# Whāngārei Harbour Water Quality Improvement Strategy

WHANGAREI DISTRICT COUNCIL

WAIORA NORTHLAND WATER

NORTHLAND REGIONAL COUNCIL

November 2012
Prepared by Northland Regional Council and Whāngārei District Council

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# Executive summary

Northland Regional Council and Whāngārei District Council are working together to increase our understanding of the sources, levels, and effects of contamination in the Whāngārei Harbour (the harbour), and to better coordinate our respective management efforts to improve its water quality.

Improving the quality of water in the harbour is a key priority of both councils. For Whāngārei District Council on-going investment in stormwater and wastewater infrastructure is expected to result in reduced loads of contaminants entering the harbour, and consequently an improvement in harbour health.

For Northland Regional Council improving water quality in the harbour and its contributing catchment is part of *Waiora Northland Water* – an important project that brings together all aspects of the regional council's functions and responsibilities for managing the region's water quality and quantity. These include implementing the National Policy Statement for Freshwater Management 2011 and the New Zealand Coastal Policy Statement 2010.

This strategy sets out the key findings of our joint project and a statement of intent of both councils to enhance its management going forward. Central to this is the development of a catchment management plan in collaboration with the community, including key stakeholders and iwi and hapū.

# 1 Introduction

## 1.1 Background

The Whāngārei Harbour (the harbour) lies at the centre of Whāngārei district, physically and culturally, and it has great economic and environmental importance to the Northland region.

Over the past several decades considerable effort has gone into improving the quality of water in the harbour. Major changes to the management of the harbour include:

1. Ending the discharge of very fine textured sediment from the Portland cement factory – prior to 1982 huge quantities were discharged direct to the harbour.
2. Progressive upgrades to the Whāngārei Wastewater Treatment Plant and the Okara Park and Hātea wastewater pump stations.
3. Reduction in reclamation and dredging upstream of Limestone/Matakohe Island due to the port moving from Whāngārei to Marsden Point, and dredged material from the upper harbour no longer being discharged to other parts of the harbour.

Monitoring undertaken by Northland Regional Council indicates improvement and good water quality in the middle and lower parts of the harbour. However, despite efforts to date water quality remains degraded in the upper harbour environment, particularly in the Hātea River arm.

Resolving water quality issues tends to be complex because in many cases there are multiple sources of contamination (direct and diffuse), competing uses and values, and substantial resources and commitment are often required.

In 2011, Whāngārei District Council and Northland Regional Council agreed to undertake a joint project to increase our understanding of the types and sources of contamination in the harbour, and to better coordinate our respective current and future management efforts to improve harbour water quality, especially in the upper harbour. This report documents our findings and agreed actions.

The project has similarities to previous work undertaken by Northland Regional Council in the late 1980s, which resulted in the completion of the Whāngārei Harbour Water Quality Management Plan 1990. That non-statutory plan recommended a number of actions or strategies to improve harbour water quality. The majority of these strategies were implemented and it is now out of date (see Appendix 1 for a brief history of the plan's implementation).

We expect that this strategy will be added to over time as information on the harbour and its water quality improves.

## 1.2 Purpose of this strategy

The overall purpose of this strategy is to enhance the management of water quality in the harbour. Its specific purposes include:

1. To provide an up-to-date overview of harbour water quality and the use and values associated with the harbour;
2. To identify information and knowledge gaps that need to be addressed in order to better manage direct and diffuse sources of contamination to the harbour and better allocate resources;
3. To establish/set out the agreed actions of both councils that will contribute to maintaining and improving the quality of water in the harbour.

## 1.3 Document structure

This document is structured as follows:

- Section 2 provides an overview of the harbour and its catchment, including information about its water quality related uses and values. It also outlines the policy and regulatory framework for managing activities that can impact on water quality.
- Section 3 describes the quality of water in the harbour, with a particular focus on the upper harbour and identifies information gaps.
- Section 4 identifies known and likely sources of key contaminants. This section also comments on the effectiveness of management approaches and identifies information gaps.
- Section 5 proposes three water quality objectives for the harbour. These are based on what we have heard from the community and an understanding that water quality is expected to improve as a result of recent and planned future actions of both councils.
- Section 6 identifies the important actions of both councils for improving water quality to achieve the proposed objectives.

Generally speaking, this document has been prepared for a wide audience. Whenever possible, technical details and background information have been minimised but some is still required.

## 1.4 Integration with other initiatives

This document supports two important related programmes (described below).

### 1.4.1 Waiora Northland Water

*Waiora Northland Water* is Northland Regional Council's programme for improving the management of water quality and quantity across the region. It brings together and coordinates a number of its water management functions and responsibilities, including its programme for implementing the National Policy Statement for Freshwater Management 2011 (NPS Freshwater).

The NPS Freshwater requires Northland Regional Council to include in regional plans freshwater objectives and associated water quality and quantity limits for all of the region's water bodies. It then requires the regional council to implement regulatory and non-regulatory actions to achieve the freshwater objectives and limits.

To fulfil these requirements Northland Regional Council has committed to an approach that involves setting a combination of catchment-specific limits in priority catchments and region-wide interim default limits for other water bodies. Because the majority of the region's major rivers drain to estuarine and harbour environments, catchment-specific objectives and limits will need to incorporate water quality objectives for their coastal waters.

The Whāngārei Harbour catchment is one of the first priority catchments identified in *Waiora Northland Water* for the development of a statutory catchment management plan. The catchment-specific objectives and limits, and management methods to achieve them, to be included in the plan will be collaboratively established with the community, key stakeholders, and iwi and hapū. The harbour catchment is also a priority work area for Northland Regional Council's land management team.

### 1.4.2 Whāngārei District Council Wastewater Management Strategy

Whāngārei District Council's wastewater infrastructure has been the source of public concern for some time due to discharges and overflows of poorly and untreated wastewater into the upper harbour during periods of heavy rainfall. In recent years, Whāngārei District Council has committed significant resources to upgrading the Whāngārei Wastewater Treatment Plant and its wastewater network. Its programme for improving the performance of the district's wastewater reticulation and treatment infrastructure is set out in its wastewater strategy.[1] This strategy has been developed in conjunction with the iwi/hapū/marae Resource Management Act practitioners group and others including the Department of Conservation, Northland District Health Board and Northland Regional Council.

[1] http://www.wdc.govt.nz/WaterandWaste/Wastewater/Documents/WWTP-District-wide-wastewater-strategy.pdf

# 2 The harbour and its catchment

## 2.1 Overview

The harbour is a drowned river valley/large estuarine[2] ecosystem located on the south-east coast of Northland, which receives runoff from an approximately 300 $km^2$ catchment[3]. The harbour is approximately 107 $km^2$ and is relatively shallow with an average high tide depth of 4.4 metres due to extensive intertidal flats. At low tide water covers approximately 54 $km^2$.[4]

There is a variety of environment types (habitats) within the harbour including saltmarsh, mangroves, seagrass, intertidal mudflats, subtidal beds, and sandy reefs.

The harbour can be understood as having three distinct areas:

1. The upper harbour – the area west of Matakohe/Limestone Island which includes the northern Hātea River arm and the southern Mangapai arm. The upper harbour receives approximately 70 percent of the catchment runoff and has been substantially infilled with sediment.

2. The middle harbour – the area east of Matakohe/Limestone Island to a line between Manganese Point and One Tree Point.

3. The lower harbour – the area east of the line between Manganese Point and One Tree Point to the harbour entrance.

The extent of the harbour catchment, the three areas of the harbour and other key features are shown in Figure 1 below.

Freshwater inputs are highest in the upper harbour – the receiving environment for runoff from approximately 70 percent of the harbour catchment – and progressively decline out to the lower harbour. Water in the upper harbour is subject to longer flushing[5] periods than in the middle and lower harbour areas.[6] Flushing periods and patterns impact on the rate at which contaminants are diluted and dispersed. For example, hydrodynamic modelling shows

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[2] The term “estaury” typically refers to the lower reaches of a river or other enclosed or semi-enclosed area where tide and rivers flows interact.

[3] A catchment refers to an area of land where water (normally surface water) flows to a single point. This point can be another waterbody, such as a prominent river, a lake, an estuary, or even a harbour.

[4] Wildland Consultants Ltd (June 2007). Ecological evaluation of current and proposed marine management zones in Whāngārei Harbour. *Prepared for Northland Regional Council.*

[5] Flushing refers to the time it takes a volume of water to leave a particular area.

[6] See Venus, G.C (1984). Physical Oceanography. Whāngārei Harbour Study. *Northland Harbour Board Technical Report. No. 1. pg25* estimated that flushing time is 20.4 tidal cycles (10.5 days) in the upper harbour,10.8 tidal cycles (5.6 days) in the middle harbour and 1.1 tidal cycles (0.6 days) in the lower harbour.

contaminants flow down the harbour during a falling tide before returning with the flood tide.[7]

## 2.1 Catchment description

Prior to humans the land surrounding the harbour was covered by a mix of indigenous forest and gumland scrub on podzolised soils.[8] Substantial wetlands were found in the lowlands, particularly near river mouths but also across much of the area now called Marsden Point/Ruakaka, parts of the lower Hātea River, and across much of the Otaika Valley. Mangroves were situated on the margins of the harbour, including around what is now the present-day Whāngārei central business district and old port area.[9]

Land-use change following the arrival of Polynesians around 600-700 years ago and subsequent European settlers from the mid-1800's included vegetation clearance for cultivation and timber extraction. Most of the suitable pastoral land was cleared by the early 1900's. The majority of the catchment's wetlands have been drained and considerable tracts of the harbour margins have been reclaimed for urban uses. Figure 2 below shows the main present day land uses around the harbour.

Today the greater catchment is home to approximately 52,000 people, most of them in Whāngārei city.[10] The population is projected to grow to just over 71,000 people by 2041. This level of population increase will likely increase pressure on the harbour environment, unless it is appropriately managed.

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[7] National Institute of Water and Atmospheric Research (2010). Whāngārei Harbour hydrodynamic and dispersion model. Contaminant dispersion simulations. Volume 1. *Prepared for Northland Regional Council by NIWA, Client Report: HAM2010-083.*

[8] Kauri would have long before podzolised the soil and killed off any forest.

[9] Florence Keene (1966). *Between Two Mountains: A History of Whangarei.* Auckland: Whitcombe and Tombs Ltd.

[10] Based on 2006 New Zealand Census data.

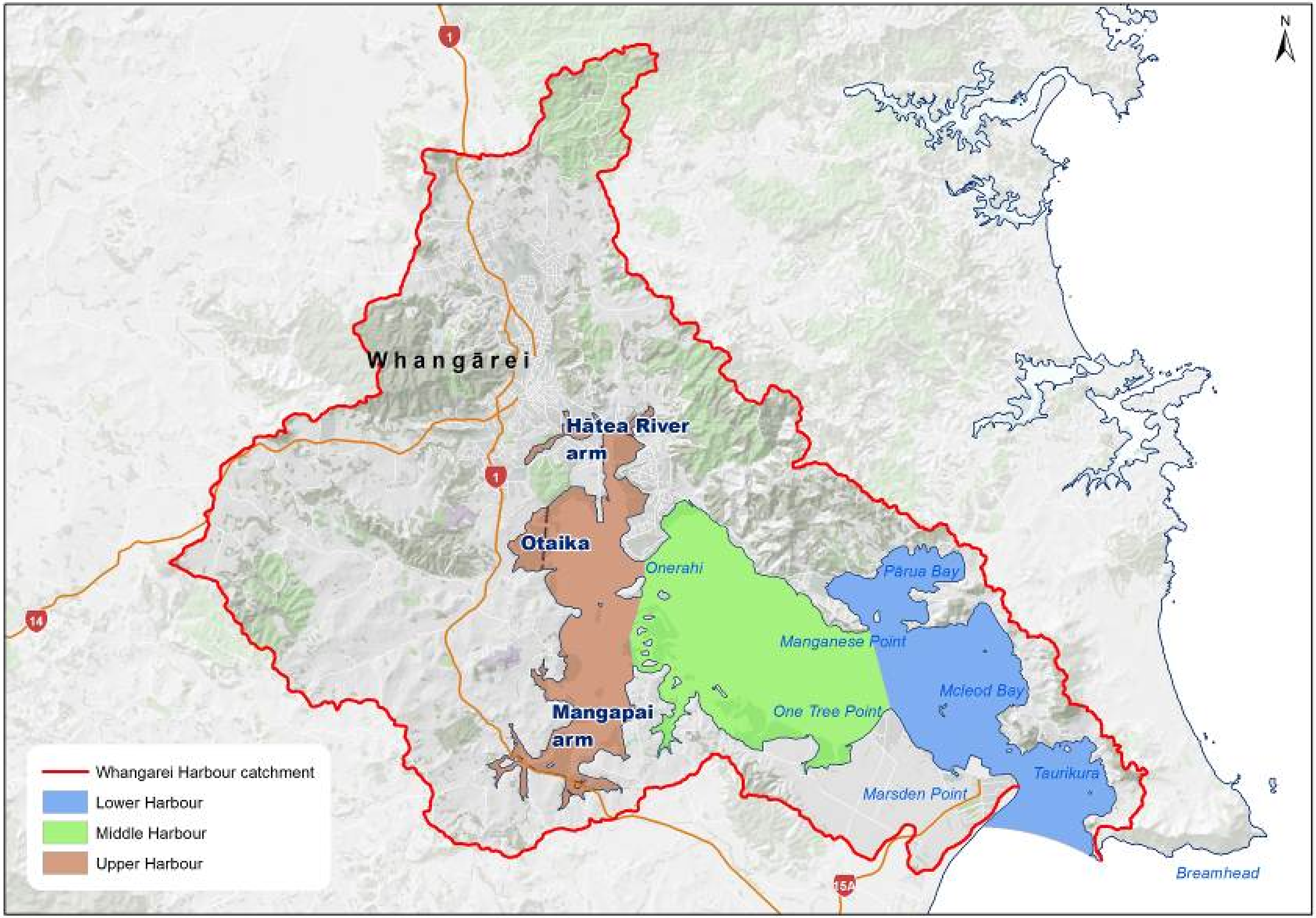


**Figure 1: The harbour and its catchment**

### 2.1.1 Sub-catchments

The harbour catchment is comprised of a number of sub-catchments. These are shown in Figure 2 on the following page and can be categorised as follows:

- Main river channels that discharge to the harbour, which include the Hātea and Otaika rivers.
- Large tributaries to main river channels that do not discharge directly to the harbour, which include the Waiarohia, Kirikiri, Raumanga, and Purewa streams.
- Amalgamated catchments comprised of minor streams that discharge to the harbour, which include the Whāngārei south, Marsden Point, Whāngārei east, and Onerahi catchments.

Brief descriptions of the sub-catchment are provided below.

#### 2.1.1.1 Hātea sub-catchment

The Hātea sub-catchment drains to the Hātea River arm of the upper harbour. It covers approximately 4,470 hectares (15%) of the greater harbour catchment. Land cover is a fairly even mix of urban land uses, exotic forest, indigenous vegetation, and pasture (including lifestyle blocks).

Its upper reaches are dominated by forestry (Glenbervie forest), lifestyle blocks (around Vinegar Hill, Glenbervie, and Whareora), and some remnant pastoral and horticultural land uses. Industrial land can be found in the Waitaua area at Springs Flat and along the lowest reaches of the river near the estuarine mouth. Its middle reach is surrounded by developed urban area. The lowest reach is dominated by retail, commercial and light industrial land uses around the central business district, and much of the area has been developed on reclaimed land.

Much of the floodplain areas (delta) of the lower Hātea River downstream of Mair Park have been reclaimed. During flood flows sediment would have been deposited in these areas. Now it is channelled straight to the harbour.

The number of people living in the sub-catchment has steadily increased, with approximately 17,500 in 2001 to 18,600 in 2006. This is projected to reach approximately 26,000 by 2041. Most of the development is expected to occur in the Tikipunga area.

#### 2.1.1.2 Waiarohia sub-catchment

The Waiarohia sub-catchment drains to the Hātea River. It covers approximately 1,890 hectares (6.4%) of the greater harbour catchment. Land cover is dominated by indigenous vegetation (54%), pasture (18%), and urban land uses (26%).

The sub-catchment is heavily vegetated above the Whau Valley reservoir, but becomes increasingly modified as it flows down through to the Whāngārei central business district. The Waiarohia Stream has been extensively redirected in its lowest reaches.

The number of people living in the sub-catchment has increased, from approximately 7,100 in 2001 to 7700 in 2006. This is projected to reach 10,200 by 2041. Most of this increase is likely to be the result of urbanisation below the Pukenui Hills, some lifestyle development in Whau Valley and some infill close to the central areas of Whāngārei

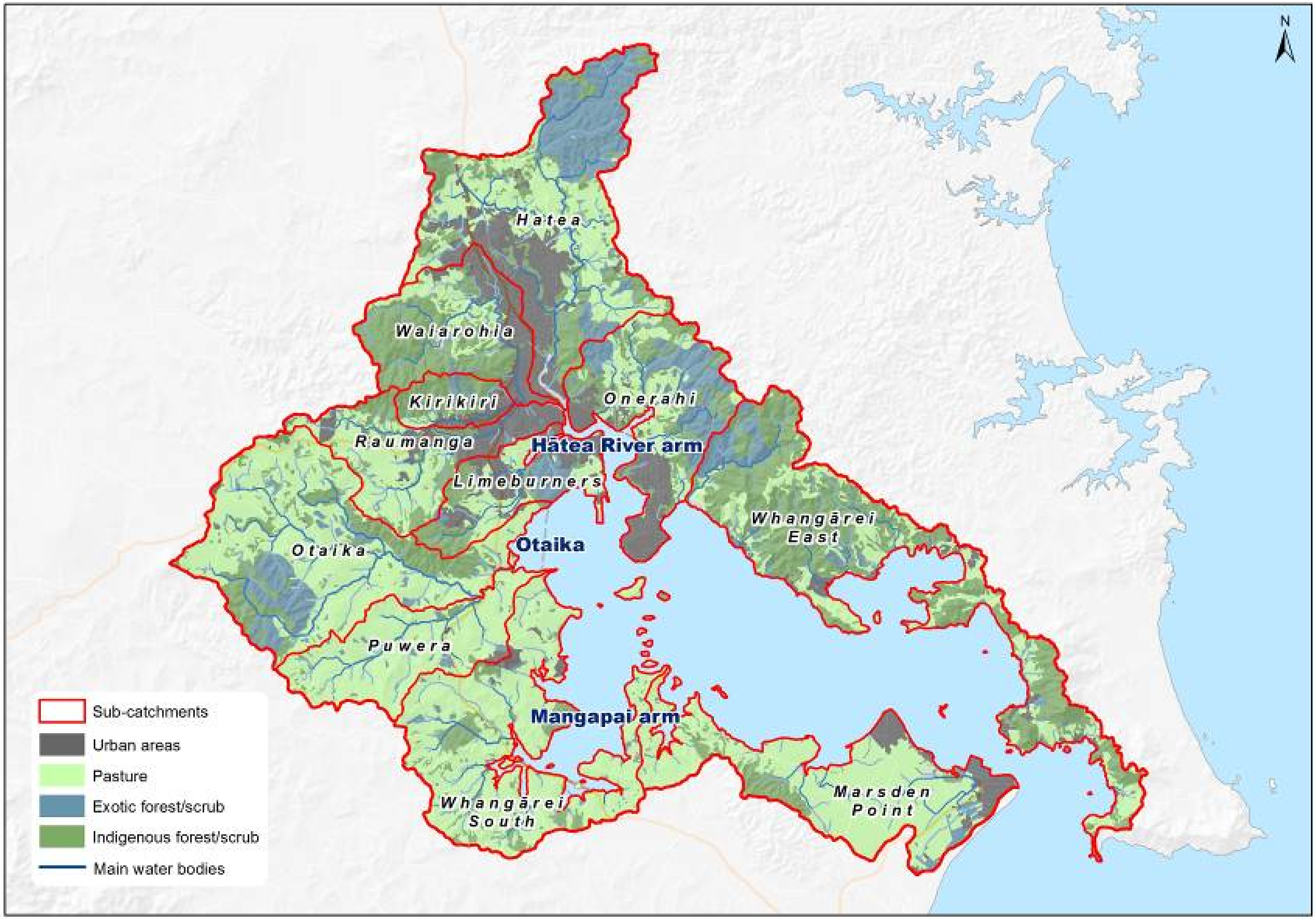


**Figure 2: Sub-catchments and main land uses**

#### 2.1.1.3 Kirikiri sub-catchment

The Kirikiri sub-catchment drains to the Hātea River via the lower reach of the Waiarohia Stream.  It covers approximately 560 hectares (1.9%) of the greater harbour catchment.  Land cover is dominated by indigenous vegetation (58%) and urban area (29%).

The number of people living in the sub-catchment has remained relatively stable, with approximately 3,500 in 2001 to 3,600 in 2006.  However, there have been a number of subdivisions in the sub-catchment in recent years, and the population is projected to reach 4,600 by 2041.

#### 2.1.1.4 Raumanga sub-catchment

The Raumanga sub-catchment drains to the Hātea River via the lower reach of the Waiarohia Stream.  It covers approximately 1,730 hectares (5.8%) of the greater harbour catchment. Land cover is dominated by pasture (49%), urban areas (27%), and indigenous vegetation (22%).

The number of people living in the sub-catchment has also increased, with approximately 5,000 in 2001 to 5,600 in 2006.  This is projected to reach 7,500 by 2041, with subdivision continuing to occur in the Raumanga and Maunu areas of the sub-catchment.  It is likely that the sub-catchment will see increased residential land-uses over time, along with continued industrial activities in the lowest parts of the sub-catchment.

#### 2.1.1.5 Limeburners Creek sub-catchment

The Limeburners Creek sub-catchment drains to the Hātea River arm of the upper harbour. It covers approximately 1,280 hectares (4.3%) of the greater harbour catchment.  Land cover is dominated by urban industrial and commercial areas (32%), grassed areas (30%), indigenous vegetation, forestry, and weeds (39%).  Increased commercial and industrial activity is likely within the catchment.  In 2006, approximately 2,400 people lived in the catchment.

The lower estuarine reach of Limeburners Creek is the primary receiving environment for treated effluent from the Whāngārei Wastewater Treatment Plant once it has passed through wetlands, and is classified as a mixing zone for this purpose in the Regional Coastal Plan.

#### 2.1.1.6 Otaika sub-catchment

The Otaika sub-catchment drains to the eastern side upper harbour.  It covers approximately 4,240 hectares (14.3%) of the greater harbour catchment.  Land cover is dominated by pasture (65%), indigenous vegetation (23%), and exotic forestry (11.5%).

The number of people living in the catchment has increased, with approximately 700 in 2001 to 800 in 2006.  This is projected to reach 1,300 by 2041.  Much of the population increase has been in lifestyle blocks, especially in the lower reaches. Over the last decade, a large number of lifestyle blocks have been established near the river in the middle parts of the catchment, and it is this type of development that is expected to continue.

#### 2.1.1.7 Puwera sub-catchment

The Puwera sub-catchment drains to the mid-point of the upper harbour via the lower reach of the Otaika River. It covers approximately 1,870 hectares (6.3%) of the greater harbour catchment. Land cover is almost entirely pastoral (92%), which is used for dairying and dry-stock farming and lifestyle blocks. Very little indigenous vegetation remains in the catchment and no significant indigenous riparian vegetation is evident.

The number of people living in the sub-catchment has remained relatively steady, with approximately 170 in 2001 and 180 in 2006. This is projected to increase to 300 by 2041.

#### 2.1.1.8 Whāngārei south sub-catchment

The Whāngārei south sub-catchment is an amalgamated catchment consisting of a large number of short streams that individually discharge directly to the southern half of the upper harbour (Mangapai arm). It covers approximately 3,720 hectares (12.6%) of the greater harbour catchment. Similar to the Purewa sub-catchment, its land cover is almost entirely pastoral (82%) for dairying and dry-stock farming. In 2006, approximately 1,200 people lived in the sub-catchment.

#### 2.1.1.9 Marsden Point sub-catchment

Marsden Point is another amalgamated catchment that has a large number of discrete minor streams, many of which are intermittent. Geologically, the area is a series of old sand dunes with peaty hollows between, as well as some larger peaty basins. These drain to the southern half of the lower harbour. The sub-catchment covers an area of 3,020 hectares (10.2%) of the greater harbour catchment. It is a fairly low-lying area and currently mainly pastoral (75%). While land cover is mainly grass there is scope for development in future years with the presence of a potential town centre and residential area all key future uses in the areas, and recognised in planning documents.

Wastewater from the townships of One Tree Point and Marsden Point is reticulated into the adjoining Ruakaka catchment where it is treated.

The number of people living in the sub-catchment has remained stable, with approximately 1,300 in 2001 to 1,400 in 2006. This is projected to reach 4,600 by 2041.

#### 2.1.1.10 Whāngārei east sub-catchment

The Whāngārei east sub-catchment is a strip of land on the northern shore of the middle and lower harbour stretching from Waikaraka Stream, immediately west of Onerahi, through to

Urquharts Bay at Whāngārei Heads. Like the Marsden Point and Whāngārei south sub-catchments, it is an amalgamated catchment consisting of many short streams. Most have permanent flows as they drain andesite rocks at Whāngārei Heads and greywacke from Parua Bay to Onerahi. In 2006, approximately 3,000 people lived in the sub-catchment.

The sub-catchment covers an area of approximately 4,390 hectares (14.9%) of the greater harbour catchment. Land cover is dominated by indigenous vegetation, exotic scrub, and weeds (60%), grassed areas (27%), and small coastal settlements (5%).

#### 2.1.1.11 Onerahi sub-catchment

The Onerahi sub-catchment is an amalgamated catchment comprised of several large streams that discharge directly to the eastern side of the Hātea River arm of the upper harbour, including the Waimahanga, Awaroa, and Waioneone streams. The sub-catchment covers an area of approximately 2,410 hectares (8.2%) of the greater harbour catchment. In 2006, approximately 7,200 people lived in the sub-catchment.

Land cover is a fairly even mixture of urban areas (21%), pasture (26%), indigenous vegetation (29%), and forestry (24%).

## 2.2 Values and uses of the harbour

The quality of water in the harbour has been a major concern of the community for some time.[11] Degraded water quality is understood to be impacting on its ecological values in the upper harbour and may be having adverse effects in parts of the lower harbour. Degraded water quality is also known to adversely impact on the recreational, cultural and spiritual values of residents. Degraded water quality may also have economic impacts in terms of reduced opportunities for fisheries and tourism. The effects of poor water quality on important uses and values of the harbour are discussed below.

### 2.2.1 Ecology

The harbour has a high diversity of estuarine vegetation types and extensive ecological sequences from intertidal flats to mangroves to saltmarsh to indigenous forest and shrubland. It also has sandy shell bank islands and small surrounding areas of wetlands. While some areas have been highly modified by reclamation, sedimentation, and drainage (for example, the Hātea River arm) much of the harbour remains in relatively good ecological condition.[12]

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[11] In the media, as submissions on Whāngārei District Council and Northland Regional Council long-term planning documents, as submissions on resource consent applications, and in iwi and hapū management plans.

[12] Wildland Consultants Ltd (2010). Ranking of Top Wetlands in the Northland Region, Stage 4 – Ranking for 304 Wetlands. *Prepared for Northland Regional Council by Wildland Consultants Ltd.*

The harbour supports a high diversity of wetland estuarine bird species, including 12 threatened or at risk species and many migrant bird species, and at times it provides feeding and roosting habitat for over 10,000 waders and shorebirds.

The harbour is ranked second of 49 estuaries in Northland for its ecological values,[13] the 10th most important harbour for shorebirds in New Zealand, and fifth-equal in importance for the endangered New Zealand dotterel.[14]

Estuaries can be considered as having two main ecological zones: the shallow margins (intertidal areas) and deeper central channels (sub-tidal areas). With regard to the harbour, its shallow margins comprise saltmarsh, mangroves, and seagrass habitats that support a diversity of invertebrates (worms, crustaceans, molluscs, etc.), which in turn support larger species such as fish and birds.

Other habitats include soft sediment intertidal flats and soft sediment sub-tidal beds. These are also very important components of the harbour ecosystem. Soft intertidal mudflats contain marine worms, snails, and other marine invertebrates and are a rich source of food for larger vertebrate species such as fish and birds. Similarly, sub-tidal areas contain shellfish in addition to other invertebrates, providing food for fish species.

Rocky reefs are not common in the harbour. Most examples have modest ecological values. Motukaroro (Passage Island) at the harbour entrance is an exception, where the combination of deep water and strong currents has shaped a rich community of reef fish and other species.[15] The locations of the key habitats in the harbour are shown in Figure 3 below, and further discussion is provided in saltmarsh, mangroves, and seagrass.

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NIWA (2005). An information review of the natural marine features and ecology of Northland. Prepared for Department of Conservation. *NIWA Client Report: AKL2005-30.*

[13] Wildland Consultants Ltd (2010). Ranking of Top Wetlands in the Northland Region, Stage 4 – Ranking for 304 Wetlands. *Prepared for Northland Regional Council by Wildland Consultants Ltd.*

[14] NIWA (2005). An information review of the natural marine features and ecology of Northland. Prepared for Department of Conservation. *NIWA Client Report: AKL2005-30.*

[15] *Ibid.* (as in the above footnote).

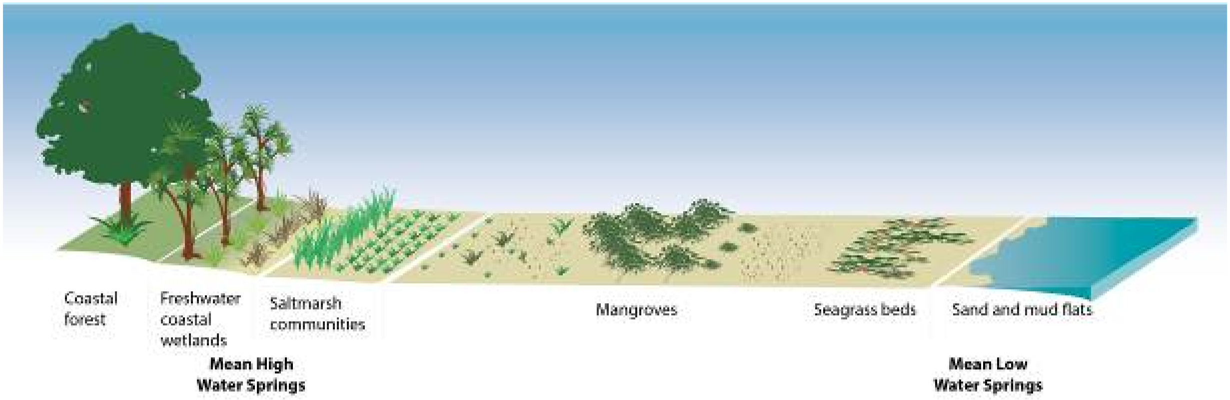

**Figure 3: Typical margin of an estuary**[16]

### 2.2.1.1 Saltmarsh

Saltmarsh is typically found landward of seagrass and mangroves in areas where there is very little wave action (low energy environments) and sediment is deposited (see section 3.2.1). Areas of saltmarsh provide important feeding and breeding grounds for birds, including some threatened bird species, and some are used by juvenile fish. Saltmarsh is an important buffer between land and water as it traps sediments and other contaminants during heavy rain.

The main plants found in local saltmarsh habitat are sea rush (*Juncus kraussii*) and jointed rush or oioi (*Apodasmia similis)*. Oioi was used by Māori for cladding on their homes, as was raupō (*Typha orientalis*), which is found in freshwater wetlands.[17]

Significant areas of saltmarsh have been lost around the harbour, mainly as a result of reclamations (for example, for roads around the harbour margins). Today saltmarsh can be found in a number of locations around the harbour, although its extent has been greatly reduced mostly due to reclamations and the altered hydrology of parts of the harbour. Figure 4 below shows the known locations of saltmarsh. However, it should be noted that saltmarsh is difficult to detect in aerial photos as it often intermingles with mangroves.

Not much is known about the relationship between coastal water quality and saltmarsh growth. However, poor water quality is likely to be much less of a factor for loss compared to reclamations and altered estuarine hydrology. Climate change may also pose a threat to saltmarshes as suitable growth areas will likely be reduced as sea level rises. Current areas may be colonised by mangroves as sea level rises.

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[16] Recreated from Turner, S. and Riddle, B. (2001). Estuarine Sedimentation and Vegetation – Management Issues and Monitoring Priorities. Environment Waikato Internal Series 2001/05. Document #: 686944.

[17] http://www.teara.govt.nz/en/estuaries/3

#### 2.2.1.2 Mangroves

Mangroves (*Avicennia marina*) are the most visible and high profile habitat type, covering approximately 1,580 hectares of the harbour margins.  Mangroves typically live in the intertidal margins of low-energy coastal and estuarine environments.  *Avicennia marina* has been in New Zealand for thousands of years.  Other species inhabited New Zealand coastlines in the past for around 19 million years.[18]

Prior to European settlement, mangrove flats covered a lot of the area about the present day Whāngārei central business district and other margins of the upper harbour.  Sarah Mathew, the wife of the Surveyor General, wrote in April 1840 of rowing up the "Wangaree" River and seeing high broken woods on one side and thickly fringed mangroves on the other side.[19] Gilbert Mair, one of the first European settlers to Whāngārei, was reported to have stated that on his arrival by boat to the harbour in 1843 that the mangroves (around the present-day Town Basin) were the prettiest he had ever seen.[20]  At the turn of the 19th century (around 1907) the margins of the Hātea River arm between Onerahi and the Town Basin were described in a survey plan as "mud flats covered with high mangroves", "sandy and mud flats", "mud flats and mangroves", "mud flats, sandy, low mangroves", and "mud and gravelly flats covered with low mangroves and rushes".[21]

It was reported later in 1925 that "[m]angrove flats, covered by sea-water at high tide, appear in every creek and sheltered inlet…The area covered by the growing mangroves depends on the extent to which each has been insilted".[22]  These descriptions would be equally appropriate today.

Over the first half of the 20th Century extensive areas around the central business district and the old port area were reclaimed, including by Northland Harbour Board.  Reclamations were also carried out in some other parts of the harbour.  As a consequence, some of the mangroves that once covered the shallow margins of the upper Hātea River arm around the present-day central business district are gone.

An analysis of aerial photographs of the harbour (dating from 1942) has revealed that there has been very little change in the overall distribution of mangroves in the harbour, and the area occupied by mangroves appears to have remained largely constant over time.  However,

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[18] Auckland Regional Council (2007).  The New Zealand mangrove: review of the current state of knowledge.  Technical Report 325.  *Prepared for Auckland Regional Council by NIWA.*
[19] Heritage Trail Panels, Whāngārei city Town Basin.
[20] Florence Keene (1966).  *Between the Mountains: A History of Whangarei.*  Auckland, Whitcombe and Tombs Ltd., pg30.
[21] David Alexander, (2006).  Northland Research Programme: Land-Based Resources, Waterways and Environmental Impacts.  Report to the Waitangi Tribunal, WAI 1040 Inquiry. pg543.
[22] Ferrar, H.T. (1925).  The geology of the Whangarei-Bay of Islands Subdivision, Kaipara Division. Department of Mines.  *Geological Survey Branch*, Bulletin No. 27 (New Series), W.A.G. Skinner, Government Printer.

mangroves have infilled tidal flats landward of mangrove stands bordering tidal channels and intertidal flats between Hewlett Point and Takahiwai. This has resulted in denser canopies, and some expansion within adjacent saltmarsh areas.[23]

It is generally recognised that elevated sedimentation is a key factor driving the expansion of mangrove stands. Increased inputs of nutrients, climate change and altered estuarine hydrodynamics (due to reclamation, for example) are also thought to contribute. [24] However, to date there is no conclusive evidence that nutrients are a key factor for mangrove expansion in New Zealand coastal margins. Altered hydrodynamics in the Hātea River arm is likely to be the key reason for mangrove infilling around Onerahi for example. Figure 4 below shows the current distribution and extent of mangroves in the harbour.

While mangroves are considered a nuisance by some people (due to their impacts on amenity and recreational values) they do provide a number of ecological benefits (ecosystem services), including: [25]

- Reducing sediment entering harbour waters, and in turn trapping associated contaminants such as phosphorus and heavy metals. Through trapping sediment, mangrove habitat may be promoting the return of seagrass to the middle and outer harbour;
- Playing a role in erosion control and shoreline stability;
- Providing effective, although not highly important, nursery grounds for some juvenile fish species;
- Providing marginal habitat for some bird species. No local bird species depend on the present mangrove habitat but some species regularly use them; and
- Providing an important food source (their decomposing leaves) for many other organisms, and in doing so forming one of the starting points in estuarine food webs.

It is interesting to note that a recent study on the Bay of Islands predicts large-scale loss of mangrove habitat as a consequence of sea level rise over the next century (5.5-8.8mm $yr^{-1}$)

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[23] Northland Regional Council unpublished data (2012). Note: Northland Regional Council analysed aerial photography of the harbour from 1942 and 2002-2004. This revealed that there has been very little seaward spread of mangroves within the harbour and no major establishment of mangroves in new areas. What has occurred is that many stands of mangroves and areas existing in 1942 have become much denser as a result of juvenile recruitment.
[24] Auckland Regional Council (2007). The New Zealand mangrove: review of the current state of knowledge. Technical Publication No. TP325. Prepared for Auckland Regional Council by NIWA.
[25] *Ibid*. (as in the reference above).

even despite sedimentation deposition rates.[26] According to the prediction, tidal creeks will provide refuges for mangroves as mangroves cannot establish below mean-tidal level. Such findings may also be relevant to the harbour.

#### 2.2.1.3 Seagrass

In New Zealand, seagrass (*Zostera capricorni*), also known as eelgrass, grows in many estuarine intertidal and sub-tidal areas, seaward of saltmarsh and mangroves. It is a marine flowering plant and a number of species are found worldwide.[27]

Internationally and locally, seagrass beds are considered to be a very important habitat with high productivity and biodiversity – indeed, they are of ecological significance. They play important roles in supporting recreational and commercial fisheries by providing shelter and food for a diversity of marine invertebrates and small fish and protecting other components of the ecosystems by binding sediment and reducing turbidity. Seagrass beds also support a wide range of other plant and animal species such as migratory birds.[28]

Recent research in Northland has found that seagrass beds are the most important nursery habitat of all estuarine habitats for a range of important species, particularly snapper. Interestingly, the research found that of 140 adult snapper caught commercially from Wellington to Ninety Mile Beach almost all of them (98%) spent their juvenile years in the Kaipara Harbour.

Seagrass relies on clean clear water to grow. High levels of suspended sediments cause water to be murky and reduce the depth that sunlight can penetrate. If seagrass is unable to receive sufficient sunlight then it struggles to grow and may die.

High nutrient levels in water can also reduce sunlight penetration by promoting excessive growth of phytoplankton (microscopic algae) in shallow water and the excessive growth of nuisance seaweed (large algae species) that can shade seagrass. While nutrients can affect water clarity they also play a key role in stimulating seagrass growth.[29] However, high concentration of some nutrient forms, such as ammonia, can be toxic to seagrass.

Seagrass meadows were once a large component of the harbour ecosystem (estimated to be around 1,200-1,400 hectares).[30] It is understood that areas around Takahiwai, One Tree

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[26] NIWA (2012). Sediment sources and accumulation rates in the Bay of Island and implications for macro-benthic fauna, mangrove and saltmarsh habitats. *Prepared for Northland Regional Council, Client Report 2012-048.*

[27] NIWA (2009). New Zealand seagrass – General Information Guide. NIWA Information Series No. 72.

[28] NIWA (2004). Feasibiity study to investigate the replinishment/reinstatement of seagrass beds in Whangarei Harbour – Phase 1. Prepared for Northland Regional Council by NIWA. Client Report: AKL2004-33.

[29] *Ibid.* (as in the above reference).

[30] *Ibid.* (as in the above reference).

Point, Snake Bank, Parua Bay and McDonald Bank were once covered with a thick layer of seagrass and would have been highly productive and rich habitats for shellfish and juvenile fish.

By the late 1960s, most seagrass meadows had disappeared in the harbour except for small remnant patches.[31] It is thought that the main causes of the disappearance were fine sediments discharged from the cement works and dredged sediments being dumped back in the harbour, which would have reduced water clarity and smothered seagrass beds. It has been estimated that between 1.23 million tons of sediment were discharged to the harbour between 1957 and 1967,[32] and a further 1.48 million tonnes between 1967 and 1981.[33] The peak year for discharge was 1967, when 250,000 tonnes of sediment were discharged to the harbour.[34]

In addition, dredged material from harbour channels used to be dumped at places like Snake Bank, off Takahiwai, and at the entrance to Parua Bay. This would have also contributed to reduced water clarity (see section 3.3.1 below). Dredging may have also altered the hydrodynamics of parts of the harbour, which in turn may have also contributed to the die-back. Another possible factor is a marine fungus (*Labyrinthula sp.*) which affects the growth of seagrass.[35]

Since 1982, a dry manufacturing process has been used at the Portland cement works and fine sediments are no longer discharged to the harbour, and dredged material is now discharged to land outside of the harbour.

The considerable loss of seagrass in the harbour likely had a significant impact on other species such as benthic invertebrates and birds, and in turn resulted in a negative cascade effect on the productivity of the harbour ecosystem.[36]

Seagrass is now returning to a number of places and good sized meadows can be found at Takahiwai, around One Tree Point, and recently in McLeod Bay. Figure 4 below shows the presently understood distribution and extent of seagrass in the harbour.

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[31] NIWA (2005). An information review of the natural marine features and ecology of Northland. *NIWA Client Report: AKL2005-30*; Morrison M. (2003). A review of the natural marine features and ecology of Whangarei Harbour. *Prepared by the Department of Conservation by NIWA.*

[32] J. A. Beck (1970). *Planning for the Utilisation of Water Resources: Whangarei Region,* Diploma of Town Planning Dissertation, University of Auckland, pg. 20. Cited in David Alexander, (2006). Northland Research Programme: Land-Based Resources, Waterways and Environmental Impacts. Report to the Waitangi Tribunal, WAI 1040 Inquiry.

[33] Northland Harbour Board (1989). *Whangarei Harbour Study.*

[34] *Ibid* (same reference as above).

[35] Northland Catchment Commission and Regional Water Board (1986). Whangarei Harbour Study.

[36] NIWA (2005). An information review of the natural marine features and ecology of Northland, *NIWA Client Report: AKL2005-30.*

It has been suggested that the regeneration of seagrass was aided by drought years in 2009-2010, as levels of suspended sediments in water were likely to be low during this period. Regrowth has also been assisted by transplantation initiatives led by the Kaitiaki Roopu of Whāngārei Harbour and Northport, and assisted by Northland Regional Council, local schools, and members of the community.

A feasibility study on the replenishment of seagrass meadows in the harbour stated that water clarity, water quality, and sediment condition are the key environmental parameters to target for restoring seagrass.[37] The study also went on to recommend that:

> *Improvements in these parameters are usually achieved by minimising the amount of suspended sediment, nutrients, and other contaminants in runoff and discharges to the harbour from its catchment. Council-led catchment management plans and/or community initiatives such as riparian plantings, treatment wetlands and erosion protection measures are the sort of methodology that can be considered to minimise these inputs.*

Of note, some limited research undertaken in the late 1970's suggested that the upper harbour area, when compared to the middle and lower harbour, is used most by fish, has the highest abundance of commercially important fish species, and is used by more species.[38] This is despite the absence of seagrass and reduced water quality in the area (see section 3.2). This may be due to the high productivity of these estuarine areas, which may be a factor of elevated nutrient levels (see section 3.2.3). These findings should be investigated as part of further surveys to see if they are still valid with the considerable regrowth of seagrass in the lower and middle parts of the harbour is recent times.

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[37] NIWA (2004). Feasibiity study to investigate the replinishment/reinstatement of seagrass beds in Whangarei Harbour – Phase 1. Prepared for Northland Regional Council by NIWA. Client Report: AKL2004-33.

[38] Mason. R., & Ritchie L. (1979). Aspects of the Ecology of Whangarei Harbour; *MAF*; Morrison. M. (2003). A review of the natural marine features and ecological of Whangarei harbour. *Prepared for the Department of Conservation by NIWA;* Wildland Consultants Ltd (June 2007). Ecological evaluation of current and proposed marine management zones in Whangarei Harbour, *Prepared for Northland Regional Council.*

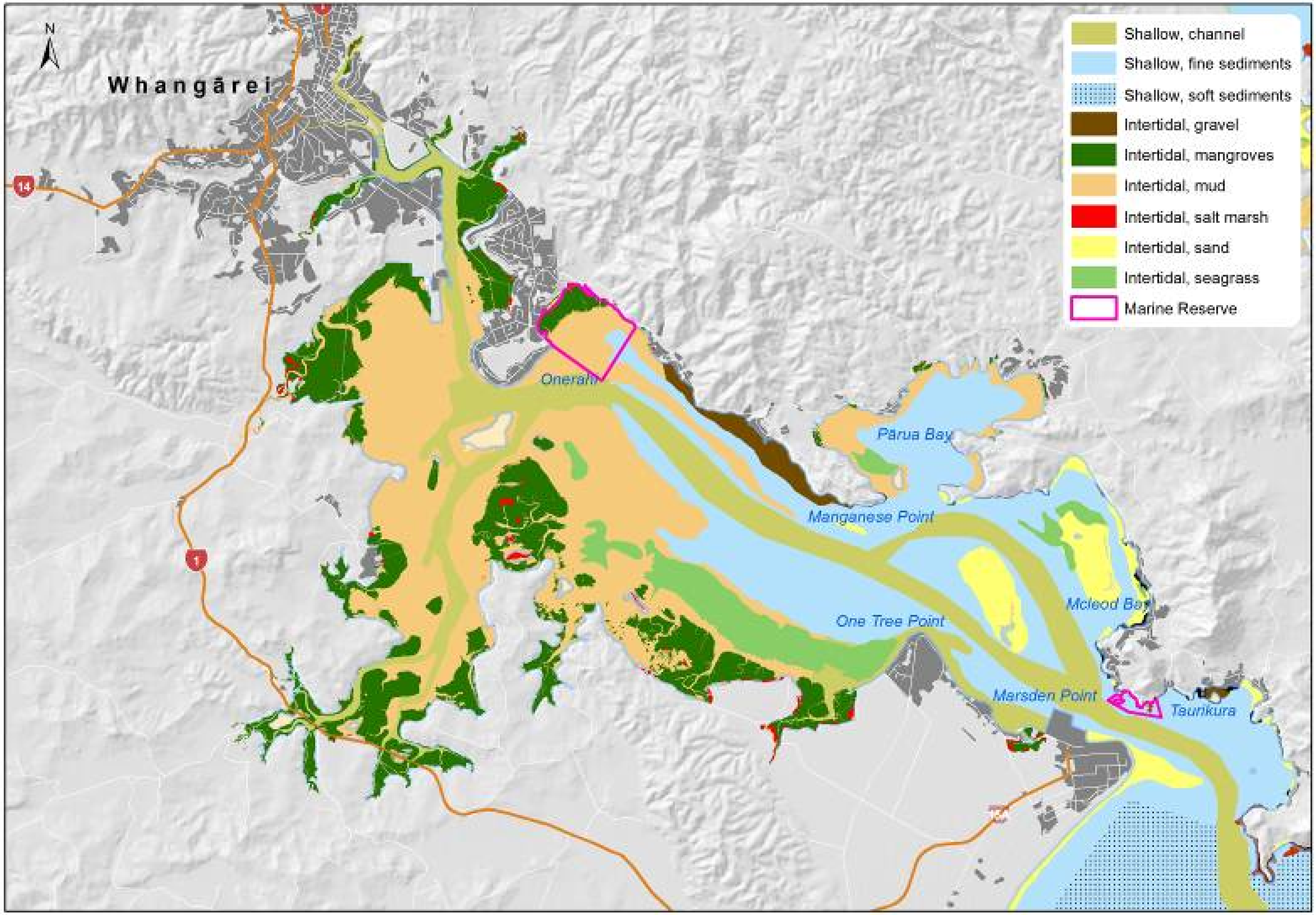


**Figure 4: Key habitats of the harbour**[39]

[39] Note: The image is based on Department of Conservation data and recent Northland Regional Council data; seagrass extent is indicative based on recent aerial photos and observation.

### 2.2.2 Recreation

The harbour is a place of great bounty and enjoyment. Water-based recreation in the harbour includes fishing, seafood gathering, sailing, waka ama, windsurfing, kayaking, rowing, stand-up paddle boarding, snorkelling, diving, and swimming.

Most of these activities are undertaken in the middle and lower harbour. Muddy intertidal flats, water quality issues (including poor water clarity), and limited public access (due to urban and industrial development) discourage primary contact recreation in the upper harbour. However, secondary contact uses such as waka ama (outrigger canoes), rowing, kayaking, and stand-up paddle boarding are common.

Recreational activities have been impacted by untreated wastewater overflows from the Whāngārei wastewater network and untreated and partially treated discharges from the Whāngārei Wastewater Treatment Plant during heavy rainfall. Recent upgrades to wastewater infrastructure and the on-going Whāngārei District Council wastewater management strategy are expected to reduce this issue over time (see section 4.1 for further discussion).

The harbour is a popular destination for domestic and overseas sailors, and is often the home of a number of international users. There are approximately 350 moorings and 430 marine berths in the harbour. Most of these are found in the Hātea River arm of the upper harbour and in the lower harbour at One Tree Point and Marsden Cove. There are also a small number of private jetties used for permanent mooring, most of which are in the Waiarohia Canal (the lower estuarine reach of the Waiarohia Stream).

There is increasing public access and use in the Town Basin environment as a result of extended walkways, the development of the second Hātea crossing (to be completed in 2013), markets, and new public amenities (for example, sculptures and playgrounds). The loop walkway (Heritage Trail), in particular, will allow for increased access to the harbour environment.[40] This revitalisation will allow the community to reconnect with the upper harbour.

Recreational uses associated with the streams and rivers that flow into the upper harbour are more limited than those associated with the harbour. A number of parks, reserves, and tracks can be found in the catchments, especially along the Hātea, Waiarohia, and Raumanga sub-catchments. A few streams, notably Otaika, are also used white-baiting.

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[40] http://www.wdc.govt.nz/TrafficandTransport/PublicTransport/Cycling/Documents/Whangarei-District-Walking-and-Cycling-Strategy-2012.pdf

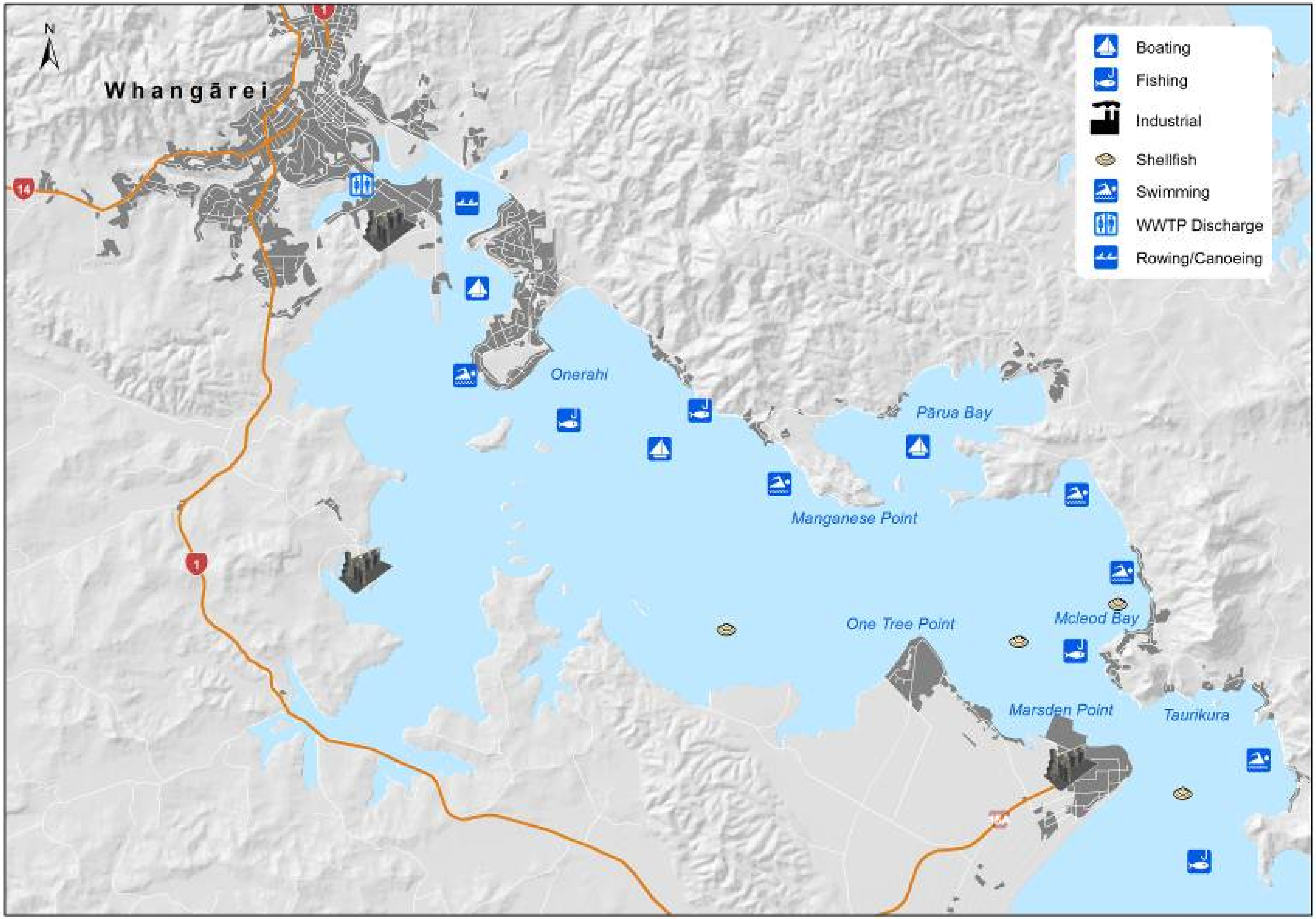


**Figure 5 Common uses of the harbour**

### 2.2.3 Economic and municipal

As noted previously, there are important economic values associated with the harbour. It is used as a means of transport for raw materials and goods, particularly by the New Zealand Refinery Company and Northport at the harbour entrance and Golden Bay Cement in the Mangapai arm of the upper harbour. There are also a number of light and heavy industrial uses in the Hātea River arm of the upper harbour, including boat maintenance facilities.

The lower harbour supports commercial pipi and cockle harvesting. The majority of New Zealand's recent commercial pipi catch has come from Mair Bank,[41] and a large proportion of New Zealand's commercial cockle catch comes from Snake Bank.[42] Commercial fin-fishing is prohibited in the harbour. Commercial fish catches from outside the harbour are landed at Port Road in the Hātea River arm and Marsden Cove. There is also a number of fishing charter boats based out of Marsden Cove.

The harbour was once famous for the numbers and quality of its oysters, which were managed by the government of the day to provide much needed income.[43] The best oyster grounds were on the northern side of the harbour, between Onerahi and the harbour entrance. Today there is only one small privately owned marine farm in the harbour at Parua Bay. Further aquaculture development has been prohibited from the harbour.

Importantly, the harbour is used as a receiving environment for contaminants from commercial and municipal sources, including municipal wastewater, stormwater and rural runoff, and rural sources. This is a value that has to be attributed to the harbour, and while it can be at odds with other values associated with the harbour it remains a very important use.

### 2.2.4 Maori cultural values

Whāngārei Harbour has a rich cultural history. Oral history tells us stories of Reitu and Reipae landing on the shores of Onerahi on the back of a Kārearea (native eagle), to those of Te Terenga Parāoa – the gathering place of whales, and later attributed to the gathering place of chiefs. These stories demonstrate the long association Māori have with the harbour and inland areas. In fact it is the story of Reipae from which Whāngārei takes its name.

> Ko te Tau***whanga a Rei***pae mō ōnā Tungane mō
>
> Te Kanapuiterangi raua Ko Kairangatira
>
> The Waiting Place of Reipae for her brothers

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[41] http://fs.fish.govt.nz/Doc/5578/PPI%201A_FINAL%2008.pdf.ashx
[42] http://fs.fish.govt.nz/Doc/22247/14_COC1A_2010.pdf.ashx
[43] David Alexander, (2006). Northland Research Programme: Land-Based Resources, Waterways and Environmental Impacts. Report to the Waitangi Tribunal, WAI 1040 Inquiry, pg561.

Te Kanapuiterangi and o Kairangatira[44]

Staying in Whāngārei, Reipae went on to marry a local chieftain, Tāhūhūpōtiki from whom all hapū of Whāngārei Te Terenga Parāoa claim descent.

Pā sites and villages dotted the coastal surrounds. From Ōruku, which occupied the bluff at the entrance to the harbour, to the Parihaka, north-east and rising above the Town Basin (and reputedly the largest Pā site in New Zealand) to Pūkawakawa Pā where the hospital now stands.[45] Whāngārei was occupied by this large connection of hapū /iwi descendants who carefully situated themselves around the busy harbour.

The harbour was integral to their life here as it served as a travel path to their northern and southern alliances, as a method of escape from warring parties from inland, and a natural protection from warring parties traveling in canoes. It also sustained them year round yielding a variety of seafood. The harbour was a means of trade and allowed safe passage and rest for European travellers who came and eventually settled here.

Well known as a mahinga kai site, the harbour was traditionally a very rich food source for local Māori, and as such it is treated as a taonga:[46]

> *Shellfish and whitebait were gathered around its edge, shellfish were harvested from the sandbanks, and finfish were netted or caught with hook and line...Finfish traditionally caught by Māori in the harbour include shark, snapper, trevally, gurnard, terakihi, kingfish, kahawai, mullet, flounder, herring, parore (mangrove fish), and inanga. Shellfish include pipi (including kokota), mussel, scallop, paua, cockles, mangrove oysters, and karahu (periwinkles).*

Today, the harbour and its surrounds are part of the overlapping rohe, or tribal boundaries, of three iwi: Ngapuhi, Ngati Wai, and Ngati Whatua.

Three hapū/iwi management plans relevant to the harbour have been lodged with Northland Regional Council. An iwi management plan is any planning document recognised by an iwi authority.

The Resource Management Act requires regional and district councils to take into account planning documents recognised by an iwi authority when preparing regional policy statements, regional plans, and district plans.[47] While this is not a statutory document there

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[44] Munro Taipari. Heritage Trail Panels, Māori history, Whāngārei city Town Basin.
[45] Ibid (as above).
[46] David Alexander (2006). Northland Research Programme: Land-Based Resources, Waterways and Environmental Impacts. Report to the Waitangi Tribunal, WAI 1040 Inquiry, pg538. Note: the list of kaimoana is a combination of the species mentioned in the evidence of Wiremu Eruera Pohe and Taparoto George, prepared in connection with a Resource Management Act application by Northland Port Corporation for a deepwater port at Marsden Point 1997.
[47] Resource Management Act 1991, ss61, 66, and 74.

are three management plans, which have been prepared by Ngati Wai, Ngati Hine, and Te Patuharakeke Te Iwi Trust that are of relevance to this strategy.

Two of the plans discuss the harbour:

> *An example of the damage to the mauri of water within the rohe of Ngatiwai is Whāngārei Terenga Paraoa Harbour. Prior to European contact the harbour boasted numerous annual visits of marine mammals. Now it has been turned into a dumping ground for fertiliser runoff, stock wastes, and sediment coming from farming operations; sediment from forestry activities and subdivision development; city stormwater runoff; and raw sewage from non-functioning pumping stations, and broken down and out of date pipe lines. The Whāngārei Town Basin – within the central city area of the harbour – requires regular dredging to maintain depth for visiting yachts. The dredged spoil then requires disposal. This is another concern to Tangata Whenua.* [48]

> *The once uncontaminated, white sand of the [southern, Takahiwai] foreshore has become a dense quagmire wreathed in Mangrove trees. The splendid places and sacred sites adjacent to the foreshore and seabed called Te Kopuawaiwaha, Toe Toe, Onemana, Motu Pomana, Mangawhiti, Waitoikoroa, Kuramakoroa, Ngatiti, Te Hopua, Takahiwai, and Motu Papa where generations of children who are Patuharakeke raced on horse back, swam, hunted, and collected seafood for redistribution to the extended families, survive no longer. The biological creatures of the harbour and its inlets, once prominent and plentiful, are sparse if not devastated by the effects of waste from the quarrying industry, the airline industry, the agricultural industry, the shipping industry, and the recreational industry. In other words, the presence of people and their activities have impacted adversely on the traditional food 'basket'; and the harbour and its waterways is a diminishing source of healthy, mouth-watering seafood, and curative waters. Places once covered in native bush, then cleared for Kauri logs and gum have been planted in grass while native bush clings to the hills called Pukekauri and Takihiwai.*[49]

The management plans also include a number of objectives that are relevant to the harbour, including objectives on:

- Protecting and enhancing its mauri;
- Maintaining and enhancing its indigenous biological diversity; and

[48] Te Iwi o Ngatiwai (2007). Iwi Environmental Policy Document, p19.
[49] Te Patuharakeke Iwi Environmental Plan (2007) p13.

- Improving its ability to provide kaimoana for manuhiri and health and wellbeing for existing and future generations.

There is also currently a treaty settlement relating to the harbour catchment which has legislative requirements of both the Whāngārei district and Northland regional councils. The Ngati Pukenga Claims Settlement Act 2013, whilst centred in the Tauranga area, has a Statutory Acknowledgement in the harbour which recognises that they were once inhabitants here.

## 2.3 Managing harbour water quality

Northland Regional Council is responsible, under the Resource Management Act 1991 (RMA), for managing the quality of the region's fresh and coastal water resources by controlling discharges and land use activities that impact on water.

Whāngārei District Council, on the other hand, is responsible, under the Local Government Act 2002 and the Health Act 1956, for the maintenance and provision of public water services, including water supply, stormwater drainage, and wastewater reticulation and treatment. It is also responsible, under the RMA, for managing subdivision and development generally. Integrating the functions of both councils for managing the use of land is important to ensure effective management of water quality.

Contaminants enter the harbour from point source (direct) and non-point source (diffuse) discharges. Direct discharges are sources of contaminants that discharge from discrete points or identifiable localised areas. These include discharges from municipal stormwater and wastewater reticulation and treatment infrastructure, industrial discharges, and farm dairy effluent.

### 2.3.1 Direct discharges

Direct discharges to the harbour are controlled by rules in the Regional Coastal Plan whereas direct discharges to land and freshwater in the harbour catchment are controlled by rules in the Regional Water and Soil Plan.

The Regional Coastal Plan classifies areas of the harbour for different water quality purposes and includes water quality standards for each classification[50]. The classifications are:

- General Quality Standard (CA) – provides for virtually all uses, including shellfish collection and protection of marine ecosystems.

[50] These classifications have been revised several times over the years. The harbour was first classified by the now defunct Pollution Advisory Council in December 1963, and later in accordance with the Water and Soil Conservation Act 1967. The current classifications in the Regional Coastal Plan are based on the boundaries recommended by the Whāngārei Harbour Water Quality Plan 1990.

- Contact Recreation Standard (CB) – provides for contact recreation and shellfish collection (but not for marine ecosystems).

Two mixing zones for major discharges are also identified in the Regional Coastal Plan. These are for the discharge from the Whāngārei Wastewater Treatment Plan and stormwater from the Marsden Point Refinery. Mixing zones are a mechanism in law that allows for discharges to benefit from mixing/dilution before meeting water quality standards. The classifications are shown below in Figure 6.

The Regional Coastal Plan includes the expectation that these standards are to be met at all times. However, they do not provide the basis for controls (at least not explicitly at present) on discharges and land uses that affect the quality of streams and rivers that drain into the harbour.

It is also important to note that as a result of a consent process under the Resource Management Act, a direct discharge to the harbour does not necessarily have to meet the relevant classifications and standards after reasonable mixing. However, it would be unlikely in today's environment that consent would be granted for discharges that would result in large departures from the water quality classifications and standards. A more common type of discharge that does not normally meet water quality classifications and standards and are normally consented is one that results from rain events, such as stormwater discharges. One of the main reasons that such discharges are granted is that their adverse effects are normally limited in both duration and frequency. Overall, the classification system has not been particularly effective at preventing contamination.

Whāngārei District Council's Stormwater Management Bylaw 2008, Wastewater Bylaw 2008, and Trade Waste Bylaw 2012 regulate the volume and quality of contaminants being discharged into its stormwater and wastewater networks upstream of final discharge points to streams, rivers, and the harbour. The bylaws assist in maintaining the on-going performance of the infrastructure and assets. They also help Whāngārei District Council meet rules in the Regional Water and Soil Plan and Regional Coastal Plan and resource consents.

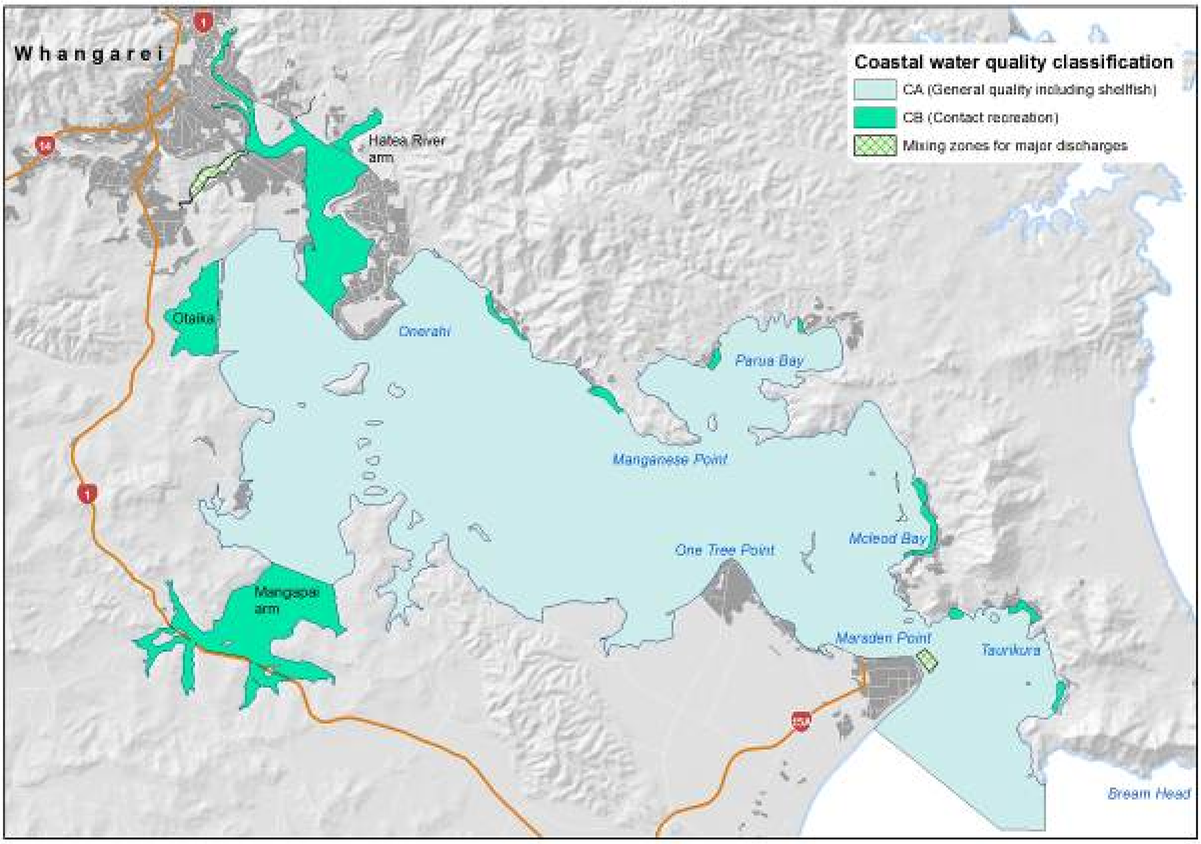


**Figure 6: Harbour water quality classifications and standards**

### 2.3.2 Diffuse discharges

Diffuse discharges typically arise from land use activities that are spread across a catchment. Diffuse contaminants enter the harbour via runoff to streams and rivers and sub-surface drainage (leaching). Diffuse sources include runoff from agricultural land and plantation forestry, stock access to water bodies, and stormwater runoff from areas that are not reticulated, including from some roads (without drains) and road banks, which can be a significant source of sediments.

Managing diffuse discharges is challenging compared to managing direct discharges. This is due to difficulties around measuring diffuse source contaminant loads, and often individual sources (for example, a discrete piece of land) are only responsible for a small proportion of the total contaminant load entering the harbour. There are also technical – such as establishing, with a good deal of certainty, direct links between adverse effects and the sources[51] – and political challenges associated with regulating land use activities for water quality purposes.

[51] http://www.qp.org.nz/plan-topics/surface-water-quality.php

The Regional Coastal Plan and Regional Water and Soil Plan contain only a few rules relating to diffuse source contamination, yet both have objectives and policies requiring the maintenance of water quality. For example, stock access to the riparian margins of streams and rivers is a permitted activity subject to conditions; only vegetation clearance and earthworks are regulated on erosion-prone land; and fertiliser application rates are not controlled. However, there is growing attention to these sources in water resource management.

Further discussion on the management of direct and diffuse source of contamination in the harbour is provided in Section 5 below.

# 3 Water quality in the harbour

Humans have been living in and modifying the harbour catchment for around 700 years. Over time, this has impacted its water quality and ecology.

The most pervasive and visible contaminant in the harbour is sediment from the accelerated erosion of catchment soils. In New Zealand, major changes have occurred in estuarine ecosystems over the last several hundred years due to large-scale clearance of native forests by people. Deforestation began soon after the initial colonisation by Polynesians around 1300 A.D and accelerated shortly after the arrival of European settlers in the 1800s.

Based on research in similar estuaries and harbours in the upper North Island, such clearance has resulted in increased sedimentation rates and a change in the texture of sediment entering the harbour.

Wastewater contamination in the harbour is also a long-standing concern. Human habitation has also resulted in elevated loadings of nutrients, organic compounds, heavy metals, and faecal pathogens in localised areas of the harbour. As the population grew, particularly in Whāngārei city, untreated domestic and factory wastes were discharged directly to the harbour either directly or through streams. For example, the Whāngārei freezing works at Reotahi used to discharge large volumes of abattoir waste direct to the entrance of the harbour. It wasn't until the Waters Pollution Act 1953 that direct discharges began to be "properly" regulated,[52] and more scrutiny was given to materials such as paints and pesticides over the following decades.[53]

[52] Parliamentary Commissioner for the Environment (2012). Water quality in New Zealand: Understanding the science.

[53] From about 1900 and until 1914, Whāngārei was one of New Zealand's most important fruit growing districts, and had the biggest output in the Dominion. See Florence Keene (1966). *Between Two Mountains: A History of Whangarei.* Auckland, Whitcombe and Tobs Ltd. Copper and other heavy metal-based pesticides and herbicides were used to treat disease.

Contaminants can have varying impacts on human health, amenity values, and ecosystems. For example, while levels of faecal bacteria are very important for assessing public health risks associated with contact recreation or shellfish gathering, they are not known to affect aquatic ecosystems. Alternatively, high levels of nutrients are known to impact on aquatic ecosystems but have limited affect in terms of public health. Toxic algal blooms are an exception to this.

The remainder of this section describes harbour water quality and how it is likely to be affecting the uses and values.

## 3.1 Current monitoring of the harbour

Northland Regional Council currently undertakes a range of monitoring programmes in the harbour and the water bodies in its catchment, including:

- Harbour Water Quality Monitoring Programme (1986 - present). In the current programme, 16 sites in the harbour are monitored bi-monthly for a number of parameters including temperature, salinity, water clarity, dissolved oxygen, faecal bacteria indicators, and nutrients. Some parameters have only been recently included.[54] The sites were selected to capture the main freshwater inputs to the harbour and to ensure a good geographical spread throughout it. The site locations are shown in Figure 7 below. More information can be found at:

  www.nrc.govt.nz/coastalWQ

- Coastal Sediment Monitoring Programme (1985 - present). Levels of heavy metal in sediment and the physical characteristics of sediments are monitored at 16 sites in the harbour every two years. In the past it was sporadic. Sediment samples are analysed for sediment grain size (that is, the proportion of mud to sand) and concentrations of total cadmium, total chromium, total copper, and total zinc. The site locations are shown in Figure 7 below. More information can be found at:

  www.nrc.govt.nz/coastalWQ

- Estuary Monitoring Programme (2008 - present). Biological communities of four representative sites in the upper harbour together with the physical (sediment particle size) and chemical properties (nutrients and heavy metal contaminants) of the sediment are monitored annually. The site locations are shown in Figure 7 below. More information and full results can be found at:

[54] Water quality monitoring has been carried out by Northland Regional Council since 1986. However, the monitoring programme has been adapted and changed during this period in response to changes in best practice and recommended guidelines, and changes to the objectives for collecting data. The programme was last updated in 2008 with the inclusion of total phosphorus, dissolved reactive phosphorus, ammonia, and nitrite-nitrate nitrogen as water quality parameters.

www.nrc.govt.nz/coastalcasestudy

- River Water Quality Network Monitoring Programme (1996 – present). The programme includes 27 river sites throughout Northland. The sites were chosen to provide a representation of water quality across catchments of different geology and land cover. Water at these sites is measured for a wide range of parameters. Five sites are measured in the upper harbour sub-catchments: one site on the Hātea River, two sites on the Waiarohia Stream, one site on the Purewa Stream, and one site on the Otaika River. More information and results can be found at:

  www.nrc.govt.nz/riverdata

- Recreational Swimming Water Quality Programme (2002/03 - present). The programme is a joint initiative administered by Northland Regional Council in partnership with Northland District Health Board and the region's three district councils. The aim of the programme is to provide information on water quality at popular freshwater and coastal swimming sites in Northland to allow the public to make an informed decision about where to swim. Five popular swimming sites in the harbour and sites on the Hātea River and Raumanga Stream are monitored as part of this programme. Monitoring reports and more information can be found at:

  www.nrc.govt.nz/swimming

Compliance monitoring is also undertaken as part of meeting conditions of resource consents and large number of one-off studies on the harbour undertaken over the past several decades.

The data obtained through these programmes and consent monitoring has been used to provide an overview of water quality in the harbour. Figure 7 below shows the monitoring site locations identified in this report.

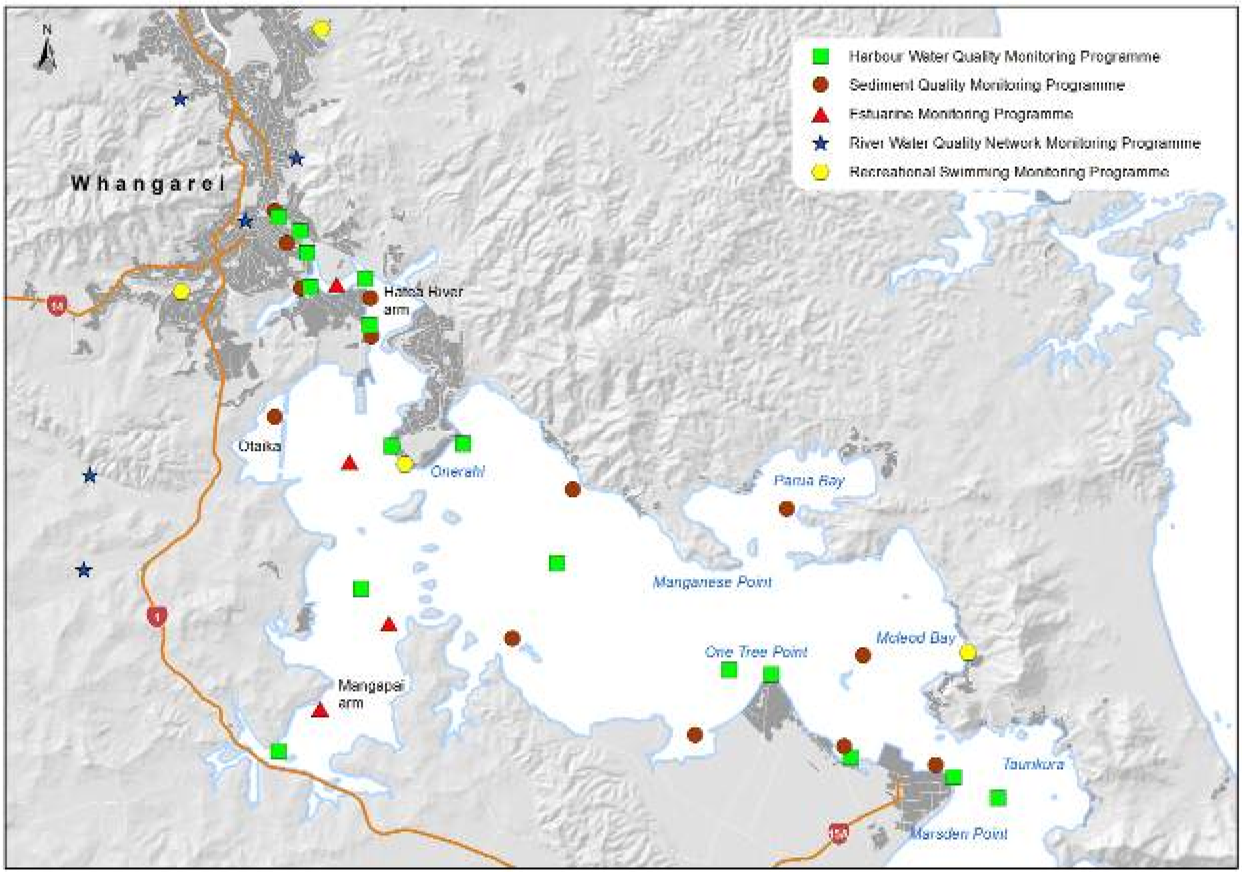


**Figure 7: Monitoring sites in the harbour and its catchment**

## 3.2 Water quality and the harbour ecosystem

The ecological health, or integrity, of the harbour ecosystem is related to a number of environmental factors including, but not limited to, the availability of suitable habitat types (for example, seagrass, saltmarsh, and mangroves), key species, seabed conditions (for example, sediment texture) and, importantly, high water quality. It is important to note that the relationship between ecosystem health and environmental factors is often very complex and unpredictable.

In the harbour the water quality parameters of concern in terms of ecological health are sediments, nutrients, and, to a lesser extent, some heavy metals[55]. Faecal pathogens are not known to affect aquatic ecosystems. The state of harbour water quality from a human health perspective is discussed in section 3.3 below.

[55] Note: elevated levels of heavy metals can be indicators of the presence of other contaminants such as organic chemicals and generally come from urban areas.

### 3.2.1 Sediments

Sedimentation is a natural process that involves rain washing soil and other small particles from both urban and rural environments into waterways and into coastal waters. Sedimentation rates are mainly influenced by geology, soil types, climate, and land uses.

Elevated sedimentation rates are understood to be one of the biggest pressures on estuarine environments in Northland.

#### 3.2.1.1 Suspended sediments

While sedimentation is a natural process, excessive levels of sediment can have significant impacts on aquatic ecosystems. Before settling on the harbour floor, suspended sediment decreases water clarity which restricts light transmission in the water column, and therefore affects photosynthesis (primary production) in aquatic plants and algae. Seaweeds and seagrass typically require more light for photosynthesis than phytoplankton and are particularly susceptible to increased concentrations of suspended sediments because they are attached to the seabed.[56]

Increased concentrations of suspended sediments can also have negative impacts on aquatic species such as shellfish and fish. Suspended sediment can clog gills and reduce feeding efficiency. [57]

Northland Regional Council monitors levels of suspended sediments using two indicators (secchi and turbidity). Turbidity, which is a measure of light transmission through water, is the principal indicator. Monitoring information shows that water in the upper harbour, particularly close to rivers and streams draining into it, has the highest turbidity (lowest clarity) in the harbour during and soon after rain. However, while clarity is low, recorded turbidity appears to be within guideline levels.[58]

Higher levels are to be expected in the upper harbour because it is the receiving environment for the majority of the runoff from the greater catchment. A lot of suspended sediment also settles out of the water column in the upper harbour by the process of flocculation, and therefore does not enter the middle and lower harbour. This process normally occurs where freshwater and salt water meet, where a number of factors such as changes in water density, pH, and temperature cause suspended sediments to bond together and settle.

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[56] Thrush, et al (2004). Muddy waters: elevating sediment input to coastal and estuarine habitats. Frontiers in Ecology and the Environment 2: pp299-306.
[57] *Ibid.* (same as above reference).
[58] ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1. Australian and New Zealand Environment and Conservation Council states that turbidity should be below 10 NTU.

It is thought that colloidal clay from old weathered soils in the Hātea and Raumanga sub-catchments, and to a lesser extent from the Kirikiri and parts of the Waiarohia sub-catchments, is a key cause of reduced water clarity.

Figure 8 below illustrates the levels of turbidity, a measure of water clarity, at 16 monitored sites in the harbour.

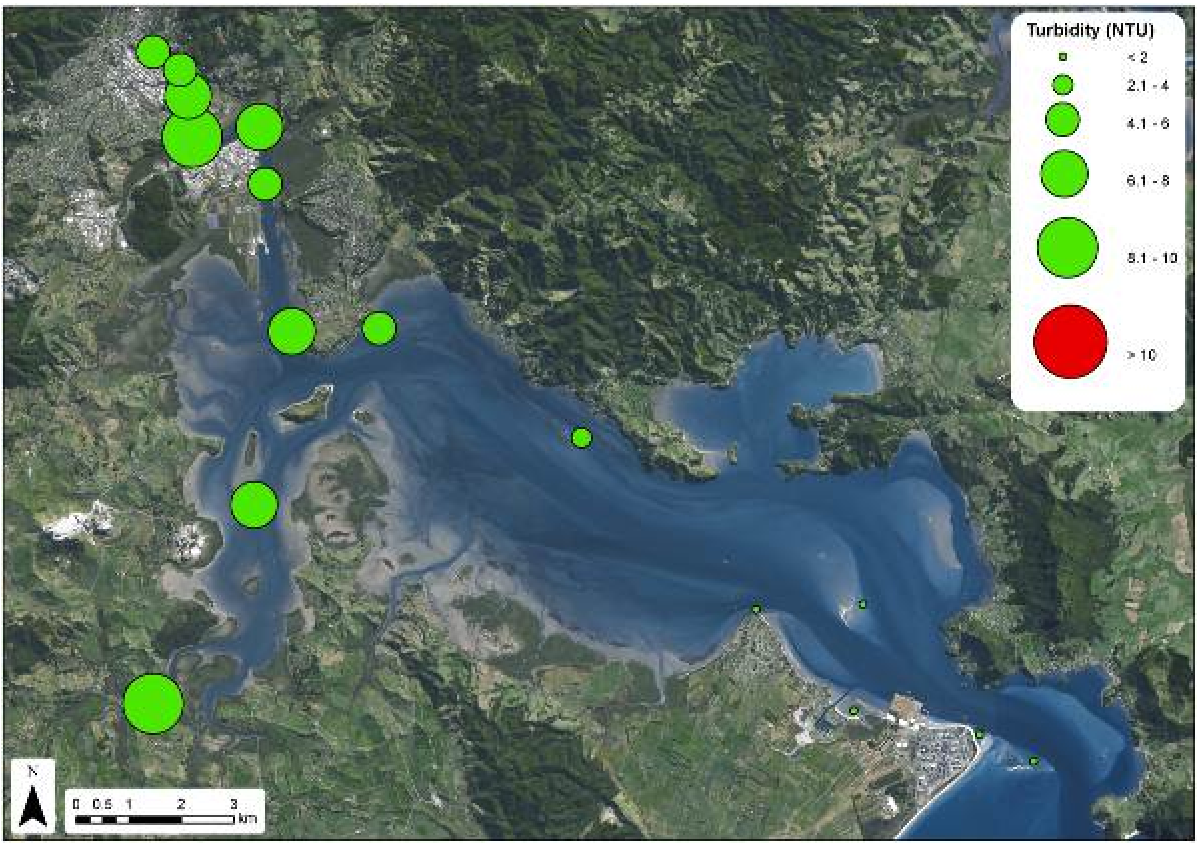



**Figure 8: Median values for turbidity 2008-2012**

#### 3.2.1.2 Deposited sediments

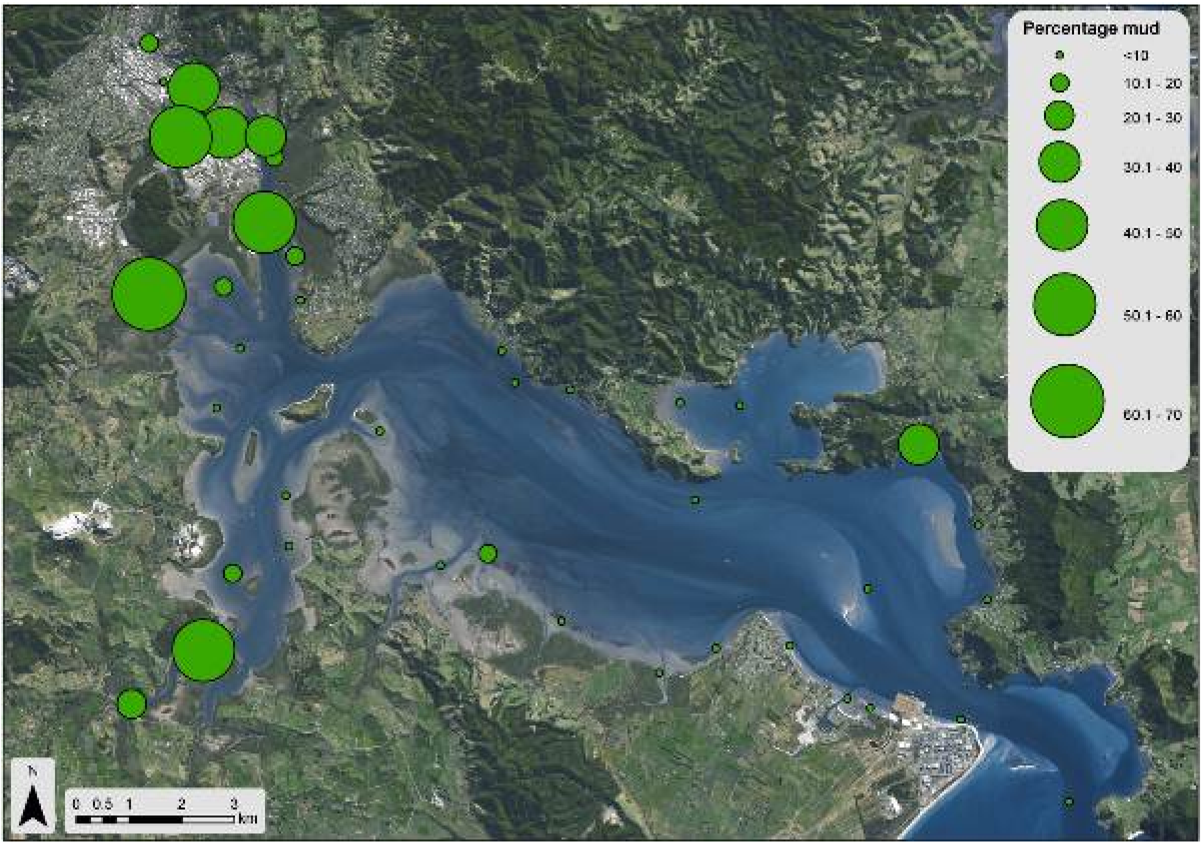
Suspended sediments typically settle out of water in low energy environments, such as in sheltered estuaries and deep areas where waves and currents are not dynamic enough to keep sediment suspended in the water column. However, very fine particulates such as colloidal clay can remain in suspension for a long time.

Excessive deposition rates (in excess natural rates) can smother habitats (e.g. seagrass) and reduce the amount and diversity of benthic (seabed and intertidal flat) animals (e.g. shellfish) Large sedimentation events caused by extreme rainfall can have very detrimental impacts on benthic species.

Elevated sedimentation rates also have an impact on social, cultural, and economic values such as natural character, navigation, recreational activities, and impacts on fisheries.

Figure 9 below shows the levels of mud measured in harbour sediment, in 2012. The results are consistent with the size and uses of major sub-catchments, and also the upper harbour being a flocculation zone.

**Figure 9: Percentage mud in benthic sediment 2012**




At the time of writing this report, Northland Regional Council was undertaking a comprehensive research study on historic and current sediment deposition rates (sedimentation rates) at various locations in the harbour.[59] This research will also determine major sources (areas and activities) of sediment. The results from the study will be used to guide future actions around sediment management.

Research undertaken at a number of similar estuaries and harbours in the North Island has shown that sedimentation rates in pre-Polynesian times (before ~ 1300 A.D.) averaged 0.1-1 millimetres per year (mm/yr). By way of comparison, the sedimentation rates have increased to 2-5 mm/yr (within the same systems since 1300AD).[60] It is likely that annual sedimentation rates in the harbour will fall within the same range as found for the similar

[59] In brief, the investigation involves studying dispersion of sediment in the harbour, analysing sediment core samples from various locations in the harbour to determine historical and current sedimentation rates, and analysing the chemical composition of sediments to determine the land use practices and catchment areas that are contributing sediment to the harbour.

[60] NIWA (2010). Bay of Islands OS20/20 survey report, Chapter 4: Recent sedimentation rates (over the last 100-150 years), *NIWA Client Report: WLG2010-38.*

systems. Originally, the main cause of elevated sedimentation rates was deforestation. Today the key causes are likely to be pastoral farming, production forestry, poorly managed earthworks that occur as part of land development, erosion of unsealed roads, roadside banks and drains, erosion of stream banks, and re-mobilised sediments from prior erosion.

### 3.2.2 Sediment contamination

While today's water quality is largely a function of current activities in the harbour catchment, today's sediment quality in the harbour reflects the cumulative impacts of many years of contaminant discharges. A range of heavy metals and chemicals generated from both human and natural sources can accumulate in seabed sediments over time and become part of the food chain. At high levels, they can have toxic effects on aquatic ecosystems, including fish. However, low levels can have chronic effects on some organisms.

Northland Regional Council has analysed samples of seabed (intertidal and subtidal) sediment at a number of sites in the harbour for concentrations of cadmium, chromium, copper, nickel, lead, and zinc. There are several guideline values that can be used to assess the probability of adverse effects associated with different levels. The ANZECC Guidelines are widely accepted in New Zealand and Australia and have been used for the purposes of this document.[61]

Results show slightly elevated levels at several sites across the harbour. The highest recorded levels are in the Hātea River arm, although it is important to note that they are below ANZECC Guideline low trigger values. This means that there is only a low probability of some localised effects on aquatic species. Such findings are consistent with the Hātea River arm being the receiving environment for discharges and runoff from the Whāngārei city area where the majority of urban and industrial development in the catchment are located.

Figures 10 to 12 below show 2012 levels of copper, zinc, and lead in benthic sediment at sites in the harbour. The red circles indicate levels that exceed ANZECC Guideline low trigger values.

[61] ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1. Australian and New Zealand Environment and Conservation Council.

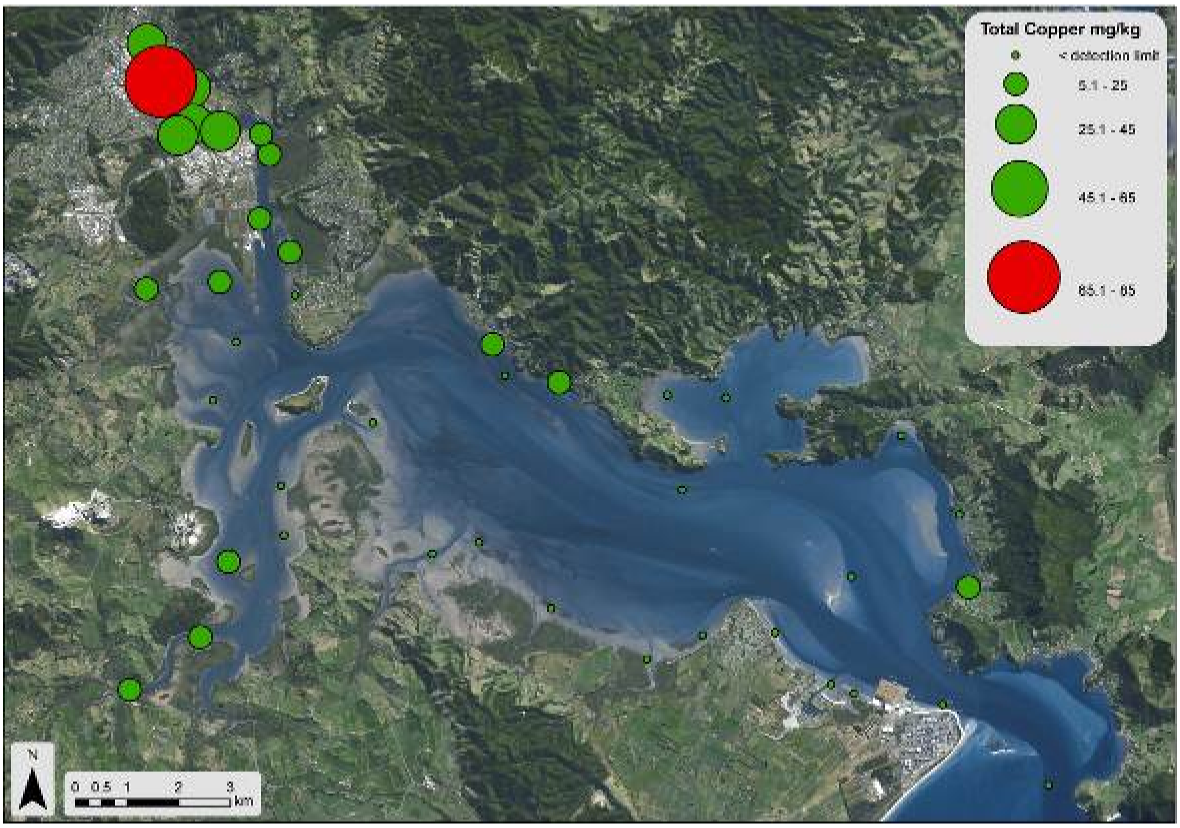


**Figure 10: Levels of copper in harbour sediment 2012**

**Figure 11: Levels of zinc in harbour sediment 2012**

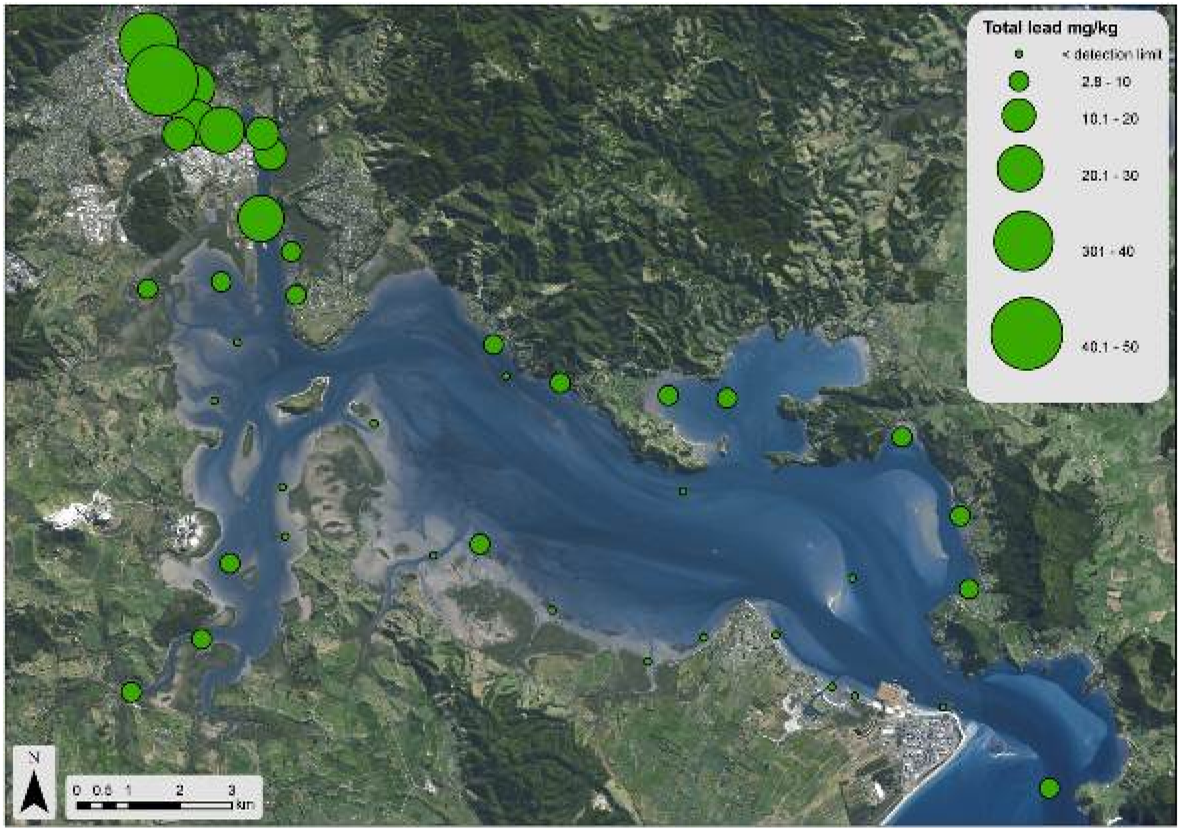


**Figure 12: Levels of lead in harbour sediment 2012**

Long-term monitoring trends for heavy metals indicate that levels have not generally increased. In fact, concentrations of lead, zinc, copper, and chromium appear to be decreasing over time. This is likely due to a number of factors including bans on lead in petrol in 1996, controls on harbour-side sandblasting and runoff from slipways, and changes in the composition of chemicals used in land use activities (for example, pesticides and herbicides used in orchards).

While sediment heavy metal concentrations in the harbour appear to be within ANZECC Guideline low trigger values, recent research undertaken on four different sites in the upper harbour (Hātea River arm, off Otaika, Mangapai arm, and Portland channel) has revealed that levels of nickel and copper are likely to be key factors for the composition of benthic invertebrate communities[62].

### 3.2.3 Nutrients

Nitrogen and phosphorus are the two main nutrients required by algae, plants, and animals for metabolism and growth. These nutrients naturally occur in water as a result of natural processes such the erosion of soil and rock, atmospheric deposition, and the breakdown of

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[62] Northland Regional Council (Unpublished) Whāngārei Harbour Estuary Monitoring Programme: Results from 2008-2010.

organic matter. Nitrogen is highly soluble and can leach through soil, whereas phosphorus usually enters water in direct discharges or associated with sediment.

While they are necessary to life, high levels of nitrogen and phosphorus can cause excessive growth rates of aquatic algae and plants. For example, enrichment can cause algae to out-compete seagrass as they are better positioned (that is, in the water column above seagrass or on its leaves) to intercept light.[63] Nutrient enrichment is also thought to be a key factor for mangrove spread. High levels of nutrients can also cause a number of other problems including toxic effects from some types of marine plankton, reduction in dissolved oxygen from plant and algae die-back, and changes to indigenous biodiversity.[64]

Typically, the main sources of elevated nutrient levels in urban water bodies are wastewater and stormwater, while agricultural fertilisers, animal effluent, and accelerated erosion are generally the major sources of elevated levels in rural waterways. Sources of nutrient contamination in the harbour are discussed below in Section 4.

Northland Regional Council monitors ammonia, nitrate-nitrite (oxidised forms of nitrogen), dissolved reactive phosphorus, and total phosphorus at 16 sites around the harbour. The ANZECC Guidelines contain low trigger values ("guideline low trigger values") for the nutrient parameters. Like the guideline low trigger values for heavy metals, the values for nutrients are not 'magic numbers' or threshold values at which an environmental problem is inferred if they are exceeded. Rather they are designed to be used to provide an assessment of the state of water.[65] If the trigger values are exceeded there is a 'potential risk' that the harbour ecosystem is being impacted. The greater the exceedance of the guideline low trigger values the higher the potential risk of adverse effects. Conversely, if results are less than the guideline low trigger values then there is only a low probability of such effects occurring.

It is also important to note that nutrient concentrations in the water column vary spatially and temporally, depending on rainfall, tide, and season for example. Therefore the following information provides a snapshot of nutrient levels at different parts of the harbour.

Monitoring results show that median nutrient concentrations in the upper harbour exceed the low guideline trigger values, and median nutrient concentrations significantly exceed the guideline low trigger values in its Hātea River arm.

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[63] NIWA (2009). New Zealand seagrass – General Information Guide, *NIWA Information Series No. 72.*
[64] ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1. Australian and New Zealand Environment and Conservation Council., pp3.3-22. It should be noted that elevated levels of nutrients are not always the key factors for changes in species composition and abundance. Other factors such as light and temperature, currents, and substrates, often contribute.
[65] ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1. Australian and New Zealand Environment and Conservation Council.

The Waiarohia Canal – the lower estuarine reach of the Waiarohia Stream that drains to the Hātea River arm – has the highest recorded concentrations of nutrients of all monitored sites including the downstream Limeburners Creek, the mixing zone for treated effluent from the Whāngārei Wastewater Treatment Plant. [66] Possible sources are discussed in Section 4 below.

Nutrient levels in the middle and lower harbour are much lower and most of the time, appear to be below guideline low trigger values. This is consistent with the middle and lower harbour having flushing rates (high dilution) and lower inputs of freshwater relative to its volume. In comparison, the upper harbour is much more influenced by freshwater inputs and direct discharges, and freshwater inputs are high relative to its tidal volume. Flushing rates and available dilution may be key factors for high nutrient levels and levels of other contaminants in the Hātea River arm, in particular.

A recent study found that nitrate and ammonia concentrations at sites in the middle and lower harbour around Snake Bank, One Tree Point, and Parua Bay were consistent with average water column ammoniacal and nitrate nitrogen concentrations measured over seagrass beds globally. A similar finding was made for dissolved reactive phosphorus.[67] This suggests that sediment is the main pressure on seagrass in the harbour.

There appears to be no statistically meaningful improving or worsening trends in nutrient levels at any sites in the upper harbour. However, it is important to note that levels of nutrients have only been measured since 2008 and more data is needed to help identify any trends. Based on other monitoring programmes around the country, generally it takes up to 10-15 years to detect statistically significant trends.

The following figures show the median concentrations of ammonia, nitrate-nitrite, dissolved reactive phosphorus, and total phosphorus, respectively, at 16 monitoring sites in the harbour. Red circles indicate median values that exceed the guideline low trigger values. The results suggest that current and future efforts should be targeted to the upper harbour sub-catchments.

[66] Northland Regional Council (unpublished) State of the Environment Water Quality in the Whāngārei Harbour 2000-2010.

[67] NIWA (2005). Feasibility study to investigate the replenishment/reinstatement of seagrass beds in Whāngārei Harbour – Phase 2. Prepared for Northland Regional Council by NIWA. Client Report: AKL2005.

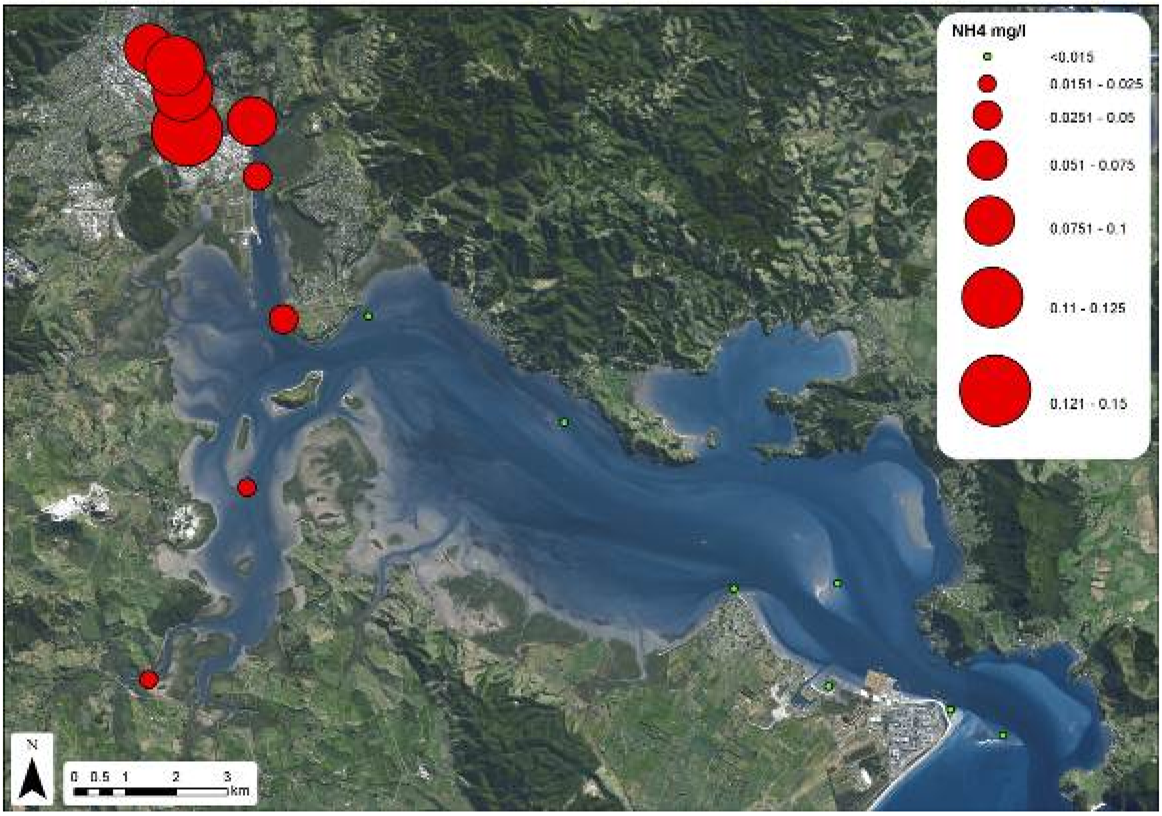


**Figure 13: Median values for ammoniacal nitrogen 2008-2012**

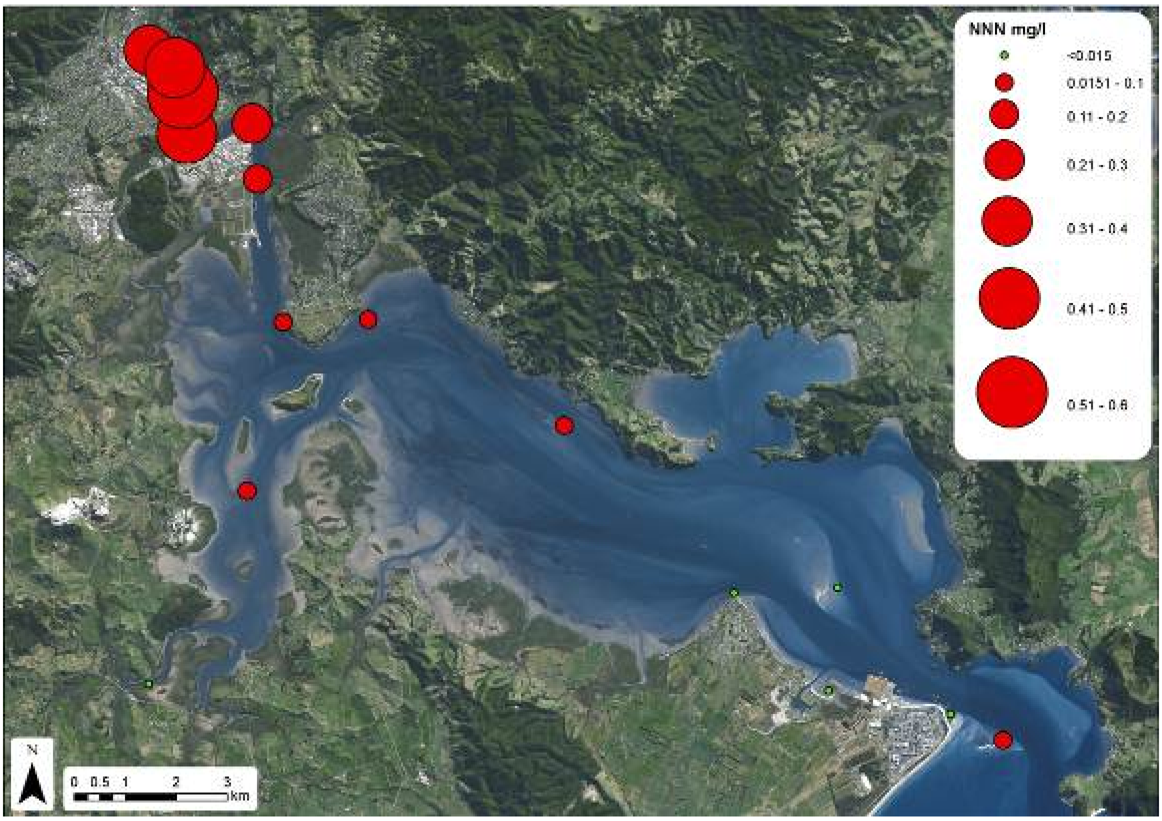


**Figure 14: Median values for nitrate-nitrite nitrogen 2008-2012**

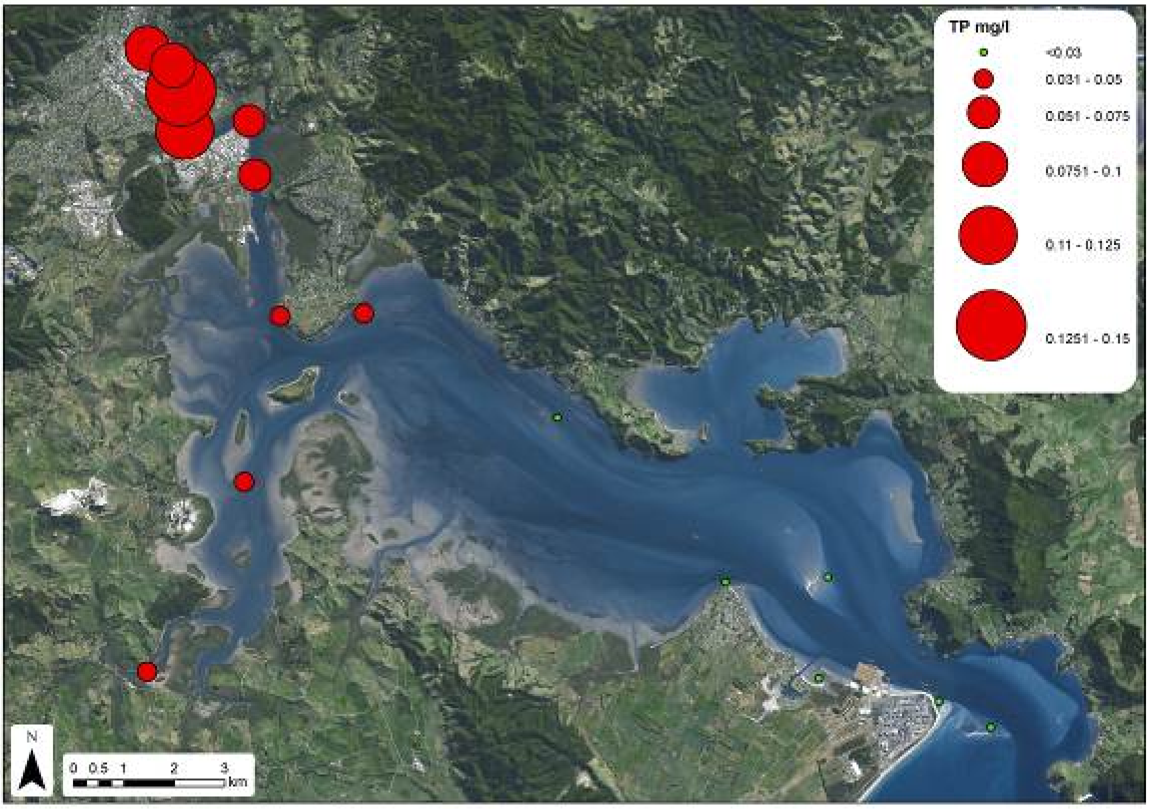


**Figure 15: Median values for total phosphorus 2008-2012**

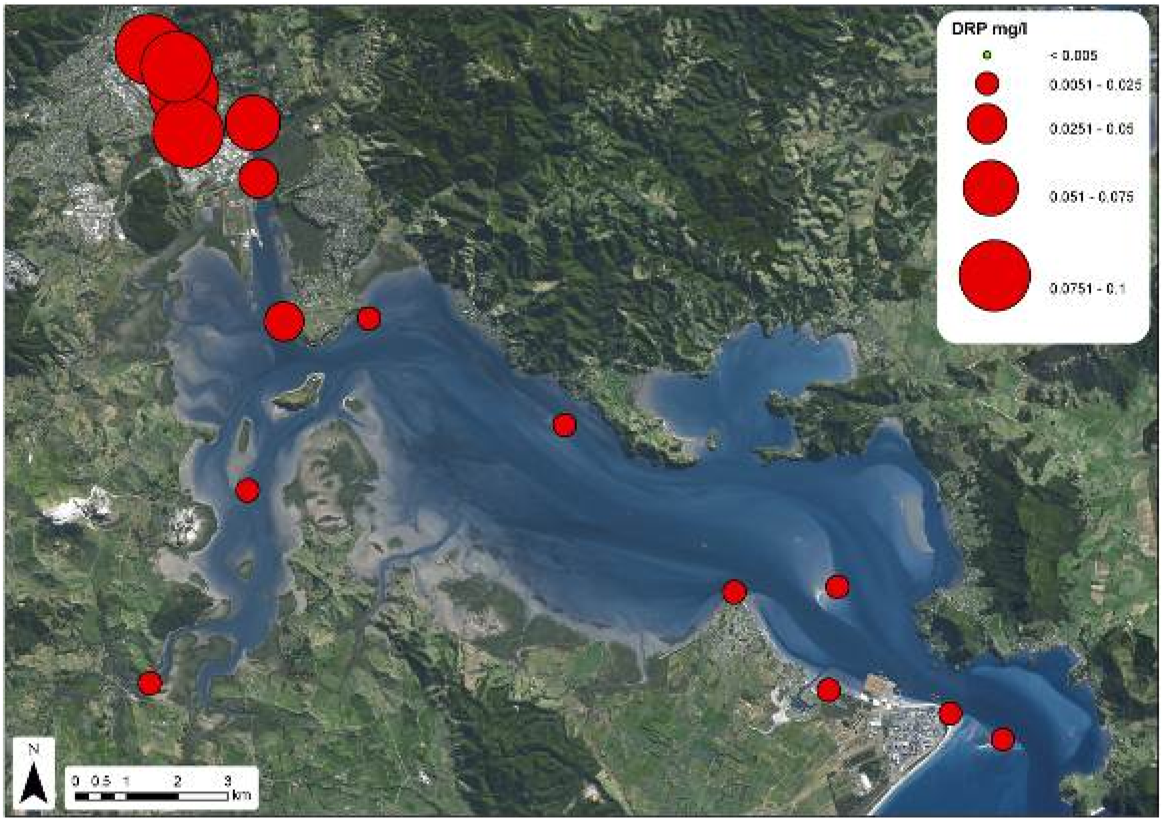


**Figure 16: Median values for dissolved reactive phosphorus 2008-2012**

Nitrogen and phosphorus levels are also elevated in benthic sediment in the upper harbour, particularly the Hātea River arm, compared to levels in other parts of the harbour. They are also high in comparison to concentrations recorded in similar monitoring programmes elsewhere in Northland and New Zealand, and are at levels that suggest the sites are enriched.[68]

Over time nutrients stored in sediments can be released into the water column and can sustain a relatively high level of phytoplankton, which in turn can reduce water clarity. High levels of algae can also result in algae blooms and a reduction in dissolved oxygen.

Figure 17 below shows recent nitrogen levels in benthic sediment at 16 sites in the harbour. The ANZECC Guideline does not include trigger values for nutrients in sediments. However, another guideline has been developed which states that levels of total nitrogen below 500mg/kg as "very good", levels between 500-2000 as indicative of low to moderate enrichment, levels between 2000 and 4000mg/kg as enriched, and levels over 4000mg/kg as very enriched.[69] Monitored levels falling in these categories are shown as green, yellow, orange, and red respectively.

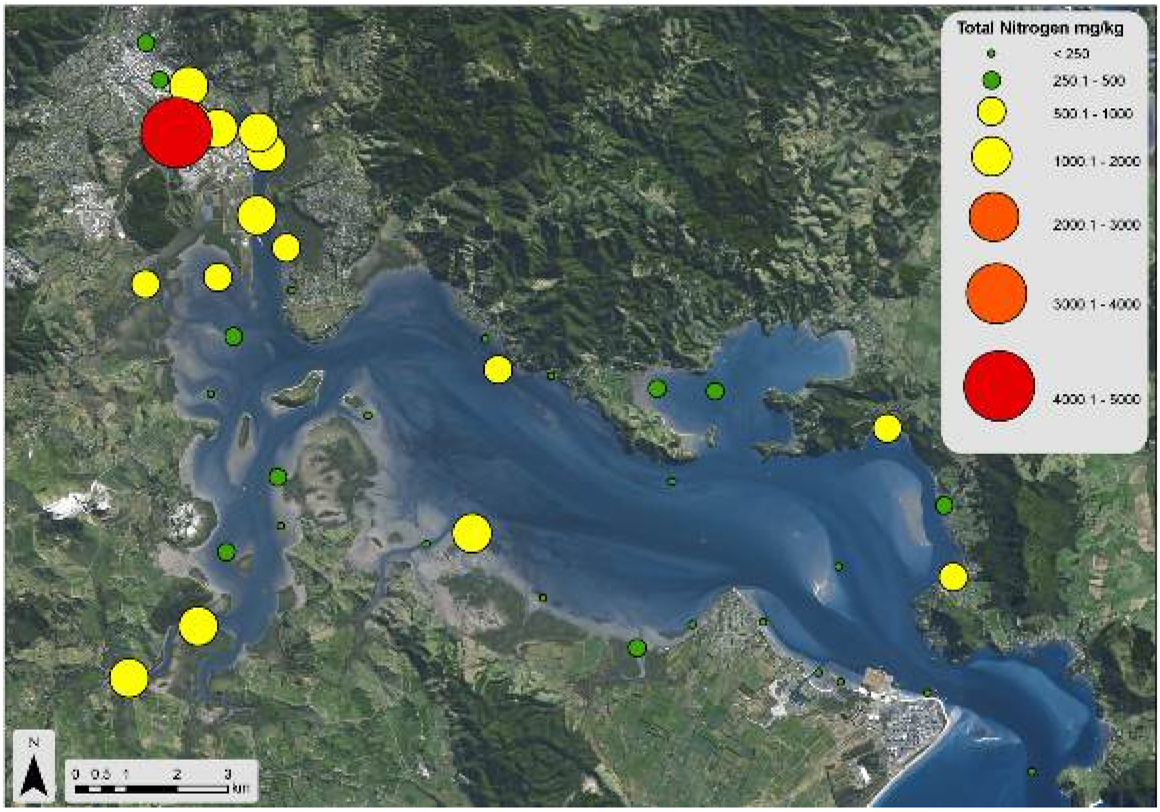

**Figure 17: Levels of nitrogen in harbour sediment 2012**

[68] Northland Regional Council (unpublished) Whāngārei Harbour Estuary Monitoring Programme: Results from 2008-2010.
[69] Robertson and Stevens (2007). Waikawa Estuary 2007. Fine scale Monitoring and Historical sediment coring. Prepared for Environment Southland.

Known and likely current sources of nutrients in the upper harbour include the Whāngārei Wastewater Treatment Plant, overflows from the Whāngārei wastewater network, urban stormwater, and pastoral activities. Section 4 below looks at sources of contamination in the harbour in more detail.

There is only limited information on the effects of elevated nutrient levels in the upper harbour, although some ecological surveys and a few reported incidents of nuisance algae in the upper harbour suggest that there may be impacts. Figure 18 below shows seaweed on intertidal mudflats in the upper harbour.

**Figure 18: *Ulva.sp* on intertidal mudflats in the upper harbour near Otaika**

## 3.3 Water quality and human health

Faecal pathogens (sickness-causing organisms)[70] enter coastal water in discharges, overflows and leakage from wastewater infrastructure (wastewater treatment plants, pipe networks, and septic systems), in contaminated stormwater, from wildlife such as waterfowl, in runoff from pastoral farm land, and occasionally in discharges of sewage from boats.

These organisms can pose risks to human health when water is used for contact recreation such as swimming, waka ama, sailing, and paddle boarding. In these activities there is a reasonable risk that water will be swallowed or inhaled, or come into contact with ears, nasal passages, mucous membranes, or cuts in skin, allowing pathogens to enter the body.[71] There are also potential risks to human health when shellfish are harvested and consumed raw from water containing elevated levels.

[70] Bacteria, protozoa, and viruses.
[71] MfE (2003). Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Ministry for the Environment and the Ministry of Health.

Health effects are generally minor and short-lived. However, there is the potential for more serious diseases, such as hepatitis A, giardiasis, cryptosporidiosis, campylobacteriosis, and salmonella.[72]

It is difficult to measure the level of faecal pathogens in water. Instead, like other agencies, Northland Regional Council measures the levels of indicator micro-organisms in accordance with the national microbiological water quality guidelines published by the Ministry for the Environment and the Ministry of Health (the recreational guidelines)[73].

The recreational guidelines use bacteriological indicators associated with the gut of warm-blooded animals to assess the risk of faecal contamination and therefore the potential presence of harmful pathogens. Compliance with the guidelines should ensure that people using water for contact recreation or gathering shellfish are not exposed to significant health risks. The bacteriological indicators used are:

- Freshwater (including estuarine waters): *Escherichia coli (E.coli)*
- Marine waters: Enterococci
- Recreational shellfish-gathering waters: faecal coliforms.

When coastal waters are strongly influenced by freshwater inputs, or semi-enclosed (like the harbour), assessing a combination of Enterococci and faecal coliform bacteria indicators is preferred.

The recreational guidelines work with a defined 'tolerable risk' rather than no risk at all. For most healthy people coming into contact with water within the guideline value will pose a minimal level of health risk. However, the same water may still pose a greater health risk to high-risk user groups such as the very young, the elderly, and those with impaired immune systems.[74] Health risks associated with levels of bacteriological indicators are discussed in further detail in the following sections.

It is very important to note however that the recreational guidelines state that they should not be directly applied to assess the microbiological quality of water that is impacted by a nearby point source discharge of treated wastewater effluent, without confirming that the guidelines are appropriate.

In addition, while it is correct to infer that water exceeding the guideline values pose an unacceptable health risk, the converse is not necessarily true. This is because wastewater effluent may be treated to a level where the indicator bacteria concentrations are very low, but pathogens such as viruses and protozoa may still be present at substantial concentrations. Wastewater treatment plants also require on-going auditing and

[72] Ibid (as above).
[73] Ibid (as above).
[74] Ibid (as above).

monitoring, and they may not operate effectively 100 percent of the time (for example, during wet weather and high inflows).

Finally, the health status of the population at any given time affects the pathogens likely in wastewater. This direction is relevant to the Hātea River arm of the upper harbour, which is the receiving environment for treated wastewater effluent from the Whāngārei Wastewater Treatment Plant and after heavy rainfall untreated wet weather overflows from the Whāngārei wastewater network.

### 3.3.1 Contact recreation

For contact recreation (for example, swimming, and paddle boarding) the recreational guidelines are summarised in Table 1. They are based on keeping sickness risks associated with recreational water use to less than 2% (that is, ≤19 people in 1,000).

When levels of enterococci in coastal water are within the surveillance (green) category, the risk of sickness from swimming is acceptable (that is, sickness risks are some way below 19 per 1,000 swimming events).[75] If levels fall into the alert category, there is an increased risk of illness from swimming, but still within an acceptable range. However, if levels enter the action category (>280 enterococci per 100 mL) then the water poses an unacceptable health risk from swimming. At this point, warning signs should be erected and the community informed that it is "unsafe" to swim at this site.

**Table 1: Surveillance, alert, and action levels for marine waters**

| Status | Enterococci per 100mL | Management action |
|---|---|---|
| **Surveillance (Green)** | <140 | Routine monitoring (that is, weekly) |
| **Alert (Amber)** | 140-280 | Increased monitoring (that is, daily), investigation of source and risk assessment |
| **Action (Red)** | Two consecutive samples within 24 hours >280 | Closure, public warnings, increased monitoring (that is, daily) and investigation of source |

#### 3.3.1.1 Popular swimming sites

Northland Regional Council monitors levels of enterococci at five popular swimming sites in the harbour over the summer period (December-March) as part of the Recreational Swimming Water Quality Monitoring Programme. This programme follows the methodology set out in the recreational guidelines, and sampling is undertaken weekly at a minimum.

[75] Based on the recreational guidelines.

The results for the past seven years are shown in Table 2. Please note that the percentage (%) samples within the guideline value are indicative of the percentage of the summer season when sites are suitable for swimming. They do not represent the actual time the sites were in compliance with the guideline value. Numbers in red show counts that exceed “safe” for contact recreation levels.

**Table 2: Recreational water quality compliance for enterococci levels at five popular swimming sites in the harbour over summers 2004/05-2011/12.**[76]

| Site name | Number of samples | Range | Median | % of samples within the guideline (<280 Ent/100ml) |
|---|---|---|---|---|
| **McLeod Bay** | 96 | 5 - 831 | 5 | 96 |
| **Onerahi foreshore** | 79 | 5 – 2,005 | 20 | 96 |
| **One Tree Point** | 45 | 5 – 2,005 | 5 | 93 |
| **Urquharts Bay** | 96 | 5 – 2,005 | 5 | 94 |
| **Taurikura Bay** | 115 | 5 – 2,005 | 5 | 93 |

The results show that water quality at these sites is almost always suitable for swimming. Where they exceed the levels, they are typically associated with heavy rain.

#### 3.3.1.2 Other sites

Northland Regional Council also monitors (generally bi-monthly) levels of enterococci and faecal coliforms at a number of other sites in the harbour as part of the Harbour Water Quality Monitoring Programme. Sites in the Hātea River arm, the area around Otaika, and the Mangapai arm are classified for contact recreation in the Regional Coastal Plan. Because the sampling is not undertaken at the frequency required by the guidelines, the conclusions that can be drawn from the results are less robust. In other words, the long-term results shown in Table 3 and Table 4 provide an indication of long-term water quality (potential health risks) however the information is not suitable to assess public health risk against the recreational guidelines.

Table 3 shows the rates of compliance for the 16 sites against the 280 *enterococci* per 100 mL recreational guidelines value. The red numbers show counts that exceed 280.

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[76] Note: a minimum of 10 samples were taken at each site over the summer period.

**Table 3: Range and median value for enterococci bacteria at 16 harbour sites 2000-2010**

| Site name | No. of samples | Range (MPN/100mL) | 95%ile (MPN/100mL | Median (MPN/100mL) | % samples within guideline value (<280/100mL) |
|---|---|---|---|---|---|
| **Mair Bank (LH)** | 60 | 1 – 42 | 10 | 5 | 100% |
| **Marsden Point (LH)t** | 63 | 1 – 31 | 10 | 5 | 100% |
| **One Tree Point (LH)** | 46 | 1 – 10 | 6 | 5 | 100% |
| **Snake Bank (LH)** | 18 | 5 – 10 | 6 | 5 | 100% |
| **Blacksmith's Creek (LH)** | 18 | 5 – 10 | 6 | 5 | 100% |
| **Mangapai (UH)*** | 18 | 5 – 20 | 20 | 5 | 100% |
| **Portland (UH)** | 18 | 5 – 20 | 20 | 5 | 100% |
| **Onerahi (UH)** | 18 | 5 – 10 | 10 | 5 | 100% |
| **Tamaterau (MH)** | 60 | 1 – 4611 | 35 | 5 | 98% |
| **Kaiwaka Point (UH)** | 97 | 1 – 624 | 66 | 5 | 99% |
| **Lower Port Road*(UH)** | 19 | 5 – 12,997 | 1927 | 10 | 89% |
| **Kissing Point*(UH)** | 97 | 1 – 10,111 | 1486 | 14 | 91% |
| **Limeburners Creek (UH)** | 103 | 2 – 4884 | 2057 | 30 | 81% |
| **Riverside Drive* (UH)** | 19 | 5 – 2005 | 492 | 42 | 84% |
| **Town Basin* (UH)** | 96 | 5 – 2489 | 1033 | 53 | 81% |
| **Waiarohia Canal*** | 19 | 5 – 2005 | 934 | 64 | 84% |

*Sites classified in the Regional Coastal Plan specifically for contact recreation.

Overall, the results indicate that most areas of the harbour are suitable for swimming most of the time. Or in other words, the potential risk of illness associated with contact recreation at most sites is likely to be 2% or less (≤19 per 1,000). However, levels of enterococci in the Hātea River arm above Kaiwaka Point exceeded 280 per 100 mL on a number of occasions (between 11% and 19% of the time). By way of comparison, these rates are very similar to exceedance rates for coastal swimming sites over the summer period at urban Auckland and Coromandel Peninsula beaches.[77]

In the harbour, exceedances were strongly correlated to rainfall. A quantitative health risk assessment undertaken for the upper harbour found that the majority of faecal contamination came from wet weather overflows from the Whāngārei wastewater network. Moreover, the loads from wet weather overflows dominated loads from the Whāngārei Wastewater Treatment Plant. This assessment is discussed in further detail below. Because most contamination is likely to be wet weather related, based on established correlations between bacteria indictor levels and rainfall, it is reasonable to assume that the potential health risks in the upper harbour are much lower in summer than during winter.

As mentioned, in areas where water fluctuates in salinity due to mixing of fresh and coastal water, such as the harbour, it is best to monitor multiple indicators.[78] For this reason, Table 4 looks at the same 16 harbour sites in terms of levels of faecal coliforms. While these are considered to be less specific than *enterococci* for assessing risk they do offer another insight on potential health risks associated with contact recreation. [79]

The guideline value in the table (median <150 faecal coliform bacteria per 100mL) is sourced from Schedule 4 of the Regional Coastal Plan and the ANZECC Guidelines 2000:

> *The median bacterial content in samples of fresh or marine waters taken over the bathing season should not exceed 150 faecal coliform organisms/100 mL (minimum of five samples taken at regular intervals not exceeding one month, with four out of five samples containing less that 600 organisms per 100 mL).*

Because the water quality monitoring results shown in Table 4 do not represent weekly or monthly sampling (required by the guideline) caution should be exercised when interpreting the percentage compliance results (shown in last column). However, for a number of the Hātea River arm sites their median values suggest that water quality does not meet the guideline value of 150 faecal coliform organisms per 100 mL the majority of the time.

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[77] Hauraki Gulf Forum (2011). State of our Gulf: 2011 Tikapa Moana – Hauraki Gulf State of the Environment Report.

[78] Note: Indicator relationships can change and/or different indicators need to be considered. This aspect of the recreational guidelines has been the subject of some debate. http://www.mfe.govt.nz/issues/water/water-quality-faqs.html#question8

[79] Note: International epidemiological studies have shown that *enterococci* are more specific indicators of human health risk from recreational contact with saline water than faecal coliforms. Faecal coliforms are a subset of the coliform group. Although faecal coliforms are predominantly found in the intestinal tract of human and other warm-blooded animals, they constitute a mixed group of organisms and some of the bacteria in this group can be derived from other environmental sources. They may also multiply in water on occasions to give a false impression of faecal contamination.

**Table 4: Range and median value for faecal coliforms at 16 harbour sites 2000-2010**

| Site name | No. of samples | Range (MPN/100mL) | Median (MPN/100mL) | % samples within guideline value (<150) |
|---|---|---|---|---|
| **Snake Bank (LH)** | 18 | 1 – 2 | 1 | 100% |
| **One Tree Point (LH)** | 52 | 1 – 4 | 1 | 100% |
| **Blacksmith's Creek (LH)** | 24 | 1 – 112 | 1 | 100% |
| **Marsden Point (LH)** | 62 | 1 – 20 | 1 | 100% |
| **Mair Bank (LH)** | 59 | 1 – 68 | 1 | 100% |
| **Tamaterau (MH)** | 62 | 1 – 6200 | 2 | 97% |
| **Portland (UH)** | 18 | 1 – 24 | 2 | 100% |
| **Onerahi (UH)** | 18 | 1 – 22 | 3 | 100% |
| **Mangapai (UH) *** | 18 | 1 – 160 | 10 | 94% |
| **Kaiwaka Point (UH)** | 98 | 1 – 1860 | 10 | 87% |
| **Lower Port Road (UH) *** | 18 | 1 – 850 | 20 | 79% |
| **Kissing Point (UH) *** | 98 | 1 – 80,000 | 40 | 64% |
| **Limeburners Creek (UH)** | 100 | 5 – 86,000 | 162 | 45% |
| **Riverside Drive (UH) *** | 18 | 10 – 3000 | 200 | 42% |
| **Town Basin (UH) *** | 100 | 5 – 37,000 | 265 | 27% |
| **Waiarohia Canal (UH) *** | 18 | 50 – 3000 | 325 | 32% |

***** Sites classified in the Regional Coastal Plan specifically for contact recreation.

The faecal coliform results paint a very different story to enterococci results in terms of potential health risks associated with swimming in the Hātea River arm. The compliance rates (shown in the last column) indicate that the potential risks are more often than not unacceptable. As with levels of enterococci, exceedances were strongly correlated to rainfall.

### 3.3.1.3 Hātea River arm

The recreational guidelines also include qualitative risk criteria (Sanitary Inspection Category) for assessing risk of faecal contamination to a site (shown as Table 5). It involves identifying potential and actual sources of contamination by considering adjacent and contributing catchment land-use, and environmental conditions that may affect water quality at the site. It is a useful way of explaining exceedances of guideline values in the Hātea River arm.

**Table 5: Sanitary Inspection Category**

| Sanitary Inspection Category | Examples of source |
|---|---|
| **Very low** | No significant source; indirect runoff from native bush or forest. |
| **Low** | Indirect runoff from horticulture or low-intensity agriculture/urban/rural catchment; direct runoff from forests. |
| **Moderate** | Urban stormwater not contaminated by sewage; receives tertiary treated discharge or sewage overflows; agricultural or rural catchment; significant feral bird/animal population. |
| **High** | Tertiary treated wastewater discharged to beach or adjacent area; urban stormwater; marinas or moorings; direct runoff from intensive agriculture or unrestricted access of stock to waterways; significant bird populations. |
| **Very high** | Direct discharges of untreated sewage or onsite waste treatment systems (including leaking septic tanks) |

The Hātea River arm of the upper harbour is assessed as falling between the High and Very high categories. This is because it is the receiving environment for treated effluent from the Whāngārei Wastewater Treatment Plant, untreated wet weather overflows from the Whāngārei wastewater network, discharges of urban stormwater, the presence of a marina and moorings, and freshwater inputs from streams and a river draining rural areas, which have unrestricted access of stock in some reaches. These sources are discussed in detail in Section 4.

While long-term water quality monitoring results indicate that potential public health risks are higher in the Hātea River arm compared to other parts of the upper harbour, recent research has suggested that the risks may be lower than previously thought and considerably lower than the faecal coliform results in Table 4 suggest.

In 2011, Northland Regional Council and Whāngārei District Council commissioned NIWA to assess human health risks associated with primary and secondary contact recreation in and consuming raw shellfish from the Hātea River arm of the upper harbour. This was undertaken using a simplified[80] quantitative microbial risk assessment (risk assessment)[81].

[80] Based on: (1) a one-dimensional mathematical model of the river and upper harbour, adapted from the 2010 three-dimensional Whāngārei Harbour hydrodynamic and dispersion model (due to the time and resources available it was not possible to use the later model), and (2) good approximate calculations to risk (implementation of the usual full iterative equations was impossible in the time and resources available).

The risk assessment was developed to inform an application to change a condition of the consent authorising discharges from the Whāngārei Wastewater Treatment Plant. The risk assessment looked at the combined impact of three sources of human pathogens discharged into the Hātea River arm:

- Treated wastewater from the Whāngārei Wastewater Treatment Plant Wastewater Treatment Plant;
- Untreated wet weather overflows from the Whāngārei wastewater network; and
- Other sources (for example, rural runoff) in stream and river flows.

The risk assessment focused on human health risks at two sites in the Hātea River arm: at its confluence with Limeburners Creek (for swimming and secondary contact recreation, for example, waka ama) and at Onerahi (for swimming, secondary contact recreation, and consumption of raw shellfish).

It is important to note that the risks were based on levels of a pathogen (rotavirus) rather than bacterial indicators such as enterococci and faecal coliforms. This is because the sickness-causing agent in the Hātea River arm is expected to be human viruses given the predominance of human wastewater (for example, the Whāngārei Wastewater Treatment Plant and wet weather overflows from the Whāngārei wastewater network). If animal sources were to dominate then consideration would have to be given to bacteria (especially *Campylobacter*) and protozoa (*Cryptosporidium* oocysts).

Table 6 shows the risk assessment-predicted individual illness risks associated with contact recreation and raw shellfish consumption averaged over entire seasons (summer and winter) for different combinations of sources. It is important to note that because the risks are averages, the actual risks associated with specific wet weather events and parts of the tidal cycles may be significantly greater, especially for swimming. Also, the predictions in the table were developed as part of a screening exercise to compare the benefits of various wastewater discharges and overflow options so it is the relative differences in risks that are important rather than the actual risks per se.

As shown in the table the risk assessment predicts:

- That the human health risks associated with contact recreation in the upper harbour are low (<5% individual illness risk) when averaged over both summer and winter;
- Average human health risks are lower in the summer than winter; and

[81] Graham McBride and Glen Reeve (2011). Predictions of Human Health Effects Associated with Wet Weather Flows in Whangarei: Effects on primary and secondary water contact, and consumers of raw shellfish. Prepared for Northland Regional Council by NIWA. Client Report No: HAM2011-069.

- Risks to persons collecting shellfish at Kaiwaka Point (Onerahi) are generally acceptable in summer but not during winter.

These findings generally align with the predicted risks based on levels of enterococci recorded over the last 10 years (see Table 3 above).

Of particular interest, the risk assessment also found that, during wet weather, faecal contamination in the Hātea River arm is dominated by wet weather overflows from the Whāngārei wastewater network – even though the overflows are substantially diluted by stormwater. Or in other words, wet weather overflows from the Whāngārei wastewater network constitute the largest risk to human health over both summer and winter, although the overall risks appear to be low.

It should be noted that the fourth scenario was selected as the preferred option by Whāngārei District Council for reducing human health risks. Whāngārei District Council is currently in the process of upgrading its wastewater treatment plant to disinfect all discharges as required by its consent and has already upgraded the Hātea pump station. Whāngārei District Council is to develop a detailed programme to reduce the number and volumes of wet weather overflows from the wastewater network to achieve a five-fold reduction in faecal pathogens. See section 4.1 below for further information.

**Table 6: Predicted individual illness risk (IIR) averaged over summer and winter associated with different water quality scenarios at two sites in the Hātea River arm of the upper harbour[82]**

| Scenario | Season | Port Road Bridge (Limeburners Creek and Hātea River) | | Kaiwaka Point (Onerahi) | | |
|---|---|---|---|---|---|---|
| | | Primary contact (swim-ming) | Secondary contact (waka ama) | Primary contact (swimming) | Secondary contact (waka ama) | Raw shellfish consump-tion |
| **(1) Background contamination only, no WWTP discharge, no network overflows** | Summer | 0.1% | 0.0% | 0.0% | 0.0% | 0.1% |
| | Winter | 0.2% | 0.1% | 0.0% | 0.0% | 2.9% |
| **(2) Network overflows only, no WWTP discharge, no background contamination** | Summer | 0.2% | 0.1% | 0.0% | 0.0% | 0.3% |
| | Winter | 1.0% | 0.4% | 0.2% | 0.1% | 8.8% |
| **(3) Discharge from upgraded treatment plant, background water quality, and network overflows** | Summer | 0.4% | 0.1% | 0.0% | 0.0% | 0.4% |
| | Winter | 1.3% | 0.5% | 0.3% | 0.3% | 9.8% |
| **(4) Discharge from upgraded WWTP and treated overflow from Hātea pump station, some overall improvement in background water quality, and a five-fold reduction in faecal pathogens from network overflows** | Summer | 0.3% | 0.1% | 0.0% | 0.0% | 0.1% |
| | Winter | 0.6% | 0.2% | 0.1% | 0.0% | 5.4% |

#### 3.3.1.4 Long-term trends

Northland Regional Council analysed water quality monitoring results (faecal coliform levels) for the period 1986-2012 and found a reduction in indicator bacteria levels at several sites in

[82] Ibid (as per previous footnote).

the Hātea River arm close to Limeburners Creek between 1989 and 1990. This improvement was linked to an upgrade of the Whāngārei Wastewater Treatment Plant at that time. However, since then there has been no statistically significant reduction in indicator bacteria levels, although on-going monitoring is expected to show a reduction in loads from the Whāngārei Wastewater Treatment Plant, and Okara Park and Hātea pump stations due to recent upgrades.

### 3.3.2 Shellfish gathering

The recreational guidelines also contain guidelines for recreational shellfish gathering. These have been adopted from the guidelines used by the commercial shellfish export sector for areas of approved shellfish-growing waters. They are an internationally accepted protocol for assessing whether shellfish grown in such waters under sanitary conditions are suitable quality for raw consumption.

The guidelines also use bacteria indicators (faecal coliforms) to determine the potential for pathogenic bacteria, viruses, and protozoa to be present.

It should also be noted that these guidelines apply to waters where there are no point sources of contamination of human health concern.

The guidelines are as follows:

> *The median faecal coliform content of samples taken over a shellfish gathering season shall not exceed a Most Probably Number (MPN) of 14/100 mL.*
>
> ***and***
>
> *Not more that 10% of samples should exceed a MPN of 43/100 mL.*

Northland Regional Council monitors three sites in the harbour close to recreation shellfish gathering areas – McLeod Bay, Taurikura Bay, and Urquharts Bay. Kaiwaka Point (at Onerahi) is not monitored as it is not known to be used for recreation shellfish gathering. It should also be noted that samples are taken at the beach and not above or immediately beside gathering areas, which are typically offshore. Table 7 below shows the results for the summer periods 2008-2011. The red numbers indicate non-compliance with part of the guidelines.

The data shows that most of the time faecal coliform levels met the first part of the guidelines (median faecal coliforms), and it was the second part of the guidelines (% samples) which sites failed against.

All three sampling sites are located close to stormwater outlets of streams that drain into the harbour. Higher levels of faecal coliforms are most likely caused by rainfall entering the harbour via these freshwater outlets. Based on faecal source tracking results for similar sites it is likely that faecal coliform bacteria are from birds and/or stock.

**Table 7: Results for recreational shellfish gathering at beaches close to three popular harvesting sites in the harbour 2008-2011**

| Site name | Summer season | No. of samples | Median faecal coliforms | % Samples >43/100 mL | Pass/Fail |
|---|---|---|---|---|---|
| McLeod Bay Beach | 2008/2009 | 12 | 6 | 17 | Fail |
| | 2009/2010 | 18 | 9 | 6 | Pass |
| | 2010/2011 | 17 | 6 | 35 | Fail |
| Tuarikura Beach | 2008/2009 | 12 | 6 | 34 | Fail |
| | 2009/2010 | 18 | 127 | 6 | Fail |
| | 2010/2011 | 17 | 10 | 18 | Fail |
| Urquharts Bay Beach | 2008/2009 | 12 | <2 | 17 | Fail |
| | 2009/2010 | 18 | 127 | 17 | Fail |
| | 2010/2011 | 17 | 2 | 18 | Fail |

On-going non-compliance of water quality for shellfish gathering throughout Northland prompted Northland Regional Council to undertake research at the coastal receiving waters of the region's most pristine catchment (the Waipōua River mouth) in order to see if it would comply with the guidelines.[83] The research found that median faecal coliform count for the monitoring period was 150 per 100 mL, which exceeded the guideline value of 14 per 100 mL. Furthermore, 86% of the samples exceeded the second guideline value of 43 faecal coliforms per 100 mL. These results indicate that even the coastal receiving waters for the most pristine catchment in Northland are unlikely to meet the recreational shellfish gathering guidelines.

Lastly, the risk assessment for the Hātea River arm of the upper harbour suggests that following the upgrades to the Whāngārei Wastewater Treatment Plant and the Okara and Hātea pump stations, and with improvements in background water quality, and a five-fold reduction in faecal pathogens from the network, the predicted individual illness risk associated with consuming shellfish from Onerahi over the summer will be 0.1% and over the winter 5.4%.

[83] Note: shellfish do not grow at this site because seabed sediment is too coarse.

## 3.4 Summary and considerations

Available information indicates that water quality in the middle and lower harbour is suitable for supporting its ecological values. However, in the upper harbour elevated levels of nutrients, poor water clarity, and substantial infilling of sediment indicate that ecologically it is moderately disturbed, and the Hātea River arm highly disturbed. It is important to note though that water quality may not be the sole factor for its loss of condition. Reclamations, dredging, altered hydrology, and lack of estuarine buffering (for example, wetlands), and invasive species have all impacted on its ecology.

Monitoring results paint a similar story about water quality for human health. While popular swimming sites in the middle and lower harbour appear to be suitable most of the time (that is, there is a low risk when swimming in these areas), there are greater human health risks associated with swimming in the Hātea River arm of the upper harbour. In that area, levels of faecal bacteria indicators are often high and background levels are elevated, mainly after heavy rain.

An analysis of four years of water quality monitoring results for the upper harbour revealed no significant improving trends in regard to nutrient levels. However, this finding should be cautiously considered because of the limited data set on which it is based. A separate analysis of water quality monitoring results going back to 1990 revealed no improving trends median faecal pathogen indicator levels in the Hātea River arm of the upper harbour. Recent and future planned upgrades to the Whāngārei Wastewater Treatment Plant and wastewater network are expected to reduce the frequency and loads of faecal pathogens and nutrients to the harbour.

Although there is reasonable information on nutrient concentrations in the harbour there is limited information about actual ecological effects in the harbour, particularly the upper harbour. Elevated nutrient levels are known to stimulate growth of phytoplankton (microscopic algae) and in turn reduce the availability of light to other species, such as seagrass. Elevated levels can also stimulate the growth of nuisance macro algae. Further research is recommended to understand the effects of high nutrient levels in the upper harbour. Undertaking monitoring of chlorophyll concentrations (a measure of phytoplankton) is recommended and would align with best practice.

Because degraded water quality appears to be mainly confined to the upper harbour efforts to control and prevent direct and diffuse source contamination should be focussed on activities in the upper harbour catchments, while remaining aware of issues in other parts of the harbour. It is assumed that improvements in upper harbour water quality (including contributing freshwater bodies) will have beneficial impacts and enhance water quality in the middle and lower harbour.

# 4 Key sources of contamination

This section looks at known and likely direct and diffuse sources of sediments, nutrients, heavy metals, and faecal contamination in the harbour. The focus is on the upper harbour, where water quality appears to be degraded. It also considers the effectiveness of existing management approaches and options for improvement.

## 4.1 Urban wastewater

Urban wastewater (wastewater) refers to domestic sewage and trade waste (liquid waste from businesses and industrial sites). Wastewater can also contain stormwater, especially during heavy rain events.

Untreated wastewater contains high levels of faecal pathogens and nutrients. It also contains a range of other contaminants, such as household chemicals, pharmaceuticals, heavy metals, and particulate matter.

### 4.1.1 Whāngārei Wastewater Treatment Plant

The Whāngārei Wastewater Treatment Plant treats wastewater from the Whāngārei city wastewater network that extends to Springs Flat in the north, Maunu in the west, Raumanga in the south, and Onerahi through to Whāngārei Heads in the east. The network services approximately 19,000 connections (households and businesses), has 343 km of gravity-fed pipelines, 53 pumping stations, and 39 km of rising mains (pipes that go uphill). There are also constructed overflow pipes located in different parts of the network.

During periods of dry weather the Whāngārei Wastewater Treatment Plant receives in the range of 10,000 to 20,000$m^3$ of wastewater per day. Treated wastewater is discharged through a series of wetlands to Limeburners Creek and ultimately the Hātea River arm of the upper harbour. During wet weather the treatment plant can receive much larger flows as a result of stormwater entering the wastewater network through illegal stormwater connections (inflow) and cracked and partly connected wastewater pipes (infiltration). Illegal connections are where stormwater pipes from properties are plumbed to wastewater pipes. Pipes crack with age or when connections between pipes fail under stress or as a consequence of age.

### 4.1.2 Network overflows and leakage

Inflow and infiltration to the network can cause capacity-related (wet weather) overflows from manholes and pump stations across the network when volumes exceed the size of the pipe network.

In the last few years Whāngārei District Council has undertaken a number of projects to reduce wastewater impacts on the harbour. The most high-profile of these include upgrades to the Whāngārei Wastewater Treatment Plant, Okara Park and Hātea pump stations, and the replacement of aging and low capacity pipes to improve network performance across urban Whāngārei. The district council has also spent considerable effort investigating and addressing illegal stormwater connections.

Until recently, the major wet weather overflow that discharged directly to the harbour was from the Okara Park pump station. Overflows of up to 20,000$m^3$ of stormwater diluted untreated wastewater were recorded. In 2010-11, the pump station underwent a major upgrade in order to eliminate virtually all wet weather overflows of untreated wastewater. The Hātea pump station was also upgraded with a large storage tank to reduce the frequency of overflows and a treatment system to reduce bacteria loads during any overflow. Any future overflows from the pump stations are authorised subject to stringent conditions in resource consents.

To accommodate increased flows resulting from recent upgrades to the Okara Park pump station, Whāngārei District Council is undertaking further modifications to the Whāngārei Wastewater Treatment Plant to increase its treatment capacity. On completion of its upgrade in 2013 the treatment plant will be able to treat flows caused during extreme wet weather events. Dilution studies and hydraulic modelling have shown that, in considering only the treatment plant discharge from the updated wastewater treatment plant, the contact recreation standards (CB) below the Port Road Bridge and the shellfish gathering standards (CA) at Onerahi can be met. This will be a significant improvement in the performance of the wastewater treatment plant.

However, as discussed in Section 3.3 and acknowledged elsewhere,[84] background levels of faecal bacteria in the Hātea River arm are elevated, and water quality is unlikely to meet contact recreation standards all of the time even after improvements to the treatment plant and Okara Park and Hātea pump stations have been completed. This is due to other contaminant inputs, for example wet weather overflows from other parts of the wastewater network and runoff from rural sources in the sub-catchment.

While considerable progress has been made in addressing large wet weather overflows from the Okara Park and Hātea pump stations and in improving treatment at the wastewater treatment plant, the wastewater network still discharges untreated wastewater at a number of other wet weather overflow points and will still need to be the subject of future work.

Whāngārei District Council developed a robust hydraulic computer model of the Whāngārei wastewater network for the purposes of informing its asset management and upgrade decisions. The model identifies a large number of regular wet weather overflow points

[84] Northland Regional Council. Application to Change Condition 16 of Resource Consent 4352(02) Relating to Discharge of Wastewater from Whāngārei Wastewater Treatment Plant Kioreroa Road into Limeburners Creek, Whāngārei Harbour. Final Decision of Hearing Commissioners. March, 2012.

(manholes and pump stations) that discharge across Whāngārei city. For example, during an annual rainfall event (1 in 1-year average return interval), the Whāngārei urban network (not including Onerahi to Whāngārei Heads) is predicted to overflow at close to 75 locations, of which the majority are less than 100 $m^3$, 10 between 100 and 200 $m^3$, six between 1,000 and 2,000 $m^3$, and two greater than 2000 $m^3$. It is important to note that these are modelled not measured volumes of stormwater diluted wastewater. At present, most wet weather overflows are not authorised by discharge permits.

Whāngārei District Council's Wastewater Strategy includes the following objective in regard to wet weather overflows:[85]

> *To minimise stormwater and groundwater entry into the wastewater network by managing inflow and infiltration with targets of:*
>
> *(a) Reducing the volume of untreated overflows from the network by 80% for the 1 in 1-year event over a 10-year timeframe (baseline year 2010).*
>
> *(b) Reducing the frequency of untreated overflows to no more than 1 every 5 years over a 50-year timeframe (baseline year 2010).*
>
> *(c) Managing any overflows so that some treatment occurs prior to discharge and/or the overflow occurs in a location where there is less impact and/or the impact can be effectively mitigated.*

Overflows can also happen during dry weather as a consequence of blockages, which are managed by regular pipe inspections. There is also the possibility of exfiltration (leakage) from cracked or partially connected pipes in some areas[86] however there is no evidence to support whether exfiltration is a significant issue in terms of faecal pathogen and nutrient loads to the Hātea River arm of the upper harbour.

Whāngārei District Council's Long Term Plan sets a level of service for the wastewater network that involves the number of dry weather overflows being limited to less than six per 100km of pipe[87]. The latter target is considered a reputable standard nationally, with the present rate of blockages in the network being less than the target.

## 4.2 Urban stormwater

Urban stormwater generally refers to water that drains impervious urban surfaces (roofs, roads, paving) during and after rainfall, but given the low permeability of local soils normally

[85] Whangarei District Council Wastewater Strategy (2010), Objective 6.1.
[86] Wet and dry weather overflows and exfiltration are common to wastewater networks.
[87] Whāngārei District Council Annual Report for 2010-2011 notes that in 2008/09 the rate of dry weather overflow was 5.2 per 100km, in 2009/10 the rate was 4.48 per 100km, and in 2010/11 the rate was 2.96 per 100km.

pervious surfaces can quickly become impermeable and runoff enters stormwater systems. In most urban areas in the catchment stormwater is collected, conveyed, and discharged to fresh and coastal water by reticulated stormwater systems (networks). The networks are made up of drains, modified water courses, and pipes.

Stormwater can carry a wide range of contaminants such as litter, sediments, heavy metals, toxic chemicals, oil, grease, lawn chemicals, faecal pathogens, and nutrients. Urban stormwater is mostly untreated in Whāngārei district.

There are a number of reticulated stormwater networks in the greater catchment. Most drain the Whāngārei urban area (shown in Figure 19). There are smaller networks at a number of other harbour locations including Waikaraka/Tamaterau, McLeod Bay/Reotahi, Blacksmiths Creek/Marsden Point, and One Tree Point, which may become important over time as populations increase, but the most important are those that drain Whāngārei city due to degraded water quality in the Hātea River arm of the upper harbour. Some of the Whāngārei city networks fall within the sub-catchment boundaries described previously; others fall across several sub-catchments (for example, the central business district and Port Road catchments).

All local networks discharge stormwater to freshwater bodies (including modified water courses). The central business district, Limeburners Creek, Port, and Onerahi networks also discharge stormwater directly to the harbour.

Whāngārei District Council is authorised by comprehensive discharge permits to discharge stormwater to freshwater bodies from five[88] of the 10 networks within Whāngārei city. Discharges from the other five[89] are unconsented as discharges from these networks have been considered by Whāngārei District Council to meet permitted activity standards in the Regional Water and Soil Plan for Northland, and therefore do not require resource consent.[90]

Whāngārei District Council is authorised by a coastal permit to discharge stormwater from the city network direct to the upper harbour from several outfalls. However, many direct discharges of stormwater to the upper harbour from other outfalls are not authorised by resource consents.[91]

Whāngārei District Council has prepared stormwater catchment management plans for a number of its stormwater networks, including for those that are consented and some of

[88] The upper Hātea, Wataua, Waiarohia, Awaroa, and Limeburners stormwater networks.
[89] The Kirikiri, Raumanga, Lower Port, city, and Onerahi stormwater networks.
[90] It should be noted that stormwater monitoring for some unconsented discharges indicates that the stormwater quality does not meet the permitted activity standards under Permitted Activity Rule 21.1.2.
[91] Rule 31.4.6(d) of the Regional Coastal Plan states that the "discharge of stormwater from the Whāngārei urban area directly into the upper Whāngārei Harbour" is a discretionary activity, which means that such a discharge must be authorised by resource consent.

those that are not. These are used to assess flooding issues, pipe capacities, resource consent applications, and the impacts of land-use changes on catchment hydrology.

In total, 15 stormwater catchment management plans have been prepared for the greater harbour catchment. Compliance with the recommendations in a given stormwater catchment plan is mandatory under Whāngārei District Council's District Plan Environment Engineering Standards (Stormwater Engineering Standards), and all new development is expected to attenuate stormwater onsite.[92] The Stormwater Engineering Standards sets out the processes and standards that are expected to be followed and met whenever any development project is undertaken. It applies to all new subdivision developments or re-developments, and all other new stormwater systems.

Where a proposed stormwater discharge is to a Whāngārei District Council owned network and/or is to be incorporated into the Whāngārei District Council's existing or future discharge consent (granted by Northland Regional Council), then the developer must demonstrate that the consent conditions, including quality requirements, will continue to be met.

In other words, developments within catchments with operative, consented stormwater catchment management plans that can comply with the requirements of the plan do not require separate resource consents for stormwater diversion and discharge from Northland Regional Council. However, where a Stormwater Catchment Management Plan is not in place or the proposal is not consistent with an operative consented stormwater catchment, developers are required to obtain all necessary resource consents from Northland Regional Council.

[92] Whāngārei District Council Environmental Engineering Standards 2010.

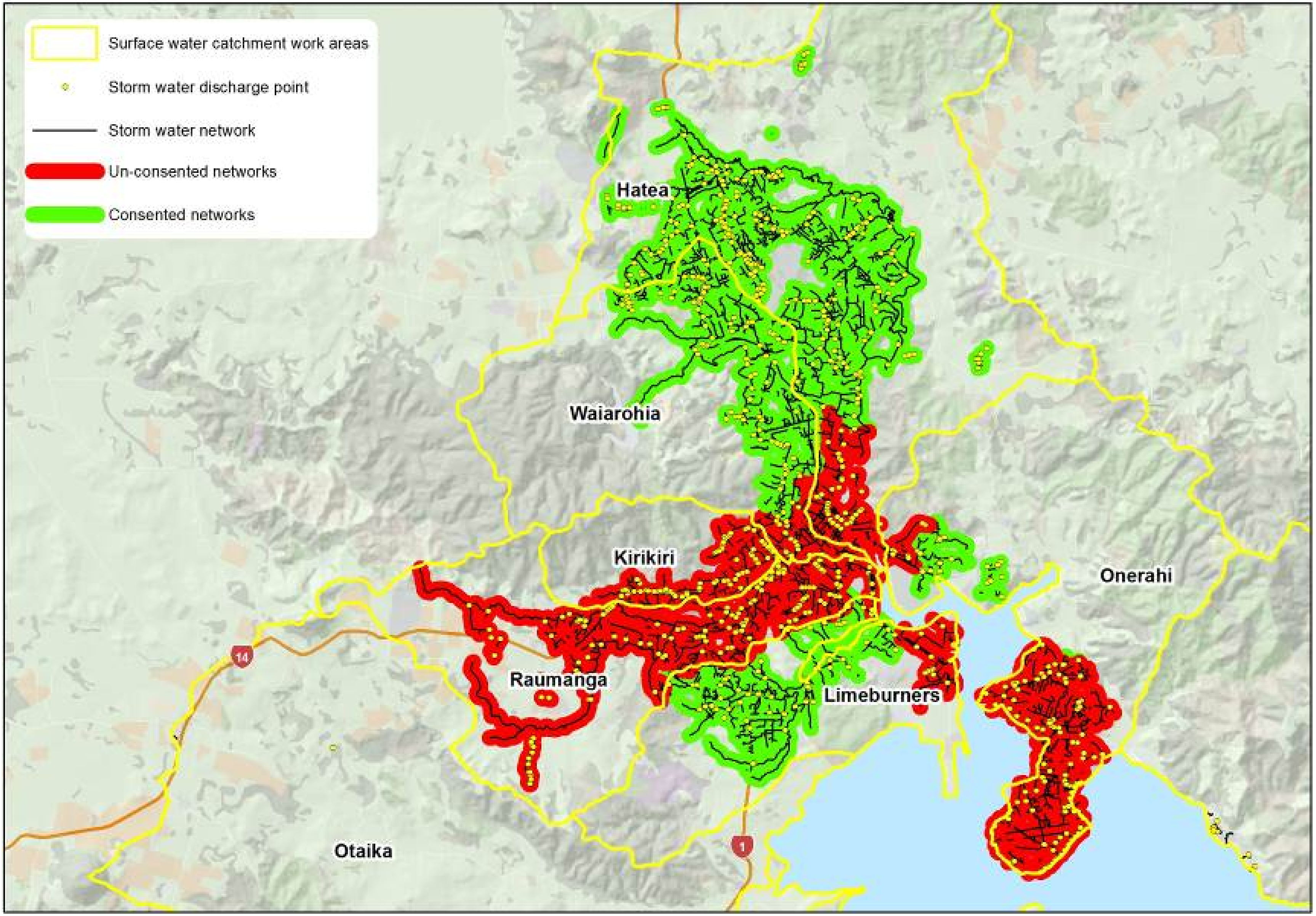

**Figure 19: Whāngārei city stormwater networks**

### 4.2.1 Stormwater quality

Stormwater quality monitoring has only been carried out on a sporadic basis at a limited number of mostly consented outfalls. Importantly, first flush events – the first part of a stormwater discharge which is thought to carry the bulk of contaminants – are poorly understood.

Stormwater quality monitoring has detected elevated levels of ammonia (a nitrogen compound) at several outfalls in the Whāngārei city networks. Very high levels of ammonia and phosphorus were detected by NIWA in an earlier (1994) study for Northland Regional Council.[93] The study concluded that the high levels suggest a widespread diffuse source, which may include urban wastewater, decomposition of organic material in gully pots (catch-pits), and/or high atmospheric decomposition. The diffuse source has not been identified, or subject to source tracking, although wastewater is potentially a key source. It is unknown whether this remains an issue, although high levels in the Hātea River arm highlight the need to understand sources and loads.

The limited stormwater monitoring data also shows above average to high levels of suspended sediments at a number of outfalls across the networks. To date, stormwater monitoring has not included sampling for faecal pathogen indicators.

Limited data also suggests that heavy metal levels in Whāngārei city stormwater are generally typical of urban stormwater elsewhere in New Zealand, that is, are at average levels. However, sediment monitoring has revealed elevated levels of heavy metals in the upper Waitaua Stream (near the industrial area), a tributary of the Hātea River. At the Waitaua Bridge monitoring site in Kamō, levels of total nickel, total lead and total zinc are consistently well above guideline low trigger values.[94] Elevated levels of heavy metals in sediments have also been found near a number of stormwater outfalls in the upper Hātea River arm close to the Town Basin.

In 2009, Northland Regional Council commissioned NIWA to model likely annual loads of suspended sediments and particulates and dissolved zinc and copper reaching the harbour via stormwater from the Raumanga catchment (including the Raumanga urban network and the un-reticulated rural area), the Port network (industrial) and the central business district network (mainly commercial).[95] The investigation found that the Raumanga catchment is the major source of suspended solids (approximately 2,900 tonnes per year) due to it having a

[93] NIWA (1994). Whangarei urban stormwater quality, *Prepared for Northland Regional Council, NIWA Consultancy Report: NRC 003/1.*

[94] ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1. Australian and New Zealand Environment and Conservation Council.

[95] NIWA (2009). Simulation of Annual Contaminant Loads from Three Stormwater Catchments to Whangarei Harbour, *Prepared for Northland Regional Council by NIWA, Client Report AKL2009-064.*

high proportion of permeable surface and the presence of open stream channels (that is, bed erosion). It also found that of the two urbanised stormwater networks, the industrialised Port catchment has the highest simulated loads of heavy metals (one tonne of copper and zinc per year).

At the time of writing this report, Northland Regional Council and Whāngārei District Council were jointly researching annual average loads of sediment, copper and zinc from the Whāngārei city urban area to the upper harbour. As commented in relation to urban wastewater, understanding stormwater contamination loads is vital to determining freshwater quality limits (required by the National Policy Statement Freshwater), informing asset management decisions, stormwater catchment management plan reviews, and helping direct future actions.

### 4.2.2 Future pressures

As well as potential stormwater quality issues, climate change projections suggest that high intensity rainfall events will increase in frequency over time. This may cause capacity-related issues at points in the networks. This is not solely a problem for Whāngārei District Council, but is considered a nationwide issue for urban councils in New Zealand.

New residential development or population growth is not considered to be a major concern in terms of stormwater, especially as Whāngārei District Council's current policy on stormwater management is for new development to mitigate stormwater on site as per the Stormwater Engineering Standards. This current stormwater management approach is expected to result in some improvements, especially as low impact stormwater development becomes more popular, and the use of more environmentally aware methods of disposal increases.

### 4.2.3 Roads and walkways

Roads, parking lots, and walkways make up a considerable proportion of impervious surfaces found in urban areas, especially in central Whāngārei. Roads are likely to be a key source of heavy metals and petroleum-based compounds in certain locations. State Highway 1, although not necessarily a major source of metals compared to the urban areas, is expected to contribute some of the total metal load to the harbour.

A large number of people make their way into central Whāngārei every day, with approximately 20,000 working in the central Whāngārei, Maunu, and Otaika areas. Expanding commercial enterprises in Kamō are also located within the Hātea catchment, especially around Springs Flat, and this area may need to be carefully scrutinised over time as development and associated traffic increases.

Whāngārei District Council's walking and Cycling Strategy plans for paths to be located close to water around the Hatea river arm.[96] Stream and river banks often make good locations for such walkways and cycle ways, due to their relative flatness, attractiveness, and space for use. Walkways and cycle ways are important locations for community infrastructure such as artworks, heritage trail panels, and information signage, as illustrated by the popularity of the initial stages of the Town Basin walkway. The Town Basin Loop (Heritage Trail) that is currently being developed largely follows the banks of the Hātea River, while the proposed Raumanga trail largely follows the Raumanga Stream between the central area and Northland Polytechnic.

The Walking and Cycling Strategy mentions a need to ensure that any proposed flood protection works located within the proposed network or off-road pathways make allowance for pedestrian and cycle ways, so that a number of co-benefits including possible water quality improvements can be realised. There is also a need to ensure that mangroves in the Town Basin are appropriately managed so that contaminants in sediments beneath them are not released into the harbour.

Unsealed roads, driveways, in peri-urban and rural areas are likely to contribute sediments, and should be addressed in a prioritised manner, particularly around the margins of the harbour.

## 4.3 Pastoral activities and rural stormwater

Approximately 50% of the greater harbour catchment is grassland, with the majority used for pastoral farming (including lifestyle blocks). The proportions of pasture differ between sub-catchments. For example, the Otaika, Purewa, and Whāngārei south sub-catchments are mainly pastoral in nature whereas the Hātea, Waiarohia, Raumanga, Limeburners Creek, and Onerahi catchments have significant urban land uses.

Stormwater runoff from pastoral land can contain nutrients, sediments, faecal pathogens, and even heavy metals.[97] Nitrogen compounds and faecal pathogens can also leach through soil to water bodies, including groundwater. Diffuse sources include, but are not limited to, stream banks and other erosion-prone land, stock access to the beds and riparian margins of waterways, general grazing of animals, and fertilisers. Farm dairy effluent is discussed below.

[96] http://www.wdc.govt.nz/TrafficandTransport/PublicTransport/Cycling/Documents/Whangarei-District-Walking-and-Cycling-Strategy-2012.pdf
[97] For example, zinc is used in facial treatment for sheep and cadmium is used in some fertlisers.

Research undertaken in the Bay of Islands has revealed that pasture and production forestry are the main current source of sediment in its harbour environments.[98] Research being undertaken at the time of writing may reveal similar findings with respect to the harbour.

Northland Regional Council has routinely monitored water quality downstream of pastoral land use at several sites in the upper harbour catchments. Only monitored sites on the Otaika and Puwera streams are free of any urban influence. The limited information is discussed below and is not sufficient to be able to calculate relative loadings of nutrients of faecal bacteria from rural and urban environments. Current research is looking at sediment sources and loads on the harbour.

### 4.3.1 Rural upper harbour sub-catchments

The Puwera sub-catchment is typical of many Northland catchments. The Puwera Stream has high flow variability (0-282 $m^3/s$), it regularly dries up in summer, and it provides a typical and realistic picture of the relationship between water quality and dairying/dry-stock land use in the region.

Waterways in the sub-catchment are generally small and were not subject to the Dairy and Clean Streams Accord (which has been replaced by the Sustainable Dairying: Water Accord). A recent report by Northland Regional Council estimated that livestock are excluded from less than 10% of streams in the Purewa sub-catchment.[99] The neighbouring Otaika sub-catchment also has a low proportion of fenced waterways.

Monitoring data reveals high levels of nitrogen, phosphorus, and faecal pathogen indicators in the Puwera Stream and Otaika River. Water is often turbid, which is indicative of high levels of fine suspended sediments.

The Whāngārei south sub-catchment has a number of very small streams that drain gently rolling soft sedimentary hill country direct to the harbour. These rock types have poor water-holding capacity so almost all of these streams go dry each summer.

Freshwater quality has not been assessed in the Whāngārei south sub-catchment. It is reasonable to assume, based on the water quality monitoring results for the neighbouring Otaika and Puwera catchments, that pastoral land uses are contributing nutrients, sediments, and faecal pathogens to the Mangapai arm of the upper harbour. Although, it should be noted that Otaika and Puwera have higher levels of intensive land use such as dairying and

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[98] NIWA (2010). Bay of Islands OS20/20 survey report, Chapter 5: Determining sediment sources and dispersion in the Bay of Islands, *NIWA Client Report: WLG2010-38.*

[99] Northland Regional Council (2012). Water quality and land use trends in the Purewa catchment, 2006-2011. Note the Purewa stream can cease flowing in summer months, which means the stream does not meet the Clean Stream Accord’s criterion of “permently flowing”.

therefore the rural production pressures may not be as great in the Whāngārei south catchment.

There is considerable room for improvement in the way that agricultural land in the catchment is managed for water quality purposes. Areas for improvement include:

1. Enhanced riparian and nutrient management.
2. Exclusion of stock from water bodies (and not just Clean Stream Accord water bodies) including significant drains, drainage depressions, and streams.
3. Creation of wetlands for the purposes of trapping sediments and nutrients, as most of the original natural wetlands and drainage depressions have been drained. The land lends itself to construction of such wetland traps because it has numerous hollows and folds in the ground into which runoff can be directed.
4. Promotion of in-paddock management to reduce pugging and compaction. This will provide a win-win situation (improved production and water quality) by reducing the quantities of sediment, nutrients and faecal matter washed from paddocks. Gumland soils in some areas (mainly lifestyle blocks) are seasonally overstocked and pugged. Work is required to re-vegetate bare areas and capture runoff.
5. Controlling and preventing gully erosion and slumping. While some erosion control has been undertaken more is required. Landowners along streams must be encouraged to control crack willow (*S. fragilis*), remove trees that fall into the river, and control stream bank erosion as each of these increases the loads of fine sediment entering the harbour.

### 4.3.2 Mixed land use upper harbour catchments

The remainder of the upper harbour sub-catchments contain agriculture (including a substantial proportion as lifestyle blocks).

Pastoral land uses in the Hātea sub-catchment are almost entirely lifestyle, although there is some remnant beef and sheep farming. Water quality monitoring data indicates that the lower Hātea River is affected by nutrients, faecal pathogens, and suspended sediments (based on turbidity data and frequent dredging), with levels of nutrients and faecal pathogens often exceeding relevant ANZECC Guideline values. Water quality in the Hātea River, above the urban environment, has not been routinely monitored, and consequently it is difficult to assess the influence of pastoral runoff and leaching compared to the influence of overflows and leakage from the Whāngārei wastewater network and discharges from the Whāngārei stormwater networks in terms of the impact on harbour water quality.

An investigation into the bacterial water quality at Whāngārei Falls (upstream of urban areas in the Hātea sub-catchment) found high levels of *E.coli* (a faecal pathogen indicator) in the four main tributaries flowing into the falls.[100] Microbial source tracking indicated that bacterial contamination at the falls is not directly runoff related and more likely a result of stock and wildfowl in streams, although this is not to disregard runoff as an issue.[101] Further research is required to assess the relative impact of land runoff on faecal indicator levels in the waterway. However, as long as there are livestock on the land, ruminant faecal contamination will occur as a consequence of rainfall events. However, pasture management and creation of sediment/nutrient traps can reduce contamination levels.

Monitoring results show that water quality in the Waiarohia Stream below the Whau Valley Dam is often degraded in terms of nutrients and faecal pathogen indicators, with levels of nitrogen, phosphorus, and faecal pathogen indicators regularly exceeding relevant guideline values.[102] However, not much is known about the source of these contaminants in the stream because there is not a lot of pastoral land use upstream of the sampling point. Levels of suspended sediments, including colloidal clay, are also likely to be an issue especially after heavy rainfall (based on recorded turbidity).

Similarly, it is difficult to determine the relative contributions of key contaminants from land uses in other parts of the catchment compared with the influence of overflows and leakage from the Whāngārei wastewater network and discharges from the Whāngārei stormwater networks.

It may be reasonable to assume that water quality in the Raumanga Stream and in the streams draining the Onerahi sub-catchment are also impacted in terms of nutrients, faecal pathogen indicators, and suspended sediments. It is recommended that sources and loads of these contaminants are researched and quantified. Loads are also necessary to inform the establishment of catchment-specific objectives and water quality limits.

Northland Regional Council's land management team is promoting and supporting good management practices in the harbour catchment.

The land management team has been bolstered by $200,000 of annual funding through the Long Term Plan 2012-2022 for the initiative. The land management team also administers Northland Regional Council's Environment Fund, which is an important resource for water quality improvement efforts (for example, funding fencing and riparian planting).

The team works with landowners and land managers to:

1. Reduce loss of sediment, nutrients, and faecal matter from land;

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[100] Northland Regional Council (2011). Whāngārei Falls Bacterial Water Quality Investigation: Project Update.
[101] Ibid (as above).
[102] ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1. Australian and New Zealand Environment and Conservation Council.

2. Trap and store any sediment, nutrients and/or faecal matter that is transported off-site, and

3. Manage streamside areas to enhance water quality.

The land management team will also work with infrastructure managers (or parks, reserves, roads) to achieve the same goals.

Implementing good management practices in primary production activities and on lifestyle blocks will contribute to a reduction in loads of sediments, nutrients, and faecal bacteria to the harbour.

## 4.4 Farm dairy effluent

The term *farm dairy effluent* refers to animal effluent from dairy farm facilities. There are approximately 4,000 dairy cows in the greater harbour catchment. Almost all of them are found in the Otaika, Puwera, Whāngārei south, and Marsden Point sub-catchments. Sixteen of the 19 dairy farms discharge their effluent to land while the other three have consents to discharge effluent to water. There are no dairy farms in the sub-catchments that drain to the Hātea River arm of the upper harbour.

A considerable amount of attention has been given to improving the management and treatment of farm dairy effluent over the past two decades. Farm dairy effluent is regulated under the Regional Water and Soil Plan for Northland, and it is unlikely to be a major source of contamination in the upper harbour, relative to other sources.

## 4.5 Forestry

Approximately 10% of the greater catchment is covered in plantation forest however there is variation in cover between its sub-catchments, with the largest stand of plantation forest (Glenbervie Forest) being in the upper Hātea sub-catchment.

Production forestry can have a positive influence on water quality by stabilising land and reducing sediment runoff during forest growth between harvesting periods (approximately every 25-30 years). However, during harvesting periods sediment can enter water bodies as a consequence of disturbance to land from felling and removing trees and have an impact on aquatic ecosystems (see section 3.2). Sediment can continue to enter water following harvesting until replanting and canopy closure has occurred (up to six years).

It is difficult to determine the influence of sediment runoff from production forestry on harbour water quality because of limited water quality monitoring data for the upper harbour catchments where forestry is a major land use. However, Northland Regional Council expects that this information will be made available from mid-2013 in the findings from the sediment accumulation rates and source tracking research.

The Regional Water and Soil Plan has a number of controls on harvesting operations including controls on earthworks and the disturbance of riparian margins of streams and rivers, riparian set-backs, and discharge rules.

In partnership with the RMA Forestry Development Group, Northland Regional Council has developed guidelines for plantation forestry.[103] The intent of the document is to provide the forestry industry (including contractors operating under permitted activity and/or a resource consent) with guidance on best practices for controlling and reducing sediment runoff. The regional council is also working with forestry managers to promote and train forestry operators in the use of the guidelines.

Lastly, comprehensive consents (encompassing multiple activities) under the Regional Water and Soil Plan could be used as a good management tool. Northland Regional Council should investigate a pilot project for this potentially using a streamlined process to encourage uptake.

## 4.6 Urban development

Land development for the purposes of building construction and subdivision activities, whether residential, commercial or industrial, can also be a source of sediment in local waterways and, ultimately, the harbour. Subdivision and building construction activity across the Whāngārei district was very high during 2001-2008, with approximately 11,300 lots created and approximately 6,650 consents for new residential or commercial buildings granted. Much of this activity occurred within the harbour catchment.

Recent activity has slowed, with approximately 350 lots being created in 2010-2011, along with approximately 340 building consents issued across the district. As maps for 2010-11 illustrate (Figure 20), most of the recent activity occurs within the harbour catchment, and with 270 new households in the harbour catchment per annum being projected in the Whāngārei Growth Strategy, this trend is likely to continue.

The Whāngārei District Plan and associated Environmental Engineering Standards contain controls on subdivision activities for the purposes of maintaining water quality. The effectiveness of these provisions in reducing sediment from building or subdivision activity will continue to be monitored and amended as necessary.

[103] www.nrc.govt.nz/forestry

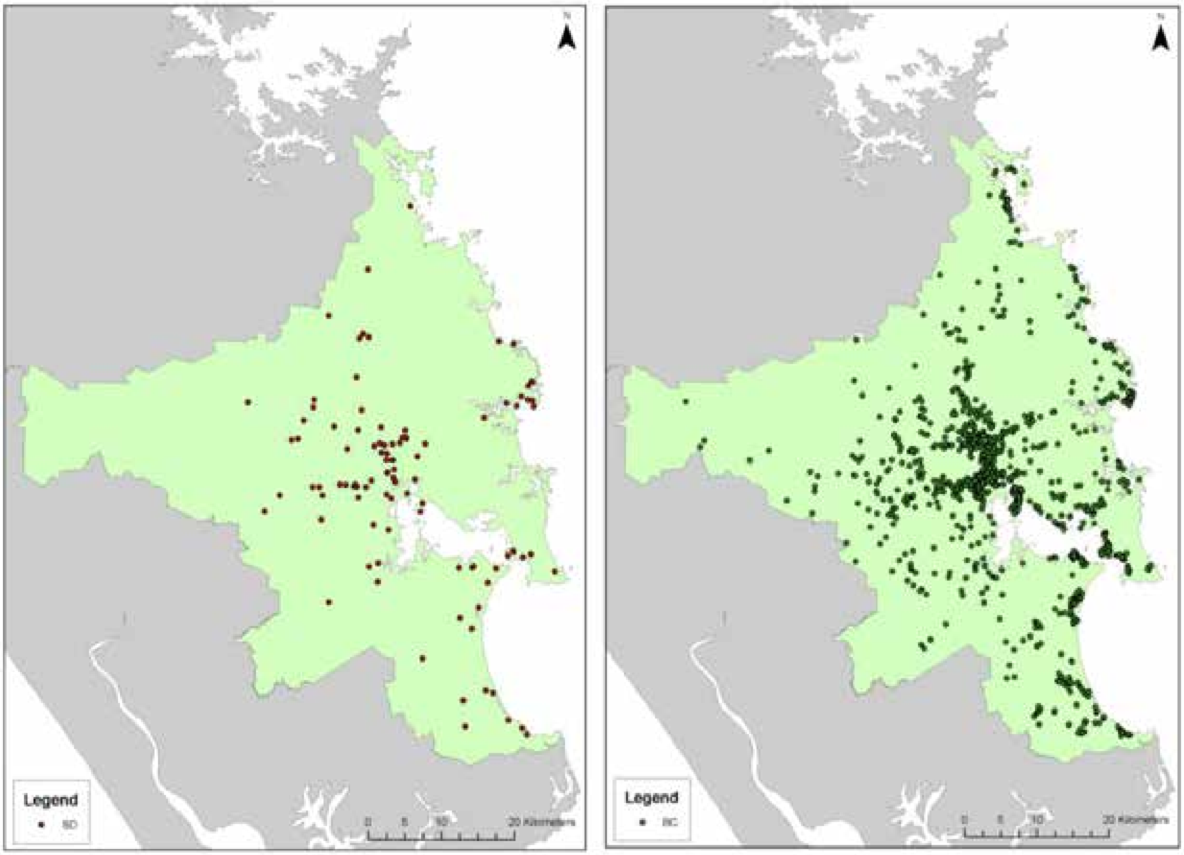


**Figure 20: Subdivision consents (left) and building consents (right) granted July 1, 2010 to June 30, 2011**

## 4.7 Septic systems

Septic, or onsite, systems refer to wastewater treatment that is not connected to a reticulated system. Septic systems fit into two main categories: community systems and single premise systems. Examples of community systems include schools, food premises, camping grounds and accommodation facilities, sports and recreation facilities, marae and community halls, and some residential communities such as retirement homes.

Until recently, failing and poorly performing septic systems were an issue in some areas, including the northern shore of the harbour. Whāngārei District Council now reticulates wastewater from Whāngārei Heads to the wastewater treatment plant and this has largely rectified the issue in this area. Northland Regional Council and Whāngārei District Council continue to investigate evidence and reports of failing septic systems in other parts of the catchment. Much of this monitoring is required as part of Northland Regional Council's operations work, and Whāngārei District Council's building and engineering compliance work.

In other parts of the harbour catchment households treat and dispose of their wastewater through septic systems. While there is always the potential for faecal pathogens and nutrients to enter streams via leaching from failing and poorly performing septic systems currently there is insufficient evidence to confirm whether it is a widespread or significant issue. For example, investigations have been undertaken in the upper Hātea catchment to determine the causes of regularly elevated levels of faecal bacteria indicators at Whāngārei Falls, a popular freshwater swimming site. The investigation found that the sources of elevated levels were ruminants, dogs, and water fowl, despite the amount of septic systems in the upper catchment.

It is important to note that some of the soils in the greater harbour catchment are poorly drained, particularly in the Otaika, Purewa, and Whāngārei south sub-catchments, and are marginal for septic system disposal. Whāngārei District Council should consider developing a bylaw on septic systems if evidence comes to light that septic systems are a significant issue.

## 4.8 Parks and reserves

Whāngārei District Council owns many parks and esplanade reserves, including road reserves, that are adjacent to water bodies in the harbour catchment and the harbour itself, many of these are located in urban environments (for example, along the Hātea River and Raumanga Stream).

Such reserves are likely to be important for meeting future water quality objectives for the harbour and its contributing freshwater bodies. There is, for example, scope to increase the provision of riparian vegetation in a number of areas while providing for public access. A re-vegetation plan for urban and rural environments in the upper harbour sub-catchments should be developed by Northland Regional Council and Whāngārei District Council. The plan should identify locations, timeframes, the nature of riparian re-vegetation, and funding opportunities. Re-vegetating rural areas should be led by Northland Regional Council while Whāngārei District Council should focus on esplanade reserves and strips adjoining urban and peri-urban water bodies.

There is likely to be an increase in the amount of reserve areas as a result of esplanade reserves and strips being taken through subdivision under the Reserve Management Act 1991. These will likely require active management including weed control. Parks and reserves may be suitable for stormwater attenuation and treatment.

## 4.9 Boats

Boating activities can be a source of faecal pathogens as well as nutrients, heavy metals and other biotoxicants. While it is illegal to discharge untreated sewage from a boat anywhere in the harbour, detection and enforcement is difficult. [104]

[104] Regional Coastal Plan for Northland.

The greatest risk of illegal discharges is associated with people temporarily or permanently living on their boats. Generally speaking, the Town Basin marina and Waiarohia private jetties are the only places where people live on board boats.[105] There are discharge (pump-out) facilities at the Riverside Drive and Marsden Cove marinas however it is understood that these are not used as much as they should be.

Northland Regional Council educates visiting owners about the rules relating to discharges, and the importance of abiding by the rules. This is usually done during on-water patrols, which happen all year round, especially over the summer months.

In order to improve the management of illegal discharges, Northland Regional Council notified a plan change in August 2012 to introduce new requirements and standards for vessels within mooring zones[106]. Under the new rules, boats must have an authorised wastewater holding tank or treatment system and, if overnighting happens for more than five nights, wastewater has to be discharged in an appropriate manner (for example, to a pump-out facility or open coastal water outside the harbour where the discharge of sewage is legal). The proposed rules have immediate effect under the Resource Management Act as they relate to water quality.

Boat maintenance facilities are a potential source of elevated heavy metals and other toxicants, although this risk is smaller than in the past due to better site management and containment and treatment facilities. The main concerns centre on possible contamination associated with dust and anti-fouling paints which can impact on aquatic species. Boat maintenance facilities are subject to regular inspection to ensure compliance with rules in Northland Regional Council's plans and Whāngārei District Council bylaws, and any consent conditions. Most boat maintenance areas are located off Port Road, and in and around the Town Basin.

As reported in section 3.2.2, there has been a significant decrease in copper concentrations in sediments at some sites in the Hātea River arm of the upper harbour. The reduction in levels is thought to be a result of a ban on harbour-side dry sand-blasting and runoff from slipways.

Despite this, it may be worth re-assessing the contribution of boats using or moored in the upper harbour. A recent joint study by NIWA and Auckland Council estimated copper export

[105] Note: jetty owners are allowed to live on board boats on the condition that they have toilet facilities available to them onshore at any time of the day.
[106] Variation 2 to Plan Change 1 of the Regional Coastal Plan for Northland.

from Auckland marinas to be double that in stormwater discharged from the entire catchment of the Waitemata Harbour.[107]

## 4.10 Harbour dredging

Dredging is undertaken to address on-going sediment deposition. Historically, harbour dredging was a major source of sediment contamination in the harbour because dredged material was deposited in other parts of the harbour rather than being removed. This is thought to have had a significant impact on the harbour ecosystem, most noticeably on seagrass.

Harbour dredging is now controlled by resource consent. Conditions of consent are aimed at minimising adverse effects, and marine dumping of dredging into harbour waters no longer occurs (dredging material is dumped on land).

Dredging still happens at a number of locations in the harbour, especially in the upper harbour area. Periodic dredging of the Town Basin and its channels occurs regularly to keep them navigable. Dredging is also undertaken to keep the Portland channel open for vessels to collect cement from Golden Bay Cement Company.

When dredging occurs, localised clouding of the water column and some sediment settling can occur. Dredging can also release various contaminants that have accumulated in the sediment in the past, such as heavy metals and other biotoxicants, and nutrients.

## 4.11 Industrial discharges

There are a small number of industrial sites and facilities in the greater catchment that discharge contaminants to the harbour. The majority of the discharges from these sites are stormwater and cooling water, with the main contaminants being suspended sediments and other particulate matter, elevated temperature, and changes in pH.

All discharges are authorised by resource consents, which are monitored and reviewed. The sites have measures in place to prevent and control contaminants entering the harbour, including management plans and procedures for any accidental spill, bunding and other detention structures, and other treatment systems.

Overall, industrial dischargers have had good compliance with respective resource consents. Northland Regional Council considers that these discharges are generally well-managed. However, there are some uncertainties regarding the actual composition of first flush stormwater and volumes discharged from some sites. These may need to be assessed over time.

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[107] Gadd, J., Cameron, M., (2012). Antifouling biocides in marinas: Measurement of copper concentrations and comparison to model predictions for eight Auckland sites. Prepared by NIWA for Auckland Council. *Auckland Council technical report TR2012/033.*

There are also a number of other industrial and commercial sites that discharge stormwater and waste products to the Whāngārei wastewater and stormwater networks (discussed previously).

## 4.12 Landfills

Landfills are necessary to the community because they collect and hold waste materials in a controlled and managed location. Most water quality concerns involving landfills related to leachate, the water that passes through landfills and picks up waste-soluble compounds and particulate matter. If designed properly and managed well landfills present very little risk to groundwater and surface waters that are hydrologically connected.

The Regional Water and Soil Plan regulates the operation of landfills to prevent and control any adverse effects on water quality.

Past and operational landfills for Whāngārei district are located within the harbour catchment. The former landfill on Pohe Island sits at a prominent location beside the Hātea River quite close to central business areas, light industrial areas, and major council infrastructure such as the Whāngārei Wastewater Treatment Plant. The Pohe Island landfill was closed in 2005 and is subject to a number of remedial works, including clay capping.

A post-closure plan for the site was completed in 2007. To date, final capping of the four hectare site has been completed and the site is well-formed and maintained.

Any leachate from this site is currently piped to the Whāngārei Wastewater Treatment Plant for disposal. Since 2006, six-monthly and annual monitoring has occurred on the site. Monitoring consists of site inspections, cap inspections, ground monitoring bores, and settlement inspections, among other activities. Drainage on site is considered to be in good condition. Monitoring bores have noted some small amounts of leachate gas, but floodgate monitoring has not indicated any major issues. Overall the site is in good condition and is well maintained. The monitoring programme is on-going, and should help identify any leachate problems at an early stage.

In 2010 a new landfill was opened at Puwera. Annual reporting is required as part of its resource consent. Monitoring to date has revealed a few small issues, with a small amount of odour and the presence of some leachate in monitoring bores, with elevated levels of ammoniacal nitrogen being recorded. However, this record may be due to the swampy nature of the monitoring site, and more baseline monitoring is required to confirm whether it is a seepage issue.

It is understood that prior to the use of Pohe Island landfills were situated at the entrance to Limeburners Creek (at the present day cricket ground) and at Onerahi. Not much information is available on them.

### 4.12.1 Quarries

There are a number of closed and operative quarries in the catchment, including in the Raumanga, Limeburners, and Whāngārei south sub-catchments. The operative quarries are monitored as part of resource consent conditions and are not considered to be major sources of sediment to the harbour, relative to other sources.

## 4.13 Summary and considerations

There are multiple sources of contaminants (nutrients, sediments, faecal pathogens, and heavy metals) in the upper harbour.

Overflows, leakage, and discharges from urban wastewater and stormwater infrastructure appear to be main sources of high levels of nutrients, faecal pathogens, and heavy metals in the Hātea River arm of the upper harbour, although other activities such as pastoral activities and boats also contribute.

Pastoral and forestry activities (including farm dairy effluent) are the likely key sources of contaminants around the confluence of the Otaika River and the Mangapai arm. However, the influence of contaminants from the Hātea River arm as a result of tidal dispersion should not be overlooked.

Primary production, forestry, and lifestyle activities are likely to be the main sources of sediments in the harbour. The proportions of sediment contribution will be better understood from mid-2013 following research into sediment sources and deposition rates in the harbour.

While the sources of contamination in the harbour are apparent, this report has highlighted that not much is known about their respective loads and impacts on the harbour. Understanding loads, particularly nutrient and sediment loads, is crucial to the setting of catchment-specific objectives and water quality limits for the harbour catchment. Moreover, quantifying individual loads allows for total loads of contaminants in the harbour to be understood. This is necessary to define the present (or baseline) state as a starting point for the future management of the harbour and its catchments.

In order to calculate loads, additional freshwater quality monitoring is likely to be required and catchment contaminant load models run. Without good data modelling outputs can be coarse, which then restricts the ability to accurately assign or allocate contaminant loads and therefore affects the ability to manage limits. In the meantime, there are a number of actions that should be undertaken immediately to reduce contaminant loads to the harbour before a statutory catchment plan is developed and implemented (see Section 6 below).

# 5 Proposed water quality objectives for the harbour

This section proposes three water quality objectives for the harbour (see below). These are based on what both councils have heard from the community over the past number of years and an understanding that contaminant load reductions will occur as a result of recent and planned future actions of both councils to improve water quality in the harbour and its contributing catchments.

Actions include significant upgrades to the Whāngārei wastewater reticulation network and treatment plant and Northland Regional Council's commitment to promoting and supporting good management practices in primary production activities in the catchment.

1. *Within 10-15 years sedimentation rates and nutrient levels have reduced in the Mangapai arm of the upper harbour, and within 30 years they have significantly reduced, so that its ecological condition is enhanced.*
2. *Within 10-15 years faecal pathogen, turbidity, and nutrient levels have reduced in the Hātea arm of the upper harbour, and within 30 years they have significantly reduced, so that it becomes more accessible to a wide range of water-related activities and its impact on the ecological condition of the rest of the harbour is lessened.*
3. *Good water quality in the middle and lower harbour is maintained for its ecological condition and high recreational, cultural, and economic uses and values.*

The proposed objectives are intended to inform the establishment of catchment-specific objectives and water quality and quantity limits for the harbour catchment, which once finalised will be included in the Regional Water and Soil Plan (or other relevant regional plan).

The objectives are structured in a way that acknowledges that improvements in water quality will take time and that there are often lags in ecosystem response. It is also important to note that the proposed objectives do not have any legal weight. They are however consistent with water management objectives in the operative and proposed regional policy statements for Northland and in the operative Regional Coastal Plan.

Both councils expect that the proposed objectives will be refined or even changed as information on current contaminant loads are understood and load reductions agreed, and as a result of community and stakeholder collaborative input.

# 6 Actions and recommendations

This section identifies current and future actions for both councils to maintain and improve water quality in the harbour and in its contributing catchment.

## 6.1 Overview

The key contaminants of concern in the harbour and its contributing catchments are nutrients (nitrogen and phosphorus), sediments, faecal matter, and to a lesser extent heavy metals. These come from both direct and diffuse sources.

### 6.1.1 Direct discharges

While considerable effort has been spent on improving the quality of water in the harbour, there is still a way to go in terms of upgrading Whāngārei's wastewater infrastructure to address wet weather overflows – as outlined in Whāngārei District Council's Wastewater Management Strategy (see section 1.4.2).

More attention is also needed on some parts of the Whāngārei urban stormwater network, particularly in critical source areas (areas that generate high yields of contaminants).

There are a number of discharges from both the Whāngārei wastewater and stormwater reticulation networks that require authorisation (either by meeting permitted activity plan rules or by resource consents). With regard to stormwater discharges, intervention in the form of treatment systems may mean that permitted activity standards can be met.

### 6.1.2 Diffuse discharges

Managing diffuse discharges can be challenging compared to managing direct discharges. This is due to difficulties around measuring diffuse source contaminant loads and often individual sources are responsible for only a small fraction of the total contaminant load entering the harbour. There are also technical and political challenges associated with regulating land use activities for water quality purposes.

Northland Regional Council considers that the best way to address diffuse source contamination in the harbour and its contributing catchment is by way of an integrated catchment management plan. The Whāngārei Harbour Catchment is a priority catchment for the development of such a plan (see below).

In the meantime, Northland Regional Council is committed to promoting and supporting the uptake of good management practices in pastoral farming activities and on lifestyle blocks in the upper harbour sub-catchment. This will be supported by Northland Regional Council's Environment Fund. In the longer term, Northland Regional Council and Whāngārei District Council will also look to develop and implement a riparian and erosion prone land re-vegetation programme.

### 6.1.3 Integrated catchment management

Integrating the management of the use of land, freshwater, and harbour water is critical to maintaining and improving fresh and coastal water quality over time. Broadly speaking, this approach involves managing the use and development of land and discharges for the wider health of the harbour and the rivers and streams draining into it, as well as their associated uses and values.

Northland Regional Council intends to put in place an integrated catchment management framework for the Whāngārei Harbour Catchment. This is identified in its *Waiora Northland Water* programme, which sets out the regional council's approach for implementing the National Policy Statement for Freshwater Management 2011. The integrated catchment management framework will include catchment-specific objectives and associated water quality and quantity limits, which will be collaboratively determined with the community, including key stakeholders and iwi and hapū.

Catchment-specific objectives and limits will help both councils and the community to more efficiently and effectively target management actions and resources. A transparent and measurable framework will also allow for higher levels of public scrutiny to ensure that improvements are happening.

In order to put in place such a management framework we need to, among other things, understand the desired environmental outcomes (management objectives) for the harbour in order to inform the establishment of catchment-specific objectives. We consider that the proposed objectives will assist with this. We also need to better understand and quantify sources and loads of key contaminants from the harbour catchment.

The following table provides a summary of the respective actions of both councils to maintain and improve the quality of water in the harbour.

**Table 8: Summary of current and future actions to achieve the proposed objectives**

| | On-going | Short-term (0-3 years) | Medium-term (4-6 years) | Long-term (7years+) |
|---|---|---|---|---|
| **Enforcement of and compliance with current regulation** | Monitor and enforce regulatory controls on point and diffuse sources of contamination (Action 1).<br>Ensure that discharges of wastewater and stormwater from Whāngārei District Council reticulation and treatment infrastructure comply with Section 15(1) of the Resource Management Act and conditions of resource consent (Action 2). | Obtain resource consent(s) to authorise wet weather overflows from the Whāngārei wastewater network in accordance with Regional Water and Soil Plan and Regional Coastal Plan (Action 3) ***See related Action 5 below.**<br>Assess the level of compliance for the discharge of stormwater to the Whāngārei Harbour and contributing freshwater bodies. Where these do not comply with the Regional Water and Soil Plan or Regional Coastal Plan either obtain resource consents or undertake works to meet permitted activity standards (Action 4). | | |
| **Undertaking, promoting, and supporting good/best management practices** | Continue to implement the Whāngārei District Council Wastewater Strategy (Action 6).<br>Continue to review and update stormwater catchment management plans for all urban stormwater networks in the Whāngārei Harbour Catchment (Action 7).<br>Work with landowners and land managers (including Whāngārei District Council managers of parks and reserves, roads, and stormwater) in the Whāngārei Harbour sub-catchments to:<br>· Reduce loss of sediment, nutrients, and faecal matter from land (Action 9);<br>· Trap and store sediment, nutrients, and faecal matter that is transported off-site (Action 10); and<br>· Manage streamside environments to enhance water quality and aquatic ecosystems (Action 11).<br>Promote the Northland Forestry Guidelines (Action 12). | Implement and review a programme to reduce the frequency and volumes of wet weather overflows from the Whāngārei wastewater network (Action 5).<br>Investigate and implement mitigation and/or remediation measures for preventing and treating stormwater contamination (Action 8). | Implement and review a programme to reduce the frequency and volumes of wet weather overflows from the Whāngārei wastewater network (Action 5).<br>Investigate and implement mitigation and/or remediation measures for preventing and treating stormwater contamination (Action 8). | Implement and review a programme to reduce the frequency and volumes of wet weather overflows from the Whāngārei wastewater network (Action 5).<br>Investigate and implement mitigation and/or remediation measures for preventing and treating stormwater contamination (Action 8). |
| **Other non-regulatory actions** | Support community groups undertaking restoration and enhancement initiatives (Action 14).<br>Inform visiting boat owners about illegal discharges of sewage to the Whāngārei Harbour (Action 15).<br>Promote the uses and values of Whāngārei Harbour and its sub-catchments (Action 16). | Develop and implement a targeted riparian and steep land re-vegetation programme for the upper Whāngārei Harbour sub-catchments in urban and rural environments (Action 13). | Implement a targeted riparian and steep land re-vegetation programme for the upper Whāngārei Harbour sub-catchments in urban and rural environments (Action 13). | Implement a targeted riparian and steep land re-vegetation programme for the upper Whāngārei Harbour sub-catchments in urban and rural environments (Action 13). |
| **Monitoring and research** | Continue current monitoring and research programmes in the Whāngārei Harbour and amend or expand them as necessary (Action 17).<br>Map the extent and distribution of seagrass in the Whāngārei Harbour every 5 years (Action 20). | Quantify loads of sediment, nutrients, heavy metals, and faecal pathogens from the upper Whāngārei Harbour sub-catchments and direct and diffuse sources (Action 18). | Assess progress towards achieving Whāngārei Harbour water quality objectives and catchment-specific objectives (Action 19).<br>Investigate and support community monitoring programmes for the Whāngārei Harbour and its sub-catchments (Action 21). | Assess progress towards achieving Whāngārei Harbour water quality objectives and catchment-specific objectives (Action 19).<br>Investigate and support community monitoring programmes for the Whāngārei Harbour and its sub-catchments (Action 21). |

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| **Improving the regulatory framework** | | Form a Whāngārei Harbour and Catchment Advisory Group to confirm/amend the proposed water quality objectives for the Whāngārei Harbour and establish catchment-specific objectives for the Whāngārei Harbour catchment/sub-catchments (Action 22).<br>Translate catchment-specific objectives into water quality limits and targets (Action 23).<br>Assess the need to amend current policies and rules and/or develop new policies and rules to manage direct and diffuse source discharges to achieve catchment-specific objectives and Whāngārei Harbour water quality objectives (Action 24). | Include catchment-specific objectives, water quality limits, and targets in the Regional Water and Soil Plan (Action 25).<br>Change the Regional Water and Soil Plan to strengthen controls on diffuse source activities, and include any other new and/or amended policies and rules (Action 26).<br>Include Whāngārei Harbour water quality objectives and any associated limits or targets in the Regional Coastal Plan, as well as any new or amended policies or rules (Action 27).<br>Assess the need for and, if required, develop an onsite wastewater bylaw (Action 28). | Review and, where necessary, change conditions of coastal permits and discharge permits to align them with water quality limits and targets (Action 29). |

## 6.2 Detailed actions

### 6.2.1 Enforcement of and compliance with current regulation

Both councils have a legal responsibility to enforce and comply with water quality regulation. Table 9 below sets out actions that are required by current regulation to prevent or control loads of contaminants to the harbour and its sub-catchments.

**Table 9: Detailed actions, enforcement of and compliance with current regulation**

| | Action | Key related actions | Timeframe | Lead | Notes |
|---|---|---|---|---|---|
| 1 | Monitor and enforce controls on point and diffuse sources of contamination (rules in regional and district plans, resource consents, and bylaws), including:<br>· Municipal wastewater discharges and overflows<br>· Municipal stormwater discharges<br>· Design and construction of subdivisions and other development<br>· Construction of septic systems<br>· Industrial discharges<br>· Farm dairy effluent discharges<br>· Pastoral activities<br>· Forestry activities<br>· Sewage discharges from boats<br>· Construction and management of landfills<br>· Maintenance and construction of roads, cycle-ways, walkways<br>· Other earthworks activities<br>· Vegetation clearance and disturbance<br>· Dredging | | On-going | NRC / WDC | Councils must apply and enforce regulation in a consistent and even-handed manner. |
| 2 | Ensure that discharges of wastewater and stormwater from Whāngārei District Council reticulation and treatment infrastructure | 3, 4 | On-going | WDC | Any discharge of contaminants of water into |

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| | comply with Section 15(1) of the Resource Management Act 1991 and conditions of resource consents. | | | | water, or contaminants onto or into land which may enter water must be authorised by a national environmental standard or other regulations, a rule in a regional plan, or a resource consent. |
| 3 | Obtain resource consents to authorise wet weather overflows from the Whāngārei wastewater network. | 2, 5, 6 | Short-term (0-3 years) | WDC | There are a number of regular wet weather discharge points that require authorisation under the Regional Water and Soil Plan. |
| 4 | Assess the level of compliance for discharges of stormwater to the Whāngārei Harbour and contributing freshwater bodies. Where these do not comply with the Regional Water and Soil Plan or the Regional Coastal Plan either authorise by consent or undertake remedial works to meet permitted activity standards. | 2, 7, 8 | Short-term (0-3 years) | WDC | There are a number of stormwater discharge points that require authorisation under the Regional Coastal Plan and the Regional Water and Soil Plan. |

(NRC = Northland Regional Council; WDC = Whāngārei District Council)

### 6.2.2 Undertaking, promoting, and supporting good/best management practices

The following table sets out actions that involve undertaking, promoting, and supporting good practices (in municipal asset management and primary production activities).

**Table 10: Detailed actions – good/best management practices**

| | Action | Key related actions | Timeframe | Lead | Notes |
|---|---|---|---|---|---|
| 5 | Develop and implement a programme to reduce the frequency and volumes of wet weather overflows from the Whāngārei wastewater network. | 3, 6 | Short-term (0-3 years) | WDC | This programme is under development, and is necessary to prioritise network upgrades to a suitable containment standard and to contribute to the achievement of the proposed water quality objectives for the harbour. A programme may support an application(s) for resource consent(s) to authorise wet weather overflows from the Whāngārei wastewater network. |
| 6 | Continue to implement the Whāngārei District Council Whāngārei Wastewater Strategy. | 5 | On-going | WDC | |
| 7 | Continue to review and update stormwater catchment management plans for urban stormwater networks in the Whāngārei Harbour sub-catchments. | 8, 13 | On-going | WDC | |
| 8 | Investigate mitigation and/or remediation options for preventing and treating stormwater contamination and, if appropriate, apply them in high risk locations such as the central business district and Port Road areas and unsealed driveways, roads, and roadside banks. | 7, 13 | Medium to long-term | WDC | Stormwater treatment and control systems can be costly and therefore should be prioritised to critical source areas. Non-vegetated road banks, roadside drains, and unsealed driveways around the |

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| | | | | | harbour are key sources of sediment. |
| 9 | Work with landowners and land managers (including Whāngārei District Council managers of roads, parks and reserves, and stormwater) in the upper Whāngārei Harbour sub-catchments to reduce loss of sediment, nutrients, and faecal matter from land, by:<br>· Controlling soil erosion (slip, gully, sheet, earthflow, tunnel gully, stream bank erosion), including by strategic planting of poplars and willows to control slips and gullies.<br>· Ensuring sufficient ground cover is retained to reduce rainfall impact, hold the soil surface intact and slow runoff (for example, dense pasture of sufficient length, healthy scrub or bush, or healthy production forest).<br>· Managing grazing to reduce pugging and avoid compaction, or minimising soil disturbance and reducing compaction during land preparation for forestry and during logging (as these cause soil disturbance, increased rates of runoff, detachment and transport of soil particles and anything attached to them).<br>· Managing soils used for primary production in a manner that reduces nutrient losses to ground and surface water resources.<br>· Retaining and improving the health of indigenous vegetation on erosion-prone land to protect the soil surface, hold the soil in place and reduce the rate of runoff.  This usually involves fencing to exclude livestock but may also involve pest control work to reduce the incidence of pests that threaten the vigour or even survival of the vegetative cover.<br>· Investigating, designing, implementing and rehabilitating earthworks associated with private tracks and roads, in order to avoid or reduce sediment loss to water both during and on completion of the works. | 10, 11, 13 | On-going | NRC | Actions 9, 10, and 11 are major work areas of Northland Regional Council's Land Management team. |

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| 10 | Work with landowners and land managers in the upper Whāngārei Harbour sub-catchments to trap and store sediment, nutrients, and faecal matter that is transported off-site, by:<br>· Establishing sediment/nutrient traps in drainage depressions and seepage areas;<br>· Creating small wetland sediment traps by having raised culverts and by enhancing existing small wetlands as high as possible within the sub-catchments;<br>· Fencing off remnant and regenerating bush where sediment loss is an issue;<br>· Planting/encouraging suitable wetland vegetation and high fertility-demanding grass species. | 9, 11, 13 | On-going | NRC |
| 11 | Work with landowners and land managers in the upper Whāngārei Harbour sub-catchments to manage streamside environments to enhance water quality and aquatic ecosystems, by:<br>· Excluding stock from waterways;<br>· Planting appropriate willow species and/or other species to control stream bank erosion; and<br>· Encouraging or enhancing vegetation on the outside of streams to increase their ability to trap sediment. | 9, 10, 13 | On-going | NRC |
| 12 | Promote the Northland Forestry Guidelines. | | On-going | NRC |

### 6.2.3 Other

Table 11 below sets out other non-regulatory actions that will contribute to improving harbour water quality.

**Table 11: Detailed actions – other**

| | Action | Key related actions | Timeframe | Lead | Notes |
|---|---|---|---|---|---|
| 13 | Develop and implement a prioritised riparian and steep land re-vegetation programme across the upper Whāngārei Harbour sub-catchments in both urban and rural environments. The programme may include:<br>· Sub-catchment scale re-vegetation targets;<br>· Identifying with landowners suitable areas for retirement;<br>· Targeting of Northland Regional Council's Environment Fund. | 9, 10, 11, 14 | Medium to long-term (4 years - ) | NRC / WDC | Whāngārei District Council will focus on urban environments and Northland Regional Council will focus on rural environments. Key to its success will be the involvement of biosecurity experts as riparian areas and corridors are susceptible to pests and weeds. It will also need to be informed by river engineers to ensure that flooding issues are addressed. |
| 14 | Support community organisations undertaking restoration initiatives through:<br>· Education;<br>· Technical assistance and advice;<br>· Northland Regional Council Environment Fund. | 9, 10, 11, 13 | On-going | NRC / WDC | This action can complement a number of other restoration initiatives, particularly riparian re-vegetation. |
| 15 | Educate visiting boat owners about the prohibition on discharges of sewage to the Whāngārei Harbour. | | On-going | NRC | |
| 16 | Improve understanding of the uses and values of the Whāngārei Harbour and its sub-catchments, and promote the values and uses in economic development strategies and promotional material in order to increase awareness of the harbour and its important role in Whāngārei district and Northland region. | | On-going | NRC / WDC | |

### 6.2.4 Monitoring and research

Table 12 below sets out actions for generating good information, which is vital to effective and efficient management of water quality in the harbour and its sub-catchments.

**Table 12: Detailed actions – monitoring research**

| | Action | Key related actions | Timeframe | Lead | Notes |
|---|---|---|---|---|---|
| 17 | Continue current monitoring and research programmes in the Whāngārei Harbour and amend or expand them as necessary, including:<br>· Sediment accumulation rates and source research, to be repeated in 10 years.<br>· Harbour Water Quality Monitoring Programme, and consider adding Chlorophyll-a as a parameter to assess the impacts of nutrients.<br>· Coastal Sediment Monitoring Programme.<br>· Estuary Monitoring Programme.<br>· Recreational Swimming Monitoring Programme. | 1, 22, 23 | On-going | NRC | There may be a need to expand or amend current monitoring programmes depending on the nature of the harbour water quality objectives, freshwater objectives, and limits and targets, and regulatory and non-regulatory methods to achieve them. See actions 22-29 below. |
| 18 | Quantify loads of sediment, nutrients, heavy metals, and faecal pathogens from the upper Whāngārei Harbour sub-catchments and direct and diffuse sources. | 19, 22, 23 | Short-term (0-3 years) | NRC / WDC | This action is necessary to underpin the development of catchment-specific objectives and water quality limits for a catchment management plan. It will also provide baseline information to assess future management actions. |
| 19 | Assess progress towards achieving harbour water quality objectives and freshwater objectives over time, including by routinely monitoring: | 25, 27, 29 | Medium to long-term (4 | NRC | |

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| | · Sub-catchment and source loads of contaminants.<br>· Environmental outcomes. | | years+) | | |
| 20 | Map extent and distribution of seagrass in the Whāngārei Harbour every 5 years. | 19 | On-going | NRC | Seagrass is the most important habitat in the harbour. There are strong relationships between its health and water quality (particularly sediment). |
| 21 | Investigate the development of and/or support for community monitoring programmes at sites in the Whāngārei Harbour and its sub-catchments where uses and values are important. | | Medium to long-term (4 years+) | NRC / WDC | Piloting community monitoring schemes will be encouraged as will the involvement of interest groups/stakeholders with specific interests relating to the uses and values of the Whāngārei Harbour and its sub-catchments. |

### 6.2.5 Improving the regulatory framework

Northland Regional Council is required to implement national policy direction on the management of fresh and coastal water quality. It has identified the Whāngārei Harbour catchment as a first priority for the establishment of catchment-specific objectives and limits for inclusion in its Regional Water and Soil Plan (or other relevant regional plan). Catchment-specific objectives and limits will need to incorporate water quality objectives for the harbour.

Northland Regional Council is committed to a collaborative approach for developing catchment-specific objectives and limits as well identifying any new regulatory and non-regulatory methods to meet them. This will be undertaken through the use of a collaborative stakeholder advisory group.

There may also be a need for Whāngārei District Council to review or even develop new bylaws to assist the achievement of water quality objectives for the harbour and freshwater objectives for its sub-catchments.

**Table 13: Detailed actions – improving the regulatory framework**

| | Action | Key related actions | Timeframe | Lead | Notes |
|---|---|---|---|---|---|
| 22 | Form a Whāngārei Harbour Catchment Stakeholder Advisory Group to:<br>· Confirm/amend the proposed harbour water quality objectives;<br>· Establish catchment-specific objectives for Whāngārei Harbour catchment/sub-catchments, which also provide for the achievement of harbour water quality objectives.<br>· Identify and make recommendations on new regulatory and non-regulatory methods to achieve harbour and catchment objectives. | 23, 24 | Short-term (0-3 years) | NRC | |
| 23 | With the Whāngārei Harbour Catchment Stakeholder Advisory Group, translate catchment-specific objectives into water quality limits and targets (interim limits). | 17, 18, 22 | Short-term (0-3 years) | NRC | |
| 24 | Assess the need to amend current policies and rules and/or develop new policies and rules to manage direct and diffuse source discharges to achieve catchment-specific objectives and/or harbour water quality objectives. | 22, 23 | Short-term (0-3 years) | NRC | |
| 25 | Include catchment-specific objectives, water quality limits, and targets in the Regional Water and Soil Plan (or other relevant regional plan). | 26 | Circa. 2015 | NRC | |
| 26 | Change the Regional Water and Soil Plan to strengthen controls on significant diffuse sources of contamination (for example, stock access to water bodies), including any collaboratively determined policies or | 24, 25 | Circa. 2015 | NRC | |

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| | methods. | | | |
| 27 | Include harbour water quality objectives for the harbour and any associated coastal water quality standards in the Regional Coastal Plan as well as any new or amended policies and rules. | 24 | Circa. 2015 | NRC |
| 28 | Assess the need for and, if required, develop a bylaw for onsite wastewater treatment systems. | 24 | Medium-term (4-6 years) | WDC |
| 29 | Review and, where necessary, change conditions of coastal permits and discharge permits to align them with water quality limits and targets. | 27 | Long-term (7 years+) | NRC |

# 7 Conclusion

The Whāngārei Harbour is highly valued for its important ecological, social, cultural and economic values. Water quality in the upper harbour is impacting on a number of these, in particular its ecological and recreational values however water in the middle and lower harbour is generally of a high quality.

This strategy has identified areas where management efforts can be enhanced in order to improve the quality of water in the harbour, particularly in the upper harbour. It also identifies what Northland Regional Council and Whāngārei District Council need to do to achieve this.

Both councils are committed to working positively together to continue to improve the health of the harbour. Central to this is collaborating with the local community, including key stakeholders and iwi and hapū, in its management.

We envisage a future where the harbour is treasured and widely known for its good water quality, its bountiful kaimoana, a place for recreation and reflection, and its value to the local and regional economies.

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# Appendix 1 – Whāngārei Harbour Water Quality Management Plan 1990

During the period 1980-1990, a considerable amount of research was undertaken on the Whāngārei Harbour by Northland Regional Council (known for most of the decade as the Northland Harbour Board). While some of this research was initiated due to new developments at Marsden Point, it was local interest in harbour health that broadened the work into a more substantial study. The research underpinned the development of the Whāngārei Harbour Water Quality Management Plan (the management plan).

Work started on the management plan in 1985 completed in June 1990 (predating the Resource Management Act). Many aspects from the plan were incorporated into the Regional Coastal Plan for Northland and the regional council's monitoring programme. They also led Whāngārei District Council to undertake capital works projects on its wastewater reticulation and treatment infrastructure.

There were 37 actions in all and the majority have been implemented in full or in part. Set out below are the actions (strategies) and brief comments on their implementation.

***Strategy 1: Reclassify the waters of Whāngārei Harbour to reflect the level of improving water quality as depicted in Figure 16 [of the management plan].***

The waters of the harbour were reclassified and the classifications included in the Regional Coastal Plan.

***Strategy 2: Re-affirm the 1981 Water Quality Management Statement for Whāngārei Harbour as a statement of the goals for future water quality management.***

There doesn't appear to be a reaffirmation as part of the Regional Coastal Plan. However, similar objectives for the region's coastal water quality are contained in the Regional Water and Soil Plan.

***Strategy 3: In considering water rights, the Northland Regional Council will require that, unless agreed otherwise by the tangata whenua, methods of wastewater disposal are as compatible as possible with Māori spiritual and cultural values.***

This strategy was written before the Resource Management Act 1991. Sections 6, 7, and 8 of the Act require Northland Regional Council to consider Māori cultural values relating to harbour water quality when including policies and rules in the Regional Coastal Plan and when considering applications for discharges under the plan.

***Strategy 4: Rescind the 1986 amendment of the Water Quality Management Statement which stipulates rainfall-related restrictions on the applicability of the stated goals.***

It appears that this was undertaken. The Regional Coastal Plan makes no reference to rainfall-related restrictions.

It should be noted however that the operative Regional Policy Statement for Northland (July 2002) states as an objective that the effects of natural events on harbour water quality should not be taken into account when assessing the effectiveness of management objectives for the harbour.

***Strategy 5: Eliminate, within the constraints of the Northland Regional Council's jurisdiction, the discharge of untreated sewage from any source to the Whāngārei Harbour unless the discharge can be clearly shown to be absolutely necessary and cannot reasonably be avoided.***

This has been partially achieved:

- Reticulation of the northern shores of the harbour has eliminated most septic system issues.
- Northland Regional Council conducts on-going work with discharges from boats promoting its zero discharge rule and taking enforcement action where sufficient evidence exists.
- Two large wet weather overflow points (Okara Park and Hātea pump stations) in the Whāngārei wastewater network have been addressed in recent years.
- The Whāngārei Wastewater Treatment Plant is being upgraded to treat virtually all flows to it.

However, there are still a number of wet weather overflows (discharges) of untreated wastewater (sewage) which occur at a number of locations across the network. These are likely to be a source of faecal and nutrient contaminant in the harbour.

***Strategy 6: Actively promote the use of methods of disposal of treated wastewater on to land, where practicable, in order to minimise the number of direct discharges to the Whāngārei Harbour.***

***Strategy 7: Where a proposed wastewater discharge cannot be accommodated by disposal on to land and a discharge to the Whāngārei Harbour is therefore unavoidable, to establish through a quantitative assessment that the effluent will not compromise the relevant water quality classification standards.***

Strategies 6 and 7 are undertaken as part of the consent application process under the Regional Coastal Plan. However, it is noted that the water quality classifications and standards for the harbour are not strictly enforceable.

***Strategy 8: Maintain regular and effective water right monitoring to ensure compliance with water right conditions [consent conditions] and the maintenance of classification standards.***

***Strategy 9: Carry out long-term monitoring of general harbour water and sediment quality to ensure that the objectives of the management plan are met. Specifically, to monitor the following using sampling strategies developed from the plan investigations:***

a) ***water quality in the Hātea River arm of the upper harbour at fortnightly intervals;***

b) ***water quality in the middle and lower harbour at two-monthly intervals;***

c) ***harbour sediment heavy metal and hydrocarbon levels at two-yearly intervals.***

Northland Regional Council continues to undertake this work to assist its functions under the Resource Management Act. The programme was last reviewed and revised in 2008.

***Strategy 10: Encourage the Whāngārei District Council in its work towards upgrading the Onerahi sewage treatment plant and endorse its moves toward applying for a water right [resource consent] for the discharge to the harbour in mid-1991.***

The Onerahi sewage treatment plant was decommissioned. Wastewater is now pumped to the Whāngārei Wastewater Treatment Plant.

***Strategy 11: Continue regular monitoring of harbour water quality adjacent to shoreline settlements where septic tanks are the principal means of sewage disposal and to annually forward the results to the Whāngārei District Council and the Northland Area [District] Health Board.***

This continues to occur. Settlements on the northern shore of the harbour are now reticulated to the Whāngārei Wastewater Treatment Plant.

***Strategy 12: Oppose further housing development in areas where septic tanks have been shown by the results of regular monitoring or other similar investigation to be contaminating harbour water quality to the extent that relevant classification standards are compromised.***

This strategy was not strongly taken up by either Whāngārei District Council or Northland Regional Council. The Regional Water and Soil Plan and Whāngārei District Councils Environmental Engineering Standards contain rules that address new septic systems.

***Strategy 13: Request that the Whāngārei District Council signpost streams shown to be contaminated by septic tank seepage as representing a potential human health hazard.***

This strategy was not strongly taken up in any documents. However, signs are posted by Northland Regional Council at popular swimming sites if high levels of faecal bacteria are detected. This is undertaken as part of the Recreational Swimming Water Quality Programme. Whāngārei District Council also posts signs following significant wastewater overflows from its reticulation network.

***Strategy 14: Request that the Whāngārei District Council and the Northland Area [District] Health Board jointly carry out a detailed assessment of the performance of septic tank systems in the settlement areas adjacent to Whāngārei Harbour identifying existing or potential areas of public health concern and recommending appropriate measures to remedy them.***

This strategy was undertaken at the time, but little has occurred recently. The Whāngārei Heads Wastewater Reticulation Scheme has addressed septic tank issues on the northern shore of the harbour.

It should be noted that Northland Regional Council and Whāngārei District Council continue to investigate allegations of failing on-site systems.

***Strategy 15: Advise shipmasters that the discharge of sewage from ships while within the limits of Whāngārei Harbour is considered an offence under Section 242 of the Harbours Act, 1950 and Section 24 of the General Harbours (Nautical and Miscellaneous) Regulations, 1968.***

This strategy was superseded by the Resource Management Act Marine Pollution Regulations. The Regional Coastal Plan prohibits discharges of sewage from boats to the harbour. Northland Regional Council continues to monitor ship sewage holding and treatment systems to ensure that they comply with rules.

***Strategy 16: Investigate the possible discharge of sewage from boats in the Town Basin and enact Recommendation 2 of Section 8.10.4 of the Northland Harbour Board's Whāngārei Harbour Study.***

This is on-going. Northland Regional Council continues to respond to incidents relating to discharges from boats in the Town Basin and upper harbour, and it has an education and enforcement programme.

***Strategy 17: Monitor, at two-year intervals, the levels of heavy metals and hydrocarbons in pipi from the Marsden Point and Mair Bank.***

This is undertaken as part of monitoring stormwater discharges from the Marsden Point Oil Refinery.

***Strategy 18: Continue toward regularising the fertiliser works discharge under the water right system.***

The fertiliser works (now known as Balance Agri-Nutrients) operates under resource consent.

***Strategy 19: Carry out a detailed investigation into the effects of the discharge of selected heavy metals on upper harbour water quality.***

This has been undertaken by Northland Regional Council as part of its Estuarine Monitoring Programme and harbour sediment quality monitoring programme

***Strategy 20: If the results of the detailed investigation referred to in Strategy 19 indicate the discharge of heavy metals in concentrations which are toxic to aquatic life, to require that leachate be treated prior to discharge.***

Concentrations of heavy metals in bottom sediment are below relevant guideline levels. Leachate from the decommissioned Pohe Island Landfill is reticulated to the Whāngārei treatment plant.

***Strategy 21: Provide educational material to boatyard owners on the sources of pollution associated with maintenance activities, and on means of preventing or reducing the level of introduction of antifouling paint, and other toxic material into the harbour.***

***Strategy 22: Inform boat maintenance facility owners of the contamination of the harbour caused by maintenance activities, and hold joint discussions on possible measures for preventing or reducing the input of toxic wastes into the harbour.***

***Strategy 23: Promote the use of appropriately designed oil and sediment traps to collect particles of antifouling primer, paint, and other contaminants in stormwater runoff from hardstand areas with stormwater systems and require, in line with established policy, water rights for stormwater system discharges from boatyards where there is likelihood that the discharge will contain such pollutants.***

With regard to strategies 21, 22, and 23 boat maintenance facilities now operate under consent and are subject to regular inspections to ensure compliance.

***Strategy 24: Require water rights for marine disposal ('dumping') of dredging spoil within Whāngārei Harbour.***

***Strategy 25: Develop and/or adopt clear procedures for assessing water quality management issues associated with dredging and dredging spoil disposal.***

***Strategy 26: Support future dredging and dredging spoil disposal operations only when these are not likely to:***

***a) Significantly reduce the rate of tidal flushing within any area of the harbour;***

***b) Significantly alter water movement patterns within any area of the harbour;***

***c) Otherwise increase the long-term risk of a general reduction in water quality or the build-up of pollutants within harbour sediments.***

With regard to strategies 24, 25, and 26, dredging operations now operate under resource consent (as per the Regional Coastal Plan), and dredged spoil is no longer disposed in the harbour.

***Strategy 27: Promote the use, where practical, of stormwater retention basins to minimise pollutant loadings in stormwater discharges to the harbour.***

No stormwater retention basins were ever constructed.

***Strategy 28: Promote public awareness of the fact that stormwater systems ultimately drain to the harbour and that consequently any waste material disposed of into stormwater systems contribute to the pollution of the harbour.***

This has regularly occurred over the years, with the most recent initiative being the Stormwater to Drains programme.

***Strategy 29: Recommend that the Whāngārei District Council compile a complete set of accurate plans of the Whāngārei city stormwater drainage system and identify on those plans, industries which could, through spillages or mismanagement, indirectly introduce pollutants into the harbour.***

This has been undertaken through the development of stormwater catchment management plans. The Whāngārei District Council has also promulgated a Stormwater Management Bylaw (2008) and the Trade Waste Bylaw (2012) to deal with such issues.

***Strategy 30: Require, as a condition of catchment water rights, that stormwater system cesspits be regularly cleaned and maintained to maximise the removal of pollutants which would otherwise reach the harbour.***

This is covered by rules regulating stormwater discharges in the Regional Water and Soil Plan and the Regional Coastal Plan, in terms of end of pipe quality standards.

***Strategy 31: Promote and support the retention of riparian vegetation and mangroves in order to reduce pollutant loadings in diffuse stormwater runoff into catchment water courses and the harbour.***

The Regional Coastal Plan for Northland contains rules that regulate pruning and removal of mangroves and other riparian vegetation. The Regional Water and Soil Plan regulates disturbance of riparian vegetation.

Northland Regional Council also promotes riparian management practices via its land management team and through its Environment Fund.

***Strategy 32: Ensure that all quarrying operations likely to contribute to the introduction of sediment into the harbour waters are controlled through the use of both water rights and consents issued under Section 34 of the Soil conservation and Rivers Control Amendment Act, 1959.***

Quarries now operate under rules in the Regional Water and Soil Plan.

***Strategy 33: Ensure, through regular surveillance, that forestry operations conform to Northland Regional Council guidelines and do not result in significant soil erosion or introduction of appreciable sediment into natural watercourses.***

Forestry operations now operate under rules in the Regional Water and Soil Plan and are regularly monitored. The recently released (2011) Northland Forestry Guidelines assist by providing examples of best practice to control and reduce sediment runoff.

***Strategy 34: Monitor the effectiveness of current measures in limiting the introduction of material into the harbour through the mishandling or spillage of cargo.***

The Regional Coastal Plan contains rules that regulate the discharge of contaminants to the harbour. Northland Regional Council monitors and responds to pollution incidents.

***Strategy 35: Enforce the provisions of the Harbours Act 1950 and Northland Harbour Board Bylaws which prohibit the deliberate discharge into the harbour of residual material from ships holds, barges, and wharf areas.***

The provisions have been superseded by the Resource Management Act 1991 and the Regional Coastal Plan that sits under it.

***Strategy 36: Continue the programme of rocky shoreline monitoring as recommended in the Whāngārei Harbour study with a view to establishing a baseline of ecological information with which to assess the impact of possible future oil spills.***

This is no longer carried out as it is considered a low priority as a good body of knowledge has been built.

***Strategy 37: This management plan is reviewed in the year 2000 or at such earlier time as may be necessary to allow for:***

***a) Changes in the aspirations of the public for the use of Whāngārei Harbour; or***

***b) New information or legislative changes which allow improvements to be made in the effectiveness of the plan.***

The plan was not formally reviewed in 2000, but many of its strategies were used in the development of the Regional Coastal Plan. The management plan is now out of date.

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