Mangere

Catchment Description


Mangere at Knights Rd bridge sampling site

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Putting Northland first

WAIORA NORTHLAND WATER

NORTHLAND REGIONAL COUNCIL

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WAIORA NORTHLAND WATER

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Executive Summary

Under the Resource Management Act 1991 (RMA) Northland Regional Council is responsible for managing the region‟s freshwater quality and quantity by controlling discharges, water takes and land use activities that impact on water.

Waiora Northland Water is a programme for improving the management of water quality and quantity across the region. It brings together and coordinates a number of Northland Regional Council‟s water management responsibilities, including its programme for implementing the National Policy Statement for Freshwater Management 2011 (NPS). Waiora Northland Water will include both catchment specific and region-wide approaches to water management.

The Mangere River catchment has been monitored by NRC since 1996 and is one of the regions most impacted rivers. Based on monitoring results from the Mangere Catchment Water Quality Investigation (2007-2010), water quality is poor with water quality degrading between upstream and downstream sites. The Mangapiu Stream has particularly poor water quality with none of the water quality medians meeting the national guidelines.

Overall, habitat quality is marginal with some riparian cover but little understory vegetation to help filter runoff. The MCI and SQMCI values for macroinvertebrates (made up of mostly freshwater insect larvae) indicate that the Mangere River is severely polluted. Pohe (2010) also reported an overall declining trend in macroinvertebrates in the Mangere River.

A recent fish survey in the Mangere recorded four native species (longfin eel, shortfin eel, crans bully, common bully) in addition to the introduced brown trout. There are also historical records of young banded kokopu migrating through to the upper reaches of the Pukenui Forest from August to December. They are highly sensitive to cloudy water and current sediment concentrations in the river are at levels likely to affect their migration.

The Mangapiu Stream and the lower reaches of the Mangere River drain a high number of dairy farms. Eighteen of the 19 farms in the Mangere catchment have upgraded their effluent disposal systems at least once. Eleven of these farms have upgraded more than once. Nine consented farms, which previously discharged treated effluent to water throughout the year, have installed land application systems, and only discharge to water during wet conditions. The effects of farm dairy effluent upgrades within the Mangere catchment during the last six years are already paying dividends, with all geochemical indicators for ecosystem health and recreation at Knights Road Bridge either stable or improving. In some cases, positive changes have been very large. For instance, 32% less ammonia has been discharged to the Mangere at Knights Bridge, per year since 2007 (2007-2012). However, water quality is still severely impacted in this catchment and ongoing land management changes are required to continue to improve water quality.

Water is a valuable resource in the Mangere Catchment and is mainly used for horticulture, pasture irrigation, stock drinking and dairy shed washdown. The allocation in the catchment is considered to be high with a total water use of 10,047 cubic metre per day (m^3/d).

1 Introduction

1.1 Background

Northland Water

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

The NPS requires Northland Regional Council to establish freshwater objectives and set associated water quality and quantity limits for every stream, river, lake, wetland, and aquifer across the region. It then requires Northland Regional Council to implement regulatory and non-regulatory actions to achieve the freshwater objectives.

Northland Regional Council has committed to an approach that involves setting a combination of specific limits in priority catchments and region-wide interim and/or default limits for other freshwaters. Northland Regional Council is also aware of the strong correlation between freshwater and coastal water in Northland, especially given that all of region‟s major river systems drain to estuaries and harbours. The proposed Regional Policy Statement for Northland (proposed RPS), notified in October 2012, establishes a framework for the integrated management of fresh and coastal waters, including by identifying a number of regulatory and non-regulatory actions to be implemented by Northland Regional Council.

Actions include policies, regulations, and incentives. Achieving objectives is also dependent on a good deal of landowner and community commitment. Robust information is critical to the limits setting process and very important to assess the on-going achievement of freshwater objectives.

Northland Regional Council has identified the Mangere catchment as one of three priority catchments in implementing the Waiora Northland water programme.

2 Document structure

This document has been prepared to provide an up-to-date overview of the Mangere catchment, describing landuse, water quality monitoring results, locations of water related consents, and the context for decision making and water management within the Waiora Northland Water Programme.

The catchment description is intended to inform the Mangere Catchment Group of current NRC knowledge concerning the catchment"s freshwater quality and allocation inviting representatives of the group to contribute their local knowledge and identify knowledge gaps.

3 The Mangere catchment

3.1 Catchment description

The Mangere Catchment lies approximately 12 kilometres west of Whangarei and has a catchment area of approximately 82km2 (Figure 1). The Mangere River is a low-lying, sluggish tributary to the Wairua River, which flows through a mostly intensive agricultural catchment.

The river begins as the Mangere Stream, which flows east out of the Pukenui forest near Whangarei. It becomes a river on the flats before joining the Wairua River just west of Kokopu. The Mangere River is classified as a low-elevation, pasture river as per the River Environment Classification (REC) system.

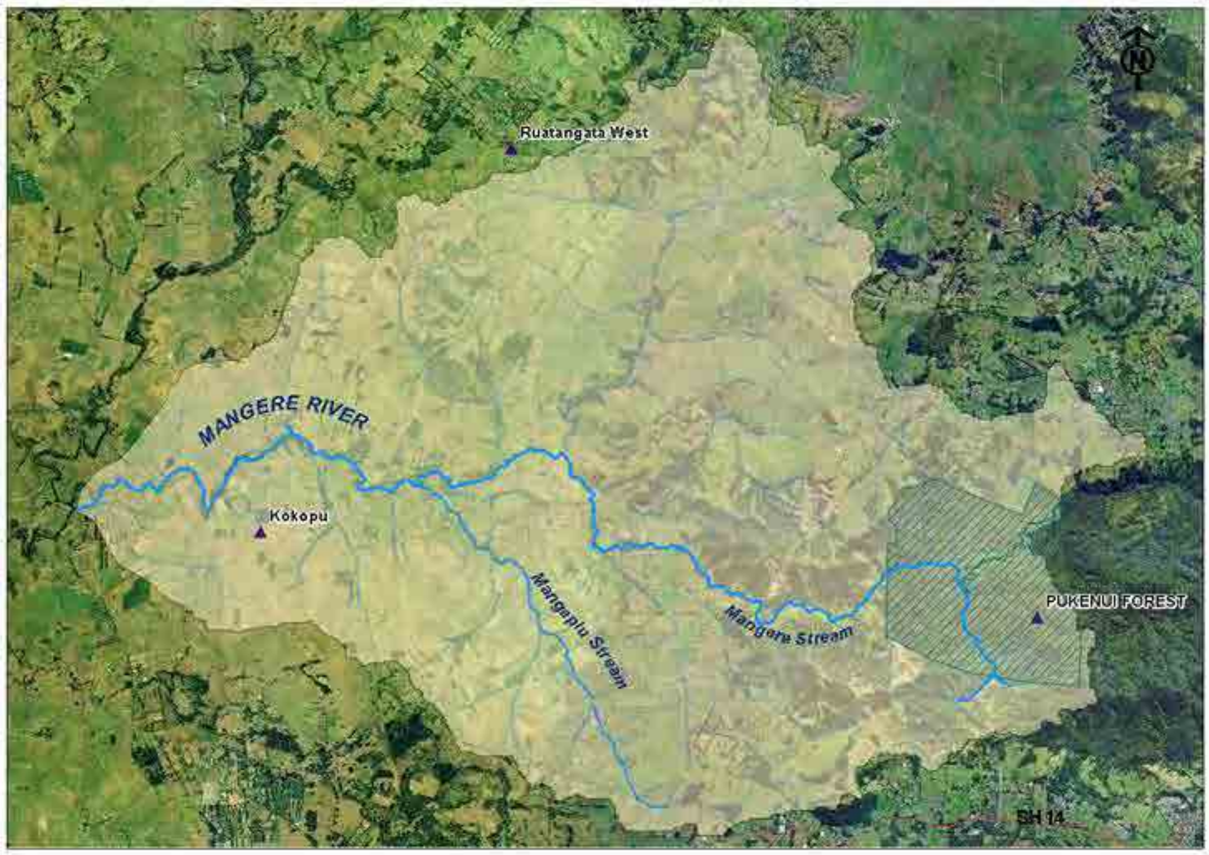

Figure 1 The Mangere catchment

4 Surface water

4.1 Waiora Northland water resources

The fresh water resources in Northland can be found in three broad forms: rivers and streams, lakes and wetlands, and groundwater.

Northland has a dense network of rivers and streams, many of which are relatively short, with small catchments. Most of the major rivers have their outlets into harbours; few discharge directly to the open coast. The Northern Wairoa River is Northland's largest river. It drains a catchment area of some 3650 square kilometres, or 29% of the land area in Northland.

Northland has a large number of small and generally shallow lakes and associated wetlands, most of which have been formed between stabilised sand dunes along the west coast. These dune lakes are grouped on the Aupouri, Karikari and Pouto Peninsulas. They vary in size, with the majority being between 5 and 35 hectares in area and generally less than 15 metres deep. Lake Taharoa of the Kai Iwi Group is one of the largest and deepest dune lakes in the country, covering an area of 237 hectares and being 37 metres deep.

There are three main types of geological formations associated with groundwater in Northland. These are sands and gravels, volcanic cones and related lava flows and sedimentary rocks such as greywacke and limestone. The main aquifers (rocks which store water) are the Aupouri sands, Kaikohe basalts and Whangarei basalts. There are a number of smaller sand and gravel coastal aquifers such as those at Russell, Matapouri and Taipa. A number of smaller less productive greywacke aquifers are situated throughout the region.

4.1.1 Small streams within the Mangere Catchment

There are a number of small streams such as the Mangapiu, Waipui, Patuwairua, Takahie, Punua Te Anau and the Mangere River which then discharge into the Wairoa River.

4.1.2 Lakes and Wetlands

Only minor areas of wetland remain in the Mangere Catchment and most of these are degraded by farming activities, drainage, or weed invasion especially by crack willow and reed sweet grass (Glyceria). There are some constructed dams but no natural lakes. Stream sides and valley bottoms offer opportunities for areas to be retired and restored to wetland which would assist with water quality.

There is approximately 167 hectares of riverine forest and wetland remnants along the Mangere River from Pipiwai Road to the Wairua River including the Mangere Falls and Patuwairua Stream Tributary. The Mangere River is forested along much of its length making it an important habitat for riverine plants and animals. Animal species include kukupa, Australasian shoveler, shags, freshwater crabs and long-finned and short-finned eels. The Regionally Significant plant green mistletoe or pirita (Ileostylus micranthus) has been recorded and there are historic pre-1900 records of threatened plants from Mangere Falls including a species of shrub daphne – Pimelea tomentosa (Nationally Vulnerable) and the Nationally Vulnerable sedge Machaerina complanata. It is the only site in the ecological district where raupo-harakeke-willow weed wetland has been recorded.

Crossing Kokopu Road near the Kara Road Junction is a 5 hectare streamside wetland comprising harakeke with the exotic reed sweet grass. Spotless crake have been recorded in this wetland. Another area of 12 hectares of wetland associated with a stream on Atwood Road has been fenced and the margins replanted. There are also areas of wetland associated with streams flowing out of Pukenui Forest including an area of raupo with willow weed and occasional ti kouka (cabbage tree) and rushes.

5 Geology

5.1 Greywacke Fault Blocks

A series of northwest-trending faultlines pass through the middle and just to the east of the catchment. Faulting at right-angles to these faults and tilting of the fault blocks so formed has formed the Pukenui and Ruatangata Fault Blocks. The basement rock in these fault blocks is greywacke, with layers of sandstone, mudstone, more sandstone and crystalline limestone above. Most of these softer sediments have been eroded off the greywacke except where they have been protected by older basalt lava flows or at the base of the next fault scarp.

Greywacke is the surface rock under Pukenui Forest, the immediately adjoining steeper hill country, a strip of south-facing steeper hills immediately north of Wood Road and a similar block between Knight Road and Kokopu Road. Soil types on greywacke in the Pukenui Fault block are moderately to strongly leached Marua soils while those on the Ruatangata Fault Block are older, strongly leached to weakly podzolised Rangiora soils.

Small areas of remnant sandstone and crystalline limestone on the south side of the Ruatangata Fault have Konoti soils.

5.2 Soft Sediments of the Northland Allochthon

The Northland Allochthon (25M Before Present), a large (7km thick) slide of sedimentary and intrusive volcanic rocks covered the whole of Northland. Rocks from the Allochthon form a large part of the catchment. Crushed sandstones, mudstones/shales and muddy limestone cover much of the Ruatangata Fault Block and form the easy hill country from Knight Road right through to the southern catchment boundary south of Kokopu. These rock types have been, in the main, deeply weathered, most podzolised, to create gumland soils. The two main gumland soils are named after land within or immediately adjoining the Mangere catchment – Kara and Wharekohe soils.

The easier slopes south of Mangere Stream are mainly Wharekohe soils, podzolised sandstone, mudstone, and in a few cases, ash that has been deposited as alluvium (see later description of individual soil types. The steeper slopes and easy ridges are generally a mosaic of clay soils and gumland soils, the former on steeper slopes where natural erosion has exposed new parent material and gumland soils on ridge tops and easy side slopes.

5.3 Volcanic Activity

Within and immediately adjoining the Mangere catchment there are two overlapping ages of volcanics which produced slightly different rock types, both basalts (iron and aluminium-rich rocks). The earlier (Horeke) age, which started about 2.5 to 3 million years before present, erupted a very fluid lava which flowed long distances on very slight grades. There were at least two volcanoes of this type within the catchment, one at Mirowhakatiki, Matarau or Ruatangata mountain, and the other somewhere in the Maunu-Maungatapere area (or possibly an earlier eruption of Whatitiri).
The lava from Mirowhakatiki flowed down the valley beyond Titoki, blocking both the Wairua and Mangakahia Rivers. It also flowed through a saddle along what is now

Kokopu Road and down the Kokopu-Mangere valley to form the Kokopu Falls, with some spillage into side valleys. Tudehope and Goings Roads traverse the eroded cone of this volcano.

Lava from the older Maunu-Maungatapere or early Whatitiri vent can be found under the edge of the later lava flows on Otaika Valley Road, Lower Cemetery Road, around the Poroti Pub, with bits poking through in various places including at the very back of Royce Kokich‟s place, with some in the middle.

These lava flows have trapped sediment and redirected streams. A basin in the vicinity of Ruatangata Garage has accumulated sediment of volcanic origin and trapped a peat swamp behind it near the intersection of Pipiwai and Matarau Roads. Sediment spread on the surface of the lava flow along Kokopu Road from Pipiwai Road has podzolised to form Kara soils. Similarly, the lava flow down the Kokopu Valley is covered in most places by podzolised alluvium/Kara soils.

5.4 Taheke Basalts

The lava flows erupted by the later Taheke volcanics was more viscous and bubbly so the rock is not as dense. The lava flows did not flow as far, usually just flowing a few kilometres to fill in the nearest valley. The cones of these eruptions are still evident with Maungatapere, Maunu, Ngararatunua and Hurupaki within the catchment or close to the catchment boundary.

5.5 Alluvial Deposits

The Mangere Stream/River has a narrow floodplain and only a thin strip of recent alluvial soils (Whakapara) along its immediate banks. There are two small areas of older terraces, the first terrace with Whareora soils near McKinley Road and higher Waipuna soils near Kokopu Road. Most of the tributary valleys within the lower catchment have infilled with sediment and podzolised to Kara soils.

The lower half of Northland also experienced ash showers from the rhyolitic volcanoes of the central North Island. The ash washed off the vegetation and land to coat alluvial deposits of a certain age. Ash-derived soils are found around the edges of the Kara-Kokopu flats.

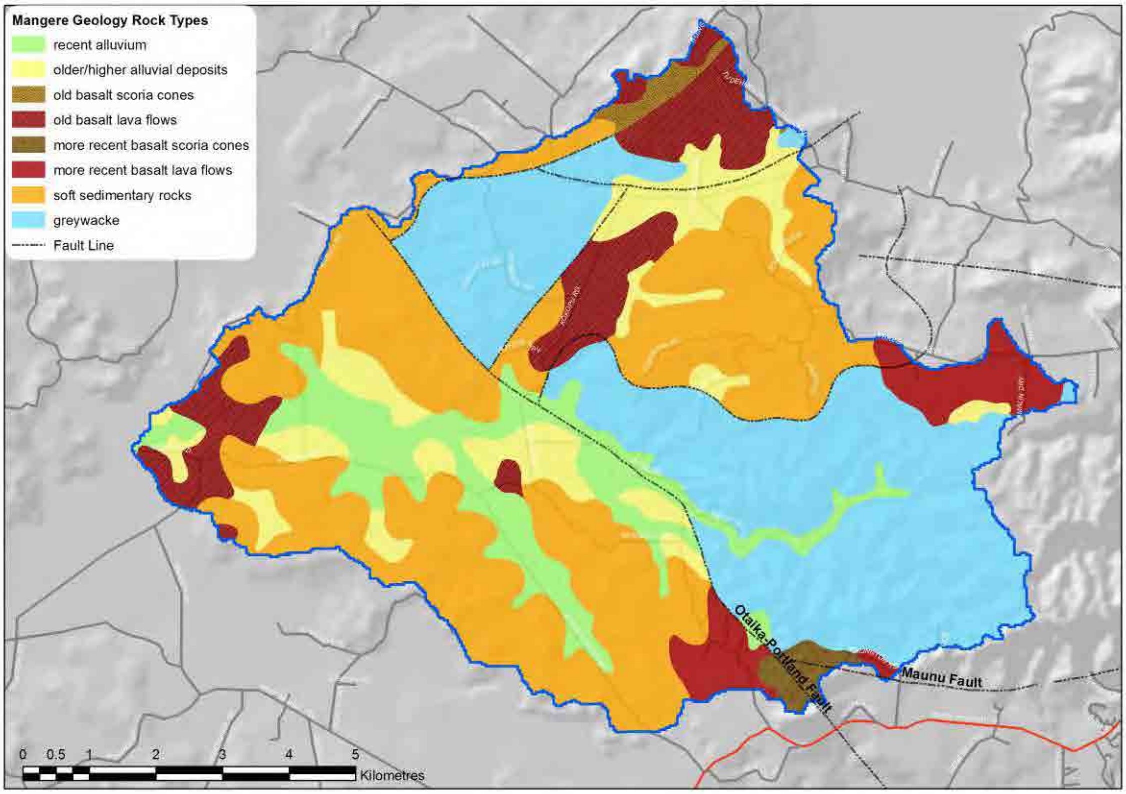

Figure 2 Rock geology of the Mangere Catchment

6 Soils

6.1 Soil types

Northland lies outside New Zealand‟s belt of vigorous geologic activity and has, for millions of years, remained relatively calm. The low relief, the absence of any deposits from recent ash showers, the warm moist climate and the original vegetation have combined to cover much of Northland in strongly leached, mature, heavy clays. Generally, topsoils are thin and subsoils are of low fertility. The main exceptions are the fertile volcanic soils, young alluvial deposits and the young soils developing on unstable steep slopes.

6.1.1 Soils formed on greywacke

MR Marua clay loam (MRH Hill soil) – a moderately to strongly leached Yellow Brown Earth (YBE) (ultic) soil formed on the greywacke edges of the up-thrust Ruatangata and Pukenui Fault Blocks.
RA Rangiora clay, clay loam and silty clay loam (& Hill soil) – a strongly leached to weakly podzolised YBE.
RAI Rangiora silty clay loam - a strongly leached to weakly podzolised YBE
HKr Hukerenui silt loam with yellow subsoil (and Hill soil YKrH) – a moderately podzolised soil.

6.1.2 Soils formed on sandstone

YC Waiotira clay loam (and hill soil) – a moderately to strongly leached YBE/ultic soil
YCe Waiotira clay (and hill soil) just over the boundary in Sam Brown‟s.
RP Riponui clay and silty clay – strongly leached to weakly podzolised YBE formed on massive sandstone
RPa Riponui sandy clay loam and sandy loam – strongly leached to weakly podzolised YBE formed from alternate thin bands of sandstone and mudstone.
PD Puketitoi sandy loam – a strongly leached to weakly podzolised YBE
HKa Hukerenui sandy loam (and Hill soil) – a moderately podzolised soil formed on sandstone generally.
WKa Wharekohe sandy loam – a mature podzol
Wkap Wharekohe sandy loam with pan – a mature podzol

6.1.3 Soils formed on Claystone, Mudstone and Shale

AP Aponga clay – a weakly to moderately leached YBE formed on a complex of mudstone and limestone/calcareous mudstone
OA Okaka clay and silty clay – a strongly leached to weakly podzolised YBE
PX Puwera clay – a strongly leached to weakly podzolised YBE
YK Waikare silt loam – weakly to moderately podzolised
OP Otaika silt loam – weakly to moderately podzolised
HK Hukerenui silt loam – moderately podzolised
WK Wharekohe silt loam – podzol
WKp Wharekohe silt loam with pan

6.1.4 Soils formed on crystalline limestone

KN Konoti clay loam – a moderately to strongly leached soil (rendzina) formed on a

KNr Konoti clay – complex of crystalline limestone, sandstone and mudstone.

6.1.5 Soil types on these Horeke basalts include:

Red Loams formed on scoria, ash and lava flows on the cone

PK Papakauri silt loam - a weakly to moderately leached soil that has developed on ash and scoria from the very end of the eruption, both on the top of Mirowhakatiki and on Whatitiri.

AT Apotu friable clay– A deeply weathered and strongly leached soil formed on the eroded cone and slopes of Mirowhakatiki.

Brown loam formed on basalt flows

YO Waiotu friable clay (and Hill soil) – a moderately to strongly leached brown loam

MC Matarau friable clay (and Hill soil) –a moderately to strongly brown loam leached soil formed on the lower slopes of the cone and on the hill in Kokopu Road.

RT Ruatangata friable clay (and Hill soil) - a strongly leached formed on lava flows.

6.1.6 Soils formed on Taheke basalts

Red Loams are formed on the scoria and ash cones, scoria and ash erupted from the vent are:

PK Papakauri silt loam (and Hill soil) - a weakly to moderately leached soil that has developed on the ash and scoria cone itself (found on Ngararatunua and Rawhitiroa)

Pke Papakauri clay loam – a more weathered variant of this soil found on Maunu mountain/hill.

Brown Loams formed on these later lava flows include

KB Kiripaka bouldery silt loam – a weakly to moderately leached brown loam formed on basalt lava flows.

KBb Kiripaka bouldery silt loam with large boulders, a very bouldery variant around the edges of the flow.

6.1.7 Soils formed on alluvium

WF Whakapara silt loam and clay loam- the current floodplain - formed on recent alluvium from sedimentary rocks

WO Whareora clay loam – first terrace - formed on terrace alluvium from sedimentary rocks

WU Waipuna clay – second terrace - formed on higher and older terrace alluvium from sedimentary rocks

KRa Kara sandy loam – podzolised alluvium from sandy parent rocks

KRap Kara sandy loam with pan – podzolised alluvium from sandy parent rocks

KR Kara silt loam – podzolised alluvium from finer textured rocks (mudstone and shale)

KRp Kara silt loam with pan– podzolised alluvium from finer textured rocks (mudstone and shale)

KRy Kara peaty silt loam – hollows or basins on alluvial terraces on which peat has developed over or in association with the podzolised soil.

6.1.8 Soils formed on terrace alluvium from sedimentary rocks

YUy Waipu peaty silt loam and peaty clay – a gleyed and peaty soil formed on alluvium and peat deposits laid down in a „trapped" tributary valley, the outflow from which has been blocked by a rising floodplain in the main valley.

6.1.9 Soils formed on rhyolitic ash-rich deposits

WKl Wharekohe fine sandy loam ash variant – airfall and rewashed rhyolitic ash, most probably from ash showers from central North Island volcanoes has been washed of the catchment and deposited on higher terraces and footslopes (higher and therefore older than those with Kara soils) around the edge of the floodplain. The ash, being high in silica, has been readily podzolised.

WKlp Wharekohe fine sandy loam with pan (ash variant) – The ash, being high in silica, has been readily podzolised.

6.1.10 Soils formed on alluvium from 'semi-volcanic' rocks

PC Pakotai clay – a strongly to very strongly leached Brown Granular Clay formed on terrace alluvium from dolerite and andesite rocks (usually Tangihua volcanics but in this case more likely to erosion products from the Mirowhakatiki cone.)

PC Pakotai mottled clay – more gleyed variant of this soil formed in hollows on terraces.

6.1.11 Soil formed on basalt alluvium

KO Kamo clay loam – a gleyed soil formed in basins of alluvium from recent basalt volcanics, often having bog-iron nodules in the subsoil

6.1.12 Organic Soils

OG Otonga peaty clay loam – formed in basins on peat deposits with some alluvium

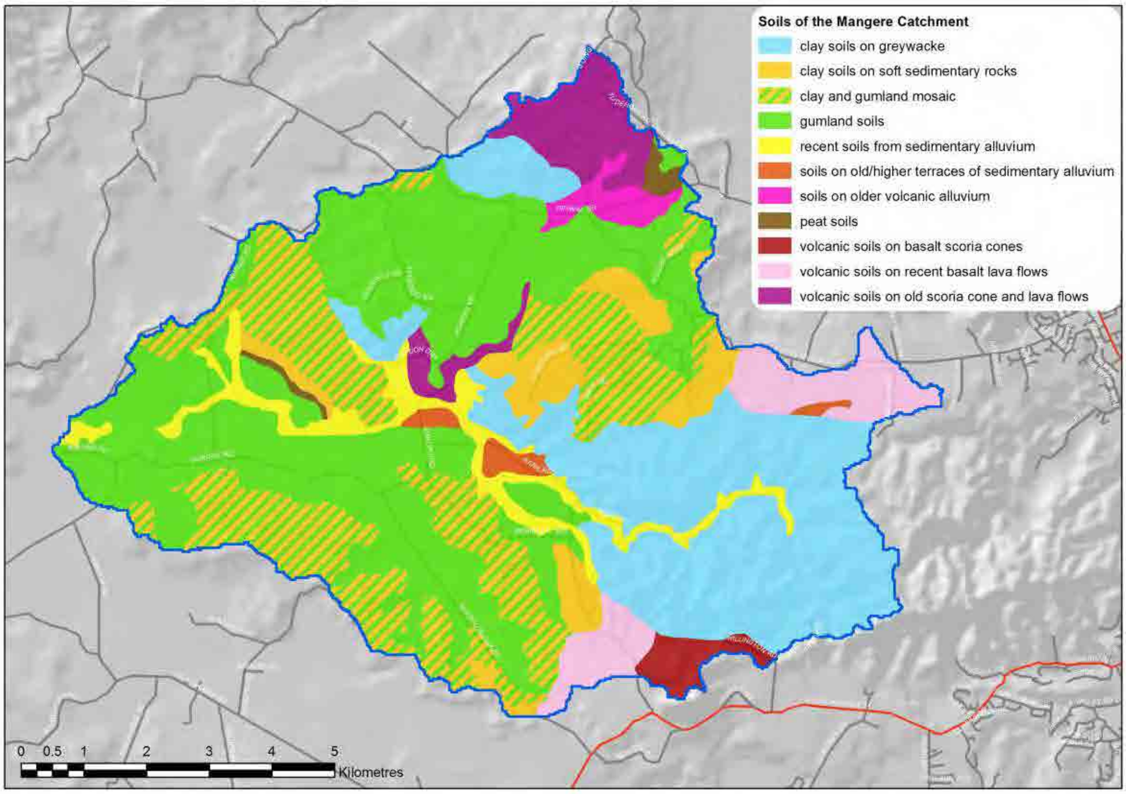

Figure 3 Soil map for the Mangere Catchment to come

7 Land use

Northland has a very complex geology and physical structure which results in a wide variety of landforms, soil types and associated land uses. In Northland, farming, forestry and horticulture collectively contribute 13.7% of the Gross Domestic Product (GDP) of the region.

The future of these industries depends on maintaining the productive capacity of Northland's soils. The consequence of poor soil management is not only the loss of productivity but also an increased environmental impact including the downstream degradation of water quality.

7.1 Land use pressure on water quality and biodiversity

Intensification of land use can impact on water quality and indigenous biodiversity in a number of ways. Although in recent years there has been retirement and regeneration of some areas of marginal land, this has often been negated by the intensification of land use on the more productive areas. Increased fertiliser use and the corresponding increase in stocking rates can lead to higher levels of loss of effluent and nutrients from farms to surrounding areas.

Dune lakes, gumlands, bogs and fens are examples of some of the habitat types in Northland that are particularly at risk. These ecosystems have developed under naturally low fertility conditions and the plant and animal species present are adapted to these conditions. Nutrient enrichment brought about through the intensification of land use within the catchment can lead to rapid invasion by weeds leading to a system dominated by introduced species.

The Mangere catchment consists predominantly of high producing exotic grassland and indigenous forest (see Figure 4). For the most part, soft sedimentary rocks make up the underlying geology of the catchment.

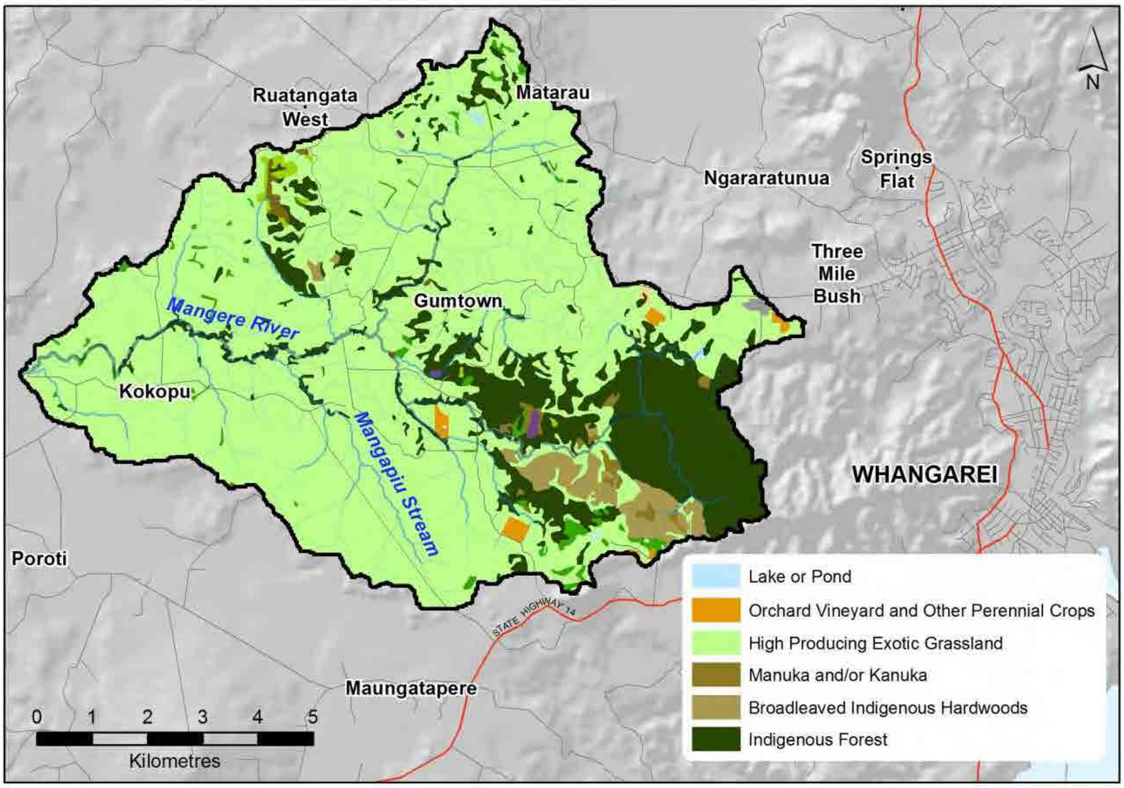

Figure 4 Land use within the Mangere Catchment

8 Current monitoring in the catchment

Northland Regional Council currently undertakes the following monitoring in the Mangere catchment:

- **River Water Quality Monitoring Network** (RWQMN) established in 1996. 36 river sites throughout Northland encompassing 22 river catchments are monitored monthly for a range of parameters, including temperature, dissolved oxygen, pH, water clarity, nutrients and bacterial levels. This monitoring includes one site in the Mangere River catchment located at Knights Road Bridge, which has been monitored since 1996. Annual and 5 yearly reports are available here: http://www.nrc.govt.nz/Resource-Library-Summary/Environmental-Monitoring/State-of-the-Environment-Monitoring/

- **Mangere Catchment Water Quality Investigation** initiated in 2007-2010 at 6 sites within the Mangere catchment to determine the likely cause of the high nutrients and bacteria, and low water clarity recorded at the Knights Road Bridge site.

- **Stream invertebrate monitoring** at RWQMN sites since 1997. Every site in the Network is monitored once a year in summer. Monitoring at the one network site on Mangere River started in 2008. Annual reports are available here: http://www.nrc.govt.nz/Resource-Library-Summary/Research-and-reports/Rivers-and-streams/

- **Stream habitat assessments** at RWQMN sites since 2004. Assessments are typically carried out every second year. The Mangere River site has been assessed in 2010 and 2012. Reports are available here: http://www.nrc.govt.nz/Resource-Library-Summary/Research-and-reports/Rivers-and-streams/

- **Hydrological monitoring.** River water level is recorded at the Knights Road site with recordings transmitted via telemetry to NRC database every two hours. Stream flow gaugings are routinely carried out to maintain accurate rating curves for the site. Rainfall is measured using an automated 0.5mm tipping bucket raingauge and manual calibration check gauge. Rainfall is recorded every five minutes using a datalogger (Unidata Ecologger) and Telemetered to NRC database every two hours.

- As well as specific monitoring programmes some ad hoc monitoring as also been carried out to check compliance with resource consent conditions and to investigate environmental incidents.

Together, the information is central to assessing the state of the Mangere River. The data obtained through these programmes and consent monitoring has been used to provide an overview of water quality and ecosystem health in the River.

9 River ecosystem and water quality

9.1 River ecosystem water quality

The ecological health, or integrity, of river ecosystems are related to a number of environmental factors including, but not limited to, the availability of suitable habitat types (e.g. diverse range of substrate sizes, aquatic plants, large woody debris and varied flow types), food and light availability, disturbance and water quality. It is important to note that the relationship between ecosystem health and environmental factors is often very complex and unpredictable.

In rivers the water quality parameters of concern in terms of ecological health are, in no particular order, temperature and dissolved oxygen, clarity, nutrients, and suspended solids. Faecal pathogens are not known to affect the health of aquatic ecosystems, but do affect the suitability of a water body for swimming and stock drinking water. Biological monitoring information, such as invertebrates, periphyton, habitat assessments and fish, can be used to help determine the impacts of water quality on river ecosystems, however as alluded to above causal effects are not always clear.

A water quality index is used to facilitate inter-site comparisons of the state of water quality in the region‟s rivers and streams. The water quality index used in Northland is calculated using the median values for the following six variables: dissolved oxygen (% saturation), turbidity, ammonical nitrogen, nitrite-nitrate nitrogen, dissolved reactive phosphorus, and Escherichia coli (a faecal indicator bacteria). The application of the water quality index enables water quality at each site to be classified into one of four categories according to how many medians meet national guideline values for the protection of aquatic ecosystems (Table 1).

- **Excellent**: median values for all six variables are within guideline values.
- **Good**: median values for five of the six variables are within guideline values, of which dissolved oxygen is one variable that must be met.
- **Fair**: median values for three or four of the six variables are within guideline values, of which dissolved oxygen is one variable that must be met.
- **Poor**: median values for <3 of the six variables comply with guidelines.

Table 1 Water quality parameters and national guideline values for protection of aquatic ecosystems

Water Quality indicator	Abbreviation	Reference	Guideline value
Dissolved Oxygen	**DO%**	RMA 1991 Third Schedule	≥80 (% saturation)
Dissolved Reactive Phosphorus	**DRP**	ANZECC (2000)	≤0.010 (mg/L)
Escherichia coli	***E.coli***	ANZECC (1992)	≤126 (cfu/100 mL) Stock Drinking Water
Ammonical Nitrogen	**NH4**	ANZECC (2000)	≤0.021 (mg/L)
Nitrite-Nitrate Nitrogen	**NNN**	ANZECC (2000)	≤0.444 (mg/L)
Turbidity	**TURB**	ANZECC (2000)	≤5.6 (NTU)

The Mangere River is a low-lying, slow-flowing tributary to the Wairua River, which flows through a mostly intensive agricultural catchment. Within the Mangere catchment are two major tributaries, the Mangere and Mangapiu Stream which discharges into the Mangere River. The Mangere‟s overall **'POOR'** Water Quality Index score places it in the bottom 5% of Northland‟s monitored rivers (NRC, 2012).

Table 2 Water quality indicator range and percent of samples meeting national guideline values for protection of aquatic ecosystems. Numbers in green indicate median meets guideline, while numbers in red indicate median exceeds guideline.

Water Quality indicator		Mangere @Knights Rd Br	Mangere @Kovic weir	Mangapiu @Kokopu Rd Br	Mangere @Kokopu Rd Br	Mangere @Kara Rd Br	Mangere @End of Wood Rd
DO%	No. samples	234	39	39	45	45	35
	Median	83.6	86.3	68.3	89.7	92.3	82.6
	Maximum	119.2	103.1	98.3	107.7	112.4	100.5
	Minimum	38.3	71.2	20.7	68.6	77.7	45.5
	% samples meet guideline	67	79	13	89	98	54
DRP	No. samples	232	43	43	49	49	35
	Median	0.078	0.048	0.24	0.026	0.01	0.012
	Maximum	3.13	0.25	0.76	0.092	0.063	0.32
	Minimum	0.003	0.015	0.02	0.013	0.002	0.005
	% samples meet guideline	3	2	0	16	86	91
E.coli	No. samples	200	43	42	49	49	35
	Median	611	1178	623	650	613	554
	Maximum	24192	19863	24192	7270	10462	1467
	Minimum	10	289	31	221	31	30
	% samples meet guideline	4	14	45	31	41	49
NH4	No. samples	251	43	43	49	49	35
	Median	0.08	0.04	0.12	0.02	0.005	0.01
	Maximum	2.1	0.16	1.1	0.1	0.06	0.18
	Minimum	0.005	0.005	0.005	0.005	0.005	0.005
	% samples meet guideline	19	23	7	71	92	86
NNN	No. samples	234	43	43	49	49	35
	Median	0.666	0.543	0.81	0.53	0.602	0.542
	Maximum	2.35	1.91	1.442	1.6	1.242	1.3
	Minimum	0.01	0.035	0.001	0.032	0.011	0.078
	% samples meet guideline	26	40	21	43	37	37
TURB	No. samples	221	39	39	39	39	35
	Median	6.9	7.3	9.1	5.6	5	5
	Maximum	158	16.3	25	19.4	16.8	14.3
	Minimum	0.2	3.3	2.5	2.9	2.1	2.2
	% samples meet guideline	32	15	18	49	62	69
Water Quality Score		**Poor**	**Poor**	**Poor**	**Fair**	**Fair**	**Fair**

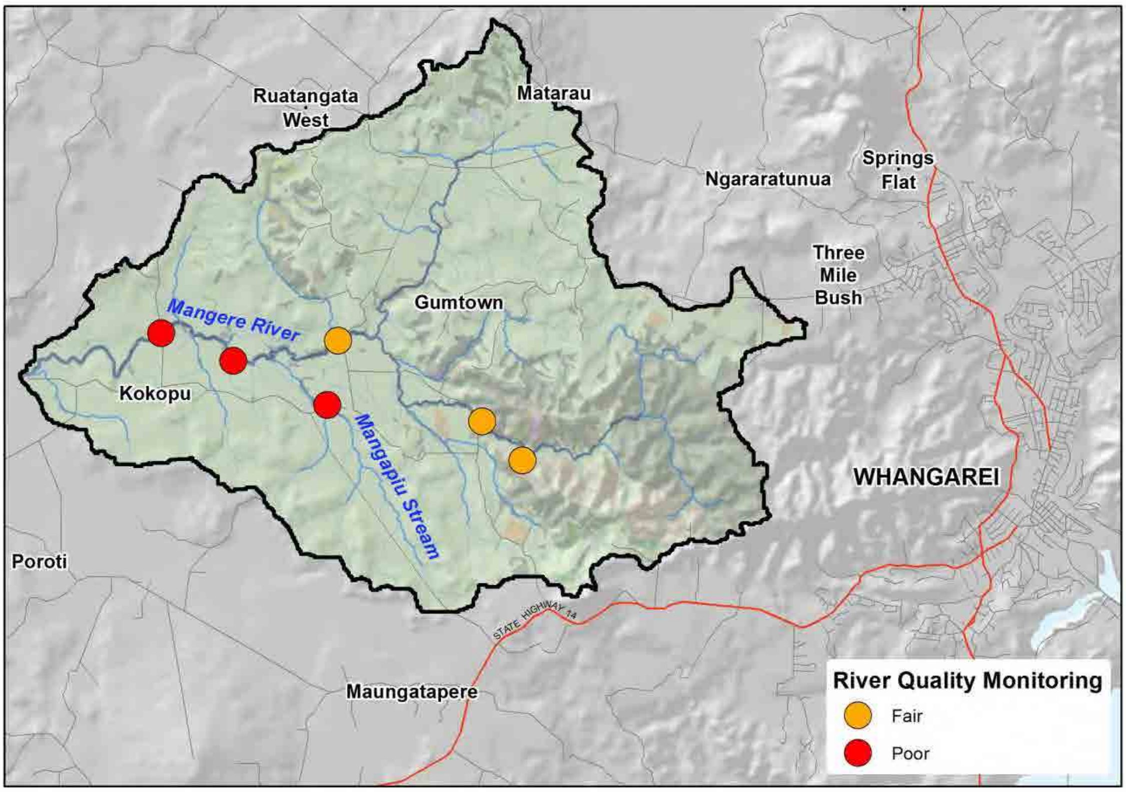

Figure 5 Mangere Catchment Water Quality Investigation sites 2007-2010. The programme ran from 2007 to 2010 and each site‟s water quality grading was defined by the water quality index methodology described on previous page.

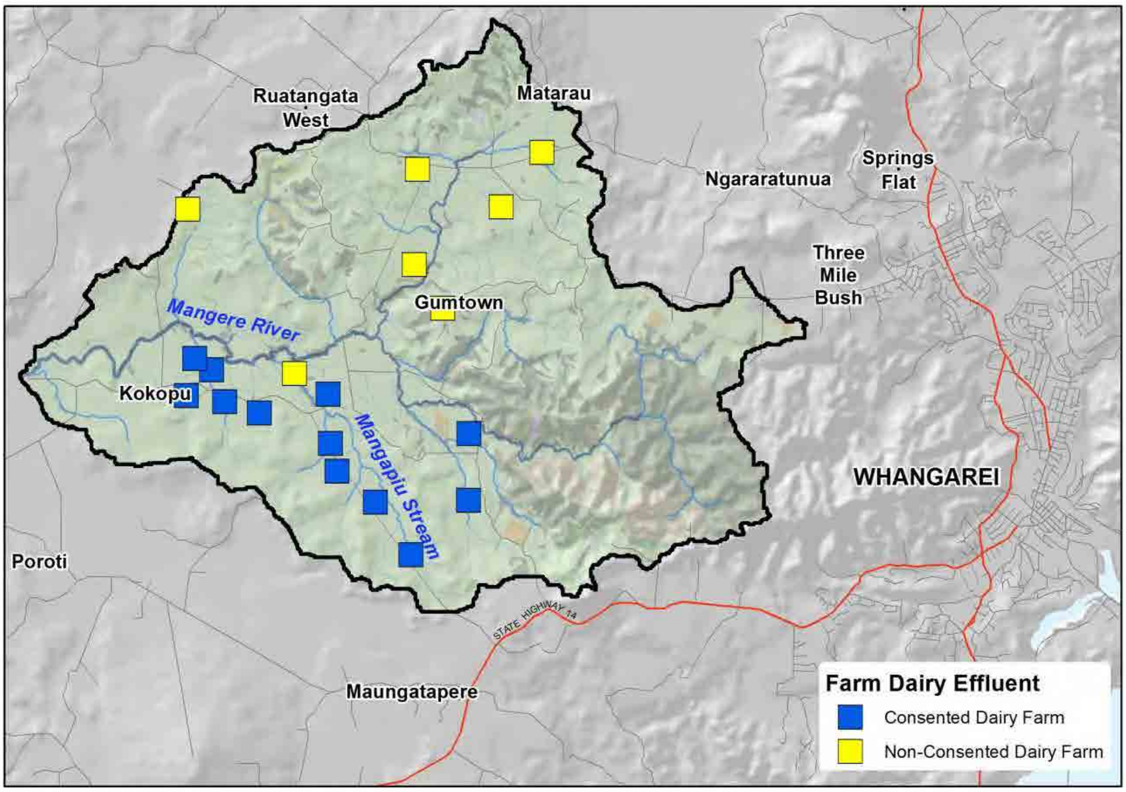

Figure 6 Consented and non-consented dairy farms in the Mangere catchment.

The following section describes water quality in the Mangere catchment using box and whisker plots to graphically display the distribution of water quality data based on a five value summary: the minimum value, first quartile, median, third quartile, and maximum. The central rectangle spans the first quartile to the third quartile (the *interquartile range* or *IQR*) covering the middle 50% of data. A segment inside the rectangle shows the median and "whiskers" above and below the box show the locations of the minimum and maximum. Any small circles or stars beyond the minimum/maximum values are considered outliers i.e. the value is 3 times the IQR or more above the third quartile, or 3 times the IQR or more below the first quartile.

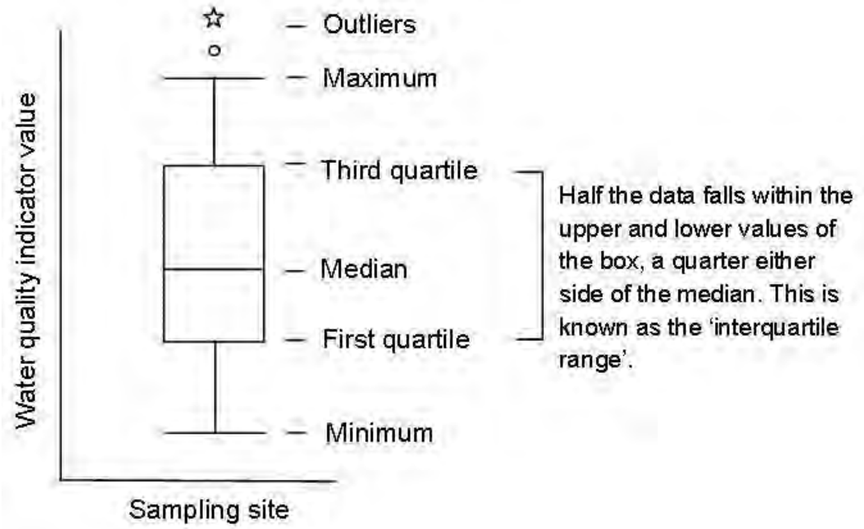

Figure 7 Mangere River at an unmonitored site in the Pukenui forest (left) and the Mangere at the permanent monitoring site at Knight Roads bridge (right).

9.2 Dissolved oxygen

Dissolved oxygen is important for freshwater invertebrates and fish, with some species being more sensitive to low oxygen levels than others. Dissolved oxygen levels vary with temperature, biological activity and how quickly it transfers from the atmosphere. Biological activity includes microbial activity by bacteria and primary production by plants and algae. Aquatic plants photosynthesise during the day (producing oxygen) and respire at night (using oxygen). With its high levels of macrophytoes (aquatic plants) the Mangere River is likely to have large fluctuations in dissolved oxygen throughout the day compared to rivers within pristine native habitat with little of no aquatic plants such as the Waipoua. Because sampling usually takes place between 8 a.m. and 2 p.m., these variations are generally either not observed or less apparent. Future monitoring would benefit from continuous measurements using a SONDE or equivalent to determine the DO% saturation pattern.

Between 2007 and 2010 the lowest dissolved oxygen recorded in the Mangere River at Knights Road was 38.3%, well below national guidelines and at a level which would potentially put aquatic plants and animals under stress. The median was 83.8%, just within national guidelines (Table 3). The highest level recorded was 119.2%. Such excessive levels can also be harmful to aquatic life, causing „gas bubble" disease in fish and invertebrates.

In 2007 to 2010 a Mangere catchment investigation was initiated at six different sites in the catchment to determine the likely causes of degraded water quality. This showed that DO% saturation is generally the lowest in the Mangapiu Stream (Figure 8 and Table 3). Additional analysis of the data showed that dissolved oxygen is higher during winter (Figure 9) at the majority of sampling sites, and lower in summer and autumn. This seasonal pattern is most likely in response to seasonal rainfall, stream flow, temperature, and sunlight hours. During winter, higher rainfall and stream flow generally create more turbulent flow in the rivers and streams. Turbulent flow entrains oxygen from the air, thus increasing the DO saturation of the water. During the drier summer months, organic matter (such as leaves, branches, twigs) accumulates on land because it is not washed off as often as a result as a result of higher runoff/rainfall events. Plants and algae biomass also tends to increase during summer. During autumn when rainfall increases, soil moisture increases and air temperature decreases, runoff caries the organic matter into the rivers and streams. As it decomposes, it consumes oxygen which could explain the low levels observed in April or May. Additionally, as the plants and algae die off, they also consume oxygen as they break down.

Table 3 Dissolved oxygen (DO%) range and percent of samples below the national guideline value of (>80%) for protection of aquatic ecosystems.

Dissolved Oxygen (%)	Mangere@ Knights Rd Br	Mangere @Kovic weir	Mangapiu @Kokopu Rd Br	Mangere@ Kokopu Rd Br	Mangere @Kara Rd Br	Mangere @End of Wood Rd
Total samples	234	39	39	45	45	35
Median	83.8	86.3	68.3	89.7	92.3	82.6
Maximum	119.2	103.1	98.3	107.7	112.4	100.5
Minimum	38.3	71.2	20.7	68.6	77.7	45.5
Sample meets guideline (%)	67	79	13	89	98	54

WAIORA NORTHLAND WATER

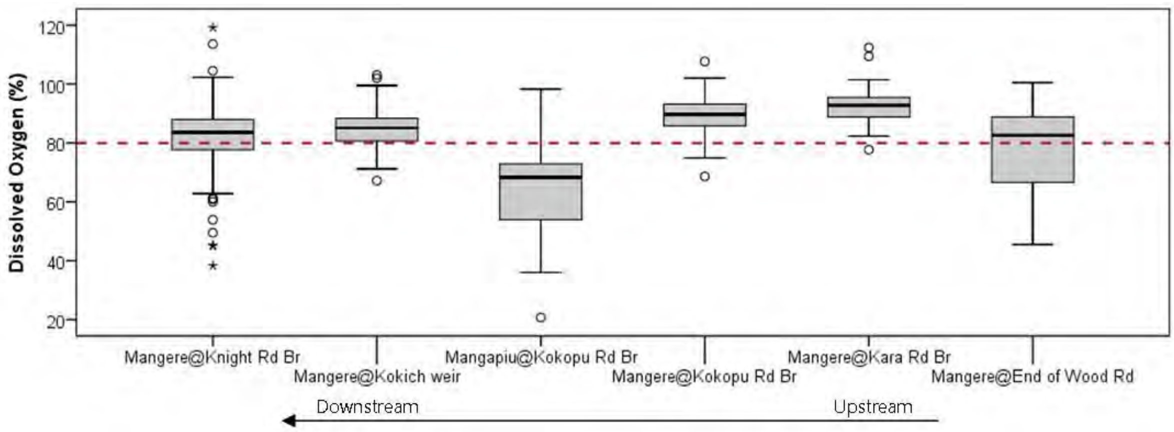

Figure 8 Dissolved oxygen (DO%) boxplots at different sites during the Mangere catchment water quality investigation (2007-2001). The red dotted line indicates the national guideline value (>80%).

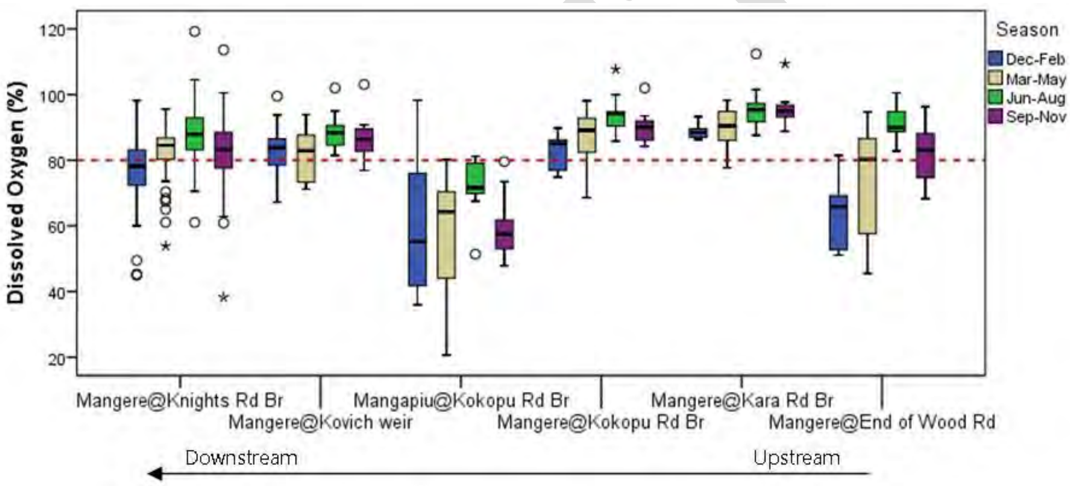

Figure 9 Seasonal variation in dissolved oxygen (DO%) levels at different sites during the Mangere catchment water quality investigation (2007-2001). The red dotted line indicates the national guideline value (>80%)). Note the elevated levels in winter and spring.

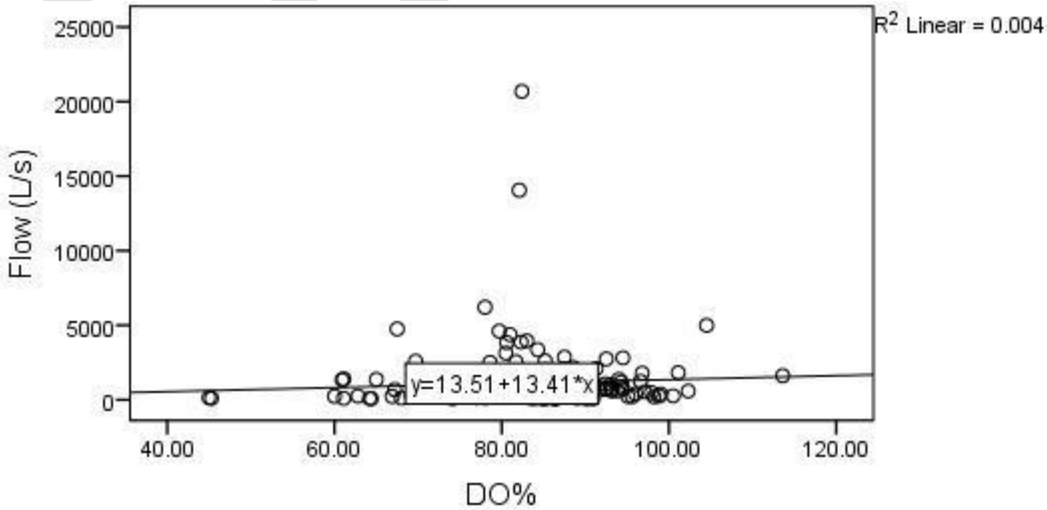

Figure 10 There is no linear regression between flow and DO (R^2=0.004). However Spearman"s statistical test displays a significant positive weak correlation (0.228).

9.3 Nutrient levels

Nitrogen and phosphorus are the two main nutrients required by algae, plants and animals for metabolism and growth. Nitrogen and phosphorus naturally occur in water as a result of natural processes, such as the erosion of soil, atmospheric deposition and the breakdown of organic matter. Nitrogen is highly soluble and can leach through soil, whereas phosphorus usually enters water in direct discharges or associated with sediment.

9.4 Nitrogen

Both common forms of nitrogen in water – nitrate and ammonia – can cause problems. Very high levels of nitrate can make groundwater unsafe to drink. Nitrate can also kill sensitive organisms like young fish. Ammonia is highly toxic to fish and other creatures that live in water, so direct discharge of ammonia-rich wastes such as raw sewage or dairy shed effluent can be particularly damaging. But the main impact of too much nitrogen and phosphorus is the „overfertilisation‟ of aquatic plants, leading to excessive plant growth, algal blooms and the depletion of oxygen dissolved in the water (PCE, 2012).

Nitrogen is reported here as ammonical nitrogen (NH4), and nitrate, nitrite nitrogen (NNN). Total Nitrogen (TN) is the total amount of nitrogen in water and includes nitrogen from inorganic (e.g. NH4 and NNN) and organic sources (dead animals and plants).

As would be expected, the headwater sites at Wood Road and Kara Road met the guidelines for a greater proportion of the time than the remaining downstream sites. The Mangapiu Stream exceeded the guideline values the most and as a consequence, guideline values were lower at the sites downstream of the Mangapiu (Figure 11, Figure 12,

Table 5,
Table 6).

There are four resource consents to discharge animal waste both to land and water upstream of the Mangapiu site (Figure 6). It is possible that these discharges are contributing significant volumes of nitrogen to the stream hence the elevated nitrogen concentrations. There are elevated levels of ammonia in winter and spring (Figure 13), perhaps due to spring calving effects and higher rainfall. The difference in nitrate and nitrite nitrogen levels between sites is not as pronounced as ammonia, but has a similar seasonal trend with elevated levels in autumn, winter and spring. River flow is measured at the Knights road site and there is a positive weak/moderate correlation with ammonia and nitrate and nitrite nitrogen (Figure 15 and Figure 16). Nitrogen concentration increases as flow increases, generally in response to contaminants entrained in runoff. Note: nitrogen concentrations have not been flow adjusted.

NRC monitors compliance with resource consents within Northland. Part of this programme includes monitoring farm dairy effluent (FDE) discharges. The Council‟s FDE team actively work with dairy farmers in Northland to continuously improve farm practices and upgrade FDE systems in line with current best practice. As is the case with the rest of Northland, most of the systems within the Mangere catchment have been upgraded at least once over the last eight years. This is as a result of NRC follow-up action to farms which were identified as non-compliant during routine annual monitoring. Seventeen of the 19 farms in the Mangere catchment have upgraded their FDE systems at least once. Eleven of these farms have upgraded more than once. Nine consented farms, which previously discharged treated effluent to water throughout the year, have installed land application systems (see Table 4). These farms retain their resource consents to discharge treated effluent to water during extended wet periods and apply effluent to land when ground conditions are suitable. Other improvements within the catchment include larger treatment ponds, larger storage ponds for land application and increased areas reticulated for land application. Although there have been many positive improvements to treatment/disposal systems within the Mangere catchment, there are still a number of issues within the catchment that require ongoing management and continued improvement.

Table 4 Year changed to land application for FDE discharge consents (for locations refer Figure 28)

Site	Date changed to land application
1053601	2007
925701	2007
1188101	2007
1120801	2008
1188701	2008
913901	2008
885101	2008
1134401	2009
972101	2011

Table 5 Ammonical nitrogen (NH_4) range and percentage of samples below the national guideline value of (<0.021mg/L) for protection of aquatic ecosystems.

Ammonical Nitrogen	Mangere@ Knights Rd Br	Mangere @Kovic weir	Mangapiu @Kokopu Rd Br	Mangere@ Kokopu Rd Br	Mangere @Kara Rd Br	Mangere @End of Wood Rd
Total samples	251	43	43	49	49	35
Median	0.08	0.04	0.12	0.02	0.005	0.01
Maximum	2.1	0.16	1.1	0.1	0.06	0.18
Minimum	0.005	0.005	0.005	0.005	0.005	0.005
Sample meets guideline (%)	19	23	7	71	92	86

Table 6 Nitrate, nitrite nitrogen (NNN) range and percentage of samples below the national guideline value of (<0.444mg/L) for protection of aquatic ecosystems.

Nitrate, Nitrite Nitrogen	Mangere@ Knights Rd Br	Mangere @Kovic weir	Mangapiu @Kokopu Rd Br	Mangere@ Kokopu Rd Br	Mangere @Kara Rd Br	Mangere @End of Wood Rd
Total samples	234	43	43	49	49	35
Median	0.666	0.543	0.81	0.53	0.602	0.542
Maximum	2.35	1.91	1.442	1.6	1.242	1.3
Minimum	0.01	0.035	0.001	0.032	0.011	0.078
Sample meets guideline (%)	26	40	21	43	37	37

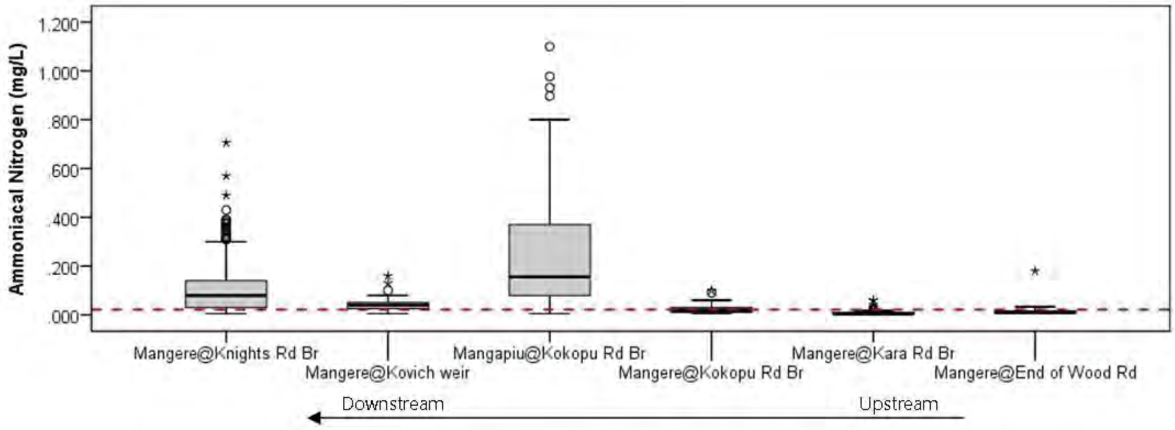

Figure 11 Ammonical nitrogen (NH_4) boxplots at different sites during the Mangere catchment water quality investigation (2007-2001). The red dotted line indicates the national guideline value (<0.021).

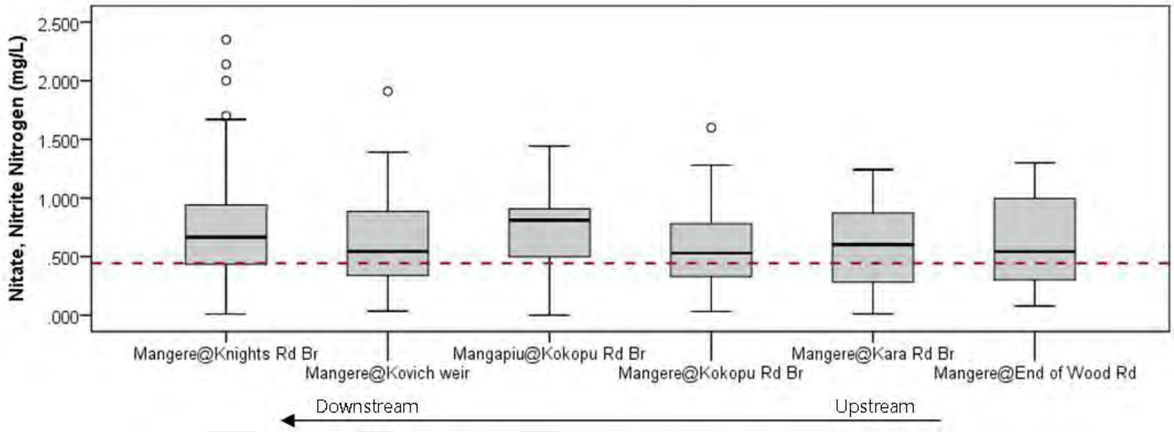

Figure 12 Nitrate/nitrite nitrogen (NNN) boxplots at different sites during the Mangere catchment water quality investigation (2007-2001). The red dotted line indicates the national guideline value (<0.444).

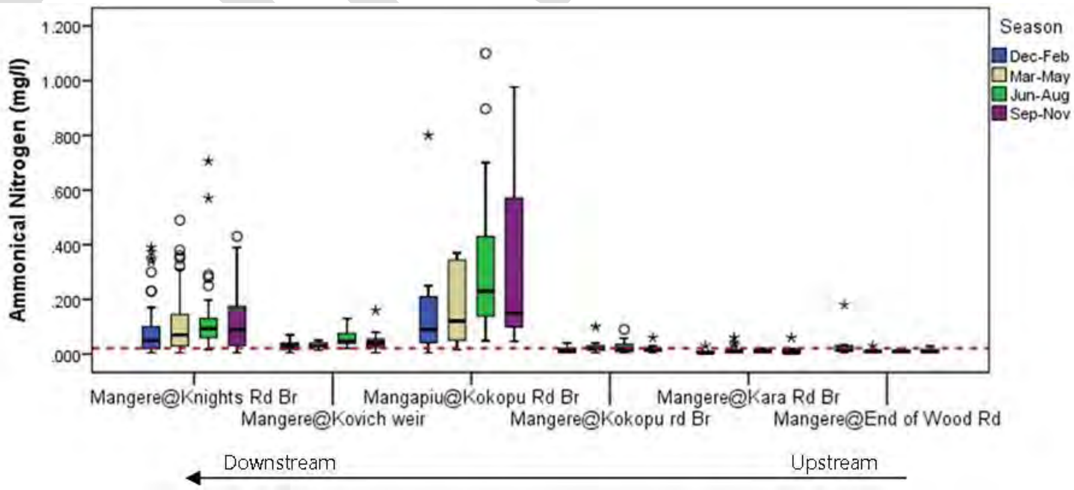

Figure 13 Seasonal variation in ammonical nitrogen (NH_4) levels at different sites during the Mangere catchment water quality investigation (2007-2001). The red dotted line indicates the national guideline value (<0.021). Note the elevated levels in winter and spring.

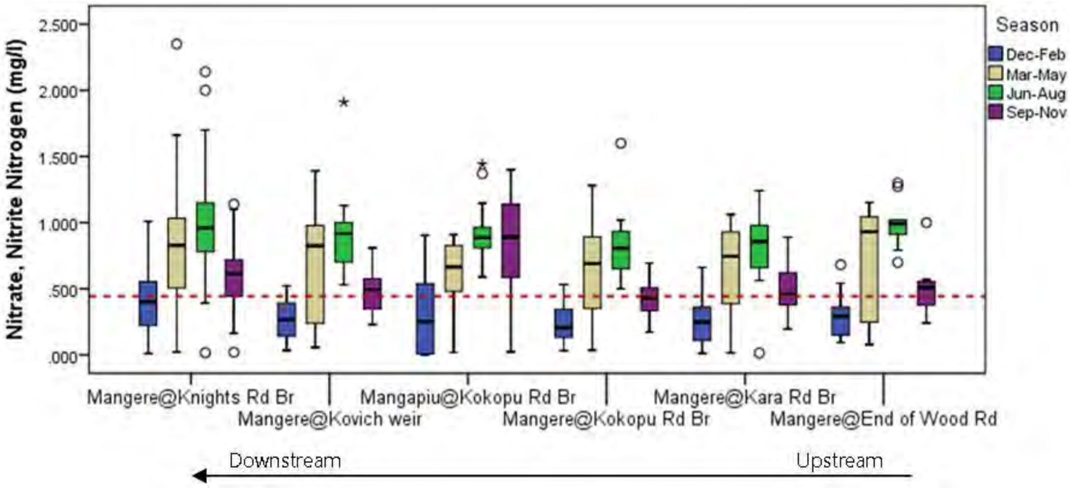

Figure 14 Seasonal variation in nitrate/nitrite nitrogen (NNN) levels at different sites during the Mangere catchment water quality investigation (2007-2001). The red dotted line indicates the national guideline value (<0.444). Note the elevated levels in autumn, winter and spring.

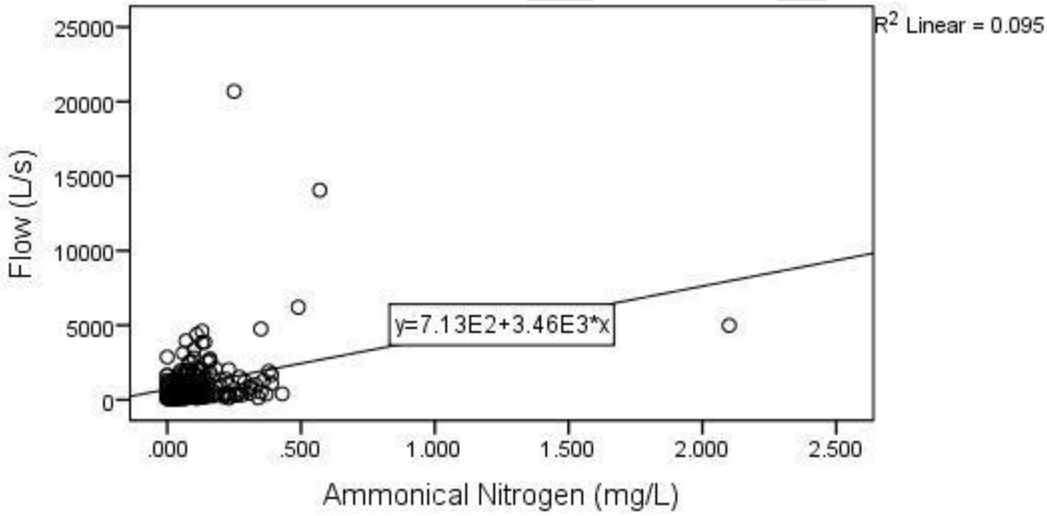

Figure 15 There is no linear regression between flow and NH4 (R^2=0.095). However Pearson‟s statistical tests displays a significant positive weak correlation (0.309).

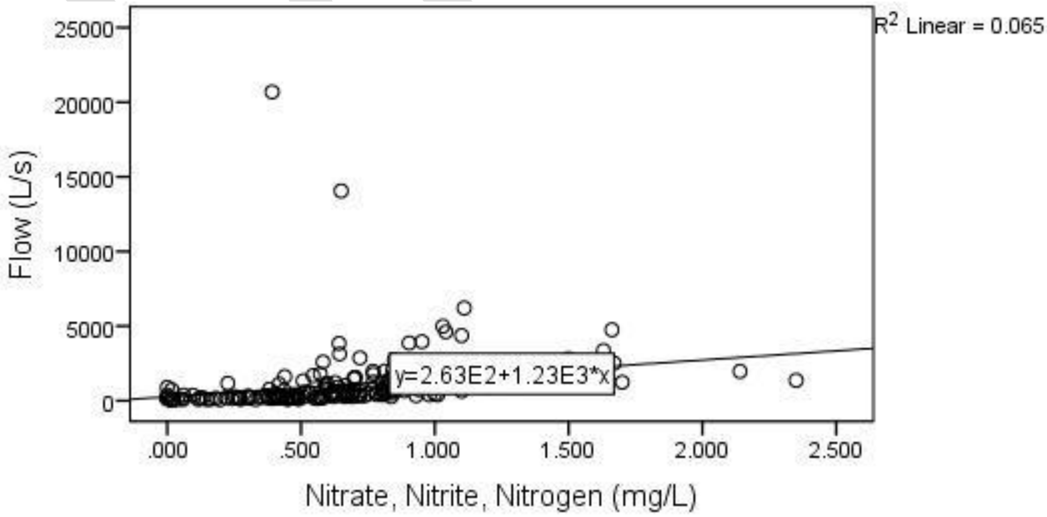

Figure 16 There is no linear regression between flow and NNN (R^2=0.065). However Spearman‟s statistical test displays a significant positive moderate correlation (0.735).

9.5 Phosphorus

Because phosphate usually attaches to soil particles, the main way in which phosphorus gets into water is when soil/sediment is washed into it. Much of the phosphorus in rivers and lakes is a legacy of erosion caused by forest clearance and fertilising for sheep farming. Most New Zealand soils are naturally low in phosphorus, but when washed into water add to the cumulative effect of decades of erosion and topdressing with superphosphate (PCE, 2012).

Phosphorus levels are reported here as Dissolved Reactive Phosphorus (DRP). DRP is the amount of phosphorus that has dissolved in water and is therefore readily available for plant growth. Total Phosphorus (TP) is the total amount of phosphorus present in water and includes the phosphate that is stuck to sediment as well as DRP.

DRP concentrations met the guideline value in more than 86% of samples at the headwater sites at Wood Road and Kara Road. However, DRP concentration tended to increase with distance downstream with large changes observed between the Kara Road and Kokopu Road sites, and then from Kokopu Road to Knights Road site (Table 7 and Figure 17). These elevated levels could be associated with fertiliser residues and effluent washing of the land, as well as erosion of the stream bank and channel as evidenced by high turbidity levels (Table 9). There was no significant correlation between river flow and DRP levels (Figure 19).

Table 7 Dissolved reactive phosphorus (DRP), range and percent of samples below the national guideline value of (<0.01mg/L) for protection of aquatic ecosystems.

Dissolved Reactive Phosphorus	Mangere@ Knights Rd Br	Mangere @Kovic weir	Mangapiu @Kokopu Rd Br	Mangere@ Kokopu Rd Br	Mangere @Kara Rd Br	Mangere @End of Wood Rd
Total samples Median Maximum Minimum	232 0.078 3.13 0.003	43 0.048 0.25 0.015	43 0.24 0.76 0.02	49 0.026 0.092 0.013	49 0.01 0.063 0.002	35 0.012 0.32 0.005
Sample meets guideline (%)	3	2	0	16	86	91

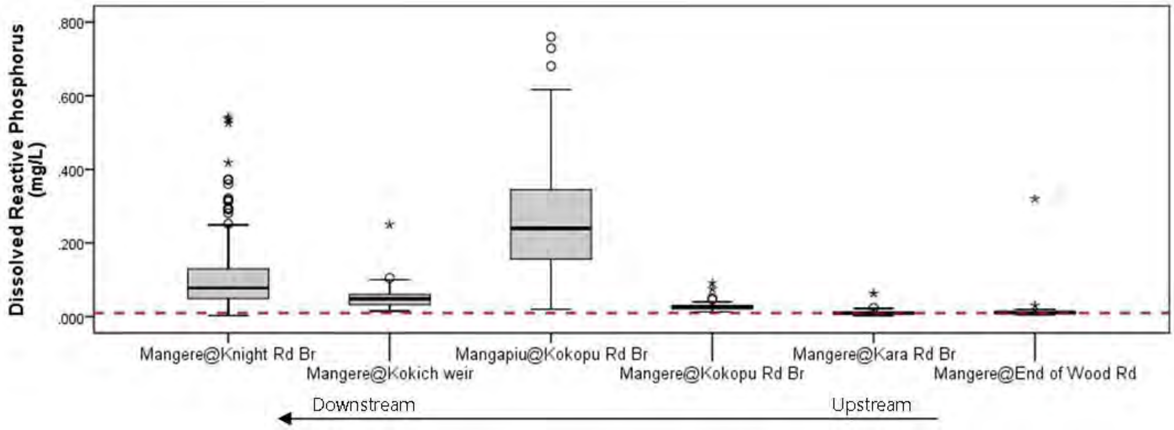

Figure 17 Dissolved reactive phosphorus (DRP) boxplots at different sites during the Mangere catchment water quality investigation (2007-2001). The red dotted line indicates the national guideline value (<0.01mg/L).

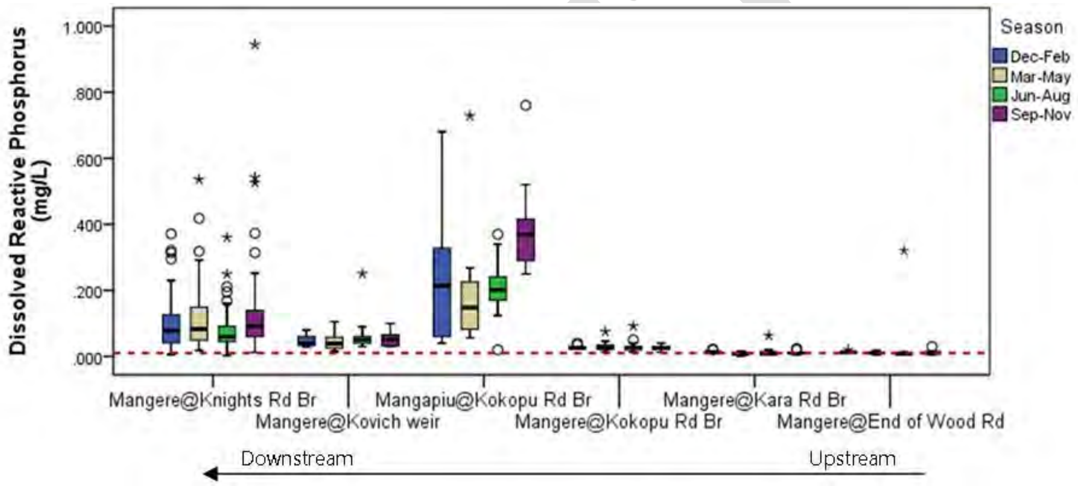

Figure 18 Seasonal variation in dissolved reactive phosphorus (DRP) levels at different sites during the Mangere catchment water quality investigation (2007-2001). The red dotted line indicates the national guideline value (<0.01mg/L). Note the elevated levels in winter and spring.

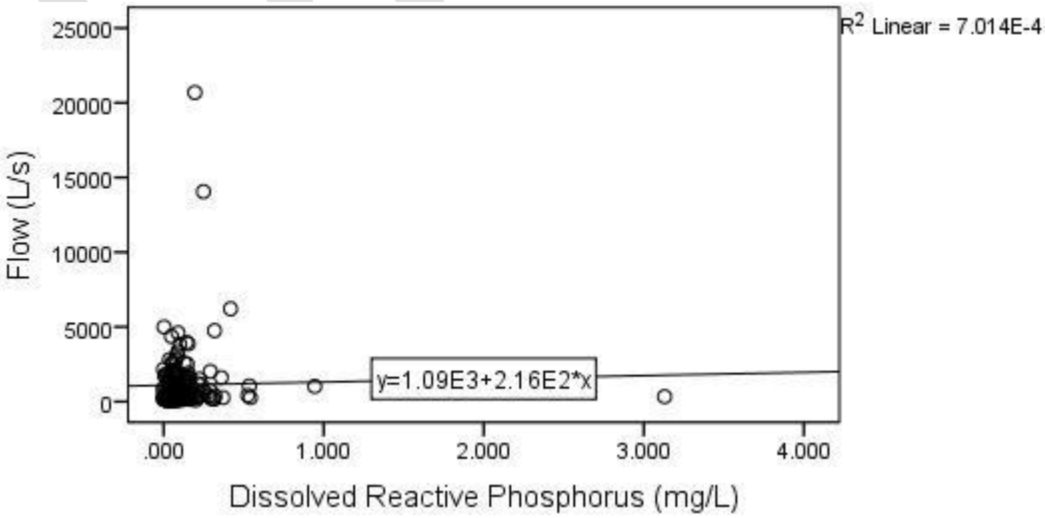

Figure 19 There is no linear regression between flow and DRP (R^2=0.0007), and no significant correlation for either Pearson or Spearman"s statistical tests (0.026, 0.063) respectively.

9.6 Faecal pathogens (Escherichia coli)

Low levels of bacteria are present in freshwater bodies as a result of natural processes, such as plant decay. However, land use practises and human activity can increase the levels of bacteria in freshwater. Although faecal pathogens are not known to affect the health of aquatic ecosystems they are of concern for both human and animal health. *E.coli*, while not harmful in its self, is a type of bacteria that is found in the gut and faeces of warm blooded animals and is therefore indicative of faecal matter which can potentially contain harmful pathogens.

The median for *E.coli* of 611 MPN/100ml (Table 8 and Figure 20) recorded at the most downstream site (Knights Road) is well above the guideline value and the maximum value of 24,192 MPN/100ml is very high for a river, and can probably be attributed to a rainfall event and associated run off of faecal matter from land. It should be noted that natural background levels of *E.coli* tend to be slightly higher in warm wet lowland areas compared to other river environments in New Zealand (McDowell et al, 2013), however the high levels of *E.coli* in the Mangere highlight the need for good land management and effluent disposal systems to protect the freshwater environment.

In addition to stock drinking water, all median values at each site in the Mangere exceeded the suitability for swimming guideline of <550/100mL (MfE, MoH 2003), suggesting the Mangere is generally unsuitable for contact recreation.

There is a positive moderate correlation between river flow and *e.coli* levels at the Knights Road site which suggests that *e.coli* levels in the water are a combination of diffuse and point-source discharges. Point-source discharges (such as direct fowling from animals or birds in streams, or discharges from pipes) are generally not related to rainfall, runoff or stream flow. Diffuse contamination is the faecal matter that is washed off the land during rainfall events generating runoff.

Table 8 Median E.coli count, range and percent of samples *E.coli* was below the national guideline value of <126 MPN/100mL for stock drinking water.

***E.coli* stock drinking water**	Mangere@ Knights Rd Br	Mangere @Kovic weir	Mangapiu @Kokopu Rd Br	Mangere@ Kokopu Rd Br	Mangere @Kara Rd Br	Mangere @End of Wood Rd
Total samples	200	43	42	49	49	35
Median	611	1178	623	650	613	554
Maximum	24192	19863	24192	7270	10462	1467
Minimum	10	289	31	221	31	30
Sample meets guideline (%)	4	14	45	31	41	49

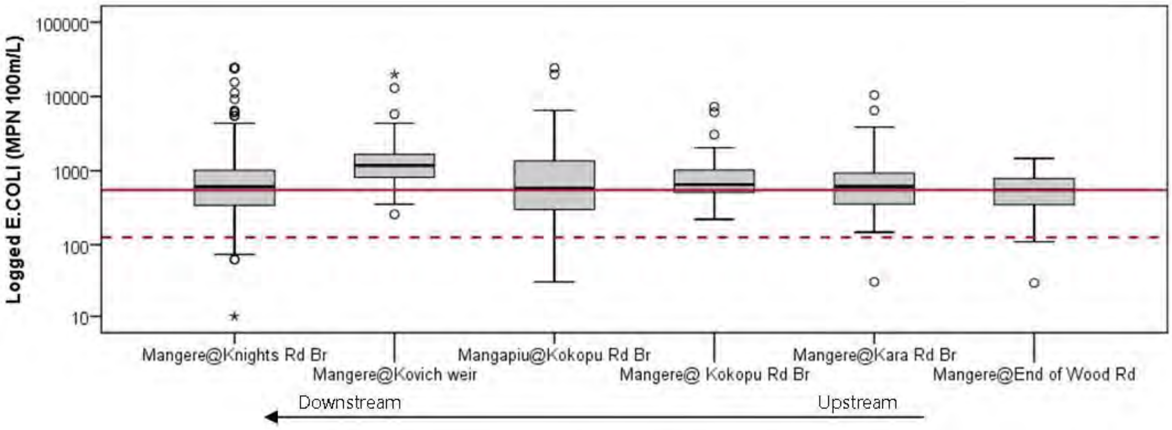

Figure 20 E.coli boxplots at different sites during the Mangere catchment water quality investigation (2007-2001). The red dotted line indicates the stock drinking guideline value (<126 MPN/100mL), while the unbroken red line indicates the Ministry for the Environments contact recreational guideline (<550 MPN/100mL).

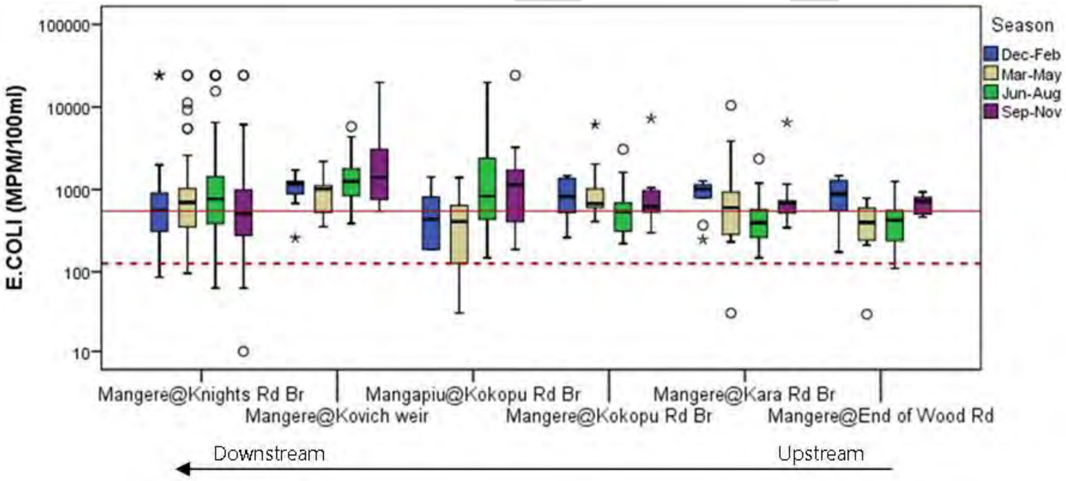

Figure 21 Seasonal variation in *E.coli* levels at different sites during the Mangere catchment water quality investigation (2007-2001). The red dotted line indicates the stock drinking guideline value (<126 MPN/100mL), while the unbroken red line indicates the Ministry for the Environments contact recreational guideline (<550 MPN/100mL).

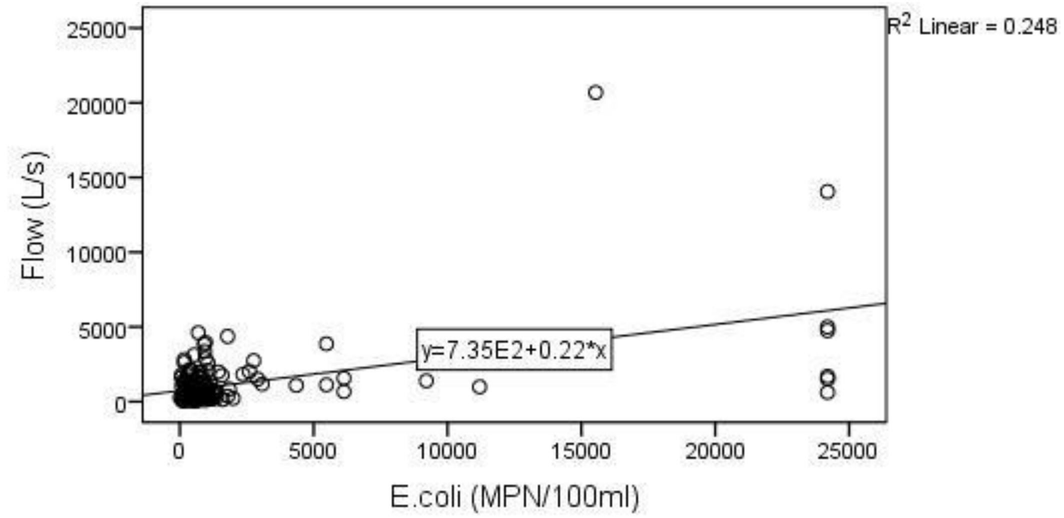

Figure 22 There is a weak linear regression between flow and *E.coli* (R^2=0.248), and a positive moderate correlation for Pearson‟s statistical test (0.498).

9.7 Water clarity

Good water clarity is important for light availability for periphyton growth, the primary food resource for stream life. Clear water is also important for visual feeding by fish and invertebrates. Water clarity is influenced by suspended sediment and algal biomass. Suspended sediments are typically elevated following high rainfall events, causing lower water clarity and higher turbidity. Turbidity is one measure of water clarity.

Turbidity showed a similar trend to the other water quality indicators with the upstream sites having lower turbidity levels (Table 9 and Figure 23) than downstream sites. The largest change in turbidity occurred between the Kokopu Road and Kokovich weir sites with samples meeting the guideline 49% and 18% of the time respectively. The most downstream site at Knights Road had a median turbidity level of 6.9 NTU, and met the guideline on 32% of sampling occasions.

There is also a clear seasonal trend in the data with turbidity levels higher during winter and spring due to higher rainfall and turbidity. Flow and turbidity correlations displayed a positive moderate relationship.

Even rivers in pristine native forested catchments have elevated sediment levels following heavy rain, being a combination of sediment being washed into the river from surrounding land, bank erosion, and sediment being re-suspended from the river bottom during high flows. However where there is intensive agriculture, forestry harvesting, subdivision, a lack of riparian vegetation and/or stock access to waterways sediment loads entering rivers can increase considerably. This is exacerbated in the Mangere catchment due to the underlying soft sedimentary rocks (mud/sandstone) being vulnerable to accelerated erosion. The soils formed from this rock are made up of very fine textured clay, some of which stays suspended in water indefinitely, thereby having a greater impact on water clarity than larger sediment particles. These soils require careful land management to avoid further deterioration of water quality.

Table 9 Median Turbidity count, range and percent of samples turbidity was below the national guideline value (<5.56NTU) for protection of aquatic ecosystems.

Turbidity	Mangere@ Knights Rd Br	Mangere @Kovic weir	Mangapiu @Kokopu Rd Br	Mangere@ Kokopu Rd Br	Mangere @Kara Rd Br	Mangere @End of Wood Rd
Total samples	221	39	39	39	39	35
Median	6.9	7.3	9.1	5.6	5	5
Maximum	158	16.3	25	19.4	16.8	14.3
Minimum	0.2	3.3	2.5	2.9	2.1	2.2
Sample meets guideline (%)	32	15	18	49	62	69

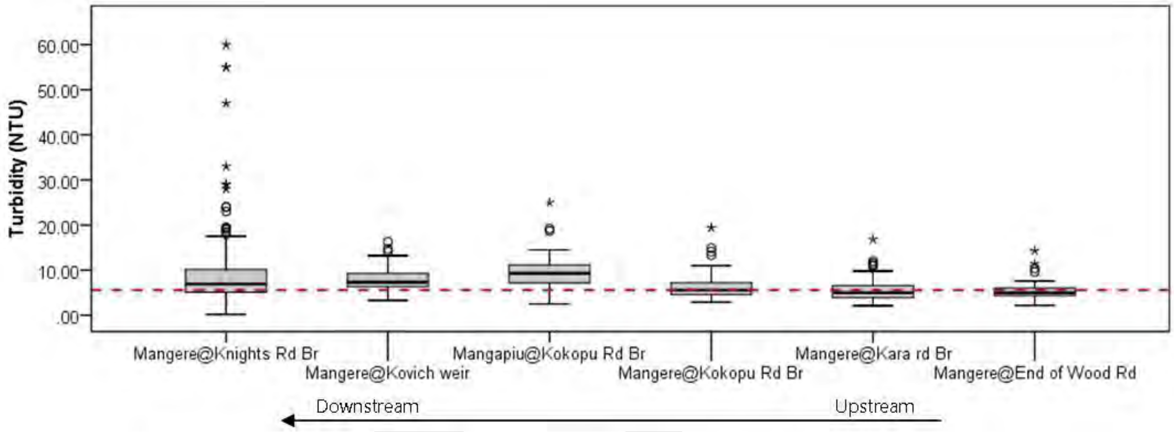

Figure 23 Turbidity boxplots at different sites during the Mangere catchment water quality investigation (2007-2001). The red dotted line indicates the national guideline value (<5.56NTU).

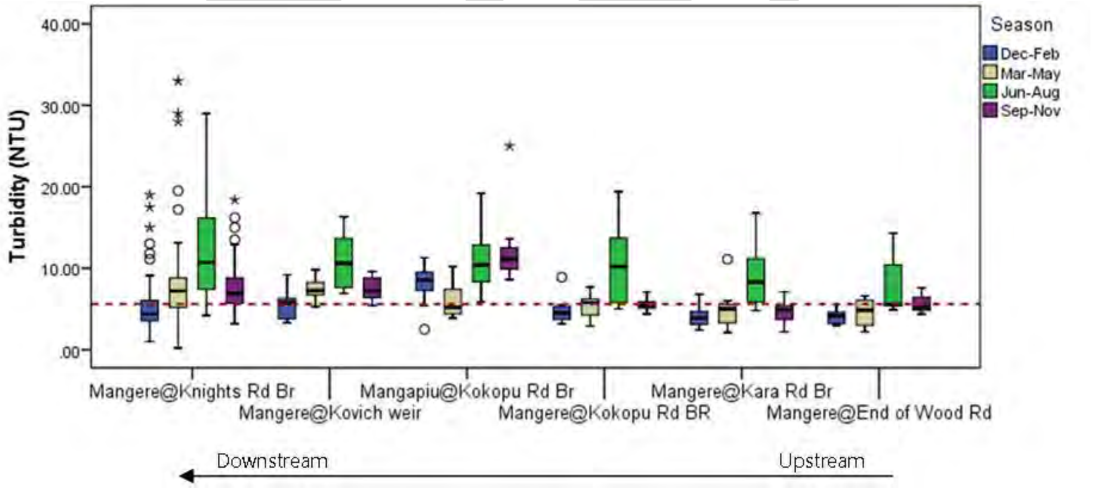

Figure 24 Seasonal variation in turbidity levels at different sites during the Mangere catchment water quality investigation (2007-2001). The red dotted line indicates the national guideline value (<5.56NTU). Note the elevated levels in winter due to higher rainfall.

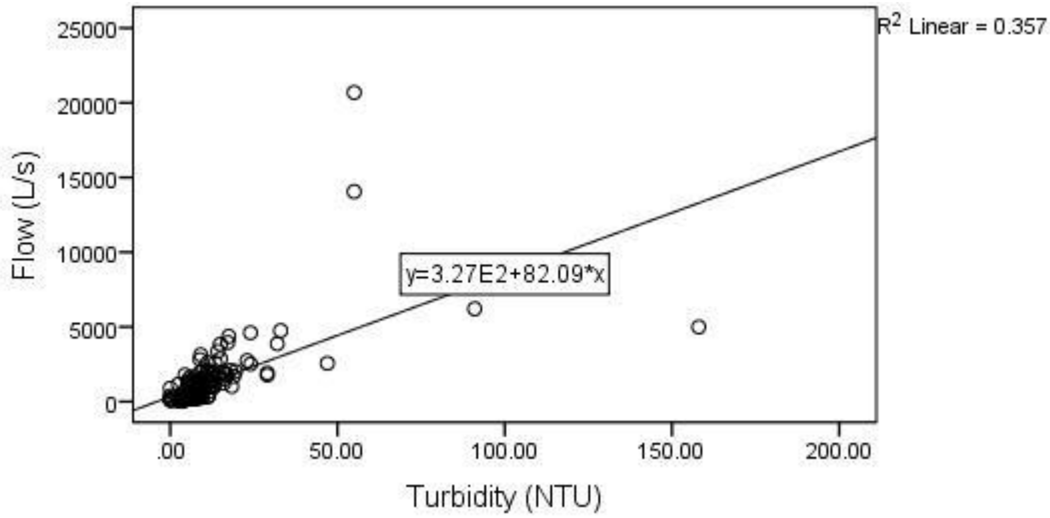

Figure 25 There is a weak linear regression between flow and turbidity (R^2=0.357), and moderate correlations for Spearman"s statistical test (0.789).

9.8 Water quality trends

The effects of farm dairy effluent upgrades on 18 of the 19 dairy farms within the Mangere catchment during the last six years are already paying dividends, with all geochemical indicators for ecosystem health and recreation at Knights Road Bridge either **stable** or **improving** (see Table 10). In some cases, positive changes have been very large. For instance, 32% less ammonia has been discharged to the Mangere at Knights Bridge, per year since 2007 (2007-2012). To qualify this, changes ≥1% per year are considered to result in noticeable improvements to ecology. However, water quality is still severely impacted in this catchment and ongoing land management changes are required to continue to improve water quality.

Table 10 Recent trends in water quality indicators for the Mangere, across six sites, corrected for changes in flow. The record at 101625 is 6 years in length (2007-2012) and is most reliable whereas trends at other sites are tentative because of the more limited record length. Only statistically significant and ecologically-meaningful trends are highlighted. Empty cells indicate stable water quality. The sum of improving and worsening trends are displayed at the foot of the table.

Monitoring Site and Location		**Temperature (°C)**	**Dissolved Oxygen (%)**	**Turbidity (NTU)**	**Total-N (g/m^3)**	**Nitrate (g/m^3)**	**Ammoniacal-N (g/m^3)**	**Total-P (g/m^3)**	**Dissolved Reactive-P (g/m^3)**	***E.coli* (MPN/100ml)**
Downstream	**Mangere@ Knights Rd Br**						-32.1% per yr	-11.0% per yr	-14.0% per yr	-13.9% per yr
	Mangere@ Kovich weir*	-3.2% per yr			-8.5% per yr		-61.5% per yr	-13.4% per yr		
	Mangapiu @Kokopu Rd Br*	-3.1% per yr	+1.6% per yr							
Upstream	**Mangere@ Kokopu Rd Br***			-13.8% per yr			-21.1% per yr	-17.0% per yr		-22.6% per yr
	Mangere@ Kara Rd Br*							-19.2% per yr		
	Mangere@ End of Wood Rd**									
Improving		2	1	1	1	0	3	4	1	2
Stable		4	5	5	5	6	3	2	5	4
Worsening		None								

*Record length only 4 years (2007-2010); **Record length only 3 years (2008-2010).

9.9 Invertebrate community health

Stream invertebrates (macroinvertebrates) can be used as biological indicators of water quality and stream health. The number of taxa (taxanomic diversity) at a site is a good indicator of the health and conservation value of a site. However, identification as part of the invertebrate monitoring programme is not to species level, so the diversity is likely to be higher than the data suggests.

The Macroinvertebrate Community Index (MCI) is an indicator of organic enrichment, where taxa are assigned predetermined scores on a scale of 1 to 10 depending on their sensitivity to organic pollution. The total MCI score at a site is based on the taxa present with the categories in Table 11 used to determine the overall level of enrichment. The Semi-Quantitative Macroinvertebrate Community Index (SQMCI) is similar to the MCI but takes into account the relative abundance of each taxa present. The categories used to determine the level of organic enrichment for SQMCI are also shown in Table 11. "Fuzzy boundaries" of ± 5 MCI units and ± 1.0 SQMCI unit are often used when interpreting the categories (Pohe 2012), to account for the complexity and variation in invertebrate communities.

Table 11 Categories for MCI and SQMCI (Boothroyd and Stark 2000).

Category	**MCI**	**SQMCI**
Clean water	> 120	> 6.00
Possible mild pollution	100 – 119.9	5.00 – 5.99
Probable moderate pollution	80 – 99.9	4.00 – 4.99
Probable severe pollution	< 80	< 4.00

Most mayflies (Ephemeroptera), caddisflies (Trichoptera) and stoneflies (Plecoptera) are more sensitive to changes in their environment. Therefore, like the MCI and SQMCI, the number of Ephemeroptera, Trichoptera and Plecoptera taxa present as a proportion of the total number of taxa recorded can be used as a measure of likely organic pollution at a site (%EPT).

The invertebrate indices are consistent with the water quality data, indicating that Mangere River is in a degraded condition. The MCI consistently falls in to the „probable severe pollution" categories with a median score of 75.5 and a range from 68.4 to 79.9. The site is dominated by pollution sensitive taxa such as snails and fly larvae, with percent EPT taxa ranging from 9.1 to 17.6% in the five years of sampling (Table 12). Changes in land management practices including wetland rehabilitation, riparian fencing and planting, and nutrient management are required to continue to improve water and habitat quality to be optimal for macroinvertebrate re-colonisation.

Table 12 Freshwater invertebrate data for Mangere River ant Knights Road

	No. of taxa	**MCI**	**SQMCI**	**%EPT**
Mar-07	24	71.4	3.52	12.5
Jan-08	22	68.4	3.23	9.1
Apr-09	16	75.5	2.76	12.5
Jan-10	17	76.2	2.95	17.6
Mar-11	16	79.9	2.89	12.5
Median	17	75.5	2.95	12.5

9.10 Fish community

The use of fish as an indicator of ecological health is complicated in New Zealand by the fact that many species are diadromous (spend part of their life cycle at sea) so their presence is influenced by factors such as barriers to migration, distance inland as well as habitat availability, water quality etc. They are an important part of the food web however and their absence will skew normal predator prey relationships. Their presence is an important measure of ecological stability and underpins a streams ecological value.

The native fish community in the Mangere is naturally limited by large physical barriers like the 12 m high Mangere Falls. From historic surveys it"s clear that the native fish community includes only a handful of fish (longfin eel, shortfin eel, crans bully, common bully, and banded kokopu). Banded kokopu young migrate through the catchment to the Pukenui Forest headwaters from August to December. They are highly sensitive to cloudy water and inputs of sediment, and like other native fish can also suffer from the effects of excessive nutrients (too many nutrients can alter growth, reproduction and feeding behaviour).

Sediment concentrations in the river are at levels likely to affect the migration of young banded kokopu. For instance, in 2010 and 2011 over a third of migrating banded kokopu were more than likely excluded from travelling up the Mangere by the levels of sediment suspended in the river. Riparian surveys by DairyNZ are being used to identify hotspots and tailor management programmes to each.

A recent survey in 2013 recorded four native species (longfin eel, shortfin eel, crans bully, common bully) in the Mangere in addition to the introduced brown trout.

9.11 Periphyton community

Periphyton is an important indicator of environmental quality, as the main primary producer in stream ecosystems, but also because of its ability to respond quickly to changes in water quality and form excessive growths under ideal conditions, affecting instream values, such as biodiversity and recreational use. However periphyton growth normally requires a stable substrate such as rocks and cobbles to become established. In the Mangere River the substrate is mainly fine sediment which is easily disturbed making it difficult for periphyton to become established. For this reason the Mangere River has not been sampled for periphyton.

9.12 Stream habitat quality

Where there is a diverse habitat available with a variety of flow types (runs riffles and pools) and good quality riparian vegetation, there tends to be high ecological health. Different flow types offer a variety of different habitats, encouraging greater diversity. Riparian cover stabilies banks, provides a sink for nutrients, traps sediment, provides shade during hot summer months as well as a source of food in the form of falling vegetation and terrestrial invertebrates.

The habitat at Mangere River consistently scores as marginal. The river is surrounded by pasture with livestock having direct access to the river which results in unstable banks and high in stream sediment loads. While there are Totaras along much of the stream bank providing good shade, little understory vegetation exists to trap sediment. Stream diversity is poor due to the homogenous nature of the river which provides only one habitat and flow type. Results from a more detailed habitat survey are being prepared by DairyNZ.

10Groundwater

The Mangere River catchment borders three major basalt aquifers, Maunu, Matarau and Three Mile Bush (see Figure 26). These three aquifers have been listed in Schedule A of the Regional Water and Soil Plan for Northland (NRC 2004) as „At Risk‟ from actual or potential demand.

The Three Mile Bush aquifer is classified as calcium bicarbonate-type water, which generally represents recharging water that has not had time to dissolve the surrounding rock minerals, or mix with other water types. Groundwater quality is generally good in this aquifer with the exception of high bacterial counts and slightly low pH. Discharge from this aquifer would contribute to low flows in the headwaters of the Mangere Stream (SKM 2006).

The Matarau aquifer is classified as sodium-chloride type water and generally referred to as end-product water. Groundwater in this aquifer has low pH, high bacteria counts, and high iron and manganese (SKM 2011).

The Maunu aquifer has a mean resident age of 45 years and also has calcium bicarbonate-type water. Discharge from this aquifer would contribute to low flows in the tributaries of the Mangere Stream near the southern boundary (SKM 2010).

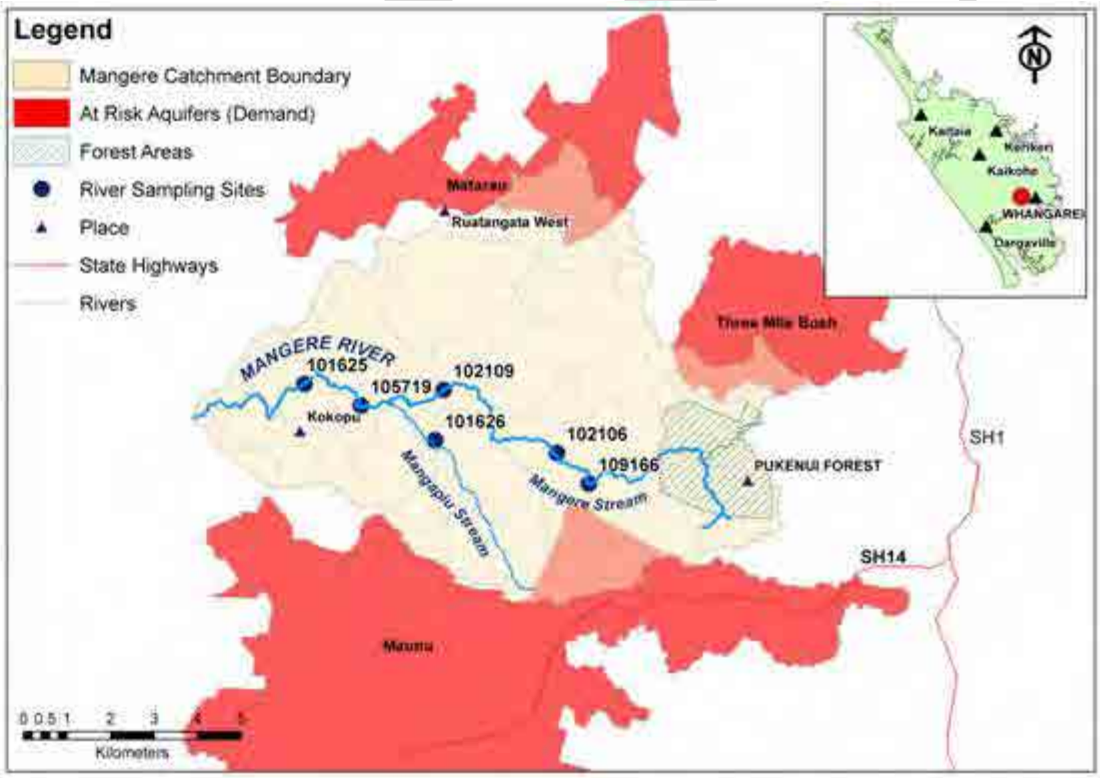

Figure 26 Maunu, Matarau and Three Mile Bush aquifers

11 Managing the catchment

11.1 Management of the catchment

Contaminants can enter waterbodies from direct and diffuse discharges. Direct discharges are sources of contaminants that discharge from discrete points or identifiable localised areas. Direct discharges, including stormwater and wastewater, to streams, rivers, and land are controlled by rules in the Regional Water and Soil Plan (RWSP). Diffuse discharges typically arise from land use activities that are spread across a catchment.

Diffuse contaminants can enter waterbodies by sub-surface drainage (leaching) and surface run-off. Diffuse discharges can include fertilisers, animal faeces and soil from agricultural land, and soil and fertilisers from forestry and horticultural land use. Diffuse discharges also includes stormwater from areas that are not reticulated, including from some roads (without drains) and road banks, which can be a significant source of sediments.

11.2 Consents

Under the Resource Management Act 1991 (RMA) Northland Regional Council is responsible for managing the region‟s freshwater quality and quantity by controlling discharges, water takes and land use activities that impact on water. Under the Local Government Act 2002, the Far North District Council is responsible for the provision and operation of wastewater, stormwater, and potable water infrastructure, as well managing use and development of land generally. Integrating the functions of the two councils for managing the use of land is important for ensuring effective management of water quality.

11.3 Water Use

Water is a valuable resource in the Mangere Catchment and is mainly used for horticulture, pasture irrigation, stock drinking and dairy shed washdown. The allocation in the catchment is considered to be high with a total water use of 10,047 cubic metre per day (m^3/d)

11.3.1 Permitted water takes

The Regional Water and Soil Plan for Northland (RWSP) provides rules for the taking and use of water without consent. In the Mangere catchment these rules permit the taking of water for reasonable domestic and stock drinking uses. In addition 10 m^3/d of water may be taken for any purpose (refer to Section 24 of the RWSP).

To determine how much water is being taken in accordance with the permitted activity rules, the Council adopted a similar approach to Environment Waikato to estimate potential permitted takes based on land use capability maps and actual stocking rates where available. These estimates were then ground truthed by a small scale water use survey carried out in the Otaika catchment.

The majority of permitted water takes within the Mangere catchment are for stock drinking water. It is estimated that there are approximately 5250 dairy cattle in the catchment (based on cow numbers provided to the Council) for the 19 farms. It is acknowledged that this figure regularly fluctuates. Drinking water requirements for dairy farms has been estimated based on 70 litres of water per cow per day to be 367 m^3/day.

The permitted water use calculations and survey indicated the volume of water taken for some properties exceeds permitted activity criteria and these takes do not have consents. The vast majority of these currently unauthorised takes relate to dairy farm water takes for milk cooling and dairy shed washdown. An estimate of water use that has been accepted by the Environment Court for a dairy shed is 70 litres of water per cow per day for milk cooling and shed wash-down. Based on this, dairy farms with an average herd size of 143 cows or more exceed the permitted take volume of 10 cubic metres per day and need a resource consent.

Based on the best information available, an estimate 740 m^3/d of water is taken for permitted and unauthorised use in the Mangere catchment.

11.3.2 Consented water takes

There are 11 active water takes within the Mangere catchment from 12 take sites (Figure 27), eight of these are surface water takes for irrigation. Five of these surface water takes are for less than 80m3/day. The two largest surface water takes are for 4000 and 3110 m3/day and are both for pasture irrigation. The consent on the Mangapiu Stream includes retaining water in an on-stream dam and taking water from behind the dam.

The total consented take for the Mangere is 9,307 cubic metres per day.

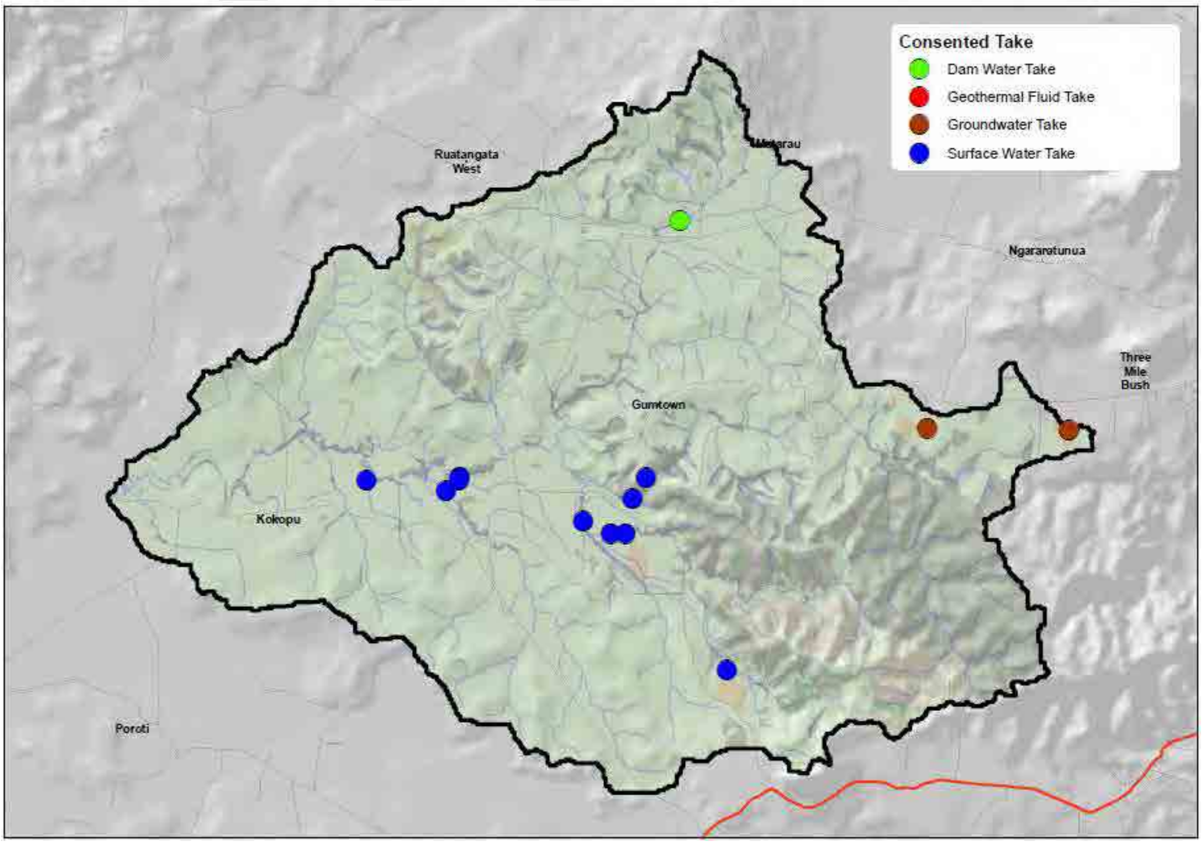

Figure 27 Active water take consents in the Mangere catchment

11.4 Consented Discharges

There are 14 resource consents to discharge animal waste (either to land or to water) within the Mangere catchment – these coincide with the consented dairy farms. There are also 11 resource consents within the Mangere catchment to discharge sewage to land (Figure 28).

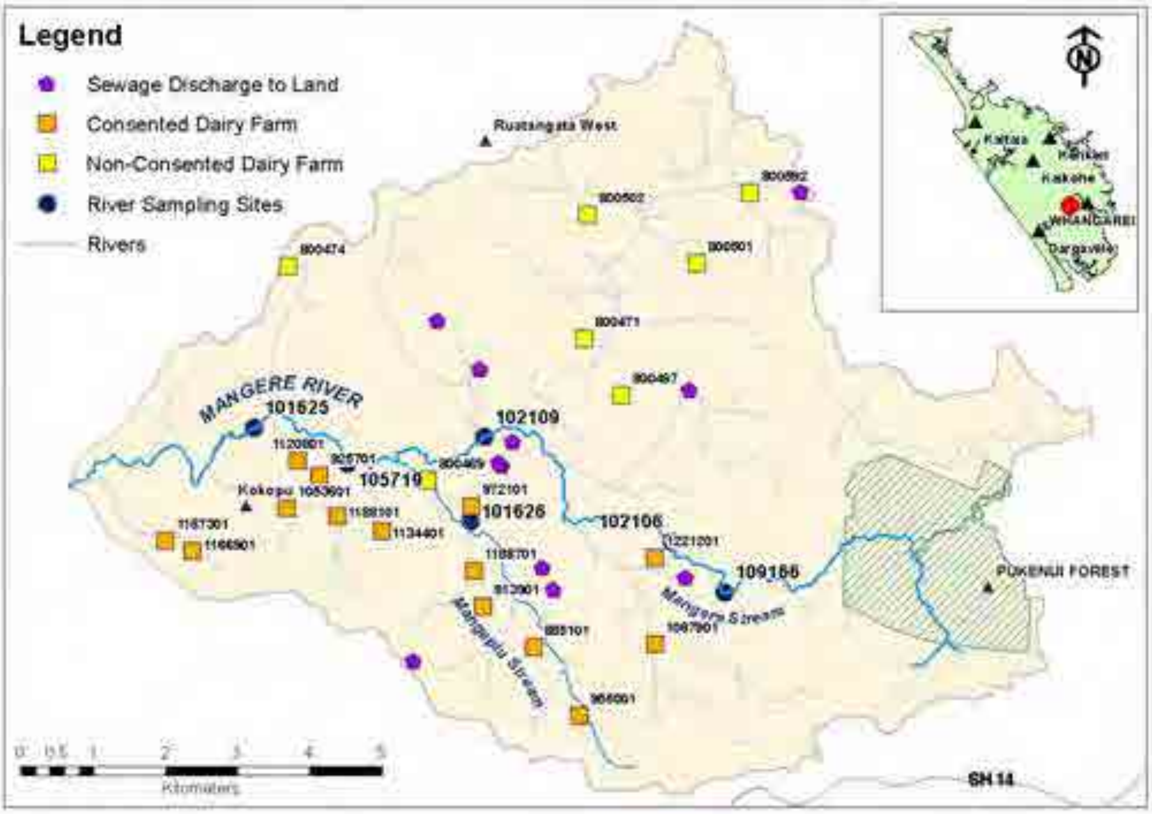

Figure 28 Discharge Resource Consents within the Mangere catchment.

12 Iwi environmental management

Iwi Māori have a living relationship with freshwater that is founded in the respective cosmologies of each iwi and that has spanned, and will continue to span, the full breadth of cultural, environmental, social and commercial interests. The nature of the relationship between iwi and freshwater forms the basis of iwi rights, interests, values and objectives pertaining to freshwater management. Iwi assert foundation rights to freshwater based on the Treaty, customary, and aboriginal rights and that these rights continue to hold relevance in the wider legal framework of water management.

12.1 Te Runanga A Iwi O Ngapuhi[1]

Te Runanga A Iwi O Ngapuhi (TRAION) is established to lead the spiritual, cultural, social and economic growth of Ngāpuhi. Our vision and mission is to ensure that the sacred house of Ngāpuhi stands firm. This is a vision we have and continue to strive towards.

TRAION works closely with their people to build empowering initiatives for their future and provide a range of services and funding opportunities to support the achievements and goals of descendants of Ngāpuhi.

12.2 Te Runanga O Whatua[2]

Te Runanga O Ngāti Whātua has interests in five harbours throughout its rohe: Whangārei, Mangawhai, Kaipara, Waitematā and Manukau. The Kaipara Harbour is the largest harbour in the southern hemisphere and is the largest enclosed harbour in Aotearoa.

The Rūnanga provides advice to local and central government agencies regarding Mana Whenua issues across the rohe relating to both marine and land based resource management activities and processes.

12.3 Te Uri O Hau[3]

Te Uri o Hau is a Northland hapu of Ngati Whatua whose area of interest is located in the Northern Kaipara region. Through Te Uri o Hau' MoU (Memorandum of Understanding) Protocols and Agreements, Te Uri o Hau' Deed of Settlement 2000 and Te Uri o Hau' Claims Settlement Act 2002.

Environs Holdings Ltd is heavily tasked to ensure that Territorial authorities and government agencies adhere to the Settlement Act and are continually advocating Te Uri o Hau' position in relation to their kaitiakitanga obligation.

Guiding Aim of Environs Holdings Limited is “To advocate and support Kaitiakitanga throughout the rohe as well as in the education and empowerment of whanau to be proactive in their role as Kaitiaki for Te Uri o Hau”.

[1] http://www.ngapuhi.iwi.nz/
[2] http://www.ngatiwhatua.iwi.nz/kaitiakitanga
[3] http://www.uriohau.com/the_trust/organisation/environs_holdings_ltd

13 Community environmental management

There are a number of community environmental groups within the Mangere catchment area.

13.1 Waimarie Nursery[4]

Waimarie Nursery is a dedicated and committed team who provides native plant knowledge for younger generations. They work towards those ends by stating their values and acting as agents to change families, friends and associates & wider community by way of educating children and letting them educate their parents.

The aim is to steer our society into a more sustainable direction for the benefit of our future. We are dedicated to providing the best native plants of the highest quality while delivering superior services and expertise to all customers.

13.2 Pukenui Western Hills Forest Charitable Trust[5]

The Pukenui Western Hills Forest Charitable Trust is an over-riding body to coordinate the restoration of the Pukenui Forest. The forest comprises some 1700 hectares of public land administered by the Department of Conservation and the Whangarei District Council in conjunction with local Iwi, adjoining owners and recreation groups; such as tramping clubs, etc.

Their vision is a forest treasure, a beating heart, with our help, its health and wellbeing remains, for future generations. The Trust has a management plan that was approved by the Minister of Conservation and the Whangarei District Council in June 2009 and forms the blueprint for their restoration and conservation efforts.

[4] http://www.waimarienurseries.co.nz/Index.cfm
[5] http://www.pukenuitrust.org.nz/pukenui-trust.htm

14Education and awareness

14.1 Education

The Enviroschools programme is available to all schools in Northland. The North‟s Enviroschools programme is funded by and operated through the Northland Regional Council, with support from The Enviroschools Foundation and the Department of Conservation.

In Northland, 70 schools and three kindergartens are currently on the pathway towards creating sustainable communities. They are all working at their own pace to achieve a range of sustainability actions, with some choosing to go for awards along the way.

14.1.1 Kokopu School

Kokopu School is part of the Enviroschools Programme and are very active, they are currently involved with water quality study, Waimarie Nurseries, Whitebait Connection and are doing ongoing water quality monitoring in local waterways which flow into the Mangere Catchment. The whole is school involved with about 40 students five to 12 years old (up to year eight).

14.1.2 Matarau School

Matarau School is just outside catchment boundary but many of the families live within the catchment.

14.1.3 Comrie Park Kindergarten

Comrie Park Kindergarten is part of the Enviroschools Early Years programme. They have studied water quantity/conserving water. As a result, they have installed a water tank for irrigating their gardens and orchard. The whole kindergarten is involved with about 40 students.

14.2 Awareness

In a new approach, we will be working at a catchment level to enable better integrated management of our freshwater systems. This will be guided by catchment groups, to be formed from locals with an interest in their local water issues, to help determine how each catchment can best be managed.

Regional environmental improvements are also the target of other important Council work programmes that integrate with the WNW programme, including the Priority Rivers Project, the Top Wetlands Project, Community Pest Control Areas, and Farm Management Plans.

13.2.1 Regional State of the Environment Report

The State of the Environment report provides quality environmental information that is accessible and understandable to Northlanders and which can be used to make important resource management decisions in the future. The report is arranged into five chapters: Our people; Our place; Our land, our air; Our freshwater; and Our coast. The chapters provide a broad picture of the core components that make up the state of our environment.

- Each chapter begins with a scene-setting introduction which explains why this part of the environment is significant for Northlanders and what the major pressures on the environment are;
- Describes the current state of each aspect of the environment – core information is presented on the state of the environment and key trends or changes over time;
- Outlines the management responses to environmental conditions now and into the future.
- Information is presented on what is being done now to address issues raised and what might be done in the future; and
- Provides a summary of progress in implementing regional objectives and policies.
- The report is available online http://www.nrc.govt.nz/SOE

13.2.2 Environment Fund

The Northland Regional Council Environment Fund has provided around $4 million to help people enhance and protect Northland"s natural environment since 1996.

The regional council recognises the effort and commitment that Northlanders are putting into addressing their environmental issues and the continuation of funding reflects this. The fund is provided through five different funding streams with projects funded at up to 50% of their total costs.

Priority Funding Streams have been identified to ensure that recipients of funding are proposing activities aligned with Regional Council Land Management priorities.

13.2.3 Priority Funding Streams

Soil conservation – targeting the maintenance and control of erodible soils, e.g. erodible land soil stabilisation via tree planting, fencing to exclude stock, pest control and other suitable means.

Biodiversity – targeting the restoration and protection of wetlands and lakes, e.g. fencing to keep out stock, riparian planting, pest control.
Coastal – targeting the restoration, protection and maintenance of estuaries, dunes and salt marsh, e.g. the planting of spinifex and pingao for dune stabilisation, pest control, fencing to exclude stock and riparian planting.

Water quality – targeting dairying and clean stream accord targets, dry stock exclusion from waterways and similar projects within recreational bathing site catchments e.g. fencing to exclude stock from waterways, riparian enhancement.

15Conclusion

The Mangere River catchment has been monitored by NRC since 1996 and is one of the regions most impacted rivers. Based on monitoring results from the Mangere Catchment Water Quality Investigation (2007-2010), water quality is poor with water quality degrading between upstream and downstream sites. The Mangapiu Stream has particularly poor water quality with none of the water quality medians meeting the national guidelines.

Overall, habitat quality is marginal with some riparian cover but little understory vegetation to help filter runoff. The MCI and SQMCI values for macroinvertebrates (made up of mostly freshwater insect larvae) indicate that the Mangere River is severely polluted. Pohe (2010) also reported an overall declining trend in macroinvertebrates in the Mangere River. A recent fish survey in 2013 recorded four native species (longfin eel, shortfin eel, crans bully, common bully) in the Mangere in addition to the introduced brown trout. There are also historical records of young banded kokopu migrating through to the upper reaches of the Pukenui Forest from August to December. They are highly sensitive to cloudy water and current sediment concentrations in the river are at levels likely to affect their migration.

The Mangapiu Stream and the lower reaches of the Mangere River drain a high number of dairy farms. Eighteen of the 19 farms in the Mangere catchment have upgraded their effluent disposal systems at least once. Eleven of these farms have upgraded more than once. Nine consented farms, which previously discharged treated effluent to water throughout the year, have installed land application systems, and only discharge to water during wet conditions. The effects of farm dairy effluent upgrades within the Mangere catchment during the last six years are already paying dividends, with all geochemical indicators for ecosystem health and recreation at Knights Road Bridge either stable or improving. In some cases, positive changes have been very large. For instance, 32% less ammonia has been discharged to the Mangere at Knights Bridge, per year since 2007 (2007-2012). However, water quality is still severely impacted in this catchment and ongoing land management changes are required to continue to improve water quality.

Water is a valuable resource in the Mangere Catchment and is mainly used for horticulture, pasture irrigation, stock drinking and dairy shed washdown. The allocation in the catchment is considered to be high with a total water use of 10,047 cubic metre per day (m^3/d).

APPENDIX 1 References and further sources of information

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Parliamentary Commissioner for the Environment 2012. Water Quality in New Zealand: Understanding the science.

Further sources of information

1 Northland Regional Water and Soil Plan
2 Northland State of the Environment Report
3 Northland Lakes Strategy
4 Northland Wetlands Strategy

Websites

1. www.nrc.govt.nz
2. www.ngapuhi.iwi.nz
3. www.ngatiwhatua.iwi.nz
4. www.uriohau.com
5. www.waimarienurseries.co.nz
6. www.pukenuitrust.org.nz

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