MANGERE CATCHMENT

WATER QUALITY UPDATE

Date: April 2016

Version: 1.0

Putting Northland first

WAIORA NORTHLAND WATER

NORTHLAND REGIONAL COUNCIL

CONTENTS

FIGURES

TABLES

1 Current monitoring in the catchment

The following environmental monitoring is currently conducted by Northland Regional Council in the Mangere catchment:

- **River Water Quality Monitoring Network** (RWQMN) established in 1996. Thirty six 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 Knight Road bridge, which has been monitored since 1996 as well as a formerly monitored site in the Pukenui Forest. Annual and five yearly reports are available here: http://www.nrc.govt.nz/Resource-Library-Summary/Environmental-Monitoring/State-of-the-Environment-Monitoring/

  Waiora Northland Water (WNW) water quality sites were established in July 2014 consisting of 29 sites distributed between the Whāngārei Harbour, Mangere, Waitangi and Doubtless Bay priority catchments and bringing the total number of sites monitored in Northland to 66. In total six sites are currently monitored in the Mangere catchment, incorporating the Mangere at Knight Road and Mangere at Pukenui RWQMN sites.

- **Mangere catchment water quality investigation** was carried out between 2007 and 2010 at six sites within the Mangere catchment to determine the likely cause of the high nutrients and bacteria levels and low water clarity recorded at the Knight Road site.

- **Stream invertebrate (macroinvertebrate) monitoring** at RWQMN sites since 1997. Every site in the Network is monitored once a year in summer. Monitoring at the Mangere at knight Road site 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. Historically assessments were carried out every second year. The Mangere River site was assessed in 2008, 2010 and 2012. Since 2014 habitat assessments are undertaken alongside the macroinvertebrate monitoring programme annually. 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 Knight 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 rain gauge and manual calibration check gauge. Rainfall is recorded every five minutes using a data logger (Unidata Ecologger) and Telemetered to NRC database every two hours.

- **Groundwater Water Quality Monitoring Network** (GWQMN) monitors 31 groundwater bores throughout Northland encompassing 27 aquifers. These bores are monitored every three months for a range of parameters, including temperature, dissolved oxygen, pH, water, nutrients and bacterial levels. This monitoring includes three bores located in Matarau, Three Mile Bush and Maunu aquifers. Annual and five yearly State of Environment reports are available here: http://www.nrc.govt.nz/Resource-Library-Summary/Environmental-Monitoring/State-of-the-Environment-Monitoring/

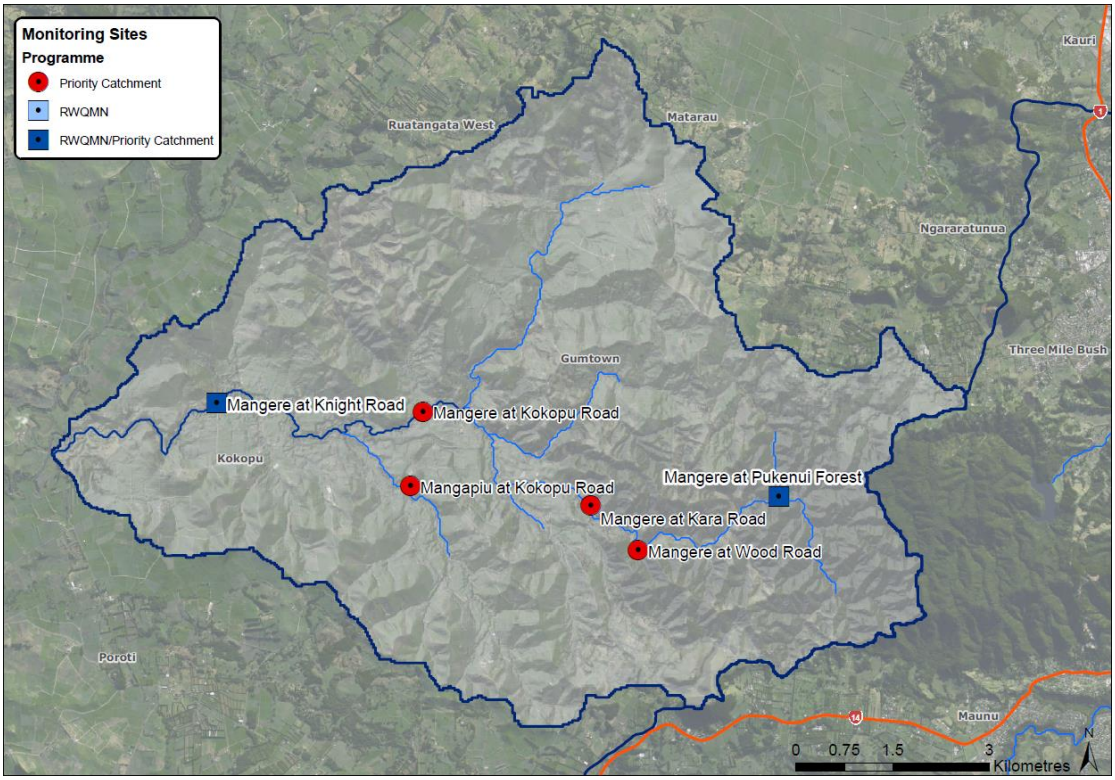

Figure 1: Mangere catchment RWQMN and WNW water quality monitoring sites.

Table 1: Water quality monitoring sites in the Mangere catchment.

	Site Name	Dominant surrounding land-use
Upstream	Mangere at Pukenui Forest	Indigenous forest
	Mangere at Wood Road	Indigenous forest & high producing exotic grassland
	Mangere at Kara Road	High producing exotic grassland
	Mangere at Kokopu Road	High producing exotic grassland
	Mangapiu at Kokopu Road	High producing exotic grassland
Downstream	Mangere at Knight Road	High producing exotic grassland

All sites within the Mangere catchment are classified as low-elevation source-of-flow draining through pasture according to the River Environment Classification (Snelder and Biggs 2002). Four of the most upstream sites in the Mangere catchment, i.e. Mangere at Pukenui Forest, Mangere at Wood Road, Mangere at Kara Road and Mangere at Kokopu Road, are classified as having hard sedimentary geology, whereas the remaining two sites, i.e. Mangapiu at Kokopu Road and Mangere at Knight Road, are classified as soft sedimentary geology (Snelder and Biggs 2002).

2 River ecosystem and water quality

The ecological health, or integrity of river ecosystems is 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.

Ecological health in rivers and streams is dependent on water quality parameters such as, in no particular order, temperature and dissolved oxygen, clarity, nutrients, suspended solids and faecal pathogens. Faecal pathogens are not known to affect aquatic ecosystems, but 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 influences of water quality on river ecosystems, however as mentioned above causal effects are not always clear. Current national standards and guidelines outlined below are used to facilitate inter-site comparisons of the state of water quality in the region's rivers and streams.

2.1 Long term water quality results and trends

Currently the only site with long term water quality data in the Mangere catchment is the Mangere at Knight Road which is a RWQMN site as well as being one of the priority catchment sites. This site has been monitored since 1996 and has traditionally had some of the poorest water quality results in the Northland Region. It currently has results for *E. coli*, turbidity, ammoniacal nitrogen, dissolved reactive phosphorous and total phosphorous which rank it amongst the worst 25 percent of similar sites in New Zealand as reported on the Land Air Water Aotearoa (LAWA)[1] website (Figure 2).

Trend analysis for the past ten years show a number of meaningful improvements in *E. coli* and nutrient levels probably as a result of improved farm management practices as well as fencing and planting within the catchment (Figure 2). However, when the time period for analysis is reduced to the last five years, results indicate a levelling off with no meaningful improvement (Figure 3).

The addition of five monitoring sites within the catchment will help to identify problematic areas/sub-catchments for targeted water quality management in the catchment. This report outlines preliminary results based on one year of data and compares them to appropriate national benchmarks/standards for this purpose.

[1] For more information visit: http://www.lawa.org.nz/explore-data/northland-region/

Figure 2: Current water quality state of the Mangere at Knight Road RWQMN site compared to similar sites in New Zealand with 10 year trends for nine water quality parameters (excerpt from Land Air Water Aotearoa (LAWA) website).

Figure 3: Current water quality state of the Mangere at Knight Road RWQMN site compared to similar sites in New Zealand with five year trends for nine water quality parameters (excerpt from Land Air Water Aotearoa (LAWA) website).

2.2 National water quality standards and guidelines

The National Policy Statement for Freshwater Management (NPS-FM) was introduced by the Government in 2011 as part of the first phase of freshwater reforms. It was updated in 2014 with a National Objectives Framework (NOF) and includes targets to provide direction to Regional Councils around maintaining and improving water quality. It includes a number of grades as well as 'national bottom lines' (Table 2) – thresholds of water quality attributes that good management should prevent our waterways from reaching in a consistent way across the country. Councils are obliged to maintain or improve water quality within their regions. They cannot simply let conditions degrade down to the bottom line. The NOF water quality grades provide a reporting framework to assess water quality. The bottom line is the point separating a C from a failing D grade.

Table 2: National Objectives Framework attributes and grades.

Attributes		National Objectives Framework Grades			
		A	B	C	D
Ammoniacal nitrogen (toxicity) (mg/L)	annual median	≤0.03	>0.03 and ≤0.24	>0.24 and ≤1.30	>1.30
	annual maximum	≤0.05	>0.05 and ≤0.40	>0.40 and ≤2.20	>2.20
Nitrate nitrogen (toxicity) (mg/L)	annual median	≤1	>1and ≤2.4	>2.4 and ≤6.9	>6.9
	annual 95th percentile	≤1.5	>1.5 and ≤3.5	>3.5 and ≤9.8	>9.8
Escherichia coli (*E. coli*/100mL)	annual median (2nd contact recreation)	≤260	>260 and ≤540	>540 and ≤1000	>1000
Periphyton chlorophyll-a (mg/m^2)	exceeds no more than 8% samples over 3 years	≤50	>50 and ≤120	>120 and ≤200	>200

Key

A	Similar to reference conditions
B	Slightly impacted
C	Moderately impacted (lower/upper limit national bottom line)
National bottom line	
D	Degraded/unacceptable (must be managed to C or better)

The NOF is still under development with a number of additional attributes to be added in the near future. In the interim other water quality parameters not currently covered by the NOF are assessed against relevant trigger/guideline values (Table 3). These values differ from the NOF in that they are not national standards and therefore do not entail statutory obligations, but instead provide conservative numbers for physical and chemical measurements in rivers above or below which aquatic ecosystems may be exposed to stress. In this report annual medians are compared to the trigger/guideline values (Table 3).

Table 3: National guideline values for the protection of aquatic ecosystems.

Identifier	Abbreviation	Reference	Trigger/guideline value
Dissolved oxygen	DO	RMA 1991 Third Schedule	≥80 % saturation
Dissolved reactive phosphorus	DRP	ANZECC (2000)	≤0.010 mg/L
Total nitrogen	TN	ANZECC (2000)	<0.614 mg/L
Total phosphorus	TP	ANZECC (2000)	<0.033 mg/L
Turbidity	TURB	ANZECC (2000)	≤5.6 NTU

2.3 Water quality results

The following section describes water quality in the Mangere catchment using box and whisker plots (Figure 4) 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. The line inside the rectangle shows the median value, and "whiskers" above and below the box show the minimum and maximum values or the 95th percentile values depending on the parameter being measured. Stars indicate outliers and circles far out values (not displayed in Figure 4).

Just over a year of water quality data has now been collected at the five new sites in the Mangere priority catchment since sampling began in July 2014. This adds to data already collected at Knight Road which has been a long term RWQMN sampling site. It is very difficult to accurately interpret water quality data without several years of data to smooth out the impacts of weather patterns, climatic conditions, seasonal variation, etc. Data collected from July 2014 to June 2015 indicate that the main water quality issues in the Mangere may include elevated nutrients and *E. coli* as well as low dissolved oxygen levels and average ecosystem health, indicated by aquatic insects (macroinvertebrates). The Mangapiu at Kokopu Road site stands out, in particular, as having degraded water quality. Note: results presented for the Knight Road site only include data from July 2014 to provide consistency.

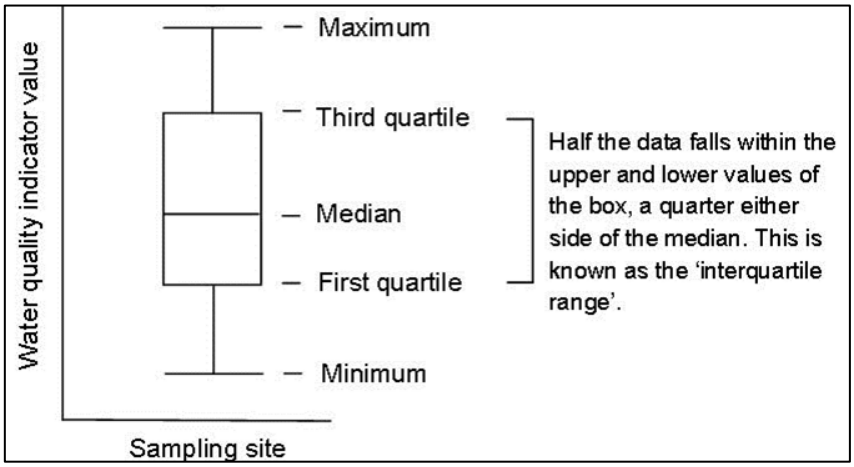

Figure 4: Box and whisker plot description.

2.3.1 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. Whilst nutrients are necessary for sustaining life, high levels of nitrogen and phosphorus can cause excessive growth of aquatic plants and algae and reduce overall water quality.

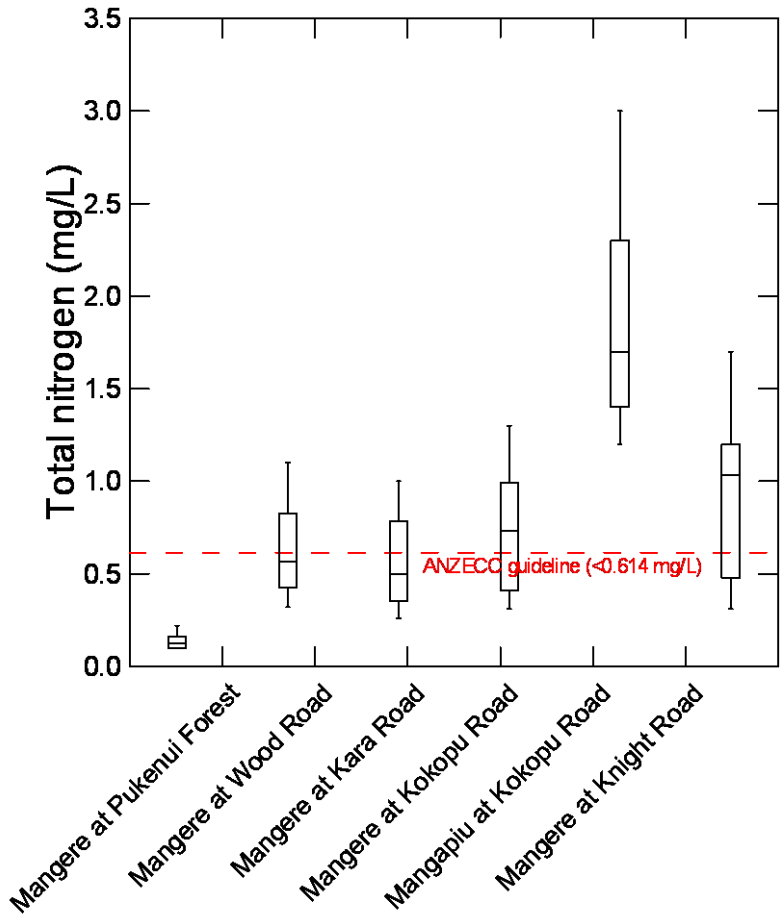

Figure 5: Total nitrogen (July 2014 to June 2015) with ANZECC guideline value.

ANZECC guidelines apply to total nitrogen as per Table 3. Between July 2014 and June 2015 (Figure 5):

- Only one site – Mangere at Pukenui Forest – recorded total nitrogen levels well below guideline.
- Two sites further down the catchment – Mangere at Wood and Kara Road – recorded total nitrogen levels above the guideline 42% of the time.
- Two sites further down the catchment – Mangere at Kokopu and Knight Road – recorded total nitrogen levels above the guideline 67% of the time.
- One site – Mangapiu at Kokopu Road – recorded total nitrogen levels above the guideline 100% of the time.

ANZECC guidelines also apply to dissolved reactive phosphorus and total phosphorus Table 3. Between July 2014 and June 2015 (Figure 6) all sites including the reference site at Pukenui Forest recorded levels above guideline. The three sites located further downstream recorded higher levels, with Mangapiu at Kokopu Road recording the highest levels. The results at Pukenui Forest site highlight the natural occurrence of readily available phosphorus in the water, possibly related to underlying geology and/or soil composition.

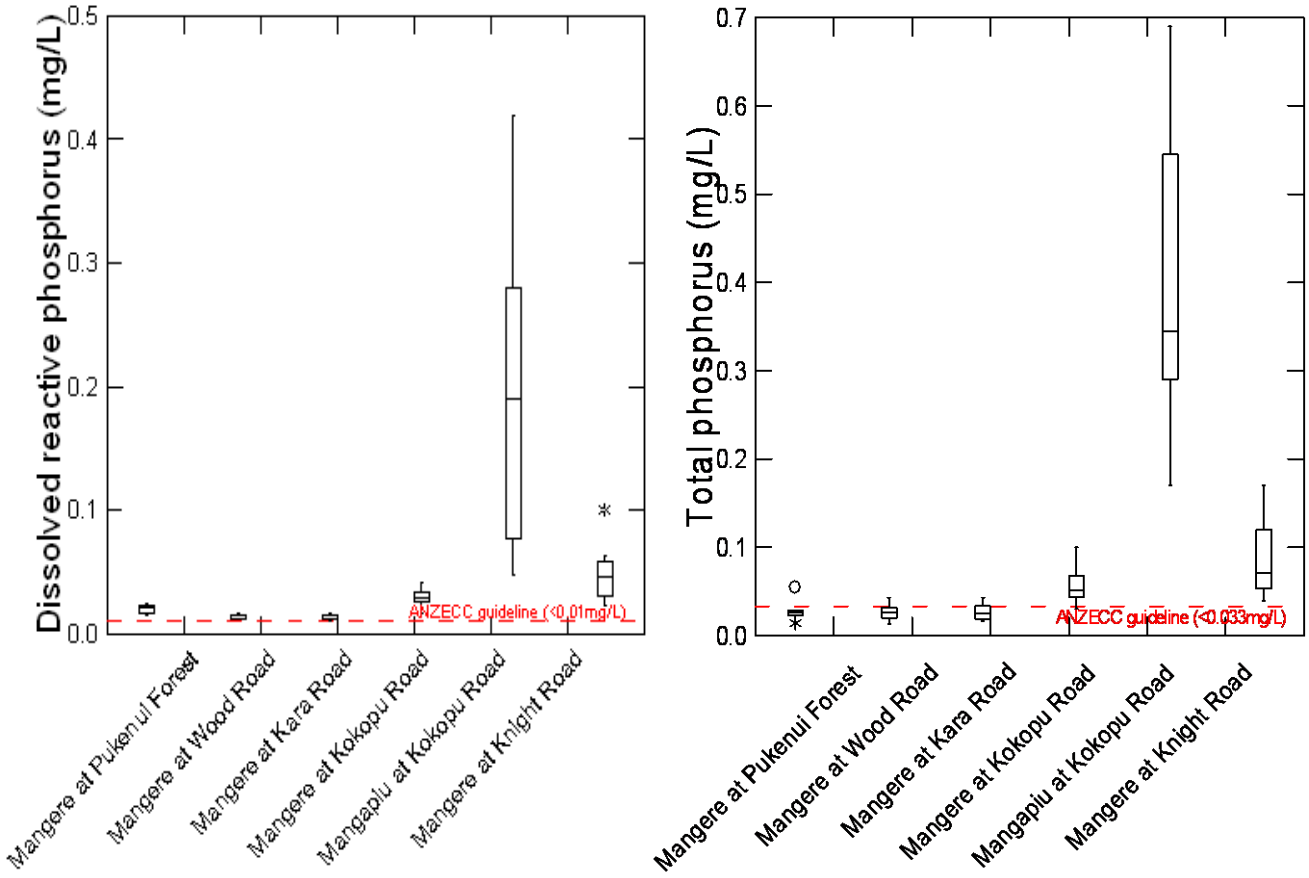

Figure 6:1. Dissolved reactive phosphorus (July 2014 to June 2015) with ANZECC guideline value.
2. Total phosphorus (July 2014 to June 2015) with ANZECC guideline value.

Total phosphorus levels are within ANZECC guideline for three sites – Mangere at Pukenui Forest, Wood Road and Kara Road. The three remaining sites recorded above guideline total phosphorus levels with highest levels recorded at Mangapiu at Kokopu Road site followed by Mangere at Knight Road site.

2.3.2 River/stream toxicity – nitrate & ammoniacal nitrogen

Results indicate nitrogen levels generally meet NOF toxicity guidelines within the Mangere catchment with the annual maximum for ammoniacal nitrogen toxicity (Figure 6) falling into the NOF A and B grades for most sites excluding the Mangapiu at Kokopu Road site where the annual maximum falls into the NOF C grade. All results for nitrate nitrogen toxicity (Figure 7) fall into the A grade

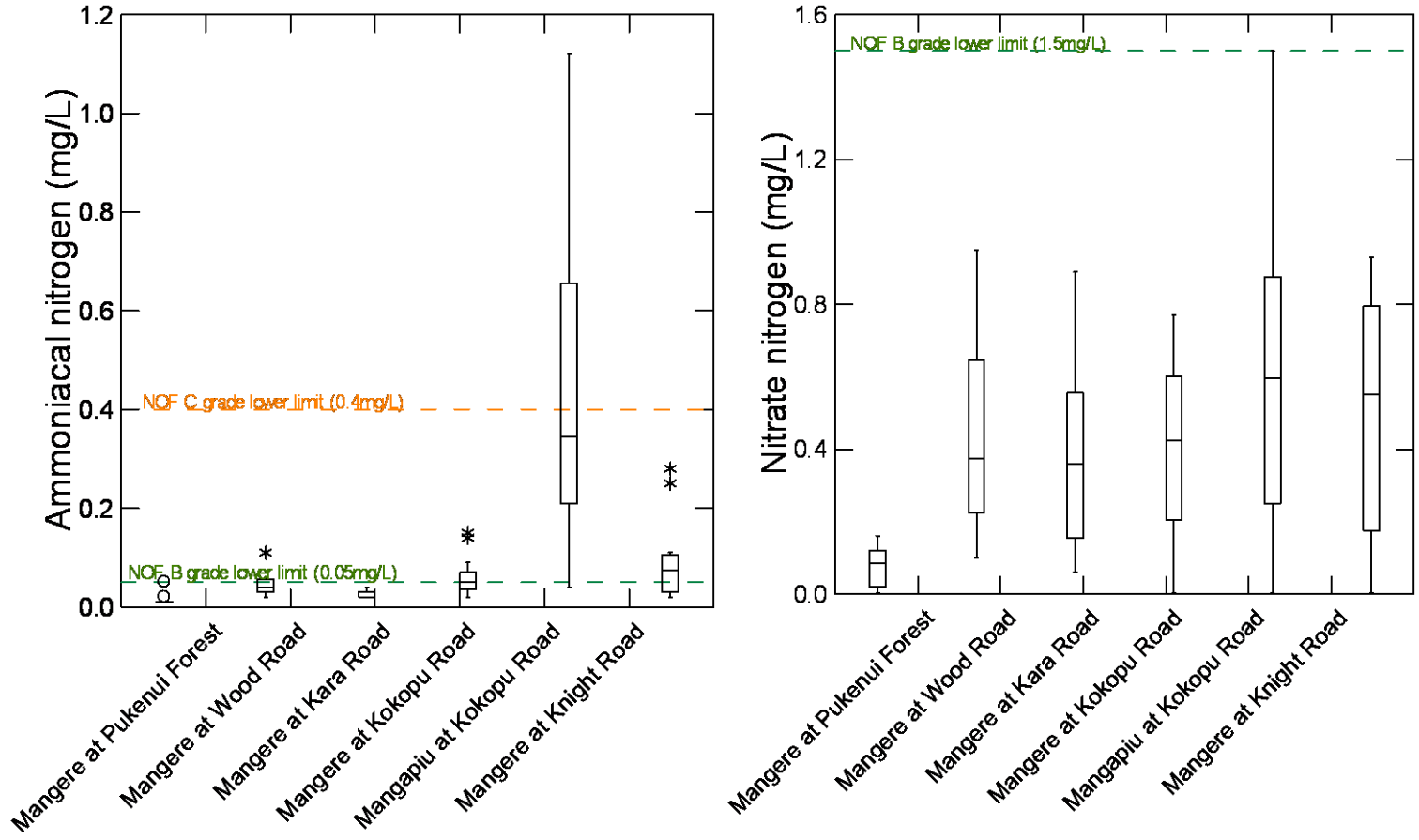

Figure 7:1. Ammoniacal nitrogen toxicity (July 2014 to June 2015) with annual maximum NOF grades. 2. Nitrate nitrogen toxicity (July 2014 to June 2015) with 95th percentile NOF grades.

2.3.3 Periphyton community

Periphyton is the community of slime and algae that grows on the beds of rivers and streams. It is an important indicator of environmental quality and is the main primary producer in stream ecosystems. It responds quickly to changes in water quality, with excessive growth occurring under ideal conditions, affecting instream values, such as biodiversity and recreational use. The main drivers for periphyton growth include light and nutrient levels. 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 it to become established. For this reason the Mangere is not sampled for periphyton.

2.3.4 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 a number of factors including suspended sediment and algal biomass. Suspended sediments are typically elevated following large rainfall events, causing low water clarity and high turbidity. Turbidity is one measure of water clarity.

Median turbidity levels (Figure 8) are above the ANZECC guideline for the three most downstream sites – Mangere and Mangapiu at Kokopu Road and Mangere at Knight Road with levels above the guideline 100% of the time at the Mangapiu site. The Mangere at

Wood and Kara Road sites have medians below the guideline with some results above. The lowest turbidity levels were recorded at the Pukenui Forest site with only one result above guideline likely associated with heavy rainfall.

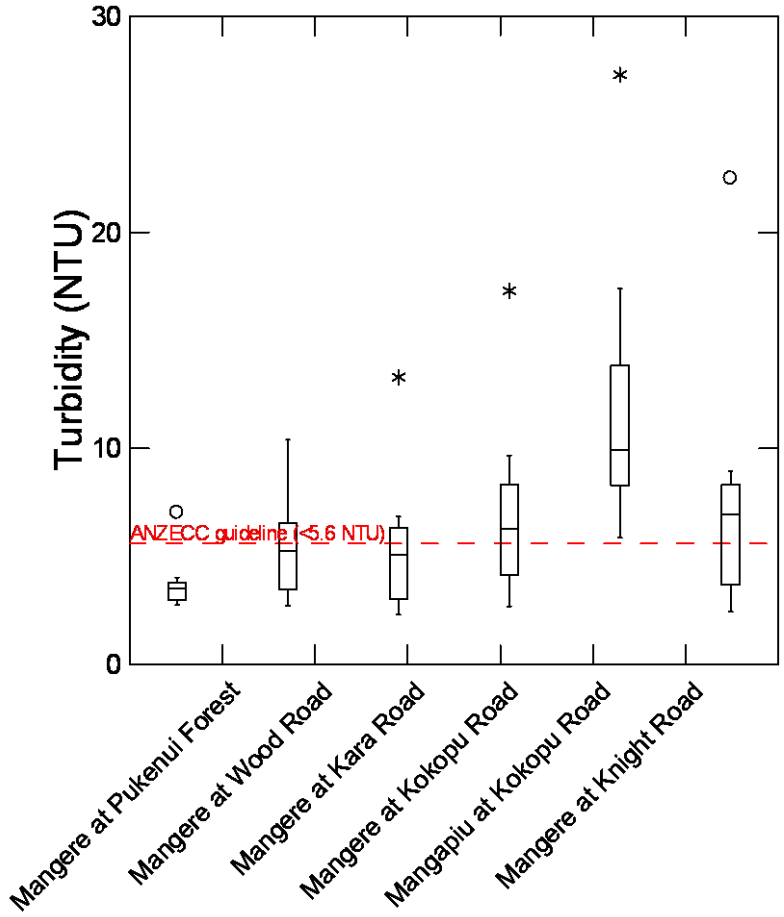

Figure 8: Turbidity (July 2014– June 2015) with ANZECC guideline value.

Even rivers in pristine native forested catchments have elevated sediment levels following heavy rain, being a combination of sediment washed into the river from surrounding land, sediment re-suspension from the river bottom due to the increased flows and streambank erosion. However, where there is intensive agriculture, forestry harvesting, subdivision, a lack of riparian vegetation and/or stock access to waterways, sediment loads increase considerably. The effects on turbidity from these activities are exacerbated in the Mangere catchment where the soils are made up of very fine textured clay sediment, much of which stays suspended in water indefinitely, reducing water clarity. These soils require careful land management to avoid further deterioration of water quality.

2.3.5 Faecal pathogens – Escherichia coli *(E. coli)*

Although faecal pathogens are not known to affect aquatic ecosystems they are of concern for both human and animal health. The faecal indicator bacteria E. coli indicates contamination from faecal matter which can potentially contain harmful pathogens. Most sites in the Mangere catchment fall into the B or C grade for secondary contact recreation (activities involving occasional immersion such as wading, boating, etc.) with median *E. coli* levels above 260 but below 1000 *E. coli*/100mL (Figure 9). *E. coli* levels are the lowest at the Pukenui Forest site, with a median falling into the A grade. Microbial source tracking results from the Knight Road site indicate the primary source of contamination is ruminant, but wildfowl markers have also been detected on several occasions.

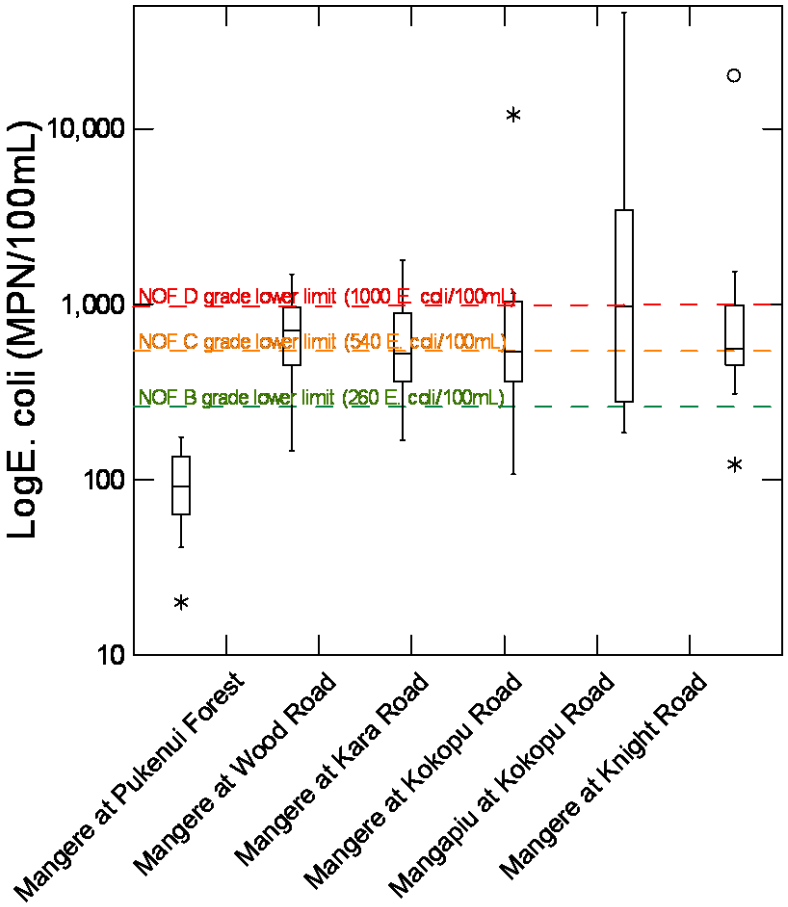

Figure 9: Annual *E. coli* levels (logarithmic scale) (July 2014 - June 2015) with corresponding NOF grades for secondary contact recreation.

2.3.6 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 concentration depends on waterbody types. In-stream wetlands may naturally have lower levels of dissolved oxygen than rivers or streams. In slow flowing low energy streams containing macrophytes (aquatic plants), such as at the Mangere at Knight and Wood Road sites, there are likely to be large fluctuations in dissolved oxygen throughout a 24-hour period compared to streams such as at the Mangere at Pukenui Forest site which is a fast flowing high energy stream within a native forested catchment (Figure 10).

Dissolved oxygen levels vary with temperature, biological activity and how quickly it transfers to and from the atmosphere. Biological activity includes microbial activity by bacteria as well as plant and algae growth, and can be associated with the presence of organic matter from decaying aquatic vegetation, sewage effluent, and animal manures. Aquatic plants photosynthesise during the day (producing oxygen) and respire at night (consuming oxygen).

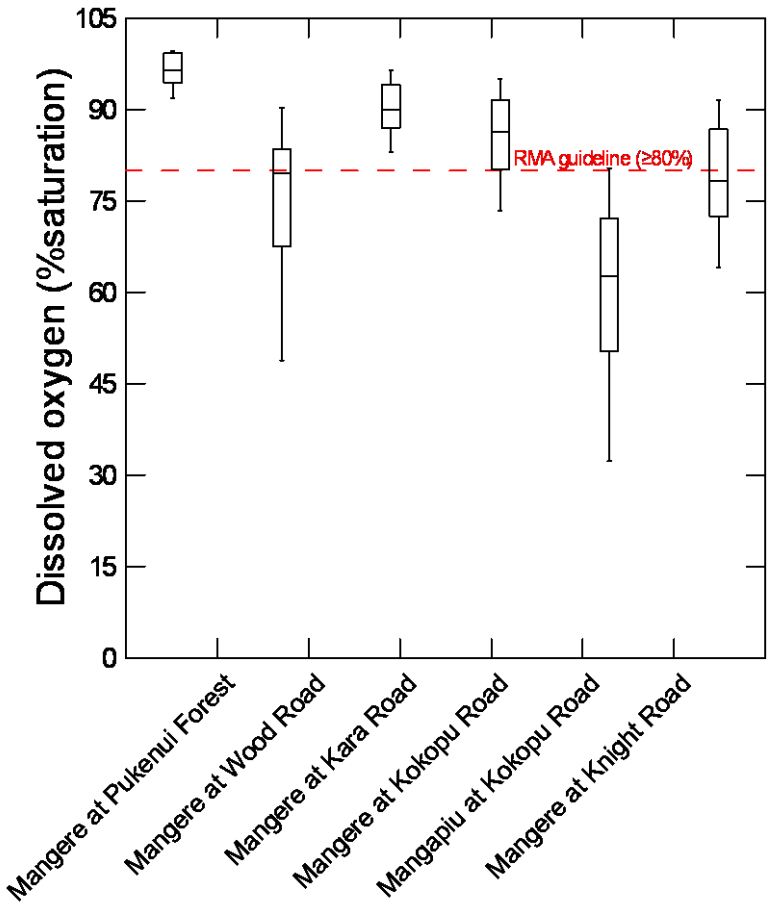

Figure 10: Dissolved oxygen (July 2014 to June 2015) with RMA guideline value.

Half of the sites monitored in the Mangere catchment recorded dissolved oxygen levels above the recommended trigger value (Figure 10) with three of the medians, i.e. Mangere at Wood Road, Mangapiu at Kokopu Road and Mangere at Knight Road sites, falling below RMA 1991 trigger value (80% saturation). Between 2014 and 2015 the lowest dissolved oxygen recorded in the Mangapiu at Kokopu Road was 32.3%, well below recommended trigger value and at a level which would put aquatic plants and animals under stress. In the same period dissolved oxygen levels remained below trigger value 92% of the time. The highest level recorded was 99.6% at Mangere at Pukenui Forest, a reference site discontinued in April 2015 due to site access difficulties.

2.3.1 Invertebrates community health

Stream invertebrates (macroinvertebrates) are used as biological indicators of water quality and stream health. As they live in the stream environment over an extended period of time they are a good indicator of overall water quality/ecosystem health. The Macroinvertebrate Community Index (MCI) is an indicator of organic enrichment and pollution, where taxa are assigned predetermined scores on a scale of 1 to 10 depending on their inherent sensitivity to pollution. The MCI score at a site is based on the taxa present, with the categories in Table 4 used to determine the overall level of water quality.

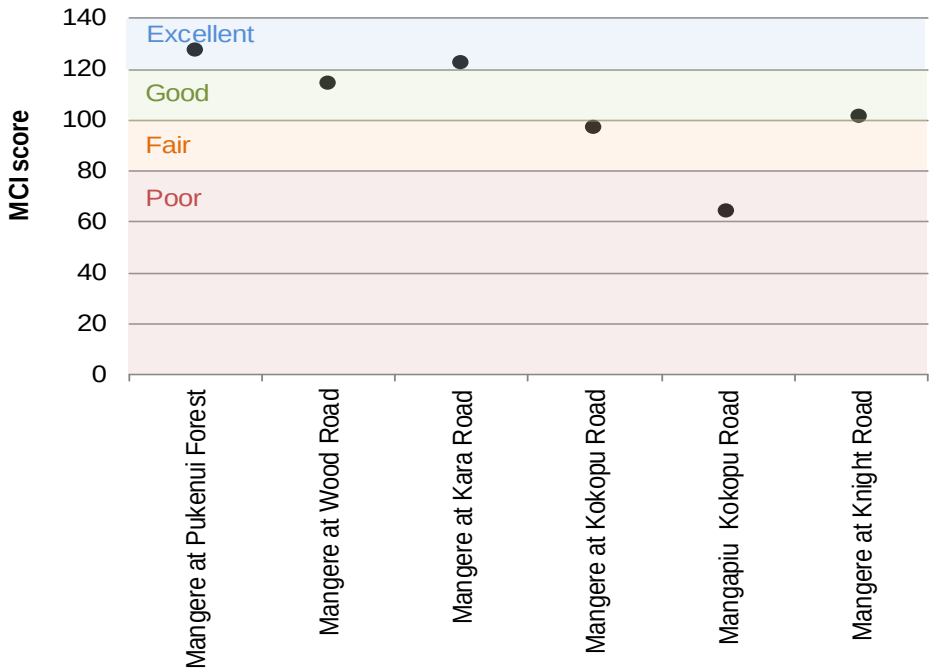

Figure 11: Macroinvertebrate Community Index results for Doubtless Bay, summer 2014/15.

Table 4: Macroinvertebrate Community Index (MCI) scoring system (Boothroyd and Stark 2000).

Category	MCI	Stream/river state
Excellent	> 120	Clean water
Good	100 – 119.9	Possible mild pollution
Fair	80 – 99.9	Probable moderate pollution
Poor	< 80	Probable severe pollution

Results for summer 2014/15 (Figure 11) suggest that:

- two sites have excellent water quality,
- two sites have good water quality,
- one site has fair water quality,
- and one has poor water quality.

The streams with the poorest macroinvertebrate scores correspond to those with the lowest dissolved oxygen levels (Figure 10): Mangapiu at Kokopu Road and Mangere at Knight Road. The Mangere at Pukenui Forest recorded the highest MCI score of all sites at 127 followed by the Kara Road site with an MCI score of 122.

2.3.2 Fish community

The use of fish as an indicator of ecological health is complex in New Zealand by the fact that many species are diadromous (that is to say 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. However fish are an important part of the food web and their absence will skew normal predator-prey relationships. Their presence is an important measure of ecological stability and underpins a stream's ecological value.

The native fish community present in the Mangere catchment is naturally limited by large physical barriers such as the 12m high Mangere Falls. From historic surveys, i.e. the National Institute of Water and Atmospheric research (NIWA) New Zealand Freshwater Fish Database (NZFFD), it is clear the native fish community includes only a handful of fish species (longfin eel, shortfin eel, crans bully, and common bully.

A recent survey in 2013 recorded the same four native species (longfin eel, shortfin eel, crans bully and common bully) in the catchment in addition to the introduced brown trout and the pest fish gambusia.

2.3.3 Stream habitat quality

Where there is a diverse habitat available with a variety of flow types (runs riffles and pools), instream debris 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 stabilises banks, provides a sink for nutrients, traps sediment, and provides shade during hot summer months as well as a source of food in the form of falling vegetation and terrestrial invertebrates.

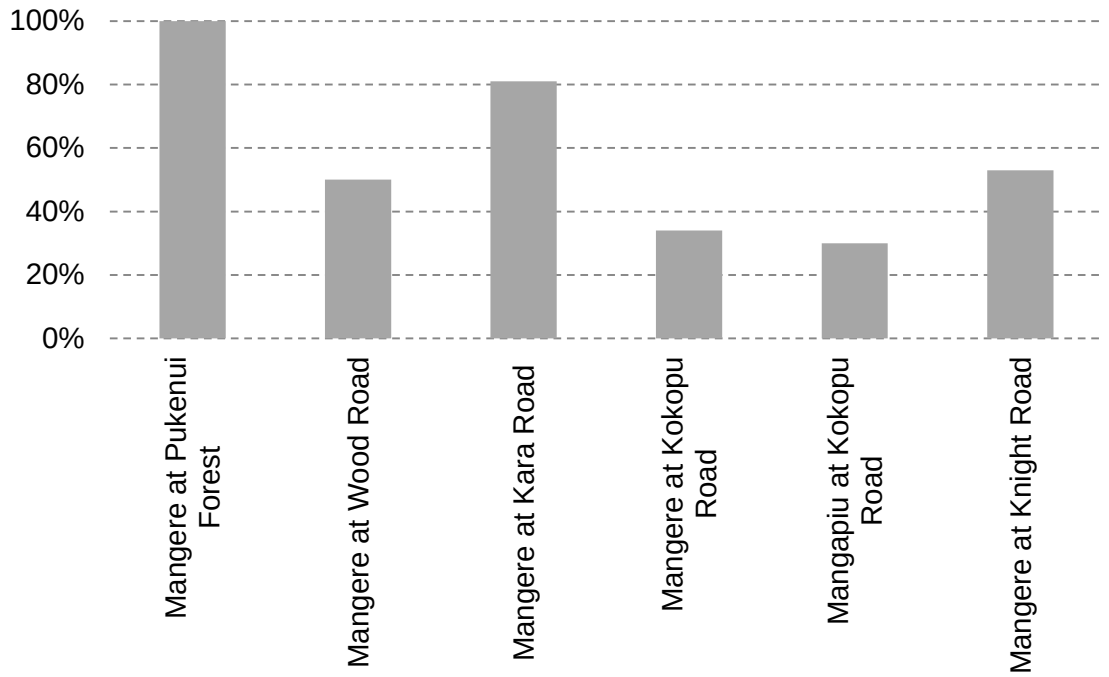

Figure 12: Rapid habitat results shown as a percentage of reference condition (Mangere at Pukenui Forest), summer 2014/15.

Four of the six sites monitored in the Mangere have a habitat score of less than 53 percent of reference condition (Figure 12) using the Pukenui Forest as the reference site. There is evidence of high sediment loads, often associated with high intensity land use and stock access, with the substrate consisting predominantly of sediment at most sites. The lowest scoring site, Mangapiu at Kokopu Road, has a surrounding land use of mainly pasture, stock have access to the river, the banks are unstable and while there are totaras along much of the stream bank providing good shade, little understory vegetation exists to contain sediment. This stream also provides little habitat diversity with a mainly uniform substrate and flow type and has the lowest MCI scores (Figure 11).

The highest habitat score of 100 percent of reference condition was the Pukenui Forest site. This site is located high in the Mangere catchment, draining native vegetation, with plenty of shading, a stony substrate and a variety of habitat types. It also had the highest MCI score of all sites at 127 (Figure 11).

2.3.1 NOF results 2012 to 2014

NOF grades from 2012 to 2014 at the two long term monitoring sites Mangere at Pukenui Forest and Mangere at Knight Road are presented in table 4. The Waitangi at Pukenui site, draining native forest, has consistently scored A grades for this period. The Knight Road site has consistently scored an A grade for nitrate toxicity but has dropped down a grade for both ammoniacal nitrogen and *E. coli*.

Table 5: NOF grades from 2012 to 2014 at the RWQMN sites in the Mangere catchment.

Value	Ecosystem health								Human health	
Indicator (unit)	Ammoniacal nitrogen toxicity (mg/L)				Nitrate nitrogen toxicity (mg/L)				Periphyton (Chla mg/m^2)		*E. coli* (*E. coli* /100 mL)	
Site name	1 year median		1 year max		1 year median		1 year 95%ile		3 year max		1 year median (secondary contact)	
2012												
Mangere at Knight Road	0.028	A	0.120	B	0.495	A	0.786	A	ND	ND	447	B
Mangere at Pukenui Forest	ND		ND		ND		ND		ND	ND		
2013												
Mangere at Knight Road	0.035	B	0.058	B	0.365	A	0.937	A	ND	ND	611	C
Mangere at Pukenui Forest	0.005	A	0.011	A	0.093	A	0.108	A	ND	ND	203	A
2014												
Mangere at Knight Road	0.039	B	0.48	C	0.550	A	0.964	A	ND	ND	692.5	C
Mangere at Pukenui Forest	0.005	A	0.024	A	0.120	A	0.160	A	3.05	A	110.0	A

ND: no data

3 Water quality summary

Table 6: Water quality summary (July 2014 to June 2015) for sites in the Mangere catchment using NOF attributes and other guideline/trigger values.

Water quality monitoring site	National Objective Framework (NOF) attributes			ANZECC guideline value		RMA 1991	Ecological indicators	
	Nitrate nitrogen toxicity (mg/L)	Ammoniacal nitrogen toxicity (mg/L)	Escherichia coli (*E. coli*/100mL)	Dissolved reactive phosphorus (mg/L)	Turbidity (NTU)	Dissolved oxygen (% saturation)	Macroinvertebrates	Stream habitat
	95th percentile A ≤1.5 B >1.5 ≤3.5 C >3.5≤9.8 D >9.8	Annual maximum A ≤0.05 B>.05≤0.4 C >0.4≤2.2 D >2.2	Annual median A ≤260 B >260≤540 C >540≤1000 D >1000	Annual median <0.01	Annual median <5.6	Annual median ≥80	MCI score (Table 4)	% rating compared with reference site
Mangere at Pukenui Forest	A	A	A	Above	Below	Above	127	100%
Mangere at Wood Road	A	B	C	Above	Below	Below	114	50%
Mangere at Kara Road	A	A	B	Above	Below	Above	122	81%
Mangere at Kokopu Road	A	B	B	Above	Above	Above	97	34%
Mangapiu at Kokopu Road	A	C	C	Above	Above	Below	64	30%
Mangere at Knight Road	A	B	C	Above	Above	Below	101	53%

Values in Table 6 are not directly comparable; some refer to national standards while others provide conservative numbers for physical and chemical measures in rivers above or below to indicate which aquatic ecosystems may be exposed to stress.

The NOF is still under development with a number of additional attributes currently being evaluated. In its current form the NOF does not address all the water quality issues of concern in Northland. For this reason a number of other guidelines, trigger values and ecological indicators have been included to provide a more holistic overview of water quality in the catchment.

Based on very limited data, results indicate that water quality deteriorates at sites further down the catchment. The lower Mangere is degraded with many water quality variables grading poorly under the NOF or failing trigger values for other national guidelines such as the ANZECC.

The Mangere at Pukenui serves as a reference site draining almost entirely native forest against which to compare results. This site fails the ANZECC trigger value for dissolved reactive phosphorous indicating naturally elevated background levels.

All sites graded NOF A for nitrate nitrogen toxicity. However, *E. coli,* dissolved reactive phosphorous, turbidity, dissolved oxygen, MCI and habitat health were commonly poor within the catchment particularly at the three sites located in the lower catchment. The worst water quality was recorded at the Mangapiu at Kokopu Road.

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5 Abbreviations

- ANZECC: Australian and New Zealand Environment and Conservation Council
- Chl a: chlorophyll a
- D/S: downstream
- DO: Dissolved Oxygen
- DRP: Dissolved Reactive Phosphorus
- *E. coli*: Escherichia coli
- IQR: interquartile range
- LAWA: Land Air Water Aotearoa
- MCI: Macroinvertebrate Community Index
- MfE: Ministry for the Environment
- NIWA: National Institute of Water and Atmospheric research
- NOF: National Objective Framework
- NPS-FM: National Policy Statement for Freshwater Management
- NTU: Nephelometric Turbidity Units
- NZFFD: New Zealand Freshwater Fish Database
- RMA 1991: Resource Management Act 1991
- RWQMN: River Water Quality Monitoring Network
- SH: State Highway
- SPI: Submerged Plant Indicator
- TLI: Trophic Level Index
- TN: Total Nitrogen
- TP: Total Phosphorus
- TURB: Turbidity
- WNW: Waiora Northland Water

6 Appendix

Photos of montioring sites in the Mangere catchment in upstream to downstream order.

Figure 13: Mangere at Pukenui

Figure 14: Mangere at Wood Road

Figure 15: Mangere at Kara Road

Figure 16: Mangere at Kokopu Road

Figure 17: Mangapiu at Kokopu Road

Figure 18: Mangere at Knight Road