebrosus	1		1	3	7	3		2	1	4		1		3	1
Notoacmea spp					2	1	2								
Zeacumantus subcarinata			1	1	1										
Bivalves															
Austrovenus stutchburyi	11	23	13	12	8	5	5	7	7	6	2	6	1	3	2
Mytilus galloprovincialis				1											
Ostrea heffordi			3	7						4					2
Echinoderms															
Ophiuroid		1													

>20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Polychaete worms															
Pomatoceros caerulus	3			2				15							
Spirorbis spp															
Barnacles															
Eminius modestus															
Chamaesipho columna														1	
Snails and Chitons															
Notoacmea spp												5	3	2	1
Chiton glaucus													1		
Cominella glandiformis															
Acanthochitona zelandica												1			
Melagraphis aethiops			1	2									1		
Micrelenchus tenebrosus	2	1	5	3	1			5	3		2	1	7	5	2
Bivalves															
Austrovenus stutchburyi	4	5	7	1		6	5	3	12	7	18	8	5	2	1
Mytilus galloprovincialis															
Ostrea heffordi			6					3			1		1		

Nemertean worms, which are uncommon elsewhere, feature in reasonable abundance at the <5m site at Portobello Road.

Diversity of infauna was quite high with 24 different species at the <5m site and 23 at the >20m site. Diversity indices (H') for infauna at Portobello Road are presented in Table 35.

Table 34. *Abundance of species of infauna collected <5m and >20m from the Portobello Road outfall.*

Portobello Rd			Location	<5m							>20m						
2010				Site 1			Site 2				Site 1			Site 2			
			Sample	1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta	Capitellidae										1		1		2	4
		Eunicidae												1		1	2
		Glyceridae		13	6	6	6	2	12	45	3	5	8	7	4	11	38
		Lumbrineridae		1						1		1			3		4
		Maldanidae		8	2		1			11							
		Nephtyidae		4					2	6	2	2	3	2			9
		Nereidae		3			1		1	5	2	1	1	1		2	7
		Nereididae		3	3	4	4	1	3	18	1	1		1	1	3	7
		Cirratulidae							3	3					1		1
		Orbiniidae						1		1				1	1		2
		Sabellidae												1			1
		Serpulidae												1			1
		Spionidae		8	3	7			3	21	2	5	4	3	2	3	19
Hemichordata																	
	Enteropneusta							1		1					3		3
Nemertea				8	7	6	8		16	45							
Crustacea																	
	Decapoda		*Macrophthalmus hirtipes*									2					2
	Amphipoda	Jassidae			2					2		1					1
		Lysianassidae			4					4							
		Oedicerotidae		3						3			1		1		2
		Phoxocephalidae					1	1		2			2	2			4
	Isopoda		*Isocladus armatus*		1					1							
	Malacostraca		*Macrophthalmus hirtipes*									1					1
	Tanaidacea					2		2		4							
	Ostracoda			2						2							
Mollusca																	
	Polyplacophora		*Chiton glaucus*									1					1
	Gastropoda	Amphibolidae	*Amphibola crenata*														
		Cominellidae	*Cominella glandiformis*		1	1				2							
		Batilliidae	*Zeacumantus subcarinatus*				1		1	2							
		Nacellidae	*Notoacmea* spp.								2			1	1		4
	Bivalvia	Veneridae	*Austrovenus stutchburyi*					1	1	2	2	2	5		2	3	14
			Puyseguria spp.					1		1							
		Tellinidae	*Macomona liliana*					1		1	3		2		1		6
Nematoda				3	2	6	2	5	7	25							
		Animals per core		56	31	32	24	16	49	208	17	23	26	22	20	25	133
		Animals per m^2		12320	6820	7040	5280	3520	10780	7642	3740	5060	5720	4840	4400	5500	4886
		Species per site								24							22

Table 35. *Diversity index (H') for infauna at the Portobello Road outfall through time.*

	<5m				>20m			
Site	2007	2008	2009	2010	2007	2008	2009	2010
Portobello Road	0.74	0.67	0.8	1.04	0.84	0.68	0.76	1.08

3.10 Shore Street

3.10.1 Stormwater

Stormwater from the Shore Street catchment drains to Andersons Bay Inlet via one large outfall at Shore Street. Concentrations of contaminants in the stormwater are generally low apart from copper and zinc which have both been traditionally high in the past, exceeding ANZECC trigger values on the majority of sampling occasions. This year is no exception with both metals exceeding NAZECC trigger values for protection of 80% of species (Table 36). *E. coli* and faecal coliform concentrations are both well above MoH/MfE guidelines for secondary contact recreation (Table 36).

Table 36. *Levels of contaminants detected in stormwater from the Shore Street outfall during a storm event on 23 April 2010. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

			Catchment	Shore Street
	Parameter	units	Outfall	Shore Street
Stormwater	As	g/m^3	2007	0.04
			2008	BDL
			2009	BDL
			2010	BDL
	Cd	g/m^3	2007	BDL
			2008	BDL
			2009	BDL
			2010	BDL
	Cr	g/m^3	2007	BDL
			2008	BDL
			2009	BDL
			2010	BDL
	Cu	g/m^3	2007	0.01
			2008	0.014
			2009	0.02
			2010	0.0118
	Ni	g/m^3	2007	0.01
			2008	BDL
			2009	BDL
			2010	BDL
	Pb	g/m^3	2007	0.003
			2008	0.0085
			2009	0.0069
			2010	BDL
	Zn	g/m^3	2007	0.02
			2008	0.44
			2009	0.21
			2010	0.115
	pH		2007	7.9
			2008	7.2
			2009	7.3
			2010	7.4
	Suspended Solids	g/m^3	2007	41
			2008	24
			2009	20
			2010	9.5
	Oil & Grease	g/m^3	2007	BDL
			2008	BDL
			2009	BDL
			2010	BDL
	FWA	µg/L	2007	0.081
			2008	0.031
			2009	0.142
			2010	0.98
	E. coli	MPN/100ml	2007	300
			2008	5100
			2009	16000
			2010	7000
	Faecal Coliforms	cfu/100ml	2007	300
			2008	5100
			2009	16000
			2010	9400

3.10.2 Sediments

Sediments at Shore Street are generally clean fine silt and fine to coarse sand with a low organic matter content. Lead, zinc and PAHs exceed ANZECC (2000) low trigger values close to the outfall, with nickel and PAHs also

exceeding trigger values >20m away (Table 37). Unfortunately there are few historic data for Shore Street sediments but it would appear that lead and zinc levels are traditionally quite high.

Table 37. *Contaminant levels in sediments within 5m and >20m from the Shore Street outfall. Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

	Units	Parameter	Shore Street <5m	Shore Street >20m	ANZECC Low trigger value	ANZECC high trigger value
As	mg/kg dry wt	Historic			20	70
		2010	6.0	9.0		
Cd	mg/kg dry wt	Historic	0.5		1.5	10
		2010	0.3	0.114		
Cr	mg/kg dry wt	Historic	10.0		80	370
		2010	19.0	27.0		
Cu	mg/kg dry wt	Historic	30.0		65	270
		2010	35.0	27.0		
Ni	mg/kg dry wt	Historic	5.4		21	52
		2010	10.0	31.0		
Pb	mg/kg dry wt	Historic	130.0		50	220
		2010	85	59		
Zn	mg/kg dry wt	Historic	300		200	410
		2010	350	171		
PAH	mg/kg dry wt	Historic			4	45
		2010	10.465	18.970		
Enterococci	MPN/g	Historic				
		2010	460	4		
Faecal coliforms	MPN/g	Historic				
		2010	130	<2		

3.10.3 Biota

There were no macroalgae visible at the Shore Street site. Epifauna, too, were relatively scarce with just a few mud craps and the occasional cockle evident (Table 38). Taxonomic diversity was low with just two species close to the outfall and three further away.

Table 38. *Epifauna within 5m (top) and greater than 20m (bottom) of the Shore St outfall.*

<5m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Decapods															
Macrophthalmus hirtipes		1				2							1		
Bivalves															
Austrovenus stutchburyi	1							1	2					1	

>20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Decapods															
Macrophthalmus hirtipes		2			2	3		1	1				2	1	
Gastropoda															
Melagraphia aethiops							1							1	
Bivalves															
Austrovenus stutchburyi	2	3		4	1			2	2		3	1	4	2	2

Diversity indices (H') for epifauna at Shore Street were low at 0.28 at <5m and 0.34 at >20m.

Infauna at Shore Street was heavily dominated by polychaete worms, with glyceriids, nereidids and spionids all being very common at both the <5m and >20m sites (Table 39). The small snail *Zeacumantus subcarinatus* was present in both locations and, although present, cockles were far less common than at other soft bottom sites. This is likely attributable to exposure to fresh water and longer exposure at low tide.

Table 39. *Abundance of species of infauna collected <5m and >20m from the Shore Street outfall.*

Shore Street			Location	<5m							>20m						
2010				Site 1			Site 2				Site 1			Site 2			
			Sample	1	2	3	1	2	3		1	2	3	1	2	3	
Phylum		**Family**	**Genus/species**							sum							sum
Annelida																	
	Polychaeta																
		Glyceridae		14	12	9	11	8	16	70	25	16	8	23	14	7	93
		Nephtyidae		1			1			2	1	1	1		2	1	6
		Nereidae		3	1	2	2	4	1	13		2		2		1	5
		Nereididae		4	6	5	3	4	7	29	8	4	6	6	7	3	34
		Orbiniidae		3		1		1	1	6	3	2	1	2		1	9
		Maldanidae			1				1	2							
		Spionidae		6	7	5	6	5	5	34	8	6	7	5	8	5	39
Iinsecta	Chironomidae											1					1
Hemichordata	Enteropneusta					1	1			2							
Nemertea								1		1							
Crustacea																	
	Decapoda																
			Macrophthalmus hirtipes		1			1		2							
Mollusca																	
	Gastropoda																
		Batelliidae	*Zeacumantus subcarinatus*	1			1			2	1		2			1	4
		Nacellidae	*Notoacmea* species					1		1							
	Bivalvia																
		Veneridae															
			Austrovenus stutchburyi		1			1		2	1	2	3	2	2		10
		Tellinidae															
			Macomona liliana								1		2			1	4
		Animals per core		32	29	23	25	26	31	166	48	34	30	40	33	20	205
		Animals per m^2		7040	6380	5060	5500	5720	6820	36520	10560	7480	6600	8800	7260	4400	45100
		Species per site								13							10

Diversity of infauna was moderate with 13 different species at the <5m site and 10 at the >20m site. Diversity indices (H') for infauna at Shore Street reflect this with 0.74 at <5m and 0.71 at >20m.

3.11 St Clair

3.11.1 Stormwater

Stormwater from the St Clair catchment drains to the open coast via two large outfalls, one at St Clair Beach and one at Second Beach, and one smaller outfall. Consent is required for just the Second Beach outfall however, as the St Clair outfall is actually a stream that carries stormwater. Consequently there are few

data for the St Clair outfall. Concentrations of copper and zinc, which have both been traditionally high, exceed ANZECC trigger for protection of 80% of species (Table 40). Lead has been high in the past but levels are low this year. *E. coli* and faecal coliform contamination are very high at both the Second Beach and St Clair outfalls, suggesting possible cross-connection with foul sewers.

Table 40. *Levels of contaminants detected in stormwater from the St Clair catchment outfalls during a storm event on 23 April 2010. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

			Catchment	St Clair	
	Parameter	units	Outfall	Second Beach	St Clair
Stormwater	As	g/m^3	2007	BDL	
			2008	0.0013	
			2009	0.0015	
			2010	BDL	
	Cd	g/m^3	2007	BDL	
			2008	0.00006	
			2009	0.00006	
			2010	0.00007	
	Cr	g/m^3	2007	0.0007	
			2008	0.0028	
			2009	0.0035	
			2010	0.00086	
	Cu	g/m^3	2007	0.0027	
			2008	0.012	
			2009	0.019	
			2010	0.0054	
	Ni	g/m^3	2007	0.0009	
			2008	0.0021	
			2009	0.0022	
			2010	0.00133	
	Pb	g/m^3	2007	0.001	
			2008	0.011	
			2009	0.013	
			2010	0.00021	
	Zn	g/m^3	2007	0.038	
			2008	0.16	
			2009	0.15	
			2010	0.092	
	pH		2007	7.7	
			2008	7.3	
			2009	7.4	
			2010	7.3	
	Suspended Solids	g/m^3	2007	BDL	
			2008	37	
			2009	41	
			2010	BDL	
	Oil & Grease	g/m^3	2007	5	
			2008	BDL	
			2009	BDL	
			2010	BDL	
	FWA	µg/L	2007	0.147	
			2008	0.19	
			2009	0.098	0.261
			2010	0.04	0.222
	E. coli	MPN/100ml	2007	560	
			2008	6800	
			2009	14000	
			2010	4800	
	Faecal Coliforms	cfu/100ml	2007	560	
			2008	8300	
			2009	14000	3900
			2010	92000	12000

3.11.2 Sediments

Sediments are unable to be sampled at the Second Beach outfall, the substrate there comprising large cobbles and small to large boulders. At St Clair sediments are very clean fine sand. The concentrations of all contaminants are well below ANZECC low trigger values (Table 41). This is likely a reflection of the low stability of the substrate here and the high energy environment of the open coast.

Table 41. *Contaminant levels in sediments within 5m of the St Clair outfall. Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

	Units	Parameter	St Clair <5m	St Clair >20m	ANZECC Low trigger value	ANZECC high trigger value
As	mg/kg dry wt	2010	3.5	2.8	20	70
Cd	mg/kg dry wt	2010	BDL	BDL	1.5	10
Cr	mg/kg dry wt	2010	3.2	1.9	80	370
Cu	mg/kg dry wt	2010	1.7	1.0	65	270
Ni	mg/kg dry wt	2010	4.9	2.4	21	52
Pb	mg/kg dry wt	2010	0.84	0.92	50	220
Zn	mg/kg dry wt	2010	5.4	5	200	410
PAH	mg/kg dry wt	2010	BDL	BDL	4	45
Enterococci	MPN/g	2010	<2	<2		
Faecal coliforms	MPN/g	2010	<2	<2		

3.11.3 Biota

Macroalgae were sparse and with low diversity at both the St Clair and Second Beach outfalls with *Porphyra* being the only alga of any abundance (Table 42 and 43).

Table 42. *Macroalgal cover, expressed as a percentage, within 5m (left) and greater than 20m (right) of the St Clair outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <5m	Q1	Q2	Q3	Q1	Q2	Q3
Enteromorpha intestinalis					2	
Porphyra spp.	25	68	43	70	95	80

	Site 1			Site 2		
Algae (% cover) >20mm	Q1	Q2	Q3	Q1	Q2	Q3
Enteromorpha intestinalis		5	45		30	
Porphyra spp.	10	5	9		7	2

Table 43. *Macroalgal cover, expressed as a percentage, within 5m (left) and greater than 20m (right) of the Second Beach outfall. Green algae in green, red algae in pink.*

	Site 1			Site 2		
Algae (% cover) <5m	Q1	Q2	Q3	Q1	Q2	Q3
Porphyra spp.					5	11

	Site 1			Site 2		
Algae (% cover) >20mm	Q1	Q2	Q3	Q1	Q2	Q3
Porphyra spp.		30	22		25	10

Epifauna at both St Clair and Second Beach was confined to just hard substrate and was typical of intertidal animals in energetic environments. Most abundant were the small barnacle, *Elminius modestus,* with snails, limpets and chitons making up

most of the remainder of the community at Second Beach (Tables 44 and 45). The abundance of animals was not significantly different at <5m from the outfalls and >20m (Table 30). Taxonomic diversity was only very slightly different with distance from either outfall a (Table 46).

Table 44. *Epifauna within 5m (top) and greater than 20m (bottom) of the St Clair outfall.*

<5m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Barnacles															
Elminius modestus	5	63		18			147		30		8				64
Snails and Chitons															
Cellana radians	1														
Cellana strigilis			1						1			2			
Notoacmea spp				1			2								

>20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Barnacles															
Eminius modestus	18							47						28	

Table 45. *Epifauna within 5m (top) and greater than 20m (bottom) of the Second Beach outfall.*

<5m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Amphipoda															
Gammaridae	14		9				23			2		1			
Barnacles															
Eminius modestus	3			7				4			9				
Snails and Chitons															
Chiton glaucus				1							2				
Diloma nigerrima	3		28	2			14			6		47		3	9
Melagraphia aethiops			1					1					2		
Notoacmea spp	2		2			2	7		1			1	2		3

>20m	Quadrat 1					Quadrat 2					Quadrat 3				
Animals	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Decapoda															
Hemigrapsus							1								
Isopods															
Gammaridae		12		3		8		9	1			5	6		2
Barnacles															
Eminius modestus	14		36					8				7		19	
Snails and Chitons															
Chiton glaucus		2			2					1	3			1	
Diloma nigerrima	18						6					5			3
Melagraphia aethiops		2					2	3			4			1	
Notoacmea spp	1			2		11			8	1				2	

Table 46. *Diversity indices (H') for epifauna within 5m (left) and greater than 20m (right) of the St Clair and Second Beach outfalls.*

Site	<5m	>20m
St Clair	0.06	0.00
Second Beach	0.55	0.68

No infauna were observed in any of the sediment cores collected at the St Clair outfall, once again a reflection of the highly energetic nature of this environment. Substrate at Second Beach is unsuitable for infaunal sampling.

3.12 Inter-catchment comparisons

3.12.1 Stormwater

It should be noted that Orari Street and Portobello Road both operate with sump systems and it is not clear if, in fact, the first flush had reached the outfall for these sites at the time of sampling. However, these sumps were operating at the time of sampling so it is assumed the first flush for these two outfalls was sampled.

Unlike last year when the highest levels of contaminants overall were at Wickliffe Street, there was no outfall this year that was clearly "worse" than others. Midland Street had the highest levels of copper and nickel, but the highest levels of other metals were shared among Halsey Street (As), Wickliffe Street (Cd), Orari Street (Cr), George Street (Pb) and Teviot Street (Zn). Generally speaking, contaminant levels showed considerable variability with location when compared with results from 2007, 2008 and 2009 (Stewart 2007a, 2008c, 2009, 2010) (Table 47, Figure 6). Nickel at Midland Street and zinc at Teviot Street stand out as being at levels higher than might be expected based on previous results. If such levels continue in future sampling it will be worthwhile carrying out further investigations in these catchments to determine possible sources.

Microbiological levels were high to very high at all sites with all values exceeding the guidelines for secondary contact recreation for both faecal coliforms and *E. Coli* (Table 47). Mason Street, Kitchener Street and Portobello Road in particular show marked increases in microbe levels compared with 2009, with Second Beach also showing an increase, but in just faecal coliforms (Stewart 2010). Wickliffe Street, on the other hand, shows a marked decrease in microbial levels (Table 47). High microbial counts are perhaps not unexpected for first flush samples with a considerable amount of animal faeces and decaying vegetable matter being washed into the stormwater system from streets and pavements.

FWAs were detected at low flows at all sites (Table 47). Levels were generally comparable with last year with values at some sites increasing slightly while those at other decreased slightly (Stewart 2010). Midland Street had the highest values, but well sort of the extreme levels seen at Bauchop Street in 2007 and 2008

(Stewart 2010). There are no standards for FWAs in New Zealand but levels above 0.2µg/L are cause for concern (Brent Gilpin, ESR, pers. comm.). It is expected that contaminants of this nature will continue to be investigated as part of the Three Waters Strategy.

PAHs were detected at all three outfalls where this parameter is monitored, albeit at very low levels (Table 48). This differs from 2009 when PAHs were detected at just the Portobello Road outfall (Stewart 2010). In 2007 PAHs were detected only in Orari Street stormwater (just Pyrene at very low levels), and in 2008 PAH levels were high at all three outfalls. Total PAH levels were very slightly lower at Portobello Road than in 2009. Anthracene, Fluorene and Biphenyl-d10, the three PAHs that have contributed the major component of the PAH total in the past were notably absent this year (Stewart 2010). Anthracene and Biphenyl-d10 are components of coal tar and it may be that the input of these substances (a by-product of gas production) to the upper harbour via stormwater is tailing off.

The one result that stands out in the 2010 sampling round is the high level of oil and grease at Teviot Street. The value is not unusually high compared with levels at the various outfalls through time, but it is the only site at which oil and grease was detected this year (Table 47). The possible source or sources is/are unknown.

3.12.2 Sediments

Levels of metals in sediments are highly variable from outfall to outfall (Table 49, Figure 7), although, as expected most values are generally higher nearer the outfall than further away from it (Figure 7). There are, however, exceptions, with arsenic, chromium, copper lead and zinc all having levels higher further away from the outfall than close to the outfall for at least one or more sites (Figure 7). The site where this phenomenon is most prevalent is Watson Park. It must be remembered that the Watson Park outfall discharges to Sawyers Bay which was, in the past, the receiving environment for discharges from a tannery and wood treatment plant. As such, the sediments within the bay harbour a quite high level of historical contaminants (Grove 1995, Stewart and Ryder 2005) so this result is not entirely unexpected.

Table 47. *Levels of contaminants detected in stormwater from outfalls in and around Dunedin during a storm event on 23 April 2010. BDL indicates Below Detectable Limits. Pink shaded cells indicate levels above the ANZECC 2000 trigger level for protection of 80% of species. For E. coli, green cells indicate acceptable levels; orange cells indicate a level that would trigger an amber alert; pink cells indicate a level that would trigger a red alert according to MoH/MfE guidelines. For FCs orange cells exceed guidelines for primary contact recreation; pink cells exceed levels for secondary contact recreation.*

		Stormwater												
	Parameter	As	Cd	Cr	Cu	Ni	Pb	Zn	pH	Suspended Solids	Oil & Grease	FWA	E. coli	Faecal Coliforms
	units	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	g/m^3	µg/L	g/m^3	g/m^3		MPN/100ml	CFU/100ml
Catchment	Outfall	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
St Clair	Second Beach	BDL	0.00007	0.00086	0.0054	0.00133	0.00021	0.092	7.3	BDL	BDL	0.04	4800	92000
Port Chalmers	George St	BDL	0.00033	0.00136	0.0148	0.006	0.0048	0.42	6.8	170	BDL	0.079	1100	1100
Port Chalmers	Watson Pk	BDL	BDL	BDL	BDL	0.0035	BDL	0.29	7.1	240	BDL	0.105	>1600	>1600
Shore Street	Shore Street	BDL	BDL	BDL	0.0118	BDL	BDL	0.115	7.4	9.5	BDL	0.98	7000	9400
Portobello Road	Portobello Road	BDL	BDL	BDL	0.0057	0.0035	0.00055	0.153	7.6	8.1	BDL	0.151	54000	54000
Andersons Bay	Teviot Street	BDL	0.00026	BDL	0.0136	0.0033	BDL	1.79	7	84	6.4	0.135	16000	16000
Andersons Bay	Midland Street	BDL	BDL	BDL	0.021	0.0075	BDL	0.22	7.5	52	BDL	0.218	3500	5400
Orari Street	Orari Street	0.00149	0.000164	0.00183	0.0096	0.00108	0.00015	0.3	7.1	130	BDL	0.052	1700	3500
Kitchener St	Kitchener Street	BDL	BDL	BDL	0.0118	0.0035	0.00196	0.62	6.9	50	BDL	0.023	92000	160000
Mason Street	Mason Street	BDL	0.00051	BDL	0.0157	BDL	0.00102	0.43	7	138	BDL	0.156	350000	350000
Gas Works	Ravensbourne Rd	BDL	BDL	BDL	0.0031	0.00148	0.00023	0.144	7.3	61	BDL	0.136	11000	11000
Halsey, Wickliffe, Bauchop	Bauchop Street	BDL	0.00049	BDL	0.0026	BDL	BDL	0.121	7.4	53	BDL	0.067	7900	35000
	Halsey Street	0.0044	0.00026	BDL	0.00162	BDL	0.0021	0.136	6.8	50	BDL	0.061	17000	92000
	Wickliffe Street	BDL	0.00078	0.00157	0.0058	BDL	BDL	0.24	7.3	86	BDL	0.048	35000	54000
	Protection for 80% of species										Primary	Amber	>260	>150
	ANZECC guidelines	0.36	0.0008	0.04	0.0025	0.017	0.0094	0.031	7.2-7.8		Secondary	Red	>550	>1000

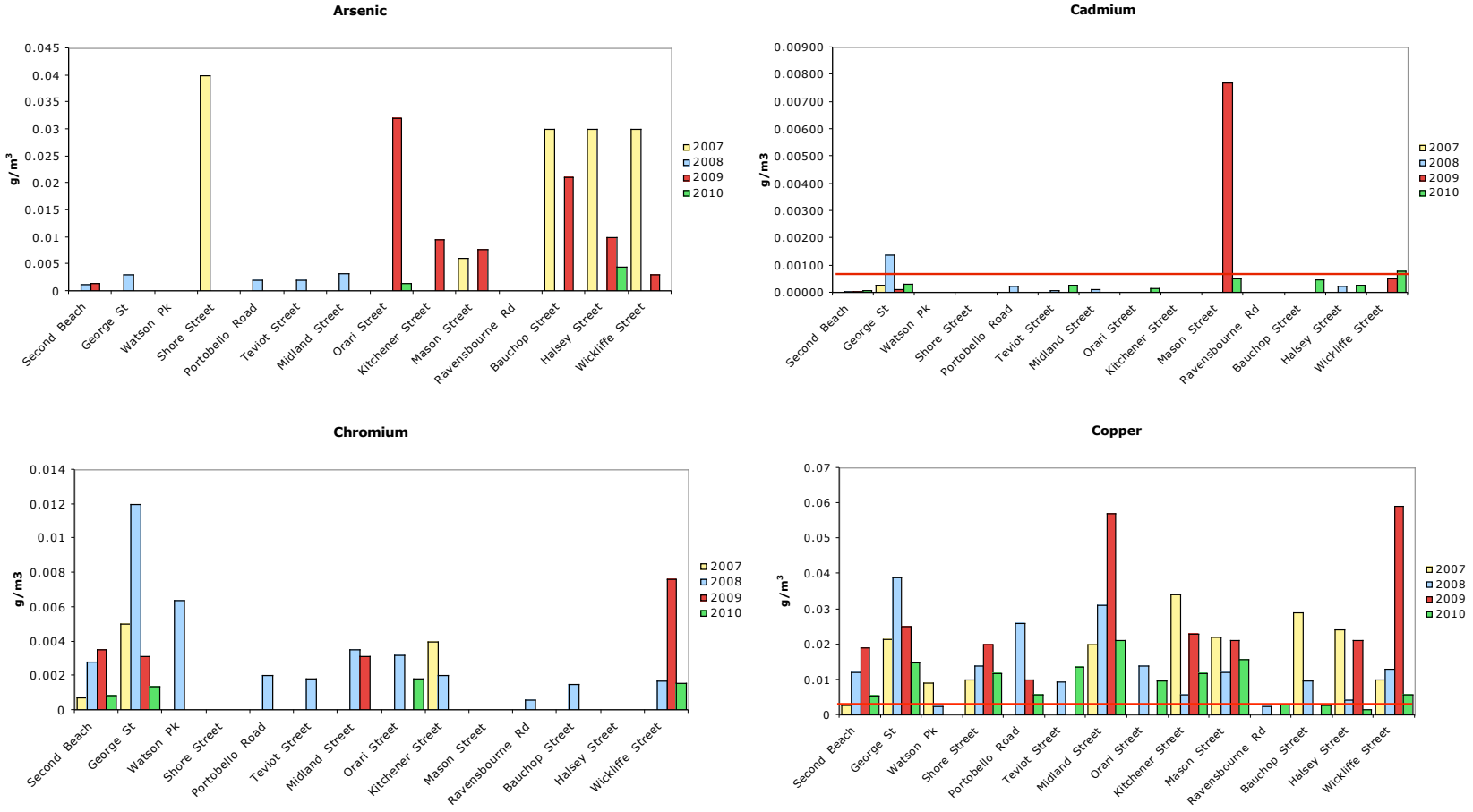


Figure 6. *Graphical representation of contaminant levels in stormwater at outfalls around upper Otago Harbour in 2007, 2008, 2009 and 2010. Red line indicates ANZECC trigger level for protection of 80% of species.*

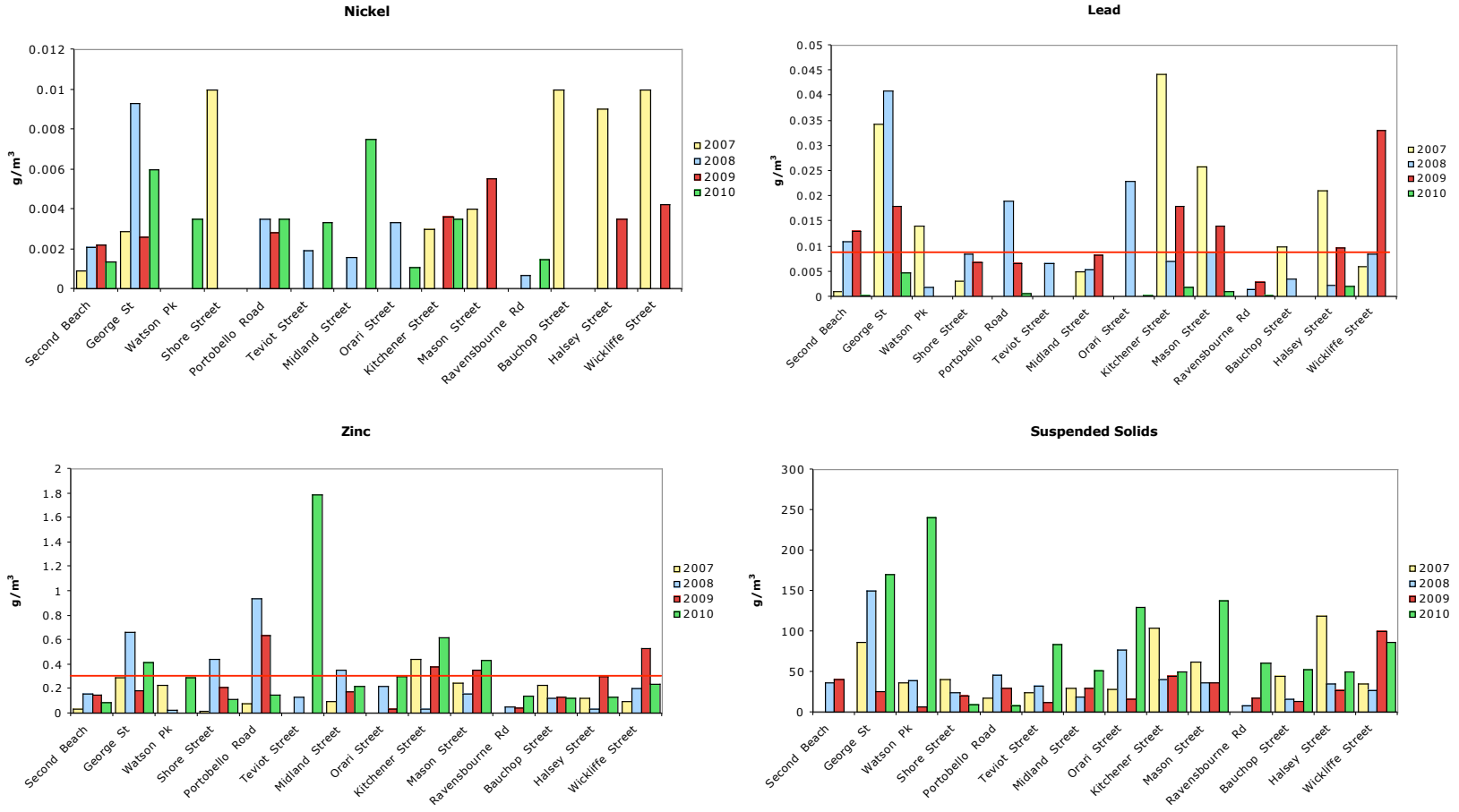


Figure 6. (continued….)

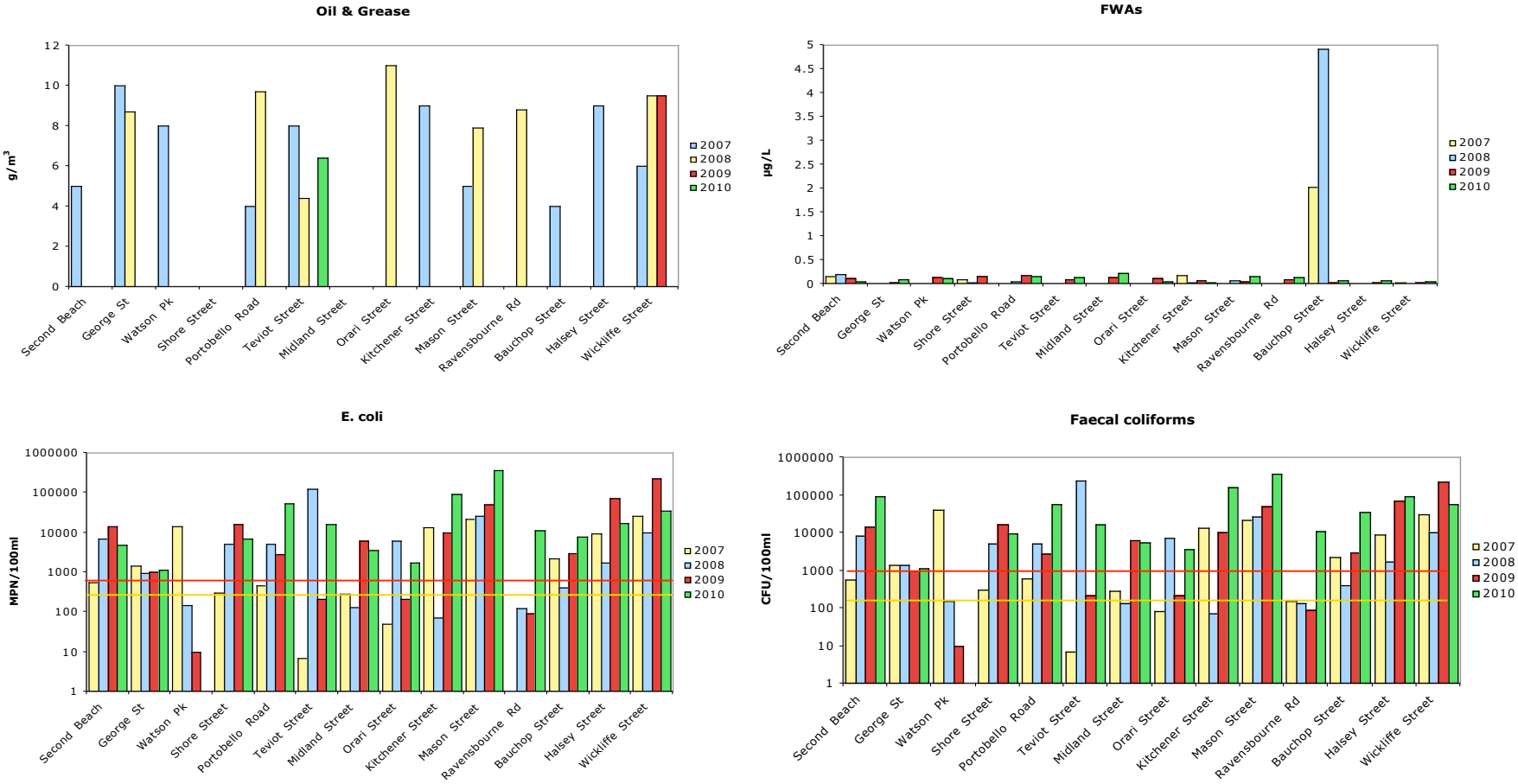


Figure 6. ***(continued)*** *Graphical representation of contaminant levels in stormwater at outfalls around upper Otago Harbour in 2007, 2008, 2009 and 2010. For microbiological graphs amber line indicates guideline for primary contact, red line indicates guideline for secondary contact.* ***Note log scale on Y axis of microbiological graphs.***

Table 48. *PAHs (g/m^3) detected in stormwater from the Kitchener Street, Orari Street and Portobello Road outfalls in 2010. BDL indicates Below Detectable Limits.*

	Kitchener St	Orari St	Portobello Rd
	2010	2010	2010
Acenaphthene	BDL	BDL	BDL
Acepaphthylene	BDL	BDL	BDL
Anthracene	BDL	BDL	BDL
Benzo[a]anthracene	BDL	BDL	BDL
Benzo[a]pyrene	BDL	BDL	BDL
Benzo[a]fluorathene + Benzo[j]fluorathene	BDL	0.00012	0.000158
Benzo[g,h,i]perylene	BDL	BDL	BDL
Benzo[k]fluorathene	BDL	BDL	BDL
Chrysene	BDL	BDL	BDL
Dibenzo[a,h]anthracene	BDL	BDL	BDL
Fluoranthene	0.000149	0.00017	BDL
Fluorene	BDL	BDL	BDL
Indeno[1,2,3-c,d]pyrene	BDL	BDL	BDL
Naphthalene	BDL	BDL	BDL
Phenanthrene	BDL	BDL	BDL
Pyrene	BDL	0.00023	BDL
Total PAH	0.0001	0.0005	0.00016

Industrialised catchments such as Kitchener Street and Portobello Road show elevated levels of some metals with levels of arsenic, cadmium and chromium nickel, lead and zinc all being higher at Portobello Road than at most other sites (Table 49, Figure 7).

Overall, levels of metals in sediments this year are generally lower than on most sampling occasions from the past (Stewart 2010). Despite this, a number of contaminants remain above ANZECC (2000) trigger values (Table 49, Figure 7) Lead levels have generally been decreasing in the environment since the removal of leaded petrol but sediments in the upper harbour still show lead levels in excess of the ANZECC low trigger value at, or near, five of the outfalls that are monitored (Table 49, Figure 7). Zinc levels in sediment also exceed the ANZECC low trigger values at four outfalls while copper exceeds trigger values at just Kitchener Street and Portobello Road.

As observed in previous investigations PAHs are to be found at moderate to high levels in much of the Upper harbour Basin, with the highest levels adjacent to the Portobello Road outfall (Table 48, Figure 7). Stormwater inputs of PAHs were lower this year than last year at Portobello Road (Stewart 2010), but very slightly higher at Orari Street and Kitchener Street indicating that, while PAHs are still being added to the upper harbour, the amount varies through time and with site. The extremely high levels of PAHs in older sediments off Portobello Road are, as

already suggested, believed to have been sourced from the now defunct gas works. The levels of PAHs off Portobello Road observed this year are much lower than those from last year and lower than to those observed in any sampling round to date (Stewart 2010). Wave action disturbing surface sediments around the time of sampling will undoubtedly have a bearing on PAH levels at any particular site. This year, sampling occurred on a relatively calm day, but wind strength was not markedly different to that on the sampling day last year.

Trends in contaminant levels at the various sites through time remain unclear with just four years of sampling revealing high variability among contaminants and among sites (Figure 7). However, levels of chromium, copper, nickel, lead zinc and PAHs are generally lower this year. It will be of interest to see if this trend becomes more apparent with the addition of further data from future monitoring rounds.

3.12.3 Biological Monitoring

Macroalgal diversity and abundance varied greatly from outfall to outfall. Second Beach showed very low diversity with just *Porphyra* present in any quantity. Algal cover was highest at both sites near the Orari Street outfall with the next greatest cover being at Portobello Road. Overall, algal cover at sites varied from >90% to nil, but there was no significant difference in cover between sites less than 5m from an outfall and those greater than 20m from the same outfall. Diversity too, showed little difference with distance from the outfalls. There is no obvious relationship of algal cover with stormwater contaminant load, with high cover found near the Orari Street and Portobello Road outfalls yet virtually no algae present at Ravensbourne Road. Possible reasons for the varied distribution of macroalgae are the presence or absence of soft or hard substrate suiting particular algal species, the amount of exposure at low tide, aspect (i.e. north facing, shaded etc.), and tidal currents near an outfall.

Table 49. *Contaminant levels in sediments at various locations within 5m of stormwater outfalls and greater than 20m from stormwater outfalls within the Upper Otago Harbour Basin. Shaded cells show sites where contaminant levels exceed either ANZECC Low (orange) or High (pink) trigger levels.*

	As	Cd	Cr	Cu	Ni	Pb	Zn	PAH	Enterococci	Faecal coliforms
Units	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	mg/kg dry wt	MPN/g	MPN/g
Parameter	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
Watson Park <5m	4.9	0.490	19.1	53.0	9.2	51	171	17.140	54	21
Watson park >20m	20.0	0.135	67.0	18.3	20.0	28	127	2.400	24	170
Ravensbourne <5m	13.0	0.200	14.0	9.0	11.0	28	149	3.705	<3	2
Ravensbourne >20m	9.8	0.133	26.0	30.0	17.5	26	107	0.740	24	5
Kitchener Street <5m	9.0	0.300	22.0	37.0	12.0	155	280	4.960	<3	<2
Kitchener Street >20m	13.3	0.189	24.0	83.0	12.1	75	570	57.020	13	2
Orari Street <5m	5.0	0.200	16.0	11.0	8.0	35	157	9.255	<3	33
Orari Street >20m	3.1	0.096	11.7	6.1	5.1	13.5	73	0.730	24	17
Midland Street <5m	10.1	0.510	29.0	48.0	13.0	54	280	9.100	>160	2
Midland Street >20m	8.6	0.350	21.0	17.1	8.8	39	210	12.570	>160	13
Portobello Road <5m	15.0	1.500	36.0	123.0	19.0	193	1040	194.060	<3	21
Portobello Road >20m	15.6	0.800	25.0	72.0	14.3	99	520	189.060	24	22
Shore Street <5m	6.0	0.300	19.0	35.0	10.0	85	350	10.465	460	130
Shore Street >20m	9.0	0.114	27.0	27.0	31.0	59	171	18.970	4	<2
St Clair <5m	3.5	BDL	3.2	1.7	4.9	0.84	5.4	BDL	<2	<2
St Clair >20m	2.8	BDL	1.9	1.0	2.4	0.92	5	BDL	<2	<2
ANZECC Low trigger value	20	1.5	80	65	21	50	200	4		
ANZECC high trigger value	70	10	370	270	52	220	410	45		

Figure 7. *Graphical representation of contaminant levels in sediment within 5m of stormwater outfalls (blue) and greater than 20m from stormwater outfalls (yellow). Green line indicates ANZECC low trigger level, red line is high trigger level.*

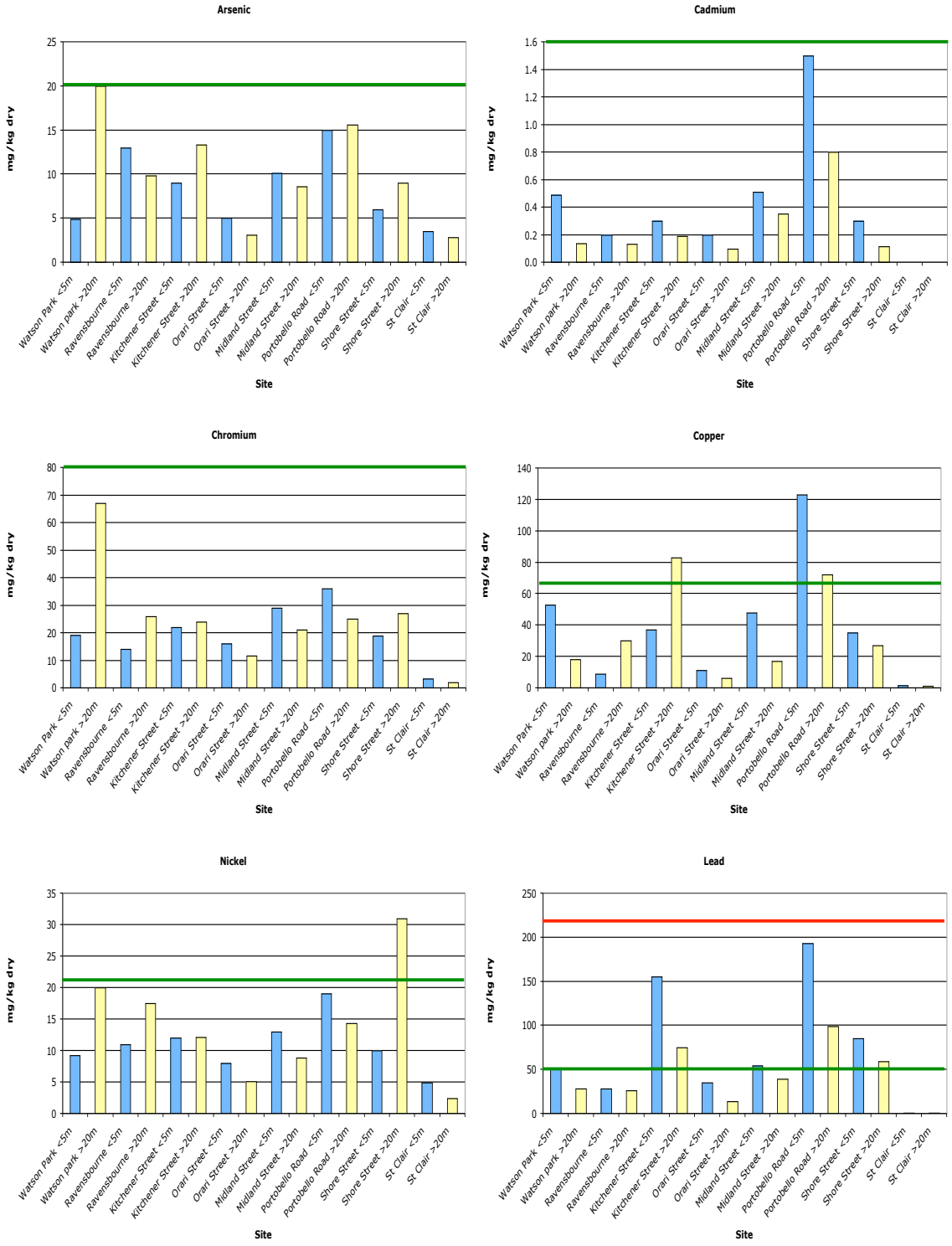
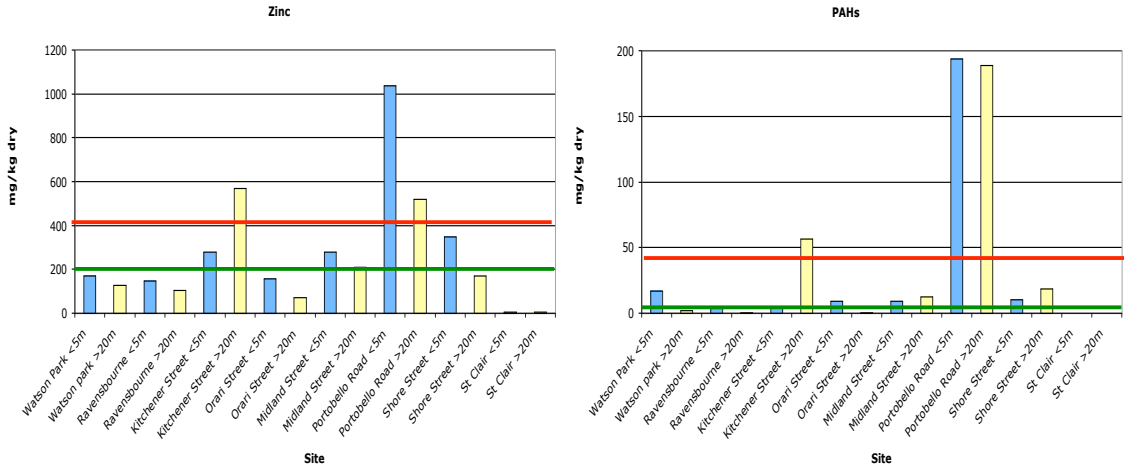


Figure 7 (continued). *Graphical representation of contaminant levels in sediment within 5m of stormwater outfalls (blue) and greater than 20m from stormwater outfalls (yellow). Green line indicates ANZECC low trigger level, red line is high trigger level.*



Epifauna was moderately abundant at all surveyed outfalls with the small barnacle *Elminius modestus* comprising the majority of animals at sites where there was hard substrate, and the topshell *Micrelenchus tenebrosus* and cockles, *Austrovenus stutchburyi*, comprising the majority of animals at soft substrate sites. For Watson Park, Ravensbourne, Kitchener Street and St Clair outfalls abundance of animals was higher within 5m of the outfall than further away. The converse was true for the Orari Street and Shore Street outfalls. The remaining outfalls, however, showed little difference in animal abundance close to or distant from the outfall. Taxonomic diversity was similar irrespective of distance at all sites except Kitchener Street where there were nine species present within 5m of the outfall but only 4 species present at the site >20m distant. Diversity within animal communities was variable from outfall to outfall however, with number of species ranging from one at St Clair >20m to twelve at Portobello Road <5m. Diversity indices were calculated for each surveyed site and ranged from 0.0 at St Clair >20m to 0.76 at Midland Street >20m (Table 50). These data will provide a useful comparison for future surveys with any significant decrease in diversity index suggesting a deterioration in community health and an increase suggesting the converse.

For outfalls that discharge to deep water (i.e. Wickliffe Street, Halsey Street, Bauchop Street, Mason Street, and minor outfalls at Fryatt Street, Wharf Street and Birch Street) epifauna comprised mainly small barnacles (*Elminius modestus*) and,

at Halsey, Bauchop and Mason Streets, encrusting ascidians. Abundance of these encrusting organisms was high at all sites with no perceptible change in abundance with distance either side of the outfall.

Table 50. *Diversity (H') of epifauna within 5m and greater than 20m of Dunedin's major stormwater outfalls.*

Site	<5m	>20m
Watson Park	0.50	0.62
Ravensbourne	0.24	0.20
Kitchener Street	0.53	0.20
Orari Street	0.12	0.16
Midland Street	0.70	0.76
Portobello Road	0.58	0.64
Shore Street	0.28	0.34
St Clair	0.06	0.00
Second Beach	0.55	0.68

On wharf piles <3m distance from the Wickliffe, Halsey and Bauchop Street outfalls sea-tulips (*Pyura pachydermatina*) were common. On sheet piles at Mason Street and on rocky substrate at these smaller outfalls oysters (*Ostrea heffordi*) and tube worms (*Pomatoceros caerulaus*) were abundant. Occasional blue mussel (*Mytilus galloprovincialis*) and limpets (*Cellana strigilis*) were present on wharf piles at all outfalls. The photographs taken of outfalls will be compared with photographs from future surveys to determine if there are any gross changes to the communities adjacent to these deep water outfalls.

No infauna were found at either the <5m site or the >20m site at St Clair, likely due to the very mobile and disturbed substrate there. Infauna at all remaining sites was dominated by polychaete worms, with glyceriids being the most abundant. Spionid worms were also common at Kitchener Street, Portobello Road and Shore Street, both close to and further away from the outfalls. Phoxocephalid amphipods were reasonably common at both locations near the Kitchener Street outfall, but were not common elsewhere. Cockles (*Austrovenus stutchburyi*) were most common at both the <5m and >20m sites near the Orari Street and Midland Street outfalls and comprised by far the major portion of the biomass at all sites. Tanaid crustaceans were found in moderate numbers at Kitchener Street, Orari Street and Portobello Road, but were absent from Midland Street and Shore Street. Numbers of animals per square metre were generally higher than in the past (Stewart 2010) and ranged from 880 at replicate 3, Site 1 at <5m from the Midland Street outfall to 12,320 at replicate 1, Site 1 at >20m from the Portobello Road outfall. This high number was largely due to high abundance of polychaetes and nemertean worms.

Despite the variability in overall numbers of animals at the various sites, diversity at <5m from outfalls is not significantly different to diversity at >20m from outfalls ($F_{1,11}$ = 0.00049, p = 0.983) (Table 51). Historical data are not available for all sites but for >50m sites at Orari Street, Kitchener Street and Portobello Road there was a significant difference observed this year ($F_{3,8}$ = 6.747, p = 0.014), with diversity being higher in this survey than in previous years at each of the three sites (Table 51).

Table 51. *Diversity (H') of infauna within 5m and greater than 20m of stormwater outfalls. 2010 data compared with 2007, 2008 and 2009 data for Kitchener, Orari and Portobello Road outfalls.*

	<5m				>20m			
Site	2007	2008	2009	2010	2007	2008	2009	2010
Kitchener Street	0.67	0.53	0.44	0.9	0.98	0.73	0.56	0.9
Orari Street	1.01	0.86	0.74	0.98	0.88	0.87	0.74	1.03
Portobello Road	0.74	0.67	0.8	1.04	0.84	0.68	0.76	1.08
Shore Street				0.74				0.71
St Clair				0				0
Midland Street				0.92				0.83

4. Discussion and Conclusion

Water samples were colleted from a total of 14 major Dunedin City stormwater outfalls in 2010. In addition, sediments were sampled from <5m and >20m from 7 of these outfalls. For interest sake historical data for some of the same sites have been included for comparison (Tables 52 and 53). Any trends observed in these data for historical sediment values should be viewed with extreme caution as sampling in some previous years may have used entirely different protocols. For example, sediments may have been collected from different depths within the substrate and by different methods meaning that results are not directly comparable, although sampling since 2007 has followed the same protocol. Stormwater sampling, however, should be comparable assuming previous investigators targeted the first flush.

There has been a decline in the levels of some contaminants at stormwater outfalls for which historic data are provided. This is perhaps to be expected for lead as it has been removed from paint and petrol and levels in the environment are very gradually declining. The reduction in the levels of some other contaminants is very slight, but gratifying, although such fluctuations may be merely a function of the intensity of the storm events when sampling occurred. However, it should be

recognised that there are currently some contaminants for which levels appear to be increasing or, fluctuating (Tables 52 and 53).

The high levels of FWAs at Bauchop Street observed in both 2007 and 2008 suggested that there is some gross cross contamination by wastewater somewhere in this catchment. Investigations up-pipe in 2008 year pinpointed this discharge and remedial action was taken. As a consequence the FWA levels at Bauchop Street this year and in 2009 are comparable with other locations. It is expected that the development and implementation of the long-term stormwater catchment management plans and the DCC's 3-Waters Strategy will contribute to addressing the issue of future contaminants in stormwater. It will be of interest to see if any long-term trends in contaminant levels can be discerned as monitoring continues.

Contaminant levels in sediments are generally, as expected, higher closer to each outfall than they are further away. However, this is not true for all contaminants nor for all outfalls, some exceptions being arsenic, chromium and nickel at Watson Park and copper and zinc at Kitchener Street. In the case of Watson Park this is likely due to wider spread contamination within the sediments of Sawyers Bay. For other outfalls, however, it is unclear if the results are due to widespread existing contamination in the upper harbour basin or if the lower levels nearer the outfall are due to "flushing away" of contaminants by the volume of stormwater being discharged. It is hoped that future sampling will make this picture clearer.

Benthic and infaunal communities in the vicinity of the upper Otago harbour stormwater outfalls have reasonably low diversity, but this is generalised and not associated with any one outfall. Consequently, it is likely to be symptomatic of a large proportion the upper harbour basin. Some of this lack of diversity may be attributable to anthropogenic influences, but a number of other factors, not least of which are freshwater exposure and exposure at low tide, must also be considered.

Rainer (1981) and Grove (1995) certainly found less diversity in soft-bottom macrofaunal communities as one moves from harbour mouth to the head of Otago Harbour. It should be pointed out that much of the shoreline around the upper harbour has been extensively modified and as such cannot be regarded as an inlet typical of those found throughout the region. Despite this the communities sampled in the upper Otago Harbour near stormwater outfalls are numerically dominated by polychaete worms and amphipods, as is usual for sheltered soft

shores around New Zealand (Morton and Miller 1973), and show distinct similarities to communities found in other moderately impacted inlets in Otago (Stewart 2007b, 2008a,b).

While not pristine, the upper harbour and the communities associated with the intertidal areas adjacent to major stormwater outfalls appear not to be undergoing any significant further degradation as a result of stormwater inputs. It is to be hoped that if the trend towards lower contaminant levels in stormwater is continued, both water quality and community health in the harbour will gradually improve over time.

Only after problem areas and problem contaminants have been identified can measures be taken to mitigate any effects. No additional mitigation measures have been undertaken by the DCC at this stage, apart from investigations into the remediation of PAH contamination at the Portobello Road outfall (Stewart 2006), the elimination of the source of FWAs at Bauchop Street, and the usual street sweeping and mud tank clearance. It is expected that further stormwater monitoring over time and investigations under the 3 Waters strategy will define problem areas such that mitigation measures may be undertaken.

Table 52. *Contaminants in stormwater being discharged to the upper Otago harbour basin through time. BDL = below detectable limits. Pink cells denote levels higher than at any past sampling event; green cells denote levels lower than at any past sampling event.*

	Parameter	Suspended Solids					Cd					Cr					Cu				
	units	g/m^3					g/m^3					g/m^3					g/m^3				
		Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010
Catchement	Second Beach		BDL	37.0	41	BDL		BDL	0.00006	0.00006	0.00007		0.0007	0.0028	0.0035	0.00086		0.0027	0.012	0.019	0.0054
	Pt Chalmers George St		87.0	150.0	26	170		0.00028	0.00140	0.00011	0.00033		0.005	0.012	0.0031	0.00136		0.0213	0.039	0.025	0.0148
	Pt Chalmers Watson Pk		37.0	39.0	7.4	240		BDL	BDL	BDL	BDL		BDL	0.0064	BDL	BDL		0.009	0.0025	BDL	BDL
	Shore Street	75.4	41.0	24.0	20	9.5		BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		0.01	0.014	0.02	0.0118
	Portobello Road	28.0	18.0	46.0	30	8.1	0.0003	BDL	0.00023	BDL	BDL	0.0029	BDL	0.002	BDL	BDL	0.03	BDL	0.026	0.01	0.0057
	Teviot Street		25.0	33.0	12	84		BDL	0.00008	BDL	0.00026		BDL	0.0018	BDL	BDL		BDL	0.0094	BDL	0.0136
	Midland Street		30.0	19.0	30	52		BDL	0.00013	BDL	BDL		BDL	0.0035	0.0031	BDL		0.02	0.031	0.057	0.021
	Orari Street	38.1	28.0	77.0	16	130	0.0005	BDL	BDL	BDL	0.000164	0.002	BDL	0.0032	BDL	0.00183	0.0132	BDL	0.014	BDL	0.0096
	Kitchener Street		104.0	41.0	45	50		BDL	BDL	BDL	BDL		0.004	0.002	BDL	BDL		0.034	0.0056	0.023	0.0118
	Mason Street		62.0	37.0	37	138		BDL	BDL	0.0077	0.00051		BDL	BDL	BDL	BDL		0.022	0.012	0.021	0.0157
	Ravensbourne Road			8.5	18	61			BDL	BDL	BDL			0.00061	BDL	BDL			0.0023	BDL	0.0031
	Bauchop Street		44.0	16.0	13	53		BDL	BDL	BDL	0.00049		BDL	0.0015	BDL	BDL		0.029	0.0096	0.021	0.0026
	Halsey Street		119.0	35.0	27	50		BDL	0.00022	BDL	0.00026		BDL	BDL	BDL	BDL		0.024	0.0043	BDL	0.00162
	Wickliffe Street		35.0	27.0	100	86		BDL	BDL	0.00052	0.00078		BDL	0.0017	0.0076	0.00157		0.01	0.013	0.059	0.0058

	Parameter	Ni					Pb					Zn					PAH				
	units	g/m^3					g/m^3					g/m^3					g/m^3				
		Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010
Catchement	Second Beach		0.0009	0.0021	0.0022	0.00133		0.001	0.011	0.013	0.00021		0.038	0.16	0.15	0.092					
	Pt Chalmers George St		0.0029	0.0093	0.0026	0.006		0.0342	0.041	0.018	0.0048		0.288	0.66	0.19	0.42					
	Pt Chalmers Watson Pk		BDL	BDL	BDL	0.0035		0.0141	0.0018	BDL	BDL		0.231	0.027	BDL	0.29					
	Shore Street		0.01	BDL	BDL	BDL		0.003	0.0085	0.0069	BDL		0.02	0.44	0.21	0.115					
	Portobello Road	0.002	BDL	0.0035	0.0028	0.0035	0.021	BDL	0.019	0.0067	0.00055	0.895	0.08	0.94	0.64	0.153	0.0031	BDL	328	0.00017	0.00016
	Teviot Street		BDL	0.0019	BDL	0.0033		BDL	0.0066	BDL	BDL		BDL	0.13	BDL	1.79					
	Midland Street		BDL	0.0016	BDL	0.0075		0.005	0.0054	0.0083	BDL		0.1	0.35	0.18	0.22					
	Orari Street	0.002	BDL	0.0033	BDL	0.00108	0.022	BDL	0.023	BDL	0.00015	0.191	BDL	0.22	0.031	0.3	0.0026	0.0001	318	BDL	0.0005
	Kitchener Street		0.003	BDL	0.0036	0.0035		0.0442	0.007	0.018	0.00196		0.445	0.036	0.38	0.62		BDL	327	BDL	0.0001
	Mason Street		0.004	BDL	0.0055	BDL		0.0258	0.0089	0.014	0.00102		0.25	0.16	0.35	0.43					
	Ravensbourne Road			0.00066	BDL	0.00148			0.0015	0.0029	0.00023			0.053	0.047	0.144					
	Bauchop Street		0.01	BDL	0.0035	BDL		0.01	0.0035	0.0097	BDL		0.23	0.12	0.3	0.121					
	Halsey Street		0.009	BDL	BDL	BDL		0.021	0.0022	BDL	0.0021		0.12	0.033	0.13	0.136					
	Wickliffe Street		0.01	BDL	0.0042	BDL		0.006	0.0084	0.033	BDL		0.1	0.2	0.53	0.24					

Table 53. *Contaminants in sediments in the upper Otago harbour basin in the vicinity of selected stormwater outfalls through time. Pink cells denote levels higher than at any past sampling event; green cells denote levels lower than at any past sampling event.*

	Arsenic					Cadmium					Chromium					Copper					Nickel					Lead					Zinc				
	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010
Rowing Club		11	10	7	13	0.0	0.2	0.2	0.1	0.2	17	18	12	16	14	10	14	13	14	9		11.3	14	13.0	11.0		19	27	27	28	81	101	130	160	149
Wickliffe		17	11	7	9		0.6	0.74	0.8	0.7		38	34	16	27		121	68	50	58		19.2	23	13.0	17.0		76	140	77	92		412	740	810	740
Kitchener St		5	8	7	9		0.4	0.35	0.3	0.3	7	23	18	98	22		70	56	90	37	5.8	10.6	12	15.0	12.0		118	97	130	155	170	249	280	300	280
Orari St		19	4	20	5	0.5	63.0	0.13	0.9	0.2	18	0	16	37	16	20	25	13	61	11	10.4	23.6	8.1	16.0	8.0	185	13	39	120	35	239	68	130	680	157
Portobello Rd		29	23	24	15	2.0	1.8	1.8	2.0	1.5	41	60	54	50	36	210	169	160	190	123	15	20.4	18	26.0	19.0	410	306	330	290	193	1300	1493	1400	1600	1040
Shore St		10	7	6	6	0.5	0.4	0.32	0.3	0.3	10	22	16	18	19	30	51	44	41	35	5.4	10.7	9	11.0	10.0	130	113	110	79	85	300	484	300	330	350

	PAH					Enterococci				
	Historic	2007	2008	2009	2010	Historic	2007	2008	2009	2010
Rowing Club		6.97	5.78	0.5	3.7		200	11	<2	<3
Wickliffe		9.21	1.18	7.3	7.2		58000	>1600	330	<3
Kitchener St		8.88	140.49	4.8	5.0	130	6633	920	5	<3
Orari St	13.41	10.23	12.59	28.3	9.3	557	12.67	8	23	<3
Portobello Rd	425.83	382.90	250.30	525.2	194.1	1120	72667	170	<2	<3
Shore St		9.56	21.01	8.6	10.5	2400	9000	>1600	<2	460

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DUNEDIN CITY COUNCIL | kaunihera a-rohe o Ōtepoti

Spencer Street stormwater –
Land discharge consent application



29 October 2019

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1 Introduction

The Dunedin City Council (DCC) manages the drainage of stormwater at Spencer and Gloucester Streets in Andersons Bay. In 2005, a new stormwater drainage pipe was installed as a means of alleviating the saturation and associated instability of properties along Spencer Street. The pipe extends over eleven properties on the Southern side of Spencer Street and connects to the Gloucester Street stormwater pipe which follows a ridge on adjacent farmland to ultimately drain onto land from an outfall approximately 25m from the lower Tomahawk Lagoon (see Figure 1).



FIGURE 1. AERIAL DEPICTING THE SPENCER AND GLOUCESTER STREET STORMWATER SEWERS (IN GREEN)

The DCC holds resource consent 2004.792 from the Otago Regional Council (ORC) to discharge stormwater to land in circumstances where it may enter the Tomahawk Lagoon, which was granted on 4 February 2005 and expires on 31 January 2020. The DCC intends to renew this consent with the ORC so the activity can be continued. A resource consent term of 35 years is sought.

2 Consent required

Except as provided for by Rules 12.B.1.8 and 12.B.1.9, the discharge of stormwater to water, or onto or into land in circumstances where it may enter water, is a ***restricted discretionary*** activity under Rule 12.B.3.1 of the ORC's Regional Plan: Water. The activity does not meet the permitted activity rule for stormwater discharge (Rule 12.B.1.8) as the discharge to land is from a stormwater system installed after 1998, and it may enter Tomahawk Lagoon which is a Regionally Significant Wetland, so resource consent is required.

It is noted that the DCC has various other stormwater outfalls within the Tomahawk Lagoon catchment, but these were installed prior to 1998, and discharges of stormwater from those outfalls are permitted.

3 Description of the environment

The Tomahawk Lagoon is a regionally significant wetland which consists of two shallow brackish water lagoons joined by a narrow channel and sharing a common sea outlet. The sea outlet is often blocked. Schedules 1A (Natural Values) and 9 (Significant Wetlands) of the Regional Plan: Water identify a range of values associated with the Tomahawk Lagoon:

Schedule 1A (Natural values):

- Ecosystem values: The lagoon which contains a silt/mud substrate, has riparian vegetation of significance to aquatic habitats and is free of aquatic pest plants. There is a significant presence of trout and eels. The lagoon also contains indigenous invertebrates threatened with extinction.

Schedule 9 (Significant wetlands):

- Type A1 values: The lagoon contains habitat for nationally or internationally rare or threatened species or communities. There is a presence of threatened plant species on the margins of the lagoon.
- Type A4 values: The lagoon has a high degree of wetland naturalness.
- Type A5 values: This type of wetland is scarce in Otago in terms of its ecological and physical character.
- Type A8 values: The wetland is a regionally significant habitat for waterfowl and waders, as well as a habitat for native fish and eels.

The Tomahawk Lagoon is identified in the 'Natural Coastal Character Values' section of the Second Generation District Plan and as a wāhi tupuna. The lagoon is a habitat for trout and perch so is popular for fishing.

The catchment of the lagoon is predominantly farmland, although the residential suburb of Tomahawk lies to the south east, between the lagoon and the coast, and the residential suburb of Andersons Bay, including Spencer and Gloucester Streets, is located above the lagoon to the west.

The land is generally steep with gradients varying from approximately 1: 20 near the urban edge to 1: 3 on the stretch between Gloucester Street and the Tomahawk Lagoon. The slope at the lagoon margin tends to level out. The pipe follows the existing natural fall of the land.

4 Description of the activity

As described in the introduction, the stormwater pipe for Spencer and Gloucester Streets was installed in 2005 to reduce saturation of residential properties along Spencer Street and reduce the potential for further slips and slumps in the area. The pipe follows a ridge towards the lower lagoon, and discharges from the outfall onto land approximately 25m from the lagoon. The outfall was placed in this location to avoid discharge onto the slip prone area.

The pipe has been designed to accommodate a 1 in 10-year return period event with a design flow of 0.104 cubic metres per second. The pipe is 225 mm in diameter to accommodate flow and ensure the water velocities at the discharge point are as low as possible.

The outfall has concrete baffle structures (seen in Figure 2) to dissipate the energy of the flow at the outfall, and a reno mattress installed to further reduce erosion and scour of land. The DCC is in negotiations with Te Rūnanga o Ōtākou and the landowners to undertake further planting on private land below the outfall.



FIGURE 2. STORMWATER OUTFALL WITH BAFFLE STRUCTURES

4.1 Nature of the discharge

The stormwater collected is from local residential properties and roads and will primarily comprise runoff from gardens and hard surfaces such as roofs, driveways and roads. In a recent literature review commissioned by the ORC entitled '*Literature review of the risks and adverse effects from discharges of stormwater, wastewater, industrial and trade waste and other hazardous substances in Otago*' the typical contaminants in stormwater were highlighted. These were litter, sediment, nutrients, microbial contaminants, biodegradable organic materials, trace organic materials and metals.

To characterise this discharge, the DCC has agreed with Te Rūnanga o Ōtākou to undertake provisional baseline monitoring. This will consist of sampling the discharge during a storm event and analysing the sample for copper, lead and zinc, which are the key contaminants of concern associated with stormwater. Sediment and water samples will also be taken from the lagoon and analysed for heavy metals. Once a baseline has been identified, it will then be determined if further monitoring should be undertaken.

4.2 Sensitivity of the receiving environment

As described in section 3, Tomahawk Lagoon is a regionally significant wetland with recognised environmental, cultural and social values. It is considered a sensitive receiving environment, and currently is reported as having poor water quality.

5 Affected parties

Te Rūnanga o Ōtākou are kaitiaki for the Dunedin area, which includes the Tomahawk Lagoon. They are consulted as Treaty partners through Aukaha. During consultation, it was agreed with Te Rūnanga o Ōtākou that the DCC would implement a planting plan on private land at the outfall and carry out baseline water quality monitoring. The outfall will also be visually inspected annually. Written approval from Aukaha on behalf of Te Rūnanga o Ōtākou has been provided and is attached as Appendix B.

Graham Wheatley and Nalini Nandan-Hallt own the land on which the discharge occurs. They were also consulted prior to the application being lodged. The Department of Conservation, and the Otago Fish and Game Council are also identified as affected parties.

A copy of the resource consent application will be circulated to these parties to seek their written approval.

6 Assessment of environmental effects

The discharge of stormwater has the potential to cause scouring and erosion of land at and below the outfall, and to impact receiving water quality in the Tomahawk Lagoon. Measures are proposed to avoid, remedy or mitigate potential adverse effects of the discharge, including:

- Use of sumps and baffle structures.
- Use of a reno mattress.
- Planting the area below the outfall.
- Educating users of the stormwater system.

6.1 Potential scouring and erosion effects

This discharge of stormwater to land has the potential to scour the land, which could result in sediment reaching the Tomahawk Lagoon. The primary mitigation measure to reduce discharge velocity and mitigate potential for scouring and erosion, is the reno mattress and outfall baffle structures. The baffle structures slow the velocity of the discharge, which prevents scour and encourages sediment to drop out of the water. The reno mattress further slows the discharge, causing it to slow and spread out over the mattress. This means water dissipates over the mattress instead of discharging directly to the lagoon.

6.2 Potential water quality effects

The discharge of stormwater has the potential to affect water quality in the Tomahawk Lagoon by nutrification, sedimentation and the deposition of heavy metals.

To encourage the reduction of contaminants entering stormwater, the DCC provides educational advice to Gloucester and Spencer Street residents serviced by the system, every two years. Residents are encouraged to stop discharges of common household contaminants like paint, oil and fertilisers entering the stormwater system, and are reminded their stormwater discharges into the lagoon.

Mud tanks along Spencer Street and at the end of Gloucester Street capture sediment and litter in the stormwater that runs off the road. The DCC carries out a mud tank maintenance programme to ensure these are regularly maintained.

To further mitigate the potential effects of the discharge, the DCC will prepare and implement a planting plan between the discharge area and the lagoon, in conjunction with iwi and the land owner. Planting will contribute to the special character of the wetland, improve the amenity of the area and may help with some water and contaminant uptake. The planting plan will include natives that are suitable for the area but also ensure the outfall will not be compromised once the plants are established.

The reno mattress and vegetated land which the discharge flows over act as a filter to help remove contaminants from the discharge prior to it entering the lagoon.

Specific contaminants and their potential effects are discussed further in the following sections.

6.2.1 Nutrification

Historically, high levels of phosphorus and nitrogen have been recorded in the upper and lower Tomahawk Lagoon. Algal blooms can be attributed to high levels of nitrogen and phosphorus, and there are often reports of cyanobacteria and toxic algae blooms in the Tomahawk Lagoon. There is the possibility of stormwater containing nitrogen and phosphorus, through the ingress of untreated sewage and fertiliser runoff respectively.

In a 2014 Otago Regional Council report titled '*Review of information on the Tomahawk Lagoons'* it is stated that '*high concentrations of nutrients in the Tomahawk Lagoons are almost certainly a result of historic land-use practices, especially aerial top-dressing with superphosphate*'. As 72% of the lower lagoon catchment is pastoral, it is likely that the source of phosphorus and nitrogen is from agricultural fertilisers running off directly into the lagoon, rather than from the urban stormwater discharge, where any potential fertiliser use would be in much smaller quantities, such as on lawns and gardens.

Another potential source of nutrients are accidental or illegal connections made by home owners between the wastewater and stormwater networks. As no new homes have been built in the catchment since the installation of the stormwater system in 2005, it is unlikely that any such cross connections are present.

It is possible that because the stormwater is filtered over the reno mattress, any water that does make it to the lagoon may be of better quality than the other runoff in the area that drains directly into the lagoon. Planting will also assist in the uptake of any nutrients in the discharge.

6.2.2 Sediment and litter

There is the potential for sediment from the catchment to reach the lagoon from the discharge itself, as well as the potential for suspension of sediment through erosion of the discharge area. Sedimentation can cause problems for aquatic life, such as smothering of invertebrates and decreasing algal growth by blocking of light resulting in less food for fish. Heavy metal contaminants are also often associated with sediment.

Mud tanks prevent any solids from being discharged at the outfall. The baffle structures, reno mattress and planting will help to reduce scour and erosion and thus the release of sediment.

Litter is also addressed in the educational advice provided to residents.

6.2.3 Heavy metals

Heavy metals are often found in urban stormwater and are also often associated with sediment. They can bio-accumulate and have toxic effects on aquatic life. The primary heavy metals of concern

in stormwater are copper, lead and zinc. While these heavy metals are mostly associated with industrial processing, copper can also be present in fungicides, and zinc is associated with unpainted galvanised roofs, which could be found in a residential area.

The planting and reno mattress, along with educational advice provided to residents, may assist with reducing heavy metals entering the lagoon.

7 Assessment of alternative options

When considering the options for an activity, the consent applicant must adopt the best practicable option. The Resource Management Act 1991 (RMA) defines the best practicable option as the following:

***best practicable option**, in relation to a discharge of a contaminant or an emission of noise, means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to—*

(a) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and

(b) the financial implications, and the effects on the environment, of that option when compared with other options; and

(c) the current state of technical knowledge and the likelihood that the option can be successfully applied.

Alternative stormwater management options include:

(1) Requiring individual property owners to manage their own stormwater;
(2) Placing the outfall further from the lagoon;
(3) Collecting stormwater and pumping it to a different catchment; or
(4) Use of stormwater detention ponds or constructed wetlands.

Option 1. This option is not practicable because this approach previously resulted in land instability issues.

Option 2. This option was explored during the construction planning phase, but because of the land instability upslope, it would only contribute to land instability further.

Option 3. This would require a powered pump (increasing the energy use and carbon footprint) and would produce noise in a quiet residential area.

Option 4. Stormwater detention ponds and constructed wetlands could provide some stormwater treatment, and therefore an improved discharge quality. These options would both require frequent maintenance and additional cost.

Both options 3 and 4 could be investigated further, if it were determined the stormwater discharge was causing unacceptable adverse environmental effects. As the current activity is considered to have no more than minor adverse effects on the environment, and the alternative options identified would incur considerable cost to implement without measurable benefit, the proposed approach is considered to be the best practicable option.

8 RMA statutory assessment

Section 104 of the Resource Management Act 1991 (RMA) sets out the matters to be considered when assessing an application for a resource consent. The following points address those matters:

8.1 Part 2

The application to discharge stormwater to land is consistent with the purpose and the principles of the Act, as set out in Section 5 of Part 2.

The proposed activity will have no more than minor adverse effects on the ability of the receiving environment to meet the reasonably foreseeable needs of future generations, or on the life-supporting capacity of the land or any ecosystem associated with it. Proposed consent conditions will ensure that any potential adverse effects of the activity will be avoided, remedied or mitigated.

Under section 6, the preservation of the natural character of the Tomahawk Lagoon wetland will be recognised and provided for by the proposed consent conditions, as will the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna.

Under section 7, particular regard has been had to the intrinsic values of ecosystems and the maintenance and enhancement of the quality of the environment.

Regarding Section 8, the proposed activity is not inconsistent with the principles of the Treaty of Waitangi.

8.2 Section 104

Section 104 (1) of the RMA outlines the matters that the consent authority shall have regard to when considering an application. The following matters are relevant for discharges to land:

(a) any actual and potential effects on the environment of allowing the activity; and

(ab) any measure proposed or agreed to by the applicant for the purpose of ensuring positive effects on the environment to offset or compensate for any adverse effects on the environment that will or may result from allowing the activity; and

(b) any relevant provisions of—

- *(i) a national environmental standard:*
- *(ii) other regulations:*
- *(iii) a national policy statement:*
- *(iv) a New Zealand coastal policy statement:*
- *(v) a regional policy statement or proposed regional policy statement:*
- *(vi) a plan or proposed plan; and*

(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application.

The actual and potential effects of the proposed activity were considered in section 6 of this report. Recommended conditions of consent will ensure that any adverse effects are avoided, remedied or mitigated.

The relevant provisions of the Regional Policy Statement for Otago 1998 and partially operative Otago Regional Policy Statement 2019, the Regional Plan: Water and the Kai Tahu ki Otago Natural Resource Management Plan 2005 are outlined below and discussed at the end of the section.

8.3 Regional Policy Statement for Otago 1998

The Regional Policy Statement for Otago (RPS) provides an overview of Otago's resource management issues, and ways of achieving integrated management of natural and physical resources. The RPS has been under review. As some provisions of the proposed Otago Regional Policy Statement are still under appeal, there are still some provisions in this statement which remain operative. The following provisions are relevant to this application.

Policy 5.5.5- *To minimise the adverse effects of landuse activities on the quality and quantity of Otago's water resource through promoting and encouraging the: … (b) Maintaining and where practicable enhancing, vegetation cover, upland bogs and wetlands to safeguard land and water values; …*

Policy 6.5.6- *To protect Otago's remaining significant wetlands from the effects of any activity except:*

(a) Where such activities can be shown to have no significant adverse effects on:

(i) Community needs; or

(iii) The natural hydrological characteristics of the wetland; or

(iv) The natural character of the water body; or

(v) Habitats of indigenous fauna; or

(vi) Amenity values; or

(vii) Intrinsic values of ecosystems; or

(viii) Salmon or trout habitat; or

(b) Where alternative habitats of a similar or improved nature are provided in compensation for any loss of habitat

Policy 8.5.6- *To promote a reduction in the adverse effects of contaminant discharges into Otago's coastal waters through: …*

(d) Promoting discharges to land where practicable and where there are no significant adverse effects on groundwater or surface water resources, or soil; … while considering financial and technical constraints.

The proposed activity meets these policies, as any potential adverse effects will be mitigated through the measures proposed. The character of the wetland will be enhanced through planting.

8.4 Partially Operative Otago Regional Policy Statement 2019

Several provisions of the Otago Regional Policy Statement (RPS) have had appeals resolved and are now operative. The relevant provisions of the partially operative RPS include:

Policy 1.1.2 Social and cultural wellbeing and health and safety

Provide for the social and cultural wellbeing and health and safety of Otago's people and communities when undertaking the subdivision, use, development and protection of natural and physical resources by all of the following:

a) Recognising and providing for Kāi Tahu values;

b) Taking into account the values of other cultures;

c) Taking into account the diverse needs of Otago's people and communities;

d) Avoiding significant adverse effects of activities on human health;

e) Promoting community resilience and the need to secure resources for the reasonable needs for human wellbeing;

f) Promoting good quality and accessible infrastructure and public services.

Policy 2.1.1 Treaty obligations

Promote awareness and understanding of the obligations of local authorities in regard to the principles of Te Tiriti o Waitangi, tikaka Māori and kaupapa Māori.

Policy 2.1.2 Treaty principles

Ensure that local authorities exercise their functions and powers, by:

a) Recognising Kāi Tahu's status as a Treaty partner; and

b) Involving Kāi Tahu in resource management processes implementation;

c) Taking into account Kāi Tahu values in resource management decision-making processes and implementation;

d) Recognising and providing for the relationship of Kāi Tahu's culture and traditions with their ancestral lands, water, sites, wāhi tapu, and other taoka;

e) Ensuring Kāi Tahu have the ability to:

i. Identify their relationship with their ancestral lands, water, sites, wāhi tapu, and other taoka;

ii. Determine how best to express that relationship;

f) Having particular regard to the exercise of kaitiakitaka;

h) Taking into account iwi management plans.

Policy 5.4.1 Offensive or objectionable discharges

Manage offensive or objectionable discharges to land, water and air by:

a) Avoiding significant adverse effects of those discharges;

b) Avoiding significant adverse effects of discharges of human or animal waste directly, or in close proximity, to water or mahika kai sites;

c) Avoiding, remedying or mitigating other adverse effects of those discharges.

The proposed activity meets these policies. The DCC recognises Kai Tahu as a Treaty partner, and as such Te Rūnanga o Ōtākou have been consulted via Aukaha prior to the lodgement of this application, and their written approval has been provided. Kai Tahu values are recognised and provided for through mitigation measures.

8.5 Regional Plan: Water

Policy 7.B.1- *Manage the quality of water in Otago lakes, rivers, wetlands and groundwater by: …*

(f) Recognising discharge effects on groundwater; and

(g) Promoting the discharge of contaminants to land in preference to water.

Policy 7.B.2- *Avoid objectionable discharges of water or contaminants to maintain the natural and human use values, including Kāi Tahu values, of Otago lakes, rivers, wetlands, groundwater and open drains and water races that join them.*

Policy 7.B.3- *Allow discharges of water or contaminants to Otago lakes, rivers, wetlands and groundwater that have minor effects or that are short-term discharges with short-term adverse effects.*

Policy 7.B.4- *When considering any discharge of water or contaminants to land, have regard to:*

(e) Any potential adverse effects on use of any proximate coastal marine area for contact recreation and seafood gathering.

Policy 7.B.8- *Encourage adaptive management and innovation that reduces the level of contaminants in discharges.*

Policy 7.C.2- *When considering applications for resource consents to discharge contaminants to water, or onto or into land in circumstances which may result in any contaminant entering water, to have regard to:*

(a) The nature of the discharge and the sensitivity of the receiving environment to adverse effects;

(b) The financial implications, and the effects on the environment of the proposed method of discharge when compared with alternative means; and

(c) The current state of technical knowledge and the likelihood that the proposed method of discharge can be successfully applied.

Policy 10.4.2- *Avoid the adverse effects of an activity on a Regionally Significant Wetland or a regionally significant wetland value, but allow remediation or mitigation of an adverse effect only when the activity:*

(a) Is lawfully established; or

(b) Is nationally or regionally important infrastructure, and has specific locational constraints; or

(c) Has the purpose of maintaining or enhancing a Regionally Significant Wetland or a regionally significant wetland value.

Policy 10.4.6- *To promote the conservation, creation and reinstatement of wetland areas and enhancement of individual and collective wetland values by:*

(a) Educating Otago's people and communities about land use activities that may affect wetlands and their values; …

The proposed activity meets these policies. The discharge is to land, and if stormwater does reach the lagoon, any potential adverse effects are provided for through the proposed mitigation measures.

8.6 Kai Tahu ki Otago Natural Resource Management Plan 2005

The Kai Tahu ki Otago Natural Resource Management Plan 2005 (NRMP) contains several objectives and policies of relevance to this application:

5.3.4 Wai Maori General Policies-

9. *To require consideration of alternatives and use of new technology for discharge renewal consents.*
10. *To encourage all stormwater be treated before being discharged.*
11. *To encourage identification of non-point source pollution and mitigate, avoid or remedy adverse effects on Käi Tahu ki Otago values.*
12. *To encourage Käi Tahu ki Otago input into the development of monitoring programmes.*
13. *To require monitoring of all discharges be undertaken on a regular basis and all information, including an independent analysis of monitoring results, be made available to Käi Tahu ki Otago.*
14. *To encourage Management Plans for all discharge activities that detail the procedure for containing spills and including plans for extraordinary events.*
15. *To require all discharge systems be well maintained and regularly serviced. Copies of all service and maintenance records should be available to Käi Tahu ki Otago upon request.*
17. *To require visible signage informing people of the discharge area; such signs are to be written in Mäori as well as English.*
18. *To require groundwater monitoring for all discharges to land.*

Any adverse effects from the discharge will be no more than minor and any potential effects will be mitigated by the recommended consent conditions, as well as the already existing mitigation measures. As the effects of the discharge are expected to be no more than minor, the intrinsic values of the Tomahawk Lagoon are unlikely to be affected and will in fact be improved through planting. The discharge of stormwater to land is preferred by all the policies and plans identified. Aukaha have provided written approval for the activity on behalf of Te Rūnanga o Ōtākou.

9 Proposed consent conditions

The DCC proposes the following consent conditions for the new consent:

1. *The discharge shall not contain any human sewage.*
2. *The discharge shall not give rise to all or any of the following effects in Tomahawk Lagoon:*
   - *(a) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; or*
   - *(b) Any conspicuous change in the colour or visual clarity; or*
   - *(c) Any emission of objectionable odour; or*
   - *(d) Any significant adverse effects on aquatic life.*
3. *The discharge shall not cause erosion, land instability, sedimentation or property damage.*

4. *The consent holder shall ensure that the reno mattress below the outfall is inspected annually and maintained as necessary to ensure its efficient and effective operation at all times.*

5. *The consent holder shall prepare a planting plan within 6 months of consent commencement. Planting shall be carried out in accordance with this plan.*

6. *The consent holder shall provide educational advice to all landowners whose properties are serviced by the residential drainage scheme, at intervals of no longer than two years. As a minimum, the educational advice shall emphasise the importance of keeping the stormwater system free of pollutants and explain potential impacts of pollutants in the receiving environment.*

10 Appendices

Appendix A - Discharge Permit 2004.792 (attached)

Appendix B - Written Approval from Aukaha on behalf of Te Rūnanga o Ōtākou (attached)

RM11.313

Otago Regional Council

In the Matter **of the Resource Management Act 1991**

And

In the Matter **of an application by the Dunedin City Council for resource consents to discharge stormwater into the Coastal Marine Area.**

Decision of Commissioners Appointed by Otago Regional Council

Commissioners:

Jeff Jones, Chair (Nelson)

Clive Geddes (Queenstown)

Nigel Mark-Brown (Auckland)

Decision

1. Having carefully considered all the relevant reports and documentation supplied with the application, submissions, the evidence presented to us during the course of the hearing and the S42A report, we have determined that the consents must be granted as the discharges are controlled activities pursuant to 10.5.3.2 of Otago Regional Council's Regional Plan:Coast.

2. In exercising the powers delegated to us we have resolved to grant discharge permits for each of the 10 catchment management plans that have been developed.

3. The consents are subject to a term of 35 years with review conditions and other conditions.

4. In terms of S.113(1)(a) of the Act we are required to give reasons for our decision. In summary we have considered the environmental effects that were drawn to our attention, the permitted baseline that must be considered and the relevant provisions of the Act, NZ Coastal Policy Statement, Regional Policy Statement, and Regional Plan: Coast. Our reasons are set out in full in section 6 of this decision.

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1. Introduction

1.1 Background

1. The Dunedin City Council (DCC) applied to discharge contaminants to the coastal marine area for the purpose of disposing of stormwater. The DCC has the responsibility for stormwater disposal in its district. The majority of stormwater generated within the urban areas of Dunedin City is currently managed by an existing underground piped network.

2. Land use within Dunedin City and Port Chalmers, in the parts surrounding Otago Harbour, is varied and includes residential, industrial and commercial sites. The Regional Plan: Coast (RPC) allows, as a permitted activity, the discharge of stormwater from residential areas, providing it is free of human wastewater and meets other conditions,

3. The current applications are required because there are trade and industrial premises within the relevant catchments and/or there is human wastewater detected by microbial contaminant indicators, within the stormwater runoff. These pathogenic bacteria are found within some catchments and may indicate illegal sewer connections in the stormwater network. The discharge of stormwater from catchments that include trade and industrial premises and/or contains human wastewater is a controlled activity under the RPC.

4. As part of the management of its stormwater network the DCC currently holds Discharge Permits 2002.080 – 2002.110 and 2006.222 which authorise the discharge of urban stormwater, and any contaminants, to the Coastal Marine Area (CMA) at 31 locations within Otago Harbour, St Clair Beach and Second Beach, Dunedin. Those permits expired on 29 November 2012. The applications under consideration in this decision are to replace those previous consents. As the replacement applications were lodged more than 6 months before the expiry of those previous consents, we note that the discharging activities may continue under S124 of the Act until the new permits are granted.

5. In granting those Discharge Permits 2002.080 – 2002.110 and 2006.222 the Council Hearings Panel at the time, requested as a condition of the consent, that catchment management plans and a comprehensive monitoring program be developed in order to be able to make a determination for longer term consents sought in the future. These

permits were issued in 2007 with a 5 year consent term to allow time to obtain this monitoring data and develop appropriate management plans.

6. After the previous permits were granted, the Waste Services Business Unit of the DCC developed the 3 Waters Strategy. This statement outlines a set of priorities and approaches for the management of Dunedin's wastewater, stormwater and drinking water.

7. A component of the three waters project was the development of 10 Integrated Catchment Management Plans (ICMP). Each ICMP provides a holistic approach to managing stormwater by identifying and prioritising stormwater issues for appropriate management action within the 10 identifiable stormwater catchments covered by these applications. The ICMP approach satisfied the requirement for catchments plans in the previous consents. The following information is discussed within each ICMP:

    - An overview of the catchment; including, land use activities, engineering information specific to the pipe network in the catchment and catchment area, and
    - A summary of any flood hazard and stormwater quality issues, and
    - Catchment specific management objectives and targets relating to stormwater quantity and quality, and
    - A description of the long and short term works and priorities to implement each management plan, and
    - Monitoring procedures to assess each plan's effectiveness, and
    - Recommendations for further study, planning and education, operations and maintenance and capital works required.

8. If a contaminant in the receiving waters is identified as being attributed to a stormwater discharge, the ICMP process allows the issue to be prioritised and the appropriate management option determined. This management option is then incorporated in the relevant action plan which accompanies each ICMP. This process forms the basis of the applicant's management of stormwater, allowing the action plans to be modified and actions reprioritised as a result of any changes to the assessed environmental effects of the discharge. As each ICMP was developed during 2009-2011, some of measures/recommendations to be undertaken have already commenced.

9. Implementing the ICMPs in each of the catchments is the basis of the consent application that is under consideration here. Monitoring in accordance with the previous consents was also carried out.

10. There are four receiving environments as follows:

    1. Upper Otago Harbour, and
    2. Andersons Bay Inlet, and
    3. Port Chalmers, and
    4. St Clair/Second Beach, Dunedin

Stormwater ICMP catchments comprise 10 catchments (33 outfall locations) as follows:

1. Port Chalmers Catchment,
2. Ravensbourne Catchment,
3. Halsey Street Catchment,
4. Mason Street Catchment,
5. Kitchener Street Catchment,
6. Portsmouth Drive Catchment,
7. Orari Street Catchment,
8. South Dunedin Catchment,
9. Shore Street Catchment,
10. St Clair Catchment

11. Within the 10 catchments listed above, any stormwater collected in the pipe network is discharged, without treatment, apart from catchpits and mudtanks, to the CMA. A complete background summary of the stormwater infrastructure, including outfall locations is provided with the application.

12. The applications were received by the Otago Regional Council (ORC) on 14 April 2012. Further information was requested with responses provided on 15 August and 9 September 2012. The applications were publicly notified on 15 September 2012 and 7 submissions were received: 5 opposing and two in support, subject to conditions.

13. The only submitters who did not appear were Mr David Mackie and the Director General of Conservation (DOC). DOC withdrew its wish to be heard on the basis of being satisfied with the conditions recommended in the S42A report. The other submitters appeared and a summary of their issues is set out in 1.3 below.

1.2 Hearing Procedure

14. Independent commissioners, requested by the DCC and appointed by the ORC to hear and determine the applications were as follows:

Dr Jeff Jones, Nelson, Chair
Mr Clive Geddes, Queenstown
Mr Nigel Mark-Brown, Auckland

15. The hearing commenced in the Mercure Hotel on Princes Street, Dunedin at 9.00am on Tuesday 16 April 2013. The hearing was adjourned, on Wednesday 17 April after all parties who wished to, had appeared, with a request to the applicant to provide some further information. After deliberating on the 18th April we also asked for some documents to be updated and provided electronically. The hearing closed on 2 May 2013.

Appearances:

For Dunedin City Council

Stephen Christensen, Rachel Brooking (counsel)

Tony Avery, General Manager Operations

Dr Laura McElhone, Water and Waste Services Manager

Helen Shaw Senior, Water Resources Engineer, Golders Associates (NZ) Limited

Dr Brian Stewart, Ryder Consulting Limited

Tim Ensor, Planner URS New Zealand Limited.

Submitters

Public Health South – Andrew Shand and Dr Keith Reid

Port Otago Limited – Len Anderson (counsel) and Lincoln Coe

Te Runanga O Otakou- Tim Vial

Brent Mackie

Save the Otago Peninsula Society Inc – Moira Parker

ORC Staff

Jamie Torrance, S42A report writer

Marian Weaver, Hearing Panel assistant

1.3 Summary of Evidence Heard

Applicant

16. **Mr Christensen** described the history of stormwater discharges and the progress made in managing them. He described the catchment approach that has been taken to manage discharges and the ICMPs that have been developed. He requested a 35 year term of consent and that four permits be issued to cover the 10 catchments for which ICMP's have been developed.

17. He noted the monitoring that has been undertaken since 2004 included harbour water quality monitoring that had not been done previously. He noted that no adverse effects have been identified from monitoring and expressed disappointment at the 10 year term recommended in the S42A report.

18. Mr Christensen outlined some of the issues with some catchments. He asserted that the existing permitted activity provision for other, non-contaminated stormwater discharges established a permitted baseline for the subject discharges which are controlled activities. He said DCC agrees with most of the conditions in the S42A report, except for some where a change is sought.

19. He noted an "end of pipe" standard for water quality with no mixing zone is recommended in the S42A report and said this is inappropriate given the approach that is to be taken under the ICMPs and the provisions of the RMA, NZ Coastal Policy Statement (NZCPS) and RPC. He asserted that after reasonable mixing the requirement of s107 of the Act will be met, and drew our attention to the fact that monitoring of the existing consents shows no adverse effects from the discharges in the receiving environment.

20. He outlined the ongoing monitoring that is proposed and noted the focus should be on the receiving environment. He commented on some draft conditions in the S42A report, seeking changes to them. He said that DCC has met with most of the submitters but agreements have not been reached with all of them.

21. Mr Christensen provided a document that set out the s42A conditions and the DCC proposed conditions side by side. He said review conditions should be used instead of a shorter term for the permits.

22. In answering a question Mr Christensen said that the ICMPs are required as a condition of consent therefore the requirement to have and implement ICMPs is enforceable.

23. **Mr Tony Avery** said the DCC must meet the future needs of the community for stormwater infrastructure and services, and has committed significant resources to improving stormwater, waste water and water supply reflecting their "3 Waters" strategy. He said an adaptive management regime is proposed for the discharges and a 35 year term is necessary to justify the significant infrastructure investment required.

24. Mr Avery noted that the Trade Waste Bylaw was implemented in July 2008 and other upgrades of wastewater treatment facilities have been carried out. He said despite the stormwater discharges not having any adverse effects, the quality of stormwater is an issue in the Dunedin community; hence the ICMP approach. He described wider work being undertaken with other stormwater and wastewater discharges, and consideration of a Stormwater Bylaw that is in progress. He outlined the cost of work being done and the commitment to ongoing monitoring.

25. He said these discharges should not be considered in isolation from the 3 Waters Strategy, and that council must achieve the best return on the funds spent. He rejected the 10 year term and end of pipe standards proposed in the S42A report.

26. Answering questions Mr Avery said

- That the DCC is prioritising the removal of cross connections to the wastewater system to reduce emergency discharges, and that this work has also identified some stormwater connections to the wastewater system.
- That there is a regular contract for cleaning out mud tanks and there have been some problems with the contract but it has been renewed recently.
- That the city has ageing infrastructure.

27. **Dr Laura McElhone** described the strategic commitment to improving stormwater, and then gave a description of the applications, the consultation undertaken, and an overview of each catchment and the receiving environment. She

discussed the issue of wastewater in the discharges, the potential adverse impact of trade and industrial premises and the proposed actions to be taken under the ICMPs.

28. She described the education program that is in place to assist in implementing the Trade Waste Bylaw, the Enviroschools programme, a sustainable living coordinator/ lesson plan and the information available on the DCC website.

29. Dr McElhone described the possibility of a stormwater bylaw, the code of subdivision, the Spatial Plan, and District Plan all of which have an effect on stormwater management.

30. Answering questions Dr McElhone said

- That cross connections are identified by doing dry weather monitoring and working back up the catchment to find contaminant sources.
- That any connection of wastewater to stormwater discovered is actioned immediately.
- That the trade and industrial premises subject to the Trade Waste Bylaw are inspected and this includes a check of the stormwater system, but that such premises, not subject to the Trade Waste Bylaw, are not inspected or visited.
- That each ICMP must have an action plan each year that must be implemented; consent conditions will be given effect to in the relevant action plan.
- That the St Clair outfall will be expensive to remove as it goes through a rock area.
- That maintenance of mud tanks and catchpits is the responsibility of DCC's roading division who discharge this responsibility by way of a recently implemented contract with the expectation that they are completely cleaned out when cleaned.
- That the Water of Leith catchment is 1017 hectares with 17% of it in urban land use.
- That the replacement cost of the stormwater network is $150 million, and there is a $1.25m per annum operational budget for the stormwater network.
- She said the expired permits required $25,000 per year of monitoring; the preparation for these applications was $50,000 and the DCC proposed new monitoring will be $90,000 per year. ORC proposed monitoring would be over $100,000 per year.

31. **Ms Helen Shaw** said she has been involved in the 3 Waters Strategy since 2008 and was involved in the development of the ICMPs. She said except for South Dunedin, all other outfalls subject to these applications discharge to the sea by

gravity. She described catchment sizes and discharge volumes, noting the mixing that occurs upon discharge.

32. Ms Shaw described the modelling that was done by NIWA that shows the indicative direction in which each outfall flows on reaching the Otago Harbour, noting the influence of freshwater from the Water of Leith and other sources had not been included. A map showing the mixing zones was produced as a result of "CORMIX" modelling.

33. She said Dunedin's stormwater is typical of stormwater elsewhere but the ICMP process has identified higher levels of PAH at South Dunedin and indicator bacteria at Halsey & Mason streets and at St Clair. She described in detail the features of ICMPs that were approved by ORC and which also influence annual planning.

34. Ms Shaw outlined the insurmountable problems presented by end of pipe treatments due to the very high cost and lack of land on which to place treatment facilities and gave examples of this.

35. She described the proposed monitoring programme which includes improving stormwater quality data, understanding marine sediment quality, identifying harbour biological health, identifying any links between the pipe discharge and the quality of the receiving environment and identifying catchments of concern. She said sites for monitoring have been agreed with ORC staff but not the frequency.

36. She described the trigger levels of contaminants that would prompt further investigation, and commented on submissions in respect of monitoring.

37. Ms Shaw said based on Auckland Councils Contaminant Load Model, an estimated 275 cubic metres of sediment is discharged to the upper harbour via the stormwater outfalls each year, which she noted was small compared with other sources of sediment to the harbour.

38. Ms Shaw commented on the S42A report and said it is inappropriate to apply ANZECC guideline levels to in-pipe water, noting the difference between ANZECC and USEPA levels; that for recreational use, guidelines for bacteria are appropriate. She said the ICMP process for prioritising issues and responses is more realistic than imposing discharge standards on outfalls.

39. She discussed monitoring; noted that the DCC proposes monitoring 5 priority catchments at a rate of one per year, using selected outfalls. She compared this with

ORC proposed monitoring and the costs thereof. She said the ORC proposed monitoring was excessive. Ms Shaw asserted that monitoring receiving water quality is important to understand the effects of the stormwater discharges, rather than the ORC proposed alternative that assumes that end of pipe water quality improvement will result in an improvement in the receiving waters.

40. Answering questions Ms Shaw said

- That modelling included only the effects of the outfall in these applications. She acknowledged that it did not include the significant influence of the Water of Leith and to a lesser extent the influence of other outfalls on water quality.

- She said that the objective was to predict the mixing zone for the outfalls in the application and that the inclusion of all contaminant sources, would complicate the modelling and the aim was to keep it simple.

- that it was appropriate to focus on subcatchments where there are issues rather than whole catchments, and this is provided for in the ICMPs.

41. **Dr Brian Stewart** described the harbour, Second Beach and St Clair Beach. He said historic contamination of the marine environment is not well documented with only 17 studies of hydrology/sediment in Otago Harbour from 1968 to 2003. He suggested 2004 data should be the baseline and included a table of values for metals, PAH and Enterococci in sediments at 16 locations at that date. He noted that the Portobello Road outfall has elevated levels of PAHs and other organocarbons. He said arsenic, cadmium, chromium and nickel levels are generally below ANZECC trigger levels. Overall, he said there are no clear temporal trends in sediment contamination.

42. Dr Stewart described harbour water quality. He said metal levels are generally low. After and during rainfall on a flood tide contaminant levels can be elevated in the upper harbour. He set out monitoring results for water quality for dry and wet weather monitoring at 3 locations.

43. Dr Stewart said there is a gradient of decreasing invertebrate density and abundance moving from the mouth to the upper harbour, typical of enclosed harbours. Benthic and infauna communities near Portobello Road, Orari Street and Kitchener Street outfalls are low in diversity and symptomatic of the upper harbour. He noted that over 9 years of monitoring there have been no detectable changes in diversity at the

above locations. He said while not pristine, upper harbour communities do not appear to be undergoing significant degradation as a result of stormwater inputs. He noted other inputs such as historic wastewater outfalls and the Water of Leith.

44. Dr Stewart suggested some changes to the monitoring proposed in the S42A report and suggested monitoring 5 outfall sites rather than all of them. Ecological monitoring should be a continuation of what has been done in the past plus two new reference sites.

45. Answering questions Dr Stewart said

- That any sediment deeper than 20cm is considered to be historic
- The best time to sample is on the ebb tide as it diminishes the impact of the Water of Leith
- That it is appropriate to monitor harbour water quality as it keeps a check on chronic water quality levels.
- That people do not take shellfish in the upper harbour as there is a general perception in the community that it is not a good place to do so. In any case the shellfish are sparse and small.
- That water quality in the upper harbour is only moderately degraded, and even if the stormwater discharges stopped there would not be much improvement in water quality.
- That water quality will be enhanced by cleaning up wastewater discharges
- That any pulses of contaminants from the outfalls will be short lived because of the tidal influence and dilution available.
- Despite the presence of small cockles and higher levels of PAH at the Portobello Road outfall, there is no need for more monitoring at this site as there has been no deterioration of that environment over the sampling period.
- That the proportion of stormwater contamination in spoil dredged by Port Otago would be very small
- That at outfalls difficult to monitor, sediment from catchpits immediately upstream of the outfalls could be sampled instead.

46. **Mr Tim Ensor** read his planning evidence. Mr Ensor said the 4 permits being sought were all for controlled activities and must therefore be granted. He noted that there is a relatively high baseline of effects due to the permitted activities allowed in the RPC. He set out reasons for applying the permitted baseline test.

47. He reported on the proposed activities in the context of the NZCPS, RPS and RP: Coast, concluding that the discharges are not contrary to the objectives and policies in those documents.

48. He referred to the adaptive management approach with the intended implementation of the ICMPs.

49. He said the concerns of submitters who sought a short term or extra monitoring on the permits are valid, but advised that given the lack of adverse effects, the ICMP approach is appropriate to address the concerns.

50. Mr Ensor said the S42a report focused on recreation values as the reason for notifying the applications, and that removing wastewater cross connections will enhance water quality for recreation. He also noted that while the S42A report refers to potential adverse effects, in fact there is no evidence from monitoring of this occuring.

51. Mr Ensor gave a detailed analysis of the proposed conditions attached to the S42a report, and referred to the comparative table of conditions that was tabled with the legal submissions.

52. He discussed the adaptive management conditions in detail, noting that an action plan is required for each ICMP. He said that while it is unrealistic to prohibit certain contaminants from a public stormwater network both long and short term improvements can be provided for through the adaptive management approach.

53. Mr Ensor said ORC proposed monitoring was too expensive and it was better to carry out the monitoring proposed by Dr Stewart.

54. He commented on the conditions that address consultation, reporting emergency spillage, erosion and reviews and agreed that they are appropriate.

55. Mr Ensor asserted that the 35 year term is appropriate due to the controlled status of the activities, the unnecessary cost of consent renewals, the lack of adverse effects under monitoring and the implementation of the ICMP processes.

56. Mr Ensor said the special condition for the St Clair outfall should be addressed via the ICMP process and not as a consent condition.

Submitters

57. **Mr Brent Mackie**, a farmer from Clinton, spoke to his submission. He said that as a farmer he wished to leave the land and creeks in good condition when the next generation takes them over. He said farmers are required to fence streams, restrict fertilizer application and so on and that similarly the DCC needs to be responsible for its discharges, if it is polluting waterways. He said farmers are prosecuted for polluting water bodies and this should also apply to the DCC if it is polluting water. He said money spent on the stadium would have been better spent on cleaning up discharges. He sought a 5 year term and said all outfalls should be monitored including those that have access problems.

58. **Mr Andrew Shand,** Health Protection Officer, from Public Health South read his submissions. He described the statutory obligations that **Public Health South** has under contract in respect of maintaining public health under the relevant statutes. He said for this application the focus is on the acute risks associated with stormwater discharges in areas where there could be direct human contact with the discharge such as St Clair, Andersons Bay and Portsmouth Drive. He sought a consent term shorter than 35 years to enable data to be analysed and responses made. He said cockle flesh monitoring should be according to the Australian and New Zealand Food Standards Code (retail) and gave some detail of the E coli levels allowed by those standards.

59. **Dr Keith Reid,** a public health physician from Public Health South, gave evidence for **Public Health South**. He said their aim is to promote the reduction of adverse environmental effects of the health of people and communities and to improve, promote and protect their health under the relevant statutes.

60. He expressed concern at the potential for these discharges to create adverse health effects with the potential to cause illness by direct human exposure to pathogens and other hazards such as heavy metals, especially in contact recreation areas. He added that the risk is likely to be low but is unquantified at present as there have been no formal reports of illness associated with recreation in the discharge locations.

61. Dr Reid's specific concern was about microbiological contamination, noting some discharges when samples have breached contact recreations guidelines. He sought the monitoring of outfalls and contact recreation sites to determine the link between the discharge and effect on water quality.

62. Dr Reid also requested that signs be erected to warn of potential risks for shellfish gathering and contact recreation. Otherwise, he advised, Public Health South has a neutral stance on the applications.

63. In answering questions Dr Reid said that the wording on a sign would be difficult but not impossible and could refer to the risk of poor water quality after rain events.

64. **Mr Len Anderson**, counsel for Port Otago Ltd, presented legal submissions for **Port Otago Ltd.** He said that the stormwater discharges allow contaminants such as heavy metals and PAHs to be discharged into the harbour and these can bind with sediment. Port Otago dredges sediment and will be left with the problem of contaminants if the DCC does not treat its discharges.

65. He said rule 10.5.3.2 of the RP: Coast refers to the treatment of the discharge prior to discharge and that the cost of treatment should not be a barrier to doing treatment. He referred to the RMA requirement to avoid, remedy or mitigate any adverse effects of activities on the environment and asserted that managing them while they continue does not avoid, reduce or mitigate the effects.

66. He submitted that the discharges are contrary to policy 10.4.7 of the RPC as there are alternatives to the proposal to manage the discharges. He did not think the proposed conditions were appropriate to prohibit or even control the deposition of contaminants in the harbour.

67. **Mr Lincoln Coe,** the general manager infrastructure, for **Port Otago Ltd,** is responsible for dredging operations in the harbour including implementing the relevant consents. He repeated Mr Anderson's concerns about contamination of sediment by stormwater discharges. He said DCC need to prevent problem contaminants entering the harbour and accept liability for any consequences of future contamination that could arise from the continuing discharges.

68. Mr Coe said there have been several meetings with the DCC about this issue but no agreements reached. He said Port Otago Ltd opposes the granting of the permits until DCC will accept liability for its discharges.

69. He said that "based on their knowledge of the harbour, the actual environmental risk from contaminated sediments to both people and the environment is extremely low, but there is insufficient information at present to clearly demonstrate this."

70. He said Port Otago wishes to work with DCC on the issue of contaminants and supported the formation of a stakeholder group and the provision of more baseline and targeted monitoring.

71. Answering questions Mr Coe said:

- That the Victoria Channel in the upper harbour does not require much dredging because the good flow along the channel reduces sedimentation.
- Dredging in the upper harbour is most frequent in the LPG wharf area: 40,000 cubic metres were removed last year and over the last 10 years an average of 35,000 cubic metres per year was removed. The material removed is mud and fine silt.
- Mr Anderson said there is a precedent for a consent holder to compensate a third party for adverse effects, for example in the Port Chalmers area, Port Otago Ltd compensates residents for noise effects.
- Mr Coe said that despite DCC sediment contribution to the upper harbour being 275cubic metres per year compared with the 35,000 cubic metres that is dredged on average each year; there is nonetheless an issue with stormwater contaminants contributing to sediment quality.

72. **Mr Tim Vial**, a resource management planner, read his evidence on behalf of Te Runanga O Otakou (the Runanga). He described the relationship that the Runanga has with the harbour, stating that it had been a significant part of the lives of all iwi generations since before European settlement.

73. Mr Vial said the changes to the harbour over the years have degraded the relationship and that further degradation is not acceptable to the Runanga. He said the Runanga has been in consultation with the DCC and supports the implementation of ICMPs and the elimination of wastewater cross-connections.

74. He said the Runanga seeks a 25 year term, the establishment of a stakeholder group and the monitoring proposed by the DCC.

75. Mr Vial requested that the Runanga representative in the stakeholder group should be alerted if proposed contaminant trigger levels are breached, or trigger levels in cockles are exceeded, or there is an unplanned spill of chemicals, fuels, hazardous substances or other contaminants into the stormwater system.

76. Answering questions Mr Vial said

- the 25 year term is set out in the Iwi Natural Resources Management Plan
- He is not aware of cockle harvesting in the upper harbour
- That the Runanga cannot exercise kaitiakitanga of the harbour unless it knows what is going on hence the need to be alerted to spills and trigger level breaches and the receipt of regular reports.

77. **Mrs Moira Parker** spoke on behalf of the **Save the Otago Peninsula Society Incorporated** (STOP). She was pleased that the ICMPs have been developed and believes that the DCC should manage its discharges by recognising the source of contaminants and having good baseline data.

78. Mrs Parker wanted a permit for each of the 10 ICMP catchments rather than only 4 permits.

79. She approved of automated monitoring that will sample the first flush after rainfall, rather than grab samples, and wants E Coli monitored at 5 year intervals.

80. She said despite DCC budgets the ICMPs must be implemented, and endorses the commitment to source control of contaminants. She wishes to see a bylaw for stormwater.

81. She said she did not support a 35 year term because technology changes might provide earlier solutions to treatment options. She thought a 10 year term was too short because of the cost of the consent renewal process.

S42A Report Writer

82. **Mr Jamie Torrance**, the S42A report writer, spoke to his report. He did not call any expert witnesses to assist him. He said he was opposed to the 35 year term because the ICMP approach does not provide clear outcomes for improving stormwater quality. He questioned how enforceable the action plans would be.

83. He approved of proposed actions such as education and development of a bylaw, and said the preference for end of pipe standards is because the link between the discharges and harbour water quality is difficult to determine.

84. He said mixing zones are opposed in known contact recreation areas, and the upper harbour is not as well flushed as St Clair. He did not think that recreational values in a mixing zone should be diminished because of the mixing; hence an end of pipe standard is appropriate.

85. He agreed that catchments should be prioritised in terms of actions and monitoring. In respect of the permitted baseline, he said that residential catchments not subject to this application did not necessarily meet the permitted activity rules, and the compliance department of the ORC is looking into that issue.

86. Mr Torrance addressed the conditions table that Mr Ensor had referred to in his evidence. He addressed each condition in turn. He was unable to comment on the removal of his first proposed condition without taking advice. He preferred to keep the monitoring regime proposed in his draft conditions, and that the requirement for composite samples had been proposed by the ORC science section. He said Enterococci are a better indicator of human faecal contamination in a marine environment than E coli.

Applicant Right of Reply

87. Mr Christensen said that the DCC still seeks a 35 year term despite ORC recommending 10 years and some submitters 20 or 25 years. He said the issues are about understanding the nature of the discharges and said that that given the program to remove cross connections there is no need for a dramatic change to what is occurring at present over the next 10 years as there is no evidence for this.

88. He emphasised the controlled status of the applications, and said that the RPC recognises that one cannot put a cork in the outfalls, and therefore maintained that it would be silly to grant short term consents.

89. He said that the previous permits set up the ICMP regime that is now in place; that the ICMP process will work with the action plans that are required. He added that review conditions could address any lack of progress or unforeseen issues as they arise. He asserted that review conditions mitigate against the risk of having a 35 year term.

90. In respect of mixing zones he said that the ORC is saying that where there is any value present within a proposed mixing zone area, then there should be no mixing zone at all. He said this view is at odds with every consent he has been involved in, where mixing zones are considered. He said in mixing zones the values are written off but accepted that mixing zone consideration is always about the nature of the discharge and the assimilative capacity of the receiving environment.

91. Mr Christensen acknowledged the problems with trying to model mixing zones without including the effect of the Water of Leith. He noted that the Chair had

suggested going with mixing zones that reflect human use values. He advised that this had been raised with ORC during the application process and rejected by them. He said this approach is practical, gets away from problems with modelling and is more useful than having end of pipe standards. He suggested an analysis of the values around each outfall and that mixing zones could be set accordingly.

92. He repeated his opening remarks about the vires of the condition that refers to the removal of the St Clair outfall.

93. On questioning Mr Christensen said that the DCC is committed to producing a stormwater bylaw and implementing the ICMPS. He said the DCC is a public body and one must trust what they say they will do.

2. Matters Considered

94. In reaching our decision we have considered the application, all submissions, all evidence, the s42A report and the relevant provisions of the RMA, the NZCPS, Regional Policy Statement (RPS) and the RPC.

3. Principal Issues and Effects

3.1 Permits must be granted

95. The RPC states that these activities are controlled. Therefore the consents must be granted, and the issues are about how many permits should be granted, the term of those permits and what conditions should be imposed on them.

3.2 Tangata whenua

96. We noted that the Runanga have had ongoing consultation with the DCC about these discharges, and this is likely to continue with the operation of the stakeholder group. We noted the special relationship that this Runanga has with the Otago Harbour and the concern at the degradation of it over time. The Runanga do not wish to see any further degradation and support the implementation of the ICMPs. Mr Vial asked that the Runanga be alerted to breaches of trigger levels for contaminants in water and shellfish, and spills of chemicals, hazardous substances or other spills into the stormwater reticulation. We acknowledge that the Runanga cannot exercise kaitiakitanga in respect of the harbour unless it has information about the activities that affect the harbour, and we agree with the inclusion of a condition to provide for such alerts.

3.3 Number of Permits

97. The DCC proposed 4 permits to reflect 4 different receiving environments. The ORC notified 10 permits to reflect the 10 stormwater catchments. We note the development of 10 ICMPs for the 10 catchments that are the subject of this application. We feel it is logical to have 10 permits as this reflects the source of the discharges in groups according to catchments.

98. The DCC rightly drew our attention to the effects on the receiving environment. However from Dr Stewart's evidence, we accept that it remains difficult to link harbour water or sediment quality to any particular outfall, except in some specified areas such as Portobello Road. As monitoring will include stormwater quality for the purposes of detecting excess contaminants or wastewater, it is appropriate to have the consents, reflecting the individual catchment programmes, as set out in the ICMPs, which will be implemented to find the source of those contaminants.

99. Concerns about setting monitoring conditions across 10 permits can be resolved by having a schedule that describes all monitoring across the 10 permits that applies to all permits, the relevant parts of the schedule being applicable to each permit.

100. We have decided therefore to grant 10 permits, one for discharge(s) from each of the 10 stormwater catchments as detailed in the application.

3.4 Duration of Permits and Permitted Baseline

101. The RMA provides a maximum term of 35 years for discharge permits. The DCC wishes to have a 35 year term, and the ORC has recommended a 10 year term. Some submitters sought 25 year terms. The ORC was concerned that the ICMP implementation does not provide any certainty in terms of progress in improving stormwater. The DCC said that despite a lack of adverse effects from stormwater discharges, the Dunedin community is nonetheless concerned about stormwater quality. The DCC confirmed it is committed to positively addressing those concerns and indeed has demonstrated this commitment to date in the development of the "3 Waters Plan" and the ICMPs that have been spawned by it.

102. Our understanding is that the ICMPs address all discharges within a catchment including wastewater discharges. Clear priorities have been set to remove stormwater from wastewater and to prevent wet weather emergency discharges from wastewater outfalls into the harbour, as well as removing cross connections of wastewater into stormwater drains. The ICMPs identify all issues to do with stormwater in a catchment including ageing pipes, flooding, treatment options and education. Wet and dry

weather sampling is proposed to detect contaminant entry to the stormwater system that should not be present. If unusual levels or types of contaminants are detected then a programme of sampling and investigation continues up the catchment to find and address the source.

103. We heard and received clear evidence from Dr Stewart that there has been no discernible degradation of stormwater quality, harbour water quality, harbour biota or sediment during the term of the previous consents. That evidence was not disputed by any other expert witness. We accept the assertion of Dr Stewart that there is no suggestion that the ongoing discharges will further degrade the receiving environment, if measures are in place to improve the quality of the stormwater and receiving environment through implementation of the ICMPs.

104. It is also appropriate to discuss the permitted baseline in the context of determining the term of the permits. We were surprised that the s42A report does not discuss this issue at all. Mr Ensor advised us that we have the discretion to observe the permitted baseline or not. His view was that we should not do so if the relevant permitted activities would be unrealistic or "fanciful".

105. In this case the RPC sends a very strong message in rules 10.5.3.1 10.5.3.2 that stormwater discharges must occur. The policy reason for adopting these rules includes the statement that "the discharge of stormwater into the coastal marine area needs to be provided for within this Plan as there are few available alternatives to the disposal of water originating from rain events".

106. Rule 10.5.3.1 provides that the discharge of stormwater from residential areas where there are no trade or industrial premises, and no intrusion of human sewage, into a well flushed area, is a permitted activity, provided that after reasonable mixing there are no S107(1)(C) effects. We are aware that in residential areas all sorts of contaminants can enter the stormwater system: from rotting leaf fall, animal excrement, car washing and other cleaning activities on residential properties, metals leaching from old pipe work and metal roofs, emissions from cars and roads such as oils, dust from brake shoes and linings and so on. The effects that must be considered in this application are in addition to such effects that will arise from stormwater discharges in other parts of the city under the permitted activity rule.

107. If a 10 year term is granted, the DCC will have to lodge new consent applications and applying the RPC as written, the ORC will have to grant them. The issue will be about what conditions should be applied for the new term, and what term would be on the new permits.

108. It seems to us that there is little point in going through a similar consent process as this in 10 years time, when other discharges of stormwater may continue infinitum under the permitted activity rule. We believe that it is possible to provide for upgrades to stormwater reticulation and stormwater quality over a 35 year term of consent. The DCC has provided the mechanisms under the ICMP implementation to do so and we accept that approach. However, we are adamant that consent conditions must be clear about tying the ICMP implementation to the consents, that an action plan for each ICMP is also a condition of consent and that review conditions can provide for new conditions to be added should progress with improvement in stormwater quality not occur as intended in the consent applications.

109. The imposition of a regular review condition pursuant to s128 of the Act, on all consents, with particular focus on the five 'problem' catchments of Halsey Street, Mason Street, Shore Street, Kitchener Street and South Dunedin will facilitate this process. We note that if necessary, when the permits require a review under s128, it could be a notified process with attendant costs. Given their submissions on the cost of the re-consenting process we would expect that DCC should wish to avoid such reviews by appropriate compliance performance.

3.5 Mixing Zone

110. In the s42A report recommended Condition 1, implies that after 5 years, for all the permits, that there is no allowance for a mixing zone; for s107(1)(c) effects nor that there be any faecal material, hazardous substance, substance that is toxic to aquatic ecosystems, any untreated waste from a trade or industrial process nor any waste from a trade or industrial process that should go to the wastewater system. Whereas Mr Torrance said he was concerned about effects on recreation values, we note that Condition 1 as described above is proposed for all permits and outfalls, whether or not within an area where recreation occurs.

111. The RMA allows S107 effects within a mixing zone.

112. The NZCPS Policy 23 states that, in making our decision we must "(e) use the smallest mixing zone necessary to achieve the required water quality in the receiving environment; and…" The definition of "mixing zone" in this document is "The area within which "reasonable mixing" of contaminants from discharges occurs in receiving waters and within which the relevant water quality standards do not apply."

113. The RPC policies 10.4.3 and 10.4.4 refer to the discharge of contaminants after reasonable mixing. The definition of mixing zone in the RPC states "An area of water

quality degradation associated with a discharge. A mixing zone is the zone outside of which the contaminant levels of the receiving waters must be at the background values again". Permitted rule 10.5.3.1, which applies to permitted stormwater discharges allows S107 effects within a mixing zone.

114. We also note that it is not appropriate to impose a condition which we know an applicant cannot meet. Under the permitted activity rule it is likely that some S107(1)(c) effects could show up at stormwater outfalls from time to time, therefore it is unreasonable to expect that in neighbouring catchments that are the subject of these consents they will not.

115. It is also questionable to depart from the policies set out in the RPC that provide for mixing zones. However if mixing zones are to be at the end of the outfalls then in those areas where humans are likely to come into direct contact with the discharge it is appropriate to have some warnings about the risks of the contaminants in the mixing zone.

116. The above is our analysis of the matter and we also record that no legally sound reason to not allow mixing zones for these discharges was placed before us.

3.6 Effects on Water Quality, Biota and Sediments

117. Dr Stewart's evidence included a summary of the monitoring undertaken under the requirements of the previous consents and in preparation for this application. For harbour water quality, biota and sediments he could not find any significant changes over the monitoring period that would indicate that an increase in contamination was occurring. He did identify several "hotspots" such as Portobello Road, where historic land contamination is likely to result in leaching of contaminants into the stormwater system then to harbour silts.

118. We noted that during storm events and in some dry weather situations monitoring has identified that there are contaminants in the stormwater pipe discharges that are in excess of ANZECC guidelines. These are of concern. The decision to remove cross connections of wastewater within 5 years will reduce such contamination. We also note that implementation of the ICMPs together with the implementation of a stormwater bylaw is expected to result in a reduction in contaminants entering the harbour from stormwater.

119. Port Otago was concerned about contaminant levels in sediments as a result of these stormwater discharges increasing over time to the extent that the contamination will become a problem with their dredge spoil disposal operations, from a consenting point

of view. There is no evidence that the existing discharges over the term of the previous consents have contributed to contamination of sediments in excess of guideline levels except at Portobello Road where Port Otago does not carry out any dredging operations. We also heard in evidence that the sediment contribution to the harbour from these discharges is approximately 475 cubic metres per year. Mr Coe said that on average 27,000 cubic metres of silt is removed from the upper harbour berthing area each year and last year it was 40,000 cubic metres. The stormwater contribution of silt is minor in this respect. Given the implementation of the Trade Waste Bylaw several years ago, the likely introduction of a Stormwater Bylaw and the implementation of the ICMPs it is difficult to accept that contaminant levels in harbour silt are likely to increase in volume or toxicity in the future because of stormwater discharges.

3.7 Monitoring

120. The implementation of the ICMPs relies on the provision of data that gives information about what is coming out of the outfalls. Harbour water monitoring is also important, to keep a record of changes that might occur over time. As previously discussed there are difficulties tying harbour water quality to the stormwater discharges, when there is tidal flushing of the harbour, the discharge from the Water of Leith the effects of which may mask or overwhelm the effects of other discharges in the upper harbour, especially during flood tides, and other activities that can contribute contaminants.

121. The DCC proposal is to investigate dry weather discharges, and monitor 5 priority catchments for wet weather discharges on a rotating basis. This means over 35 years there will be 7 sets of data and we feel that will not supply enough information for the implementation of each of the ICMPs. Focussing only on 5 catchments will mean that there is no information about what is entering from the other 5 catchments.

122. Therefore we require dry weather sampling as proposed in the DCC revised proposed conditions, plus an outfall in each of the 5 priority catchments to be monitored by automatic sampler three times each 5 years when it is raining or while wet weather discharge is still flowing. In addition to this a grab sample from priority catchments, not being measured on the 5 year rotation, and non priority catchments must be taken each year from a suitable wet weather flowing outfall. The location of grab samples in priority catchments should be the same as the 5 yearly monitoring. If after 3 years any parameter is never detected then the requirement to test for that parameter can be dropped.

123. We do not think the addition of 9 wet weather grab samples per year to what was proposed by DCC is overly onerous or expensive. The ORC staff did not raise any opposition to the dry weather monitoring proposed in the DCC revised proposed conditions.

124. In addition the harbour water quality, sediment, invertebrate and cockle sampling is to continue as proposed.

125. As mentioned above, we believe that the simplest way of showing this monitoring is to have a schedule of all monitoring that is an appendix to each of the consents. The monitoring requirement for any particular permit will be as described in the schedule.

126. Outfalls where sampling is to occur, and indeed the actual sampling point, for the few outfalls where there may be physical difficulties in accessing the actual outfall, particularly during wet weather, will need to be agreed with the ORC. In addition to the monitoring above, we note that DCC is committed to undertaking such monitoring that is required to identify the source of wastewater or trade waste entering the reticulation via the ICMP process.

4 Main Findings of Fact

127. Throughout the preceding Section 3 we have examined the effects of the proposal on a range of matters that were brought before us in evidence, submissions and in answer to our questions. In the table that follows we have, for convenience, summarized our findings with respect to each of these issues. The third column provides the statutory, policy statement or planning document reference.

Summary of Main Findings

Issue	Our Findings	RMA/ NZCPS/ RPCoast
Tangata whenua	On going consultation via stakeholder group with information going to the Runanga will assist in kaitiakitanga	RMA S.6(e), (g); 7.(a), (aa), S.8
Status of Activities	Controlled; must be granted	RPCoast 10.5.3.2
Number of Permits	10; One for each ICMP	
Duration of Permits	35 years, reflecting controlled status	RMA S.123(c) RPCoast 10.5.3.2
Mixing Zone	Smallest practicable mixing zone around each outfall; well flushed harbour; all statutory documents provide for a mixing zone.	RMA S.107(1); NZCPS policy 23; RPCoast 10.4.3, 10.4.4
Effect on Water Quality	Water quality good in harbour; no change from stormwater discernible from monitoring since 2004; improvement likely as ICMPs and bylaw implemented.	S.104 (1)(a), S107
Effect on Sediment Quality	Sediments meeting guideline levels with some exceptions such as Portobello Road; no discernible change from monitoring since 2004; improvement likely as ICMPs and bylaw implemented	S.104(1)(a)
Effect on biota	Monitoring of shellfish flesh and benthic organisms not showing adverse effects from stormwater; improvement possible as ICMPs and bylaw implemented	S104(1)(a)

5 Statutory Provisions

130. In the evidence and submissions, we received helpful guidance as to the statutory criteria that we are required to apply. The various parts of the particular plan and policy statements that are relevant to the application, were provided by the DCC and in the S42A Report.

5.1 Part 2 RMA

131. Overriding all decisions under the RMA is the requirement to be consistent with Part 2 of the Act. We have considered the ethic of sustainable management under section 5 and have determined that the conditions and term of consent proposed is consistent with managing the use of the harbour to dispose of stormwater, and that this provides for the social, economic and cultural wellbeing, health and safety of the residents of urban Dunedin. At the same time, we are satisfied that the conditions we have imposed will ensure that the harbour ecosystem is sustained and enhanced over time such that existing adverse effects associated with the discharges are avoided or remedied or mitigated.

132. In terms of section 6 we have recognised matters of national importance such as the natural character of the water and bed of the Otago Harbour, the indigenous species in the harbour and the relationship of Maori with this harbour.

133. Under section 7 we have given particular regard to Kaitiakitanga, the ethic of stewardship, the use of the harbour, the values of the ecosystem, enhancement of the quality of the environment and protection of the habitat of salmon which visit the harbour at times.

134. Under section 8 we have considered the principles of the Treaty of Waitangi.

135. The Statutory provisions relevant to this application under Part 6 of the RMA are

- S104, which provides the relevant matters to be considered
- S105, which sets out the requirements for discharge permits
- S107, which places restrictions on the grant of certain discharge permits

136. In addition S104A provides for the matters that may be considered for controlled activities, including the matters listed for consideration in the relevant plan rule that allow conditions under s108 to be imposed.

137. The actual and potential adverse effects of the proposed activity are considered in Section 3 of this decision. Conditions of consent and in particular the requirement to

implement the ICMPs and monitor the discharges and receiving environment will ensure that any adverse effects are detected so they can be avoided, remedied or mitigated.

138. The discharge of stormwater from these catchments into coastal waters is a controlled activity. The controlled activity rule 10.5.3.2 in the RP:Coast states that the matters the ORC will exercise it control over are:

(a) The location of the discharge point.

(b) The volume, rate and nature of the discharge.

(c) The treatment, if any, required prior to discharge.

(d) The duration of the resource consent.

(e) The information and monitoring requirements.

(f) The administrative charges payable.

(g) The review of conditions of the resource consent.

139. In respect of (a) the locations are fixed by the existing stormwater infrastructure, we are satisfied that alternative discharge points, from a macro point of view are not practicable for geographical and economic reasons.

140. For (b) the volume and rate of the discharges are dependent on rainfall and other water entering the stormwater system such as wastewater, spring water and surface water. Intrusion by other than rain generated water should diminish as the ICMPs are implemented including renewal of aging infrastructure and investigation and elimination of cross connections.

For (c) the treatment of the stormwater while basic at present is common practice, with only catchpits and mudtanks trapping some debris and sediment. The implementation of the ICMPs in the long term should result in improvement of stormwater quality with time by targeting industrial sites and ensuring at source treatment is incorporated with re-development.

141. For (d) we have considered the duration of the permits and decided they should be 35 years for the reasons discussed in Section 3.

142. For (e) we have discussed monitoring requirements in section 3 above and set out the details in the permits.

143. For (f) we understand the ORC's annual plan includes annual performance monitoring fees that apply to consents that provide data on the activity being undertaken.

144. For (g) we have included comprehensive review conditions that provide for a thorough consent performance review to take place every 5 years via the review provisions of S128 of the RMA. Should progress in implementation of the ICMPs not be made as envisaged in the consent application this review may result in a formal consent review process.

145. In consideration of (a) to (g) of rule 10.5.3.2 we have also had regard to the other provisions that are relevant to this application.

5.2 New Zealand Coastal Policy Statement (NZCPS)

146. The NZCPS is a national policy statement under the RMA. Its intention is to achieve the purpose and principle of the act with respect to the coastal environment of New Zealand. A number of the objectives and policies found within the NZCPS are contained within the RPCoast. The relevant objectives and policies include:

- *Objective 1- To safeguard the integrity, form, functioning and resilience of the coastal environment and sustain its ecosystems…*

- *Objective 3. To take account of the principles of the Treaty of Waitangi, recognise the role of tangata whenua as kaitiaki and provide for tangata whenua involvement in the management of the coastal environment…*

- *Objective 6. To enable people and communities to provide for their social, economic and cultural wellbeing and their health and safety, through subdivision, use and development…*

147. Having regard to these objectives, for this application, we have considered the quality of the coastal environment and decided that the existing adverse effects of the discharges are not significant and are likely to diminish over time. We have provided for the interests of the local Runanga and recognise, for the community of Dunedin, that it is necessary to dispose of stormwater to the sea as the historic built environment does not allow for more enlightened options to be adopted. Nonetheless with upgrading of infrastructure, investigation and elimination of cross connections and implementation of the ICMPs, we are satisfied that improvements to the discharges will occur.

- *Policy 2 – Treaty of Waitangi*

  *(a) recognise Tangata Whenua have traditional and continuing cultural relationships with the coastal environme*nt.

- *Policy 3 – Precautionary approach*

  (1) adopt a precautionary approach towards proposed activities whose effects on coastal environment are unknown or uncertain but potentially significantly adverse.

- *Policy 23 – Discharge of contaminants*

  (1) in managing discharges to water in the coastal environment to have particular regard to,

  > *(a) the sensitivity of the receiving environment,*
  >
  > *(b) the nature of the contaminants, the particular concentrations of contaminants needed to achieve the required water quality in the receiving environment, and the risk if these concentrations are exceeded,*
  >
  > *(c) the capacity of the receiving environment to assimilate the contaminants,*
  >
  > *(d) avoid significant adverse effects on ecosystems and habitats after reasonable mixing,*
  >
  > *(e) use the smallest mixing zone necessary to achieve the required water quality within the receiving environment, and*
  >
  > *(f) minimise adverse effects on the life supporting capacity of water within a mixing zone.*

  (2) in managing discharges of human sewage do not allow,

  > *(a) the discharge of human sewage to water without treatment,*

  (4) in managing discharges of stormwater take steps to avoid adverse effects of stormwater discharge to water of the coastal environment, on a catchment by catchment basis, by:

  > *(a) avoiding or remedying cross contamination of human sewage and stormwater systems,*

(b) reducing contaminant concentrations and sediment loadings in stormwater at source, through contaminant treatment and control by land use activities,

(c) promoting integrated management of catchments and stormwater networks, and

(d) promote design options that reduce flows to stormwater reticulation systems at source.

148. Aspects of this policy were very relevant to our consideration of issues in Section 3 of this decision. We have considered the nature of the discharges, the receiving environment, mixing zones, biota, cross connections, the ICMPss and the proposed stormwater bylaw. We are satisfied that our decision is consistent with this policy.

5.3 Regional Policy Statement (RPS)

149. The RPS contains objectives that include:

- *Objective 8.4.1 – To promote the sustainable management of Otago's coastal resource in order to meet the present and reasonably foreseeable needs of Otago's people and communities;*
- *Objective 8.4.2 – To maintain and enhance the health and diversity of Otago's existing coastal ecology;*
- *Objective 8.4.4 – To seek to maintain existing water quality within Otago's coastal water and where water quality is degraded, so seek to achieve water quality suitable for contact recreation and the eating of shellfish;*

150. We note the evidence that the water quality at St Clair and Port Chalmers is currently suitable for contact recreation and shellfish gathering. Within the harbour, water quality is also generally good. Dr Stewart advised that shellfish in the upper harbour were also likely to be safe to eat, but not so desirable because of their size and scarcity. Implementation of ICMPs will not cause degradation of water quality and should enhance it over time.

- *9.4.2 to promote the sustainable management of Otago's infrastructure to meet the present and reasonably foreseeable needs of Otago's communities*.

151. The explanation to this objective recognises pipework reticulation. We heard the entire stormwater network has a replacement value of $150 million with an annual operational cost of $1.25 million. This is significant. We have had regard to this

investment in infrastructure, while encouraging the upgrading of stormwater systems within the catchments, with particular regard to discharge quality.

152. The RPS has the following relevant policies:

- *8.5.1 – To recognise and provide for the relationship Kai Tahu have with Otago's Coast ….*
- *8.5.5 – to maintain and where practicable enhance the physical and ecological quality of the coastal environment ….*
- *8.5.6 – to promote a reduction in the adverse effects of contaminant discharges into Otago's coastal waters through:*

  (a) Adopting the existing water quality of Otago's costal water as a minimum acceptable standard; and …

  (c) Requiring that all discharges into Otago's coastal waters maintain the standard for the receiving waters after reasonable mixing; and …..

153. As discussed above Iwi concerns have been provided for; the water and biota quality should improve and the level of contaminants should reduce as cross connections are eliminated and ICMPs implemented. Our decision is consistent with the provisions of the RPS.

5.4 Regional Plan: Coast

154. The RP:Coast has objectives and policies relevant to this application:

Objectives

- *10.3.1 To seek to maintain existing water quality within Otago's coastal marine area and to seek to achieve water quality within the coastal marine area that is, at a minimum suitable for contact recreation within 10 years of the date of approval of the plan.*
- *10.3.2 To take into account community, cultural and biological values associated with Otago's coastal marine area when considering the discharge of contaminants into Otago's waters.*
- *10.3.3 To safeguard the life supporting capacity of Otago's coastal marine area*
- *10.3.4 To enhance water quality in:*

  (a) coastal protection areas, and

  (b) coastal recreational areas, and

  (c) areas adjacent to marine mammals and bird sites, and

(d) areas where there is a direct discharge containing human sewage, and

(e) areas where there is a direct discharge of waste from commercial, industrial or production activities.

- *10.3.6 To reduce the potential for spills and leakage's of hazardous substances and hazardous wastes in the coastal marine area.*

155. The discharge is stormwater containing a number of contaminants including human sewage. We have considered the potential adverse effects on contact recreation values and agreed with ORC staff conditions which should ensure that human sewage connections from the stormwater network are eliminated within 5 years. Conditions have also been recommended requiring the applicant to increase its own regulatory, enforcement and education roles in improving the quality of the stormwater discharge. We are satisfied that this together with implementation of the ICMPs to improve stormwater quality is consistent with the above objectives

Policies

- *10.4.1 In order that any proposed discharge, into the coastal marine area that will, or is likely to have, an adverse effect on cultural values Kai Tahu will be,*

  (b) notified about notified resource consent application to discharge water or contaminants to the coastal marine area.

156. Kai Tahu on behalf of the local runanga, were notified and indeed provided a cultural impact statement on the proposal along with a submission. The issues raised by them have been carefully considered in arriving at our decision.

- *10.4.2 For activities involving the discharge of contaminants to water or contaminants, priority will be given to avoiding adverse effects on values associated with areas identified as coastal protection areas and coastal recreation areas.*

- *10.4.3 To restrict the discharge of contaminants to Otago's Coastal marine area where that discharge would result in a lowering of the existing water quality in the receiving waters:(a) after reasonable mixing, and (b) after disregarding any natural processes that may affect the receiving waters.*

157. Given that these stormwater discharges have been occurring for a very long time, in many cases more than 50 years, and in some more that 100 years with minimal treatment, water quality within Otago Harbour while slightly degraded is surprisingly good. Expert witnesses told us that it is difficult to link the effect of these discharges on water quality, given the other discharges into the harbour, for example the Water of Leith. Notwithstanding this, conditions of consent have been included which will improve the quality of the discharge over time.

.

- *10.4.4 To require an effective mixing zone for discharges of water or contaminants into the coastal marine area which takes into account,*

  (a) the sensitivity of the receiving environment, and

  (b) the particular discharge, including contaminant type, concentration, and volume, and

  (c) the physical processes acting on the area of discharge, and

  (d) the community uses and values associated with the area affected by the discharge, and

  (e) the ecological values associated with the area.

158. There are important community use values within each receiving environment. The NZCPS Policies 23(1)(e) and (f) require provision of small mixing zones and the minimisation of adverse effects on the life supporting capacity of the water within the mixing zone. Mixing zones allow an area of non compliance with water quality values, and it is important that those areas are minimised, and that the level of non compliance of any value is also minimised. Removing cross connections, with the implementation of the ICMPs, is expected to have a significant effect on mixing zones. We do not consider that it is appropriate to have no mixing zones, as suggested by ORC staff, because the permitted baseline, S107, and provisions of the NZCPS and RPS provide for them.

- *10.4.6 To restrict the discharge of human sewage or wastes into any marine reserve, taiapure or mahinga mataitai area where that discharge would adversely affect the values associated with the area.*

159. Conditions are imposed which require the prompt elimination of any known or discovered human sewage connections from the stormwater network.

- *10.4.7 The discharge of a contaminant into the coastal marine area will only be allowed where,*

  (a) it can be shown that the adverse effects of the discharge to any area, other than the coastal marine area, would create greater adverse effect than the discharge to the coastal marine area, or

  (b) there are no practical alternatives to the discharge occurring to the coastal marine area, and

  (c) the discharge is of a standard which will achieve a water quality suitable for contact recreation and shell fish gathering within 10 years of approving this plan.

160. There are few alternatives available to the applicant to discharge elsewhere given the existing stormwater network. Alternatives have been considered and disregarded as a consequence of impracticability including very high costs. We accept that the discharges must continue, subject to conditions which, we are satisfied, will improve the quality of the stormwater discharges by removing all human sewage connections to the stormwater system and address any known and future contamination from industrial and trade premises within the catchments.

5.5 Other Matters

161. The Kai Tahu ki Otago Natural Resource Management Plan 2005 is relevant to this application. The matters of relevance were set out in the cultural impact statement provided by local Runanga. Further matters have been raised in a submission by Kai Tahu ki Otago. Subject to the conditions we have imposed, we are confident that the activities authorized by the consents will be consistent with Kai Tahu ki Otago's Natural Resource Management Plan 2005.

5.6 Section 105(1) of the Act

162. Section 105(1) of the Act states that where an application is for a discharge permit to do something that would otherwise contravene Section 15 or Section 15B of the Act, "*the consent authority must, in addition to the matters in section 104(1), have regard to*

(a) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and

(b) the applicant's reasons for the proposed choice; and

(c) any possible alternative methods of discharge, including discharge into any other receiving environment."

163. The above matters have been considered in Section 3 of this decision. The discharges are historical with some adverse effects on the receiving environment within the mixing zone areas. We note that no practicable alternatives were recommended or available without substantial costs. Conditions of consent will ensure the proposal is consistent with section 105 of the act. As a controlled activity, we reiterate that the permit must be granted in accordance with section 104A of the act.

5.7 Section 107 of the Act

164. This section states that a discharge permit shall not be granted (with certain exceptions) if, after reasonable mixing, the contaminant or water discharged is likely to give rise to all or any of the following effects in the receiving waters:

(a) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended material:

(b) Any conspicuous change in the colour or visual clarity:

(c) Any emission of objectionable odour:

(d) The rendering of fresh water unsuitable for consumption by farm animals:

(e) Any significant adverse effects on aquatic life.

165. The applicant considers the discharge will not cause any of the effects listed under Section 107(1) of the Act after reasonable mixing. We accept that during a storm event

the stormwater discharge into Otago Harbour will need significant mixing zones, in order to meet section 107 of the act. We also note that the same applies to permitted discharges from other qualifying stormwater catchments and thus the permitted baseline provisions apply, in that mixing zones are also required for permitted activities. However, we consider that it is appropriate that monitoring is undertaken to quantify the level of contaminants within the discharge so that measures can be put in place to reduce any such effects in the future. This is especially important for dry weather flows.

166. Overall subject to appropriate conditions, we are satisfied that the granting of the permits is consistent with the relevant statutory provisions.

6. Determination

167. Having carefully considered all the relevant reports and documentation supplied with the application, submissions, the S42A report, and the evidence presented to us during the course of the hearing, we have determined that we must grant the consents and do so on a catchment by catchment basis, and for the maximum period permissible under the Act. We therefore grant 10 permits, each for a term of 35 years.

168. In accordance with S108 of the Act, conditions have been attached to these consents. In doing so, we have largely accepted the draft conditions that were proposed by the applicants, discussed with ORC and, for most of them agreed with minor amendments. We note, with satisfaction, the evolution of these conditions as a result of discussions with ORC and DCC, and consider such self imposed mediation entirely appropriate give the commonality of DCC ratepayers with a significant section of the ORC ratepayers. Notwithstanding the agreements reached, there are some amendments imposed by us and in particular redrafted conditions addressing some of the matters discussed above.

7. Reasons for Decision

169. In exercising our limited discretion we are bound to keep in mind Part 2 of the Act and the broad purpose in s5 and provisions of sections 6, 7 and 8. We believe we have been properly guided by these provisions.

170. It is highly relevant that there is an existing stormwater reticulation that discharges to the harbour that was built some time ago and is undergoing renewal in stages. The

controlled activity status recognises the need to allow these discharges to continue; the issue is about the improvement that is required to stormwater discharges with currently minimal treatment, together with contamination from wastewater cross connections and known and future contamination from industrial and trade premises within the catchments.

171. We have been mindful of the many statutory documents that provide for mixing zones, including S107 of the Act. Added to this is the permitted baseline of unregulated stormwater discharges from residential urban areas. We therefore cannot eliminate the provision for mixing zones.

172. In light of the above, we could not see any advantage accruing to the Dunedin and Otago regional communities in requiring a further full consent process to be undertaken addressing the same issues with the same likely solutions in 10 years time. We have imposed conditions which allow for reviews which should capture all or any improvements likely to be available over a longer term, including tightening of regulatory conditions to address consistent non performance and to ensure that advances in "Best Practice" in stormwater treatment are applied to the discharges. The Act provides for a 35 year term and with the controlled status of these activities it is appropriate to provide a 35 year term.

173. In making these decisions about mixing zones and term of consent, we emphasise that conditions require gross contamination to be removed from the stormwater reticulation and that this needs to be carried out as a priority. Similarly the education program and implementation of a bylaw controlling stormwater from trade and industrial premises is also very important, especially given our acceptance of DCC's contention that costs of treatment options at the end of pipe are prohibitive. If treatment at end of pipe is not practicable then prevention of contaminants entering at source is the other option that must be pursued. The consent conditions provide for the removal of cross connections and the progressive upgrading of stormwater catchments over time.

174. To determine the catchments that require attention, it is necessary to sample stormwater pipe discharges in both dry weather and when rain has occurred. Receiving water monitoring is also useful in this respect, but that alone cannot provide the information necessary to implement the ICMPs. The ICMPs must be an integral part of the consents.

175. The receiving waters, harbour silt and biota do not appear to have degraded over the last 8 years, as a result we are satisfied that improving the quality of the stormwater can only have a positive effect on the receiving environment.

8. Conditions and Consents

176. The 10 permits have 14 conditions in each that are identical. The conditions are as recommended by ORC staff and amended after hearing submissions and evidence from the applicant.

177. Conditions require the avoidance of section 107 effects beyond reasonable mixing. This is consistent with the permitted baseline.

178. Investigation and elimination of wastewater and industrial site water intrusion to the stormwater system is required; any existing known wastewater sources are to be removed within 2 years and any new infiltration of wastewater is to be addressed via the ICMP process. Any existing industrial discharges to the stormwater system that should be going to the wastewater system are to be removed within 3 years, and the Stormwater Bylaw that is proposed is to be implemented as soon as is practicable, subject to the statutory processes that are required to develop a bylaw.

179. Suitable signage and/or warnings of the risk of recreating within the mixing zones around stormwater outfalls is required.

180. The ICMPs are to be kept updated and the action plans for each ICMP must be kept up to date and implemented. We were concerned that there were not strong enough links between the conditions and the ICMPs. The conditions ensure the link is strong and the implementation of ICMPs enforceable by the consent authority.

181. As recommended by both ORC staff and the applicant, the stakeholder group is to be developed and is to be convened no less than once per year. The outcome of the meetings are to be included in the annual report about the exercise of the consents.

182. Stormwater, harbour water, sediment and biological monitoring is to be undertaken. The monitoring required for all 10 consents is set out in Appendices 1, 2, and 3 to the permits. The conditions tabled by the applicant at the hearing made reference to monitoring methods and protocols and trigger levels that are to be found in the reports submitted with the application. With these long term consents it is important that any person administering the consents, whether the consent holder or consent authority- must be able to understand what is required from the consent documents, without having to refer to other documents. Therefore some of the methods and protocols and the trigger levels have been included in Appendix 1 for clarity.

183. The trigger levels for sediment may be adjusted as recommended in the report supporting the application; this is because further investigations may indicate the trigger requires adjusting for some parameters. This can be done by agreement between the consent holder and the ORC.

184. Monitoring of stormwater includes automated sampling after rainfall in 5 priority catchments, plus a grab sample once per year in non priority catchments. Harbour water and biota are to be sampled at 5 sites and sediment at 9 sites. Cockles are to be sampled at 3 sites.

185. If any results indicate unusual contamination in the stormwater then the protocol for further investigation as offered by the applicant must be followed. The protocol is included as condition 10 of the consents.

186. Annual reporting of monitoring and ICMP implementation is required in condition 11 of the consents. One report for all 10 permits is provided for.

187. Recommended conditions to minimise erosion of the foreshore and alerting the ORC of spills into the stormwater system have been adopted. Advice of spills is to be given to Te Runanga o Otakou, to enable them to exercise kaitiakitanga in the harbour.

188. RM11.313.10 being the permit for the St Clair and Second Beach outfalls includes a condition to review the location of the St Clair overflow outfall should it be shown that adverse effects on visitors to this area are occurring. Mr Christensen said the ORC has no jurisdiction under the controlled rule in the RPC to address this issue. We disagree; the matters that are referred to in rule 10.5.3.2 include the location and the nature of the discharge. Should any review be activated the issues raised by Dr McElhone will be considered as part of that review.

189. The review condition that applies to all permits provides the ORC with ability to review the conditions once every 5 years. Mr Torrance was concerned that the ICMP implementation was too uncertain to justify a term of consent longer than 10 years. With 5 yearly reviews available any deviation from the implementation of the stormwater protocol under condition 10 and the ICMPs can be addressed.

190. The consent documents are appended and form part of this decision.

Dr Jeff Jones



Chair Hearing Panel 27 May 2013

ORC NOTIFICATION AND SUBSTANTIVE DECISION RECOMMENDING REPORT

ID Ref: A1295466
File No: RM19.261
Application No: RM19.261.01
Prepared for: Staff Consents Panel
Prepared by: Rebecca Jackson, Consents Officer
Date: 07/05/2020

Subject: **Discharge Permit Application RM19.261.01 by Dunedin City Council to discharge stormwater to land in a manner that may enter a Regionally Significant Wetland, at Tomahawk**

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1. Purpose

To report and make recommendations under sections 95A-G and sections 104 and 104B of the Resource Management Act 1991 on notification and the substantive decision of the above application.

2. Background Information

Applicant: Dunedin City Council
Activity: To discharge stormwater to land in a manner that may enter a Regionally Significant Wetland
Location: Tomahawk, approximately 310 metres east of the intersection of Gloucester Street and Spencer Street, Dunedin
Reason: Disposal of stormwater from a residential area

2.1 Description of the Proposed Activity

The applicant currently holds Discharge Permit 2004.792 which authorises the discharge of stormwater at the above location. Discharge Permit 2004.792 expired on 31 January 2020. This application was received by the Council between three and six months before the expiry date. In accordance with Section 124 of the Act, the applicant may continue to operate under Discharge Permit 2004.792 until a decision on this application is made and all appeals are determined. This continuation is at the discretion of the Council, which has been provided in this instance (A1291954).

The applicant is seeking to discharge stormwater to land from a residential area. This stormwater may enter a Regionally Significant Wetland, Tomahawk Lagoon. The quantity of discharge will vary daily as it is dependent on rainfall in the area. The applicant has indicated that the maximum flow rate of 100.4 litres per second and the pipe has been designed to accommodate a 1 in 10-year return period event.

The stormwater collected is from local residential properties and roads and will primarily comprise runoff from gardens and hard surfaces such as roofs, driveways and roads. Typical contaminants from stormwater are litter, sediment, nutrients, microbial contaminants, biodegradable organic materials, trace organic materials and metals.

The outfall has concrete baffle structures (Figure 1) to dissipate the energy of the flow at the outfall, and a reno mattress to further reduce erosion and scour of land.



Figure 1. Stormwater outfall with baffle structures (Source: application).

Through the application process the applicant amended their application to a term of 7 years (originally 35 years) and updated proposed conditions. During this time an Environmental Assessment Study will be undertaken to better understand the impacts of all the DCC's wastewater and stormwater discharge.

2.1 Site Description

The stormwater that is proposed to be discharged through this consent is from Spencer and Gloucester Streets in Andersons Bay. The stormwater drainage pipe that was installed in 2005 extends over 11 properties on the southern side of Spencer Street and connects to the Gloucester Street stormwater pipe. The pipe then follows a ridge located on farmland to drain into land from an outfall approximately 25 m from the lower Tomahawk Lagoon as depicted by Figures 2 and 3 below.

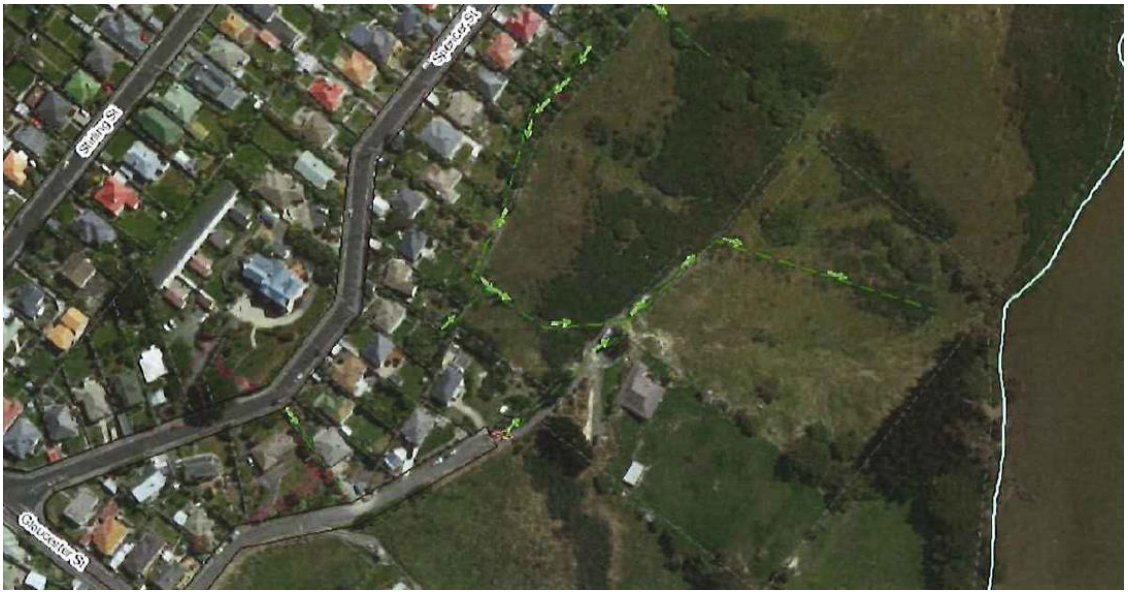


Figure 2. Aerial photograph depicting the Spencer and Gloucester stormwater sewers in green (Source: Application).



Figure 3. Location of discharge location (Source: Otago Maps)

The Tomahawk Lagoon is a Regionally Significant Wetland that consists of two shallow brackish water lagoons joined by a narrow channel and sharing a common sea outlet. The lagoon has recognised environmental, cultural and social values.

Schedule 1A of the Regional Plan: Water for Otago (RPW) outlines the natural and human use values of Otago's surface water bodies. Tomahawk Lagoon is identified as having the following values:

- Silt bed composition of importance to resident biota.
- Absence of aquatic pest plants identified in the Pest Plant Management Strategy for the Otago Region.
- Presence of riparian vegetation of significance to aquatic habitats.
- Significant presence of trout and eel.
- Presence of indigenous invertebrates threatened with extinction.

There are no Schedule 1B, 1C or 1D values associated with the Tomahawk Lagoon.

Schedule 9 of the RPW outlines the natural values associated with Significant Wetlands. Tomahawk Lagoon is identified as having the following values:

- Contains habitat for nationally or internationally rate or threatened species or communities;
- Has presence of threatened plant species on the margins of the lagoon;
- Has a high degree of wetland naturalness;
- This type of wetland is scarce in Otago in terms of its ecological and physical character;
- Regionally significant habitat for waterfowl and waders; and
- Habitat for native fish and eels

Tomahawk Lagoon is reported as having poor water quality. The catchment of the lagoon is predominately farmland, although the residential suburb of Tomahawk lies to the southeast, between the lagoon and the coast. The residential suburb of Andersons Bay, including Spencer and Gloucester Streets is located above the lagoon to the west. The Tomahawk Lagoon is a habitat for trout and perch so is a popular fishing location.

The land is generally steep with gradients varying from approximately 1:20 near the urban edge to 1:3 on the stretch between Gloucester Street and Tomahawk lagoon. The pipe follows the existing natural fall of the land.

2.1.1 Site Visit

A site visit was not undertaken for this application as there was considered to be sufficient photographic evidence, plans and aerial mapping information of the site to understand the nature of the site.

3. Status of the Application

The applicant is unable to meet the permitted activity rule for stormwater discharge (12.B.1.8) as the discharge is from a stormwater system installed after 1998 and it may enter the Tomahawk Lagoon which is a Regionally Significant Wetland.

The discharge of stormwater to land in a manner that may enter a Regionally Significant Wetland is therefore a ***restricted discretionary*** activity under Rule 12.B.3.1 of the Regional Plan: Water.

It is noted that the applicant has various other stormwater outfalls within the Tomahawk Lagoon catchment however as these were installed prior to 1998, the discharge from these outfalls meets permitted activity rule 12.B.1.8.

4. Notification Status and Written Approvals

4.1 Section 95A Public Notification

Step 1: Is public notification mandatory as per questions (a) – (c) below?

(a) Has the applicant requested that the application be publicly notified? **No**

(b) Is public notification required by Section 95C? **No**

Has further information been requested and not provided within the deadline set by Council? **No**

Has the applicant refused to provide further information? **No**

Has the Council notified the applicant that it wants to commission a report but the applicant does not respond before the deadline to Council's request? ***No***

Has the applicant refused to agree to the Council commissioning a report? **No**

(c) Has the application been made jointly with an application to exchange recreation reserve land under section 15AA of the Reserves Act 1977? **No**

Step 2: Is public notification precluded as per questions (a) – (b) below?

(a) Is public notification precluded by a rule in the plan or a NES? **No**

(b) Is the application for one or more of the following activities but no other activities

- **(i)** A controlled activity? **No**
- **(ii)** A restricted discretionary, or discretionary activity, but only if the activity is a subdivision of land or a residential activity? **No**
- **(iia)** A restricted discretionary, discretionary or non-complying activity but only if the activity is a boundary activity? **No**
- **(iii)** A prescribed activity (see section 360G(1)(a)(i)? **No**

Step 3: Does the application meet either of the criteria in (a) or (b) below?

(a) Is the application for a resource consent for one or more activities, and any of those activities is subject to a rule or national environmental standard that requires public notification: **No**

(b) Will the activity have or be likely to have adverse effects on the environment that are more than minor in accordance with Section 95D? **No**

The adverse environmental effects on the environment from the proposal are discussed in Section 5 of this report. Based on this review, I consider that there will not be more than minor adverse effects on the environment (discounting the site and adjacent sites).

Step 4: Do special circumstances exist in relation to the application that warrant the application being publicly notified? No

4.2 Section 95B Limited Notification

Step 1

Section 95B(2) Are there any affected groups or persons identified under Section 95B(2)?

(a) Protected customary rights groups **No**

(b) Customary marine title groups **No**

Section 95B(3)(a) Is the proposed activity on or adjacent to, or may it affect, land that is the subject of a statutory acknowledgement made in accordance with an Act specified in Schedule 11? **No**

Section 95B(3)(b) Is a person to whom a statutory acknowledgement is made an affected person under Section 95E? **N/A**

Step 2

Is Limited Notification precluded under Section 95B(6)?

(a) Is the application for a resource consent for one or more activities, and each activity is subject to a rule or national environmental standard that preclude limited notification? **No**

(b)

(i) Is the proposal a Controlled Activity that requires consent under the District Plan (other than a subdivision of land)? **No**

(ii) Is it a prescribed activity under Section 360G(1)(a)(ii)? **No**

Step 3
Having regard to Section 95E of the Resource Management Act, identify persons who would be adversely affected by the proposed activity by effects that are minor or more than minor, but not less than minor and give reasons why affected parties were identified.

The following parties have been identified to be affected parties due to effects on them that are minor or more than minor for the reasons stated below. There are no circumstances that justify why it would be unreasonable to require these approvals to be obtained.

- Department of Conservation on behalf of the Director General of Conservation (DoC) due to effects on indigenous aquatic values and being the landowner of Tomahawk Lagoon;
- Otago Fish and Game Council (F and G) due to effects on sports fish values;
- Aukaha due to cultural effects associated with discharging to a Regionally Significant Wetland;
- Graham Robert Wheatley being the landowner of the discharge on land that they own; and
- Royal Forest and Bird Protection Society of New Zealand Incorporated due to conservation values associated with the Regionally Significant Wetland.

Written approval from Aukaha on behalf of Te Runanga o Otakou was provided for in the consent application when it was lodged. The written approval was provided on the basis that Te Rungana o Otakou understand that the applicant agrees that the following should occur;

- The applicant will undertake sampling for copper, zinc and lead and the outfall location along with sediments and water in the upper and lower Tomahawk Lagoon;
- That sampling be carried out at the outfall to test the discharge during a stormwater event. Once a baseline has been identified, it could then be determined whether further sampling should be undertaken, and if so, how frequently;
- That the applicant prepare and implement a planting plan that includes suitable indigenous plants to be tended until self sustaining; and
- That visual inspections of the outfall are undertaken on an annual basis.

Otago Fish and Game, DoC and Mr Wheatley provided unconditional written approvals to the application.

Have all persons identified as affected under Step 3 provided their written approvals No. Forest and Bird have indicated that they will not provide written approval to the application.

Step 4 Further notification in special circumstances
Do special circumstances exist in relation to the application that warrant notification of the application to any other persons not already determined to be eligible for limited notification under this section (excluding persons assessed under Section 95E as not being affected persons)? **No**

If Notification or limited notification is required, then has the applicant paid the additional notification fee? N/A

5. Assessment of Adverse Environmental Effects

5.1 Effects on scouring and erosion

The discharge of stormwater to land has the potential to scour land which may result in sediment reaching Tomahawk Lagoon. The primary mitigation measure to reduce discharge velocity and mitigate effects is the reno mattress and outfall baffle structures. The baffle structures slow the velocity of the discharge, which prevents scour and encourages sediment to drop out of the water. The reno mattress further slows the discharge, causing it to slow and spread out over the mattress. This means that water dissipates over the mattress instead of discharging directly to the lagoon. Council's Natural Hazards Unit have reviewed the application previously and raised no concerns. It is recommended by the Compliance Unit that the applicant annually provide evidence of any required maintenance to the structures.

5.2 Water and Sediment Quality Effects

Stormwater-derived chemical contamination in urban waterways is a common result of urban stormwater schemes. Benthic sediments often contain zinc and lead concentrations exceeding ANZECC (2000) Interim Sediment Quality Guidelines (ISQG) as well as polycyclic aromatic hydrocarbons (PAHs). Dissolved concentrations of heavy metals such as copper and zinc can also be present in the water column, particularly after wet-weather flows.

PDP reviewed this application on behalf of Council's Resource Science Unit (RSU). Currently, the water quality of the Tomahawk Lagoon is believed to be relatively poor with high levels of phosphorus and nitrogen recorded in the upper and lower lagoons. Reports of cyanobacteria and toxic algal blooms are common and it is believed that the primary cause of this results from historic pastural land-use practices such as aerial top-dressing with superphosphate.

Given that Tomahawk Lagoon is already experiencing significant adverse effects from anthropogenic inputs coupled with its morphodynamic state (i.e. shallow, distribution of sediment via mixing and flushing, and sea-barrier closure) it is important to ensure no additional contaminant loading occurs.

The applicant has proposed mitigation and remediation options including:

- Planting;
- Sumps and baffle structures;
- Reno mattress; and
- Educational advice to residents.

PDP concluded that these options are appropriate to attempt to reduce the contaminant loading and bioaccumulation on site however additional conditions have been proposed (discussed in Section6.5 of this report below).

5.3 Effects on Aquatic Ecological Effects

The lagoon appears to support significant numbers of native aquatic species, some threatened with extinction, and their associated habitats.

Changes in water and sediment quality from the proposed stormwater discharge could have significant adverse effects on the ecology of Tomahawk Lagoon if not monitored. PDP recommends that sampling should occur on a regular basis (including during stormwater events). This will enable prompt remediation options to be undertaken if adverse effects are observed.

The discharge is not direct into the Regionally Significant Wetland and the applicant has applied for a short-term consent to allow monitoring of the discharge. Further, the discharge has been occurring at the site for a number of decades with upgrades undertaken after the previous consent was issued in 2005. Given the scale and short-term nature of the discharge as well as the proposed mitigation, effects on aquatic ecological effects are considered to be no more than minor.

NOTIFICATION RECOMMENDATION:

In accordance with the notification steps set out above, it is recommended that the application proceed on a limited-notified basis.



Rebecca Jackson
Consents Officer
10 March 2020

Decision on notification

Sections 95A to 95G of the Resource Management Act 1991

Date: 10 March 2020

Application No: RM19.261

Subject: ***Decision on notification of resource consent application under delegated authority***

Summary of Decision

The Otago Regional Council decides that the application is to be processed on a **limited-notified** basis in accordance with sections 95A to 95G of the Resource Management Act 1991.

The above decision adopts the recommendations and reasons outlined in the Notification Report prepared Rebecca Jackson on 10 March 2020 in relation to this application.

We have considered the information provided, reasons and recommendations in the above report. We agree with those reasons and adopt them.

Decision under delegated authority

The Otago Regional Council decides that this resource consent application is to be processed on a **limited notified** basis on the parties listed above in accordance with sections 95A to 95G of the Resource Management Act 1991. This decision is made under delegated authority by:

Joanna Gilroy
Manager Consents
10 March 2020

Mat Bell
Team Leader Consents
10 March 2020

5.4 Assessment of alternatives

The applicant has considered alternatives which are detailed below:

Options	Comment
1. Requiring individual property owners to manage their own stormwater	Previously resulted in land instability issues
2. Placing the outfall further from the lagoon	Because of land instability upslope, it would contribute to land instability further
3. Collecting stormwater and pumping it to a different catchment	Would require a powered pump and would produce noise in a quiet residential area
4. Use of stormwater detention ponds or constructed wetlands	Could provide stormwater treatment and therefore improved discharge quality. Would require frequent maintenance and additional cost.

The applicant stated that options 3 and 4 could be investigated further if after monitoring it was determined that the discharge was causing unacceptable adverse environmental effects. As the current activity has not proven to cause an adverse effect on the environment, the options considered would incur cost to implement without measurable benefits. Therefore, the applicant has stated that the proposed approach is considered the best practical option.

6. Section 104 Evaluation

Section 104 of the Act sets out the matters to be considered when assessing an application for a resource consent. These matters are subject to Part 2, the purpose and principles, which are set out in Sections 5 to 8 of the Act.

As this application is for a discretionary activity, the Council may grant or refuse the application. If granting consent, the Council may impose conditions under section 108 of the Act.

6.1 Section 104 of the Act

The remaining matters of Section 104 to be considered when assessing an application for a resource consent are:
(a) the actual and potential effects on the environment of allowing the activity;
(ab) any measure proposed or agreed to by the applicant for the purpose of ensuring positive effects on the environment to offset or compensate for any adverse effects on the environment that will or may result from allowing the activity
(b) any relevant provisions of a national environmental standard, other regulations, a national policy statement, the Regional Policy Statement (RPS), the Regional Plan: Water (RPW); and
(c) any other matter the Council considers relevant and reasonably necessary to determine the application.

6.1.1 S104(1)(a) – Actual and potential effects on the environment of allowing the activity.

The actual and potential adverse environmental effects of the proposed activity were considered in Section 5 of this report. In addition to these adverse effects, it is considered that the proposal will have the following positive effect:

- Allows for the reticulation of stormwater in a residential area.

6.1.2 S104(1)(ab)

The applicant has proposed or agreed to the following measures to offset or compensate for adverse effects that will or may result from allowing the activity:

- Planting around the discharge outlet;
- Sumps and baffle structures;
- Reno Mattress; and
- Educational advice to residents.

6.1.3 S104(1)(b) Relevant Planning Documents

6.1.4 Regional Plan: Water for Otago (RPW)

The following policies from the RPW are relevant to this application:

- **Policy 7.B.2:** Avoid objectionable discharges of water or contaminants to maintain the natural and human use values, including Kāi Tahu values, of Otago lakes, rivers, wetlands, groundwater and open drains and water races that join them.
- **Policy 7.B.3:** Allow discharges of water or contaminants to Otago lakes, rivers, wetlands and groundwater that have minor effects or that are short term discharges with short term adverse effects.
- **Policy 7.B.4:** In considering the discharge of any contaminant to land, to have regard to the ability of the land to assimilate the water or contaminants; any potential for soil contamination; any potential for land instability; any potential adverse effects on water quality; and any potential adverse effects on use of any proximate coastal marine area for contact recreation and seafood gathering.
- **Policy 7.B.8:** Encourages adaptive management and innovation that reduce the level of contaminants in discharges.
- **Policy 7.C.2:** When considering applications for resource consents to discharge contaminants to water, or onto or into land in circumstances which may result in any contaminant entering water, to have regard to: the nature of the discharge and the sensitivity of the receiving environment to adverse effects; the financial implications, and the effects on the environment of the proposed method of discharge when compared with alternative means; and the current state of technical knowledge and the likelihood that the proposed method of discharge can be successfully applied.
- **Policy 7.C.4:** The duration of any new resource consent for an existing discharge of contaminants will take account of the anticipated adverse effects of the discharge on any natural and human use value supported by an affected water body, and will be up to 35 years where the discharge will meet the water quality standard required to support that value for the duration of the resource consent; will be no more than 15 years where the discharge does not meet the water quality standard required to support that value but will progressively meet that standard within the duration of the resource consent; will be no more than 5 years whether the discharge does not meet the water quality standard required to support that value; and no resource consent, subsequent to one issued under above will be issued of the discharge still does not meet the water quality standard required to support that value.

In this instance, the discharge is not continuous and will be offset by planting and the baffle structure. The applicant is applying for a short-term consent and will undertake monitoring during this time and consider alternatives. The application is considered consistent with the RPW.

6.1.5 Regional Policy Statement for Otago (RPS) and proposed Regional Policy Statement

The provisions of Chapter 5 (Land), Chapter 6 (Water) and Chapter 13 (Wastes and Hazardous Substances) of the operative RPS are relevant to this application.

- **Policy 5.5.5(c):** is to avoid, remedy or mitigate the degradation of groundwater and surface water resources caused by the introduction of contaminants resulting from landuse activities.
- **Policy 6.5.1(a) and Policy 13.5.1:** is to recognise and provide for the relationship Kai Tahu have with natural and physical resources when managing Otago's waste stream through taking into account their cultural values and working toward eliminating human waste and other pollutants from entering waterways.
- **Policy 6.5.5(d):** promotes a reduction in adverse effects of contaminant discharges into Otago's water bodies through promoting discharges to land where practicable.

The discharge of stormwater will not be continuous and will be localised. The discharge is to land and planting will take place to buffer the discharge to the nearest water source. Aukaha were considered affected to the application and provided their written approval. The application is generally consistent with these policies.

The proposed Regional Policy Statement (pRPS) was notified on 23 May 2015 and a decision was released 1 October 2016. The pRPS was appealed but none of the appeal matters are of relevance to this application [ports and mining and biodiversity]. The pRPS is substantially through the statutory process and must be given regard to. The pRPS needs to be given consideration and it is considered that significant weight can be given. The relevant provisions of the pRPS include:

- taking the principles of Te Tiriti o Waitangi into account (Policy 2.1.2)
- managing the natural environment to support Kāi Tahu wellbeing (Policy 2.2.1)
- recognising and protecting important sites and values of cultural significance to Kāi Tahu (Policy 2.2.2)
- managing for freshwater values including
    - Maintain or enhance ecosystem health in all Otago aquifers, and rivers, lakes, wetlands, and their margins
    - Maintain or enhance the range and extent of habitats provided by fresh water, including the habitat of trout and salmon
    - Recognise and provide for the migratory patterns of freshwater species, unless detrimental to indigenous biological diversity
    - Avoid aquifer compaction and seawater intrusion in aquifers
    - Maintain good water quality, including in the coastal marine area, or enhance it where it has been degraded
    - Maintain or enhance coastal values
    - Maintain or enhance the natural functioning of rivers, lakes, and wetlands, their riparian margins, and aquifers
    - Maintain or enhance the quality and reliability of existing drinking and stock water supplies
    - Recognise and provide for important recreation values
    - Maintain or enhance the amenity and landscape values of rivers, lakes, and wetlands
    - Control the adverse effects of pest species, prevent their introduction and reduce their spread
    - Avoid, remedy or mitigate the adverse effects of natural hazards, including flooding and erosion
    - Avoid, remedy, or mitigate adverse effects on existing infrastructure that is reliant on fresh water (Policy 3.1.1)
- identify and protect the significant values of wetlands (Policy 3.2.15 & 3.2.16)

The applicant consulted with Aukaha who provided their written approval to the application. The effects on the wetland and on freshwater values have been discussed previously and concluded to be no more than minor. Overall the application is generally consistent with the pRPS.

6.1.6 National Environmental Standard for Sources of Human Drinking Water

Regulations 7 and 8 of the National Environmental Standard for Sources of Human Drinking Water (NES) need to be considered when assessing discharge permits that have the potential to affect registered drinking water supplies that provide 501 or more people with drinking water for 60 or more calendar days each year.

Regulations 11 and 12 of the NES require Councils to place an emergency notification condition on relevant consent holders if it is assessed that the activity could pose a risk to the drinking water supply in the case of an unintended event (e.g., a spill or other accident). If the Council considers that such a risk exists, a condition must be placed on the consents that requires the consent holder to notify the drinking water supplier if such an event occurs. Regulation 11 states that Regulation 12 applies to activities with the potential to affect registered drinking water supplies that supply 25 or more people with drinking water for 60 or more days of a calendar year.

There are no registered drinking water sources within 3 kilometres of the discharge site. Given the distance, no adverse effects on these drinking water supplies are anticipated by this application.

6.1.7 National Policy Statement for Freshwater Management

The objectives and policies in the NPS-FM are relevant when considering a discharge permit application which may adversely affect freshwater. The following objectives and policies are considered most relevant to this application:

Objective A1: To safeguard the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems, of fresh water; and the health of people and communities, as affected by contact with fresh water in sustainably managing discharges of contaminants.

Objective A2: The overall quality of fresh water within a freshwater management unit (FMU) is maintained or improved.

The proposed discharge is to land rather than water, however it may enter a Regionally Significant Wetland. The discharge has been occurring for a number of decades and therefore will likely maintain but not improve water quality in the Lagoon. Planting between the discharge point and the wetland is proposed with an aim of up taking nutrients which may result in water quality being improved. However, this will only be known when ongoing sampling takes place. The application is not inconsistent with these policies.

Policy A1: requires changes to regional plans to establish freshwater objectives and set freshwater quality limits for all FMUs, and to establish methods to avoid over-allocation.

Policy A2: relates to FMUs that do not meet the freshwater objectives made under Policy A.1 and requires targets and implementation methods to improve water quality.

Policy A3 requires conditions to be imposed on discharge permits to ensure limits and targets specified in Policy A1 and A2 can be met and imposing rules that require the adoption of the best practicable option.

The Council has proposed a progressive implementation plan for meeting the NPS-FM and this includes developing a new land and water plan that will be notified by 2023 that includes objective and targets for FMUs in accordance with the requirements of Policy A1-A3 of the NPS-FM. A review condition has been recommended to allow conditions to be imposed on the discharge permit, if required, once the new land and water plan is fully operative.

6.1.8 Section 104(1)(c) Any other matters

The Kai Tahu ki Otago Natural Resource Management Plan 2005 (NRMP) is considered to be a relevant other matter for the consideration of this application. This is because the RPW is yet to be amended to take into account this Plan and this Plan expresses the attitudes and values of the four Papatipu Rūnaka: Te Rūnanga o Moeraki, Kāti Huirapa Rūnaka ki Puketeraki, Te Rūnanga o Ōtākou and Hokonui Rūnanga. The following objectives and policies are of most relevance to this application:

- To require monitoring of all discharges and that this be undertaken on a regular basis and all information, including an independent analysis of monitoring results, be made available to Kai Tahu ki Otago.
- To require that all discharge systems are well maintained and regularly serviced. Copies of all service and maintenance records should be available to Kai Tahu ki Otago upon request.
- To require visible signage informing people of the discharge area. Such signs are to be written in Maori as well as English.
- To require groundwater monitoring for all discharges to land.

The proposed discharge is not considered inconsistent with the above management plan. Monitoring of the discharge has been recommended, however groundwater monitoring has not; given the concerns are around surface water bodies. Signs have also not been recommended as the discharge is located on private land.

6.1.9 Section 124B Applications by Existing Holders of Resource Consents

The following criteria must be considered when a person who holds an existing resource consent makes an application within Section 124 timeframes
(a) the efficiency of the person's use of the resource; and
(b) the use of industry good practice by the person; and
(c) if the person has been served with an enforcement order not later cancelled under section 321, or has been convicted of an offence under section 338,
(i) how many enforcement orders were served or convictions entered; and
(ii) how serious the enforcement orders or convictions were; and
(iii) how recently the enforcement orders were served or the convictions entered.

The Compliance Unit reviewed the previous compliance history and raised no significant concerns. Enforcement action has not been taken in relation to this application.

6.2 Section 105 of the Act

Section 105(1) states for a discharge permit that the Consent Authority shall have regard to:
(a) the nature of the discharge, the sensitivity of the receiving environment, and the applicant's reasons for the proposed choice; and
(b) any possible alternative methods of discharge including discharge into any other receiving environment.

These matters were considered in Sections 2 and 5 of this report.

6.3 Section 107 of the Act

Section 107(1) of the Act states that a discharge permit shall not be granted if, after reasonable mixing, the contaminant or water discharged is likely to give rise to all or any of the following effects in the receiving waters:

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

The applicant has proposed a condition stating that the discharge will not give rise to any of the above effects. A condition of consent will require the discharge point to be 25 metres from the Lagoon. Planting will also be a requirement between the discharge location and the Lagoon which will create a buffer between the discharge and the Wetland.

6.4 Part 2 of the Act

This application to discharge treated wastewater to land is consistent with the purpose and the principles of the Act, as set out in Section 5. The proposed activity will have no more than minor adverse effects on the ability of the receiving environment to meet the reasonably foreseeable needs of future generations, or on the life-supporting capacity of the land or any ecosystem associated with it. Proposed consent conditions will ensure that any potential adverse effects of the activity will be avoided, remedied or mitigated.

The matters under Section 6 of the Act have been recognised and provided for. It is considered that there are no matters of national importance that may be affected by the proposed activity. The application is also consistent with the other matters of Section 7 of the Act and particular regard has been given to intrinsic values of ecosystems maintenance and enhancement of the quality of the environment. The proposed take is consistent with these matters, provided recommended consent conditions are adopted. Regarding Section 8, the proposed activity is not inconsistent with the principles of the Treaty of Waitangi.

Overall, the application is considered to be consistent with Part 2 of the Act, given the nature of the activity and the proposed conditions of consent.

6.5 Section 108 of the Act

In addition to the conditions proposed by the applicant, PDP have recommended the following conditions:

- An appropriate planting plan is prepared and planting completed within specified timeframe;
- Sumps are visually checked regularly and emptied with required. Fill should be tested for contaminants;
- The proposed reno mattress should be visually inspected every 6 – 12 months and maintained to ensure effective operation with records provided to ORC;
- Educational advice to residents should include litter, car washing, paint cleaning, pesticides/ fungicide use, and residential burning/ ash.
- Sediment and water sampling are completed within first year during a storm event.

7. Recommendation

That the Otago Regional Council grants to Dunedin City Council, Discharge Permit RM19.261.01, subject to the terms and conditions set out in the attached consent.

7.1 Reasons for Recommendation

1. The effects of the discharge permit are expected to be minor;
2. The activity is consistent with the relevant statutory requirements; and
3. The activity is consistent with Part 2 of the Act.

8. Term

The applicant originally applied for a term of consent of 35 years however amended this to 7 years. A 7 year term is considered appropriate as it will allow for monitoring of the discharge and will allow the applicant to consider treatment of the stormwater depending on monitoring findings.



Rebecca Jackson
Consents Officer

Decision on Resource Consent Application

Section 113 of the Resource Management Act 1991

Date: 12 May 2020

Application No: RM19.261

Subject: ***Decision on non-notified resource consent application under delegated authority***

Decision on non-notified resource consent application decided under delegated authority

Applicant:	Dunedin City Council
Activity:	To discharge stormwater to land in a manner that may enter a Regionally Significant Wetland
Location:	Tomahawk, approximately 310 metres east of the intersection of Gloucester Street and Spencer Street, Dunedin
Reason:	Disposal of stormwater from a residential area

1.1 Decision and Reasons for Decision

Pursuant to section 104B of the Resource Management Act 1991 ("the RMA"), the Otago Regional Council ("the Council") hereby **grants** resource consent subject to the conditions appended in RM19.261.

We have considered the information provided, reasons and recommendation in the above report. We agree with those reasons and adopt them.

1.2 Conditions (section 108)

Pursuant to sections 108 and 108AA of the RMA, this consent is issued subject to the attached conditions.

1.3 Decision under delegated authority

Under delegated authority, this resource consent application is granted by the Otago Regional Council by:

Joanna Gilroy
Manager Consents
7 May 2020



Peter Christophers
Principal Consents Officer
12 May 2020

Our Reference: A1330376 Consent No. RM19.261.01

DISCHARGE PERMIT

Pursuant to Section 104C of the Resource Management Act 1991, the Otago Regional Council grants consent to:

Name: Dunedin City Council

Address: Ground floor, Civic Centre, 50 The Octagon, Dunedin

To discharge stormwater to land in circumstances where it may enter Tomahawk Lagoon for the purpose of disposing of stormwater from a residential drainage scheme

For a term expiring 1 May 2027

Location of consent activity: Dunedin, approximately 315 metres east of the intersection of Gloucester Street and Spencer Street

Legal description of consent location: Part Section 15 Block I Andersons Bay SD

Map Reference: NZTM 2000: E 1409198 N 4914066

Conditions

Specific

1. The discharge must be undertaken and located as described in the application for consent lodged with the Consent Authority on 31 October 2019 and amendment to the application dated 20 February 2020. If there are any inconsistencies between the application and this consent, the conditions of this consent must prevail.

2. There must be no direct discharge of stormwater to Tomahawk Lagoon.

3. The discharge must not contain any human sewage.

Performance Monitoring

4. (a) The Consent Holder must ensure that the reno mattress below the outfall is inspected annually and maintained as necessary to ensure its efficient and effective operation at all times.
   (b) A record of this monitoring must be submitted to the Consent Authority in conjunction with the results of the monitoring required by Condition 5, or supplied upon request.

5. (a) Within one year of the exercise of this consent the Consent Holder must engage a suitably qualified professional to prepare a plan to characterise the quality of the stormwater discharge and its potential impacts on the Tomahawk Lagoon.
   (b) The professional must determine the contaminants to be monitored, the location of monitoring, frequency of monitoring and the types of samples to be collected.
   (c) The Consent Holder must provide the plan to the Consent Authority within one year of the consent being exercised.
   (d) The plan must be implemented by the Consent Holder and the Consent Holder must provide any results obtained to the Consent Authority annually.

6. (a) The sampling undertaken in accordance with Condition 5 must at a minimum include analysis of copper, zinc and lead; and must comprise both water and sediment samples from the Lagoon adjacent to the outfall, and from the Upper and Lower Tomahawk Lagoon
   (b) A sample must be taken at the outfall during at least one storm event within the first year of the exercise of this consent.

7. (a) The Consent Holder must prepare a planting plan that includes indigenous plants and provide a copy to the Consent Authority within 6 months of the exercise of this consent. The objective of the plan must be to aid in:
      (i) Uptake of heavy metals such as zinc, copper and lead as well as nutrients; and
      (ii) Site stabilisation, reduction of sediment mobilization and overland flow during stormwater events.
   (b) Planting must be carried out in accordance with this plan within 6 months of the plan being submitted to the Consent Authority. The ground must not be sprayed in preparation of this planting.
   (c) The Consent Holder must provide photographs of the planted area within 2 months of completion. Photographs must be in colour and no smaller than 200 x 150 millimetres in size and be in JPEG form.

8. (a) The Consent Holder must provide educational advice to all landowners whose properties are serviced by the residential drainage scheme, at intervals no longer than 2 years. As a minimum, the educational advice must emphasise the importance of keeping the stormwater system free of pollutants, explain potential impacts of pollutants in the receiving environment and outline the consequences of not cleaning out individual household sumps.
   (b) A record of the educational advice must be provided to the Consent Authority every two years and upon request.

General

9. The discharge, after reasonable mixing, must not give rise to all or any of the following effects in Tomahawk Lagoon:
   (a) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; or
   (b) Any conspicuous change in the colour or visual clarity; or
   (c) Any emission of objectionable odour; or
   (d) Any significant adverse effects on aquatic life.

10. The discharge must not cause erosion, land instability, sedimentation or property damage.

Review

11. The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the Consent Holder of its intention to review the conditions of this consent during the period of 1 February to 31 July each year, or within two months of any enforcement action taken by the Consent Authority in relation to the exercise of this consent, for the purpose of:
    (a) determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, if any of the effects described in condition 10 are more than minor and for condition 9, significant; or
    (b) Ensuring the conditions of this consent are consistent with any National Environmental Standards, relevant regional plans, and/or the Otago Regional Policy Statement.

Notes to Consent Holder

1. *If you require a replacement consent upon the expiry date of this consent, any new application should be lodged at least 6 months prior to the expiry date of this consent. Applying at least 6 months before the expiry date may enable you to continue to exercise this consent until a decision is made, and any appeals are resolved, on the replacement application.*

2. *It is an offence under S87 of the Heritage New Zealand Pouhere Taonga Act 2014 to modify or destroy an archaeological site without an Authority from Heritage New Zealand irrespective of whether the works are permitted or a consent has been issued under the Resource Management Act or Building Act.*

Issued at Dunedin this 12th day of May 2020



Joanna Gilroy
Manager Consents



Peter Christophers
Principal Consents Officer