Lower Kaituna Catchment and Water Quality

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E mahi ngatahi e pai ake ai te taiao

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Cover Photo: Ohineangaanga Stream (Te Puke State Highway 2) during moderate rainfall event 30 June 2007.

Executive Summary

This report reviews water quality related information available for the lower Kaituna River catchment, the Kaituna River and Maketu Estuary. There has been long-term deterioration in the quality of the water in the upper catchment and lakes. Extensive research has become available as part of the outcomes from the Rotorua/Rotoiti Actions Plan. This adds to Environment Bay of Plenty's long term monitoring and provides excellent coverage of the state and predicted changes in lake quality and the effects on the Kaituna River. However in the lower catchment and Kaituna River itself there are also increasing pressures from land use change, discharges and even proposed hydroelectric schemes which need to be addressed.

Reports detailing water quality data for the Kaituna River show marked increases in nutrient concentrations in the lower reaches. Oxidised nitrogen shows the greatest degree of increase (an order of magnitude) but the increase in total nitrogen, which roughly doubles, is not so marked. Much of the phosphorus inputs are from natural sources while nitrogen inputs are predominantly from land use.

Comparison to historic data from 1975 (White et al. 1978) shows that over time nitrogen concentrations in the Kaituna River have increased between 50-100%. A number of water quality reports produced by Environment Bay of Plenty also show the same trend for nitrogen. Phosphorus concentrations do not show any change since 1975.

An assessment of land cover/use is made for the Lower Kaituna catchment and used to estimate nutrient inputs. These nutrient input estimates closely match those calculated for mass load in the Kaituna River and hence give a picture of the relative contributions from different land use and the point at which they will impact the river system. Generally the catchments around Te Puke have a high percentage of horticultural use while the plains of the lower catchments are highly developed with grasslands being dominant.

Reviewing the data and other information available has highlighted the need to update and acquire a more accurate assessment of land cover/use. There is also a need to obtain better water quality data coverage, particularly for the Mangorewa River and sampling of all streams for storm events. This would significantly help in developing an integrated catchment model which could be used to predict changes to water quality related parameters. This in turn could be used to assess changes in 'suitability for use' of the lower Kaituna River.

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Chapter 1: Introduction

1.1 Scope

This report looks at water quality related data for the catchment of the Kaituna River below the Okere outlet from Lake Rotoiti. It reviews and presents information which is available along with land use and land cover data. The aim of the report is to present an up to date picture of water quality parameters in this catchment which can serve as a basis for future work and to identify whether there are further data needs to enable proper evaluation.

1.2 Background

1.2.1 General

The Kaituna River is situated in the central Bay of Plenty. It flows from the Okere arm of Lake Rotoiti to the sea at Te Tumu and partially to Maketu Estuary. Historically the river flowed through Maketu Estuary but was diverted directly to the sea in 1958 by engineering works. Following the granting of consent to the Minister of Conservation in 1994, re-diversion of restricted flows back to the estuary then occurred in 1996.

Lakes Rotorua and Rotoiti form the upper catchment of the Kaituna River and have experienced long term deterioration in quality. To address this issue a number of projects are being researched to improve lake quality and these provide excellent background information for assessing the quality of the Kaituna River itself. The project now underway to divert water from Ohau Channel directly into the top of the Kaituna River has a water quality assessment that is particularly relevant (McIntosh 2005).

Within the lower catchment of the Kaituna River there are changes in land management and other pressures which have the potential to affect water quality, including proposed hydro electric schemes. The upper portions of the lower catchment are dominated by pastoral and exotic forestry land use with some sub-catchments retaining extensive native forest cover. In recent years there has been some conversion of exotic forestry to dairy farms. Much of the mid section of this catchment has had suitable land converted to horticulture with kiwifruit being very dominant. The lower regions of the catchment are predominantly productive river flat plains with extensive drainage schemes. The dominant land use being dairy farming.

1.2.2 Catchments

The total Kaituna River catchment area including the lakes is around 1,218 km^2. The catchment feeding directly into the Kaituna River or the lower Kaituna catchment is around 580 km^2 or 47.6% of the total. The sub-catchments in the lower Kaituna are shown in Figure 1 below and the area of each is provided in Table 2.

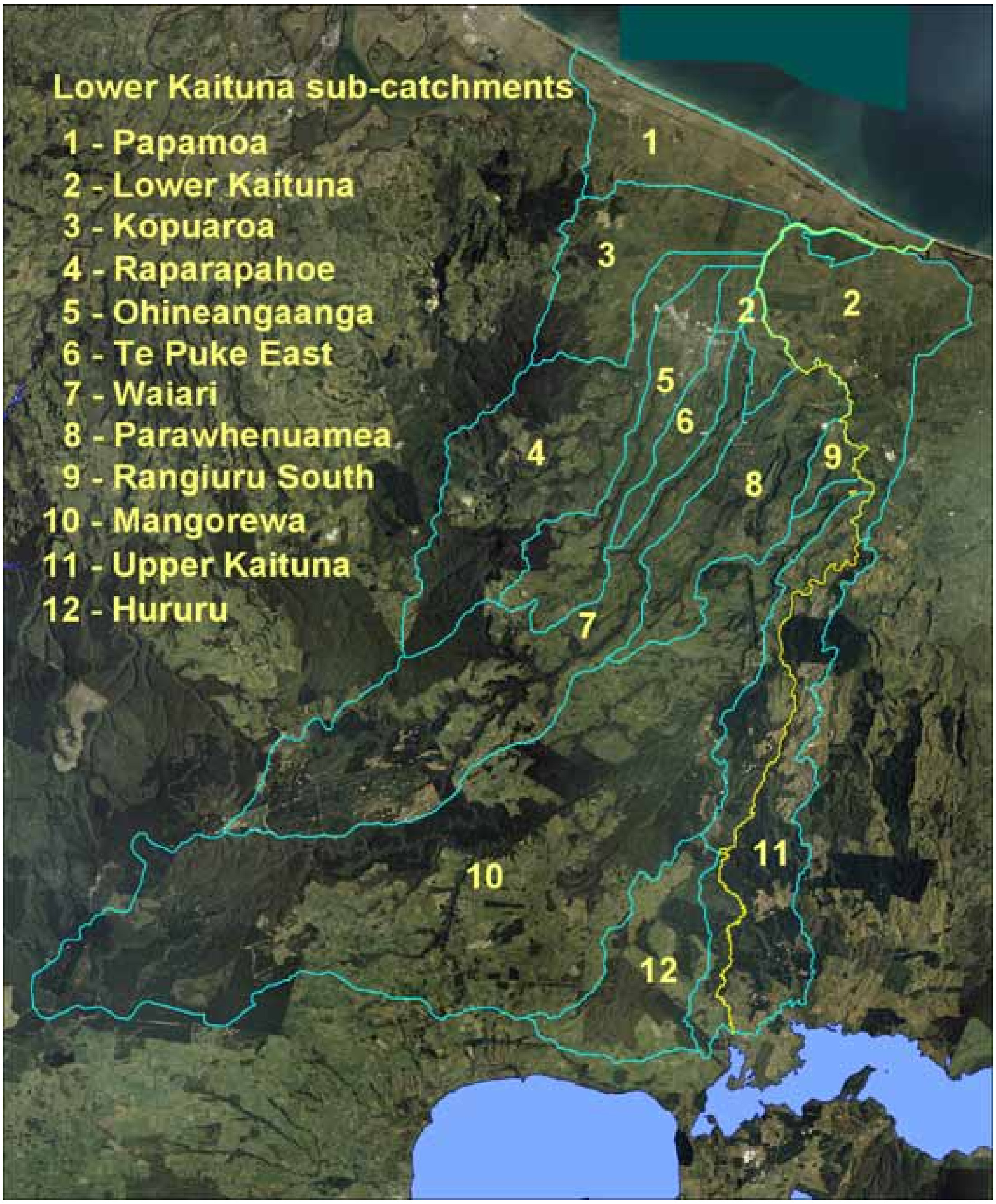


Figure 1 Sub-catchments of the lower Kaituna Catchment.

The bulk of the Papamoa sub-catchment ("1" in Figure 1) drains into the Wairakei Stream. This wetland/drainage system flows towards the Kaituna River but then reaches an area where the water soaks away into the ground. A small part of the catchment in the vicinity of Bell Road and the Kopuaroa canal does drain as surface water to the Kaituna River.

The lower Kaituna sub-catchment ("2" in Figure 1) is flat low lying land which drains to the Kaituna River via a number of small drains and much of the water is pumped out of the drains in the area near the river mouth.

The upper Kaituna sub-catchment ("11" in Figure 1) is a large number of very small rolling to steep catchments which all flow directly into the Kaituna River. Because of their small size, number and similarity they have been grouped together.

The Parawhenuamea Stream which drains this sub-catchment (8) has been diverted and now flows into the Kaituna River just above the State Highway 2 bridge at Waitangi (Te Matai).

1.2.3 River and stream flows

Flows for the Kaituna River and other streams or rivers in the catchment which have been recorded are provided in Table 1 below. The Okere outlet site (top of Kaituna River) was shifted slightly down river to the Trout Pools at Taaheke when the control structure was built, but the whole data record has been used to derive flow summaries.

Table 1 Flow statistics for rivers and streams in the lower Kaituna catchment.

Site	Mean flow – litres/second	Low flow - mean annual	Maximum - mean annual	% of flow at Te Matai
Taaheke (Okere)	20,687	13,008	31,377	52.3
Mangorewa	6124	4,557	162,794	15.5
Waiari*	4,039	3,406	34,804	-
Ohineangaanga*	350	-	-	-
Raparapahoe*	1,852	494	39,875	-
Kopuaroa*	88	-	-	-
Other streams and springs	6,379	-	-	32.2
Te Matai	39,519	29,072	133,311	-

*confluence is below Te Matai

The Kaituna River is around 53 kilometres (km) in length from Lake Rotoiti to the mouth. The first 25 km is fast flowing and drops 260 metres (m) and includes a number of water falls and an incised gorge. The remaining 28 km is slower dropping another 20 m to the sea. The residence time over the whole river from lake to sea is relatively short not taking much longer than a day.

There are only a few small surface inputs in the lower section of the Kaituna River for which there are not any flow gauging records. In Table 1 above, a considerable part of the total river flow at Te Matai is attributed to sizable cold water springs between Okere and Te Matai (Freestone 1975 – cited in White et. al 1978). Many of the more sizable stream inputs such as the Waiari and Raparapahoe join the Kaituna River well down towards the sea.

Chapter 2: Land Cover

2.1 Land cover

Land cover for the lower Kaituna River catchment is based on the 1995 SPOT satellite remote sensing maps held by Environment Bay of Plenty. The land cover categories have been summarised into generic base groupings as presented below in Tables 2 and 3. The horticultural category was updated to 2003 but all other groups remain based on 1995 data other than being adjusted for horticultural changes.

The 1995 SPOT remote sensing data contains some classification errors in the land cover ascribed despite ground checking of numerous sites. Given these errors and changes that have taken place since 1995 the data should be used as estimates. Grass based agricultural land use in the 1995 data is grouped into either high or low producing grasslands. As the bulk of the grasslands are classified as high producing without distinction between dairy and beef/sheep based farms, this study has simplified it down to just grasslands.

Table 2 Land cover (km^2) in each of the Lower Kaituna River sub-catchments.

	Catchment Area (km^2)	Grass	Horti-culture	Exotic Forest	Native Forest	Scrub	Urban	Bare
Lower Kaituna	45.8	28.5	15.5	0.6	0.1	0.1	0.6	0.1
Papamoa	31.8	23.8	0.9	0.9	0.1	0.1	5.5	0.1
Kopuaroa	30.3	20.8	1.8	1.9	5.1	0.3	0.1	0.4
Raparapahoe	53.6	14.0	9.4	1.6	27.8	0.7	0.1	0.0
Ohineangaanga	24.8	11.5	6.0	0.5	3.5	0.0	3.4	0.0
Te Puke East	9.1	1.1	6.0	0.3	0.7	0.0	1.2	0.0
Waiari	72.0	21.1	4.6	19.1	26.4	0.1	0.1	0.0
Parawhenuamea	31.4	10.7	14.0	2.2	1.3	3.0	0.1	0.0
Rangiuru South	3.9	1.6	1.9	0.1	0.2	0.0	0.0	0.0
Mangorewa	189.0	72.9	2.3	46.6	64.8	1.6	0.0	0.0
Upper Kaituna	58.5	10.6	0.8	30.5	16.4	0.2	0.0	0.0
Hururu	27.5	14.1	0.0	9.5	4.0	0.0	0.0	0.0
Total Area (km^2)	577.7	230.7	63.1	114.5	150.4	6.0	11.3	0.6

* Note $1km^2$ = 100 hectares

The largest sub catchment of the Kaituna River is the Mangorewa River with 189 km^2 or 32.7% of the total lower Kaituna catchment while the Waiari at 72 km^2 is the next largest.

Table 3 provides the percentage of each land cover category in the sub catchments as a percentage of the total. This shows which land cover types are dominant in each catchment. In the bottom line of Table 3 the percentage of each land cover type for the whole of the Lower Kaituna catchment is shown. Grass cover comprises around 40% of the whole area while native forest covers 26% and exotic forest 19.8. Horticulture comprises 10.9% of the total land area while scrub, urban and bare areas are relatively low.

Catchments lower down the Kaituna River generally have the highest covers of grass with the Papamoa catchment having nearly 75%. Areas around Te Puke have high levels of horticultural use with Te Puke East (66%), Rangiuru South (49%) and Parawhenuamea (45%) being the main catchments.

Table 3 Land cover of the lower Kaituna River catchment as a percentage of each sub-catchment.

Catchment	Grass %	Horti-culture	Forest %		Scrub %	Urban %	Bare %
			Exotic	Native			
Lower Kaituna	62.3	33.8	1.3	0.2	0.1	1.4	0.1
Papamoa	74.7	2.9	2.8	0.3	0.2	17.1	0.3
Kopuaroa	68.6	6.0	6.3	16.8	0.9	0.5	1.3
Raparapahoe	26.1	17.5	3.0	51.8	1.4	0.2	0.0
Ohineangaanga	46.4	24.0	2.0	14.1	0.0	13.6	0.0
Te Puke East	12.2	66.0	3.3	7.7	0.0	13.6	0.0
Waiari	29.3	6.4	26.5	36.7	0.1	0.1	0.0
Parawhenuamea	34.1	44.7	7.0	4.1	9.5	0.4	0.0
Rangiuru South	40.9	49.2	3.3	5.3	0.0	0.5	0.3
Mangorewa	38.6	1.2	24.6	34.3	0.8	0.0	0.0
Upper Kaituna	18.1	1.3	52.1	28.0	0.3	0.0	0.0
Hururu	51.1	0.0	34.4	14.6	0.1	0.0	0.0
% of total	**39.9**	**10.9**	**19.8**	**26**	**1**	**2**	**0.1**

The numerous small catchments along the upper Kaituna River collectively have 52% cover of exotic forest. The Raparapahoe has the highest percentage of native forest cover (52%) for any of the catchments. Scrub cover in the Parawhenuamea catchment is proportionately high compared to the other catchments. This catchment has incised stream beds and the numerous steep gulleys host the bulk of the scrub cover.

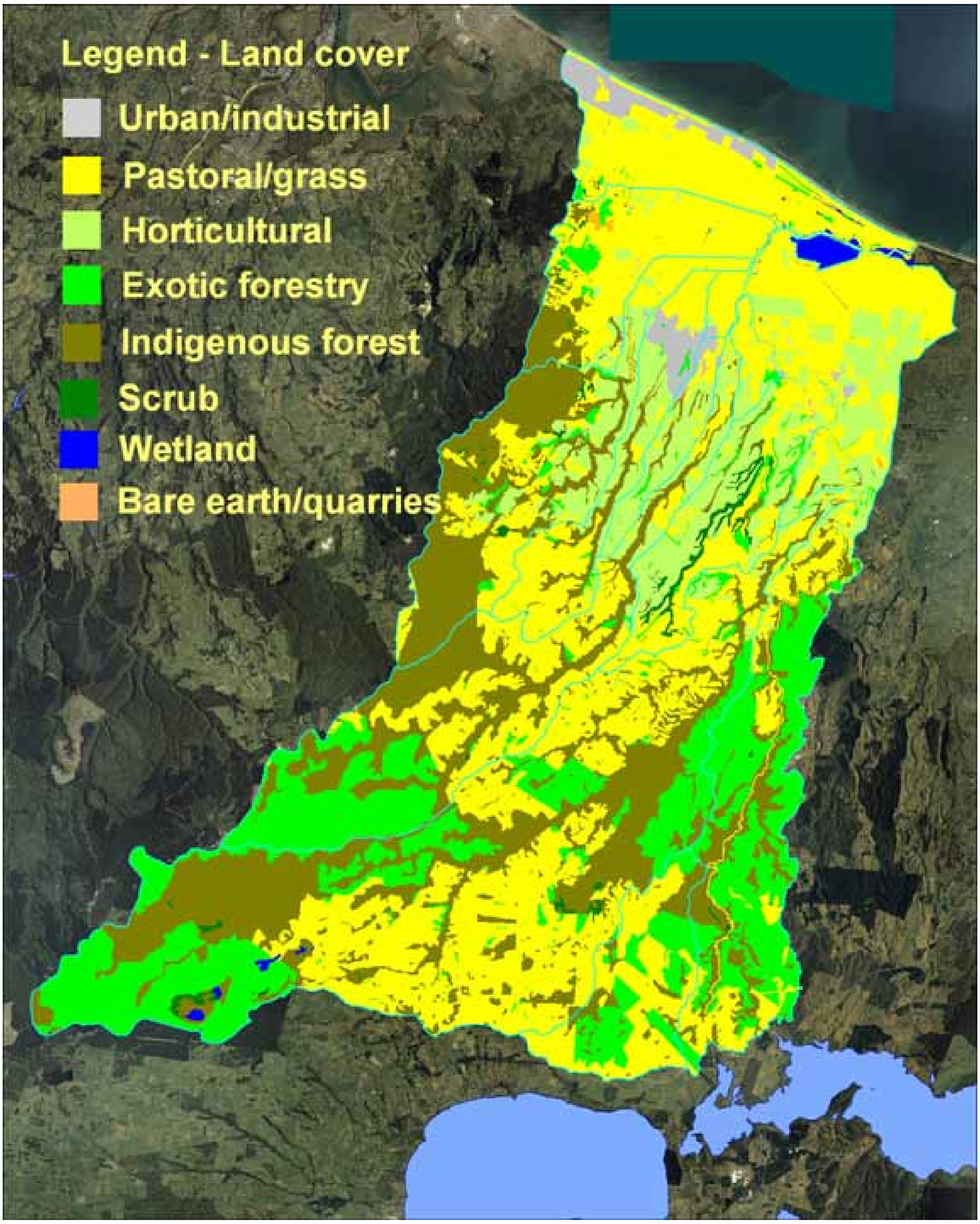


Figure 2 Land cover in the lower Kaituna Catchment based on 1995 SPOT satellite imagery with horticulture updated to 2003.

Chapter 3: Water Quality

3.1 Nutrients

3.1.1 Background

Environment Bay of Plenty monitors water quality parameters at a number of sites on the Kaituna River. Data collected up until 2000 has been analysed for changes over time and presented in a report by Taylor and Park (2001). A more recent report by McIntosh (2005) provides a detailed assessment of water quality changes up until 2004 and those expected when the Ohau Channel diversion to Okere takes place. A brief summary of that assessment is given in this report but the original should be viewed. In this report water quality has been reassessed using whatever data was available up until the end of 2006. One reason for doing this was to check for trends over time which becomes more apparent as the data period increases.

The location of Environment Bay of Plenty sampling sites are shown in Figure 3. The Okere site is where the Kaituna River starts at Lake Rotoiti. The Paengaroa site is at the Maungarangi Road Bridge just up river from the Mangorewa River confluence. Above AFFCO is just up river of the Rangiuru Freezing works discharge to the river while the Te Matai site just down from State Highway 2, below this discharge. The Te Puke sewage treatment plant discharges to the Waiari Stream which then joins the Kaituna River several kilometres down from the Te Matai site. Data is available upstream and down stream of the Waiari confluence but the number of samples is low and may not be representative of the annual average.

3.1.2 Changes over time

Starting at the top of the Kaituna River the Okere monitoring site reflects the state of the water in the upper lakes catchment. The data set for this site spans the period 1985 up to 2006. The main changes over time are well documented in the lakes reports (Scholes & Bloxham 2005). Turbidity, suspended solids and bacterial levels have increased but are still at a very low threshold. The most significant change has been an increase in total nitrogen (most in organic form).

Data from Paengaroa shows a similar increase in total nitrogen and suspended solids over time. However, there is no statistically significant increase in numbers of bacteria.

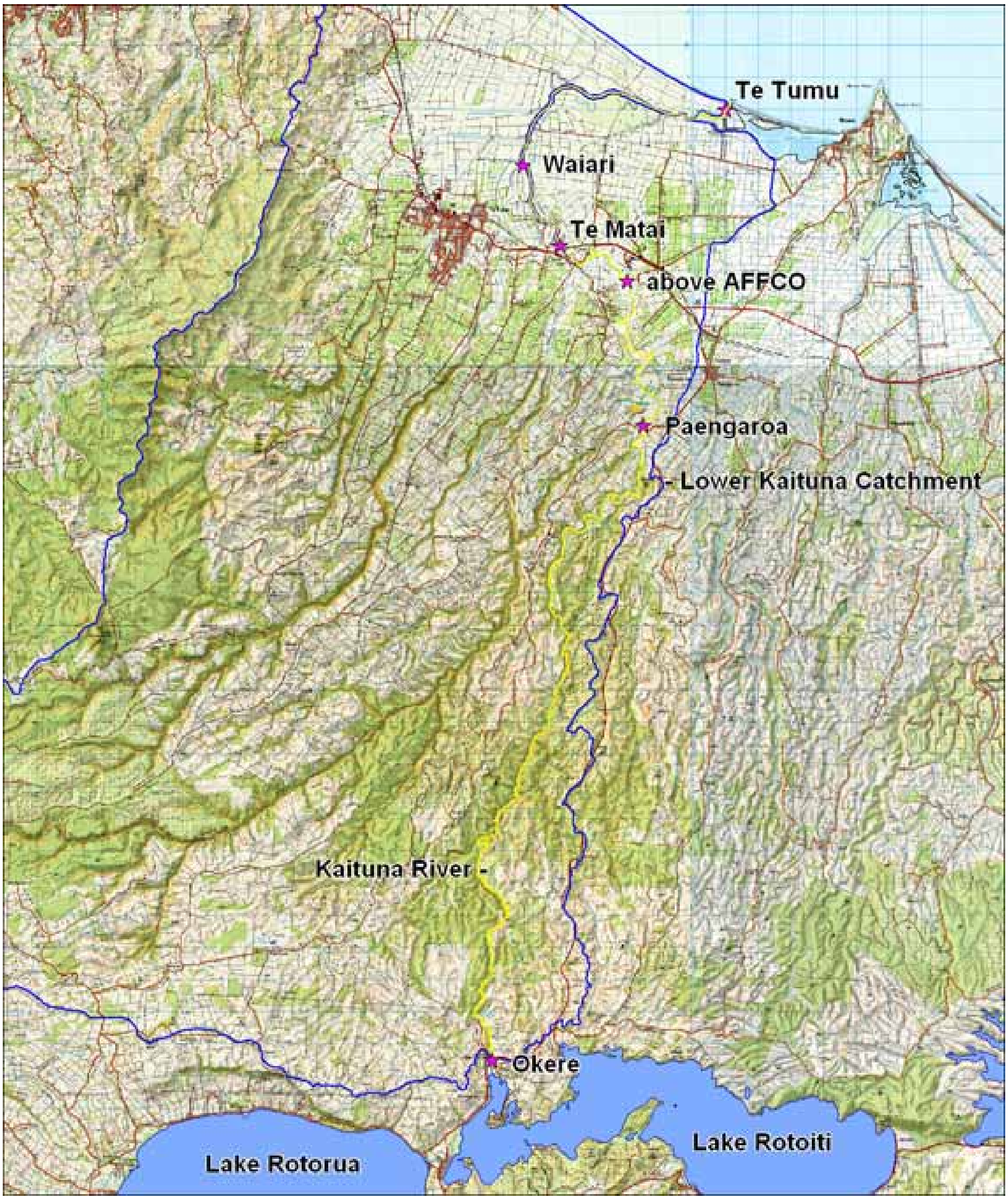


Figure 3 Water quality sampling sites on the Kaituna River.

Both the site above AFFCO and the Te Matai water quality data reflect the trend of increasing total nitrogen levels over time shown in the upper catchment. In addition, these two sites also show a significant trend with an increase in dissolved nitrogen (NOx) concentration over time and the AFFCO site shows a small but significant increase of total phosphorus over time. Down stream from the AFFCO discharge the Te Matai site has recorded a decrease in the number of Enterococci bacteria. This is the result of improvements in treatment of the AFFCO meat works effluent before being discharged to the river.

The Te Tumu site, with a much shorter record of water quality data displays similar trends to all the other sites, but the statistical significance is marginal.

3.1.3 Down river changes

Sites with sufficient numbers of samples to provide reliable mean values have been included in Table 4 below. The means use the same length of data record as stated above. An asterix displays which parameters show statistically significant change over time.

Table 4 Mean values of water quality parameters at sites down the Kaituna River.

	Okere	Paengaroa	Above AFFCO	Te Matai	Te Tumu
Km from lake	**0**	**32**	**39**	**41**	**53**
SS (g/m^3)	3.3*	10.5*	9.9	9.7	11.2
Turb (NTU)	1.8*	3.0*	2.9*	3.0	4.5
DRP (g/m^3)	0.007	0.019	0.025	0.035	0.027
TP (g/m^3)	0.028	0.037	0.042*	0.055	0.053
NH4 (g/m^3)	0.015	0.011	0.015	0.080	0.088
NOx (g/m^3)	0.041	0.191	0.367*	0.389*	0.419
TKN (g/m^3)	0.304*	0.270	0.250	0.329	0.293
TN (g/m^3)	0.345*	0.460*	0.604*	0.709*	0.724
E. coli (n/100ml)	5*	35	64	163*	104
Enterococci	4*	11	20	49	48

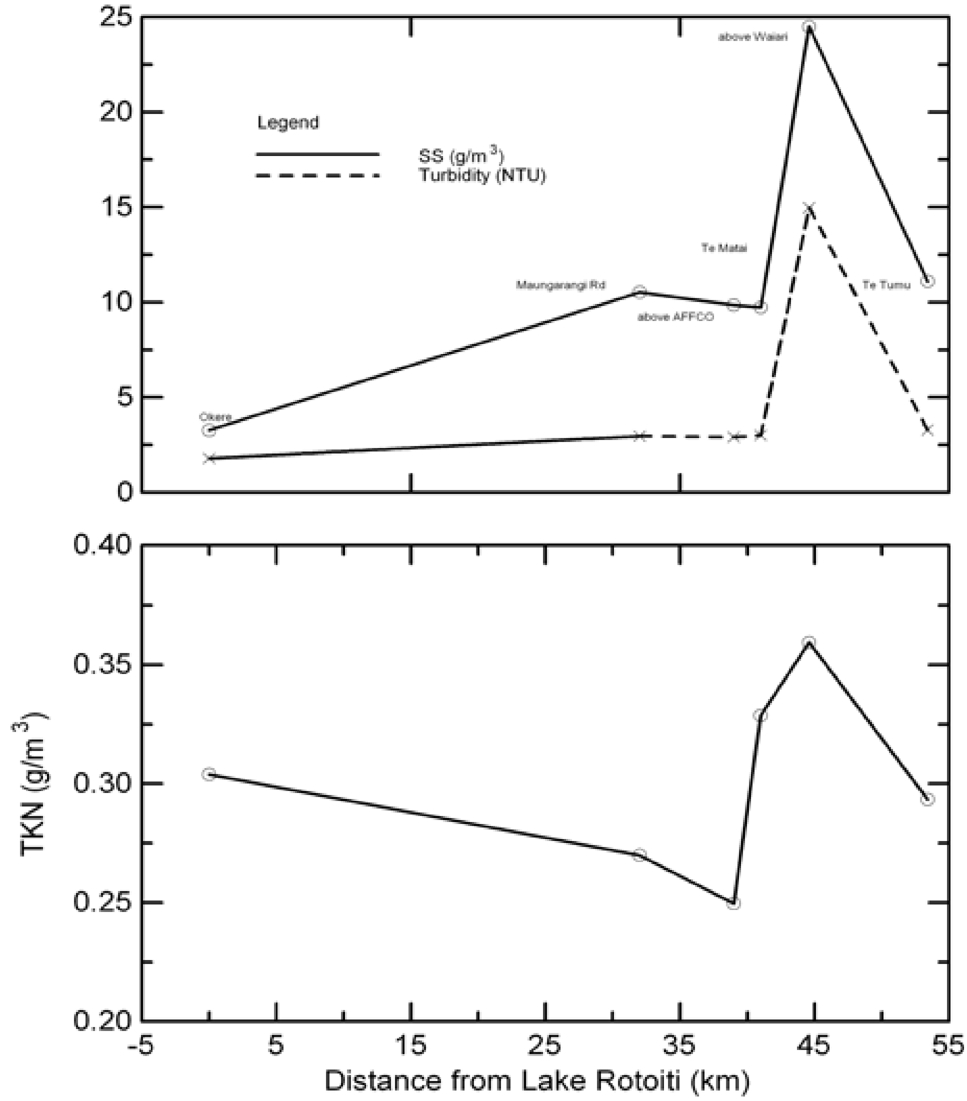
* data show significant change over time. Note bacterial means (Ecoli, Enterococci) are geometric (mean of logarithm).

The mean values presented in Table 4 above are very similar to those presented graphically in McIntosh (2005). The changes in suspended solids (SS) and turbidity (Turb) from the Okere site relate in part to the difference in the physical nature of the lake and river.

The major plant nutrients (phosphorus and nitrogen) both increase with distance down the river. In Lake Rotoiti there is proportionately far less unused (dissolved – NOx and DRP) nutrient compared to the river system. It is also in the lower reaches of the river where more of the catchment and discharge inputs occur that nutrient levels increase. Both total phosphorus and nitrogen concentrations roughly double from the lake to the river mouth. The Te Tumu site displays lower mean concentrations of most nutrients compared to just upstream, but this is due in part to dilution with sea water.

In Figure 4 below SS, Turb and total Kjeldahl nitrogen (TKN) results from Environment Bay of Plenty's data sets are shown as mean values (same as Table 4 above). The graphs include data from a site above the Waiari Stream confluence with the Kaituna River and this appears to be unusual in that it has higher readings than sites up stream and down stream. All other sites show the river has consistently higher SS and Turb than the lake input at Okere, but with little increase down river.

TKN (when NH4 is subtracted) includes nitrogen present in organic material such as plants or animals. TKN shows a decrease in concentration from the lake followed by a marked increase occurring down stream of the AFFCO discharge as a result of the organic loading in that effluent. Although the concentration decreases from the lake the actual mass may increase because the total amount of water increases.



igure 4 Mean SS, Turb and TKN values recorded by Environment Bay of Plenty at sites on the Kaituna River up to 2006.

Down river trends in dissolved nitrogen (NOx, NH4) and dissolved phosphorus concentrations (DRP) are shown in Figure 5. Oxidised nitrogen (NOx) is the main dissolved form to show a strong increase down river, particularly in the lower reaches. Ammonium nitrogen (NH4) shows an increase as a result of the AFFCO effluent discharge. Phosphorus (both TP and DRP) also shows an increase down river with a marked increase down stream of the AFFCO discharge. Most of the change in total phosphorus down the river is due to the increase in the amount of dissolved phosphorus (DRP). This indicates that overall, only a small portion of the dissolved phosphorus is taken up by phytoplankton and aquatic plants.

3.1.4 Comparison with historic data

A detailed study of the Kaituna River nutrient levels was done in 1975 by White *et al*. This provides a number of sites which are compared to Environment Bay of Plenty's data (means) in Figure 5 to give an indication of the extent of change over time.

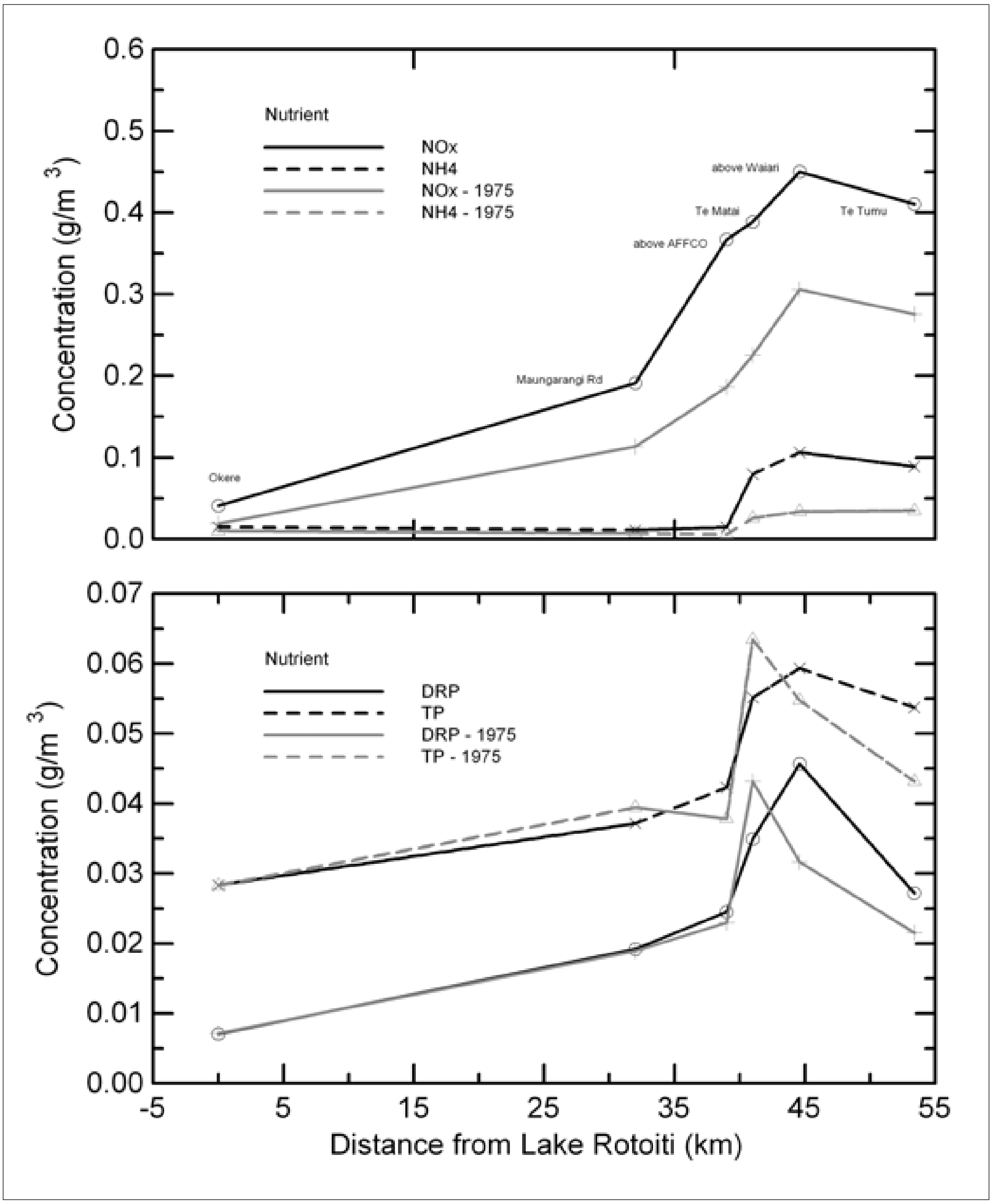


Figure 5 Nitrogen and phosphorus concentrations down the Kaituna River with comparison to historic data of White et al.

Both oxidised nitrogen and Ammonium nitrogen concentrations in the Kaituna River show increases from the 1975 levels surveyed by White *et al*. (1978) including the lake source. There were increases of around 50-100% for oxidised nitrogen and 50-200% for ammonium nitrogen. Over the same time period phosphorus has shown very little change with both data sets matching quite well. This clearly shows that nitrogen inputs from the catchment are increasing while phosphorus inputs have remained relatively constant.

3.1.5 Catchment nutrient budget

Using the mean annual flow from the Okere and Te Matai sites along with mean nutrient concentrations it is possible to estimate the mean annual mass nutrient loads of the Kaituna River. These estimates are provided in Table 5 below. Because of the steady and less variable nature of nutrient levels in the lakes, the Okere data could provide a good estimate of the annual load. However, the nutrient runoff in terms of load from the lower Kaituna River catchment will be much more variable with significant portions of the annual total being conveyed during flood events. Without sampling data of flood events being included, the annual estimate should be considered to be conservative.

Table 5 Mean annual mass load of total nitrogen and phosphorus in the Kaituna River at the Okere and downstream Te Matai site.

	Okere	Te Matai	Increase
TP (tonnes)	18.3	65.5	47.2
TN (tonnes)	225.1	883.6	658.5

In Table 5 the column titled ‘Increase’ provides an estimate of the nutrient being added to the river from the catchment below Okere outlet down to Te Matai site. At the Te Matai site total phosphorus load has increased by around 160% and total nitrogen by 190%.

Using the land cover estimates from Table 2 and co-efficients of nutrient loss from each of these classes a nutrient budget can be derived to estimate the expected contribution of nitrogen and phosphorus to the water ways. The co-efficients are those used for the upper lakes catchment of the Kaituna River and are shown in Table 6 below.

Table 6 Annual nutrient co-efficients (tonnes/km^2) used for the land cover classifications in the lower Kaituna River catchment.

Land cover	Nitrogen	Phosphorus
Native forest	0.4	0.012
Scrub - mixed	0.4	0.012
Exotic forest	0.3	0.010
Horticulture/cropping	6.0	0.200
Dairy	5.0	0.070
Beef/sheep	1.8	0.090
Urban	0.31	0.070
Wetland	0.2	0.004
Bare earth	0.5	0.050

As mentioned in the land cover section there is no separation of dairy farming from beef in the classification of grasslands in the land cover information. To account for this the lower Kaituna and Papamoa sub-catchments where calculated on the assumption that 90% of the grassland is Dairy with the balance beef/sheep while all the rest were calculated at 75% dairy and 25% beef/sheep. Nitrogen co-efficients of 4.68 and 4.2 and phosphorus co-efficients of 0.072 and 0.075 respectively are used below.

In Table 7 the estimated annual nitrogen and phosphorus contribution in tonnes from each sub-catchment is shown. Also provided is the percentage that each comprises of the whole catchment below Lake Rotoiti and the percentage of total nitrogen or phosphorus that it's nutrient contribution makes to the Kaituna River. As mentioned in the catchments section, much of the Papamoa catchment goes to ground soakage and nutrient impacts will be mainly on ground water, not streams and the Kaituna River.

Table 7 Catchment nutrient budget for the lower Kaituna Catchment.

Catchment	Area (km^2)	% of total catchment	Total N-t/yr	%total N	Total P-t/yr	%total P
Lower Kaituna	45.8	7.9	227.0	15.7	5.2	15.4
Papamoa	31.8	5.5	118.9	8.2	2.3	6.8
Kopuaroa	30.3	5.2	101.2	7.0	2.0	5.9
Raparapahoe	53.6	9.3	126.9	8.8	3.3	9.8
Ohineangaanga	24.8	4.3	86.6	6.0	2.3	6.8
Te Puke East	9.1	1.6	41.2	2.8	1.4	4.1
Waiari	72.0	12.4	132.5	9.1	3.0	8.9
Parawhenuamea	31.4	5.4	131.5	9.1	3.7	10.9
Rangiuru South	3.9	0.7	18.5	1.3	0.5	1.5
Mangorewa	189.0	32.7	360.5	24.9	7.2	21.3
Upper Kaituna	58.5	10.1	64.8	4.5	1.4	4.1
Hururu	27.5	4.8	63.5	4.4	1.2	3.6
Totals	**577.7**		**1,448.5**		**33.8**	

In terms of the percentage area of total catchment and estimated nutrient contribution, the Mangorewa, Upper Kaituna and Hururu sub-catchments have lower relative nitrogen and phosphorus inputs than the sub-catchments lower down the Kaituna River. The Rangiuru south, Te Puke east, Parawhenuamea and Lower Kaituna sub-catchments all have relatively high estimated nutrient inputs corresponding to the agricultural and horticultural use of the areas.

Adding up the estimated nutrient input of catchments above the Te Matai recording site gives a total of 639 t/yr nitrogen and 41.4 t/yr phosphorus. This is reasonably close to the recorded increases of 659 and 47.2 for nitrogen and phosphorus which are shown in Table 5. If the trends of increasing nitrogen and phosphorus levels noted for the data set are taken into account then current mean annual loads would be slightly higher again.

3.2 Review of water quality reports

This section covers and reviews some of the more recent water quality reports relating to the Kaituna River and Maketu Estuary which have been linked since the partial re-diversion of Kaituna River in 1996. Detailed earlier reviews of the estuary and river have been reported in White *et al*. (1978), Rutherford *et al*. (1989) and McIntosh and Park (1991, 1995, 1996 and 1997). These reports provide a good overview of the historic background relating to water quality in the lower Kaituna River and Maketu Estuary.

For a general historic description of Maketu Estuary refer to the report assessing the Minister of Conservation's consent application for re-diversion (McIntosh & Park 1991). A later study of Maketu Estuary by Domijan (2000) provides climate and hydrological data and more recently extensive modelling of water quality was undertaken by Goodhue (2007).

The Bay of Plenty Regional Coastal Environment Plan sets out the relevant standards for water quality in Maketu Estuary while the Regional Water and Land Plan does the same for the Kaituna River and tributaries. Most standards are based on Resource Management Act, Department of Health, Fisheries and other environmental guidelines. These cover aspects such as guidelines for protection of aquatic ecosystems, bathing, shellfish quality and general water quality.

3.2.1 Maketu Estuary

Water quality monitoring of Maketu Estuary is undertaken for the purposes of consent monitoring for the partial re-diversion of the Kaituna River and as part of Environment Bay of Plenty's regional monitoring programme. Consent monitoring looks at water quality at three sites in the estuary over a whole tidal cycle once each year. In addition shellfish are also assessed for compliance with health department guidelines for bacterial numbers and every third year surveys of shellfish density are undertaken at a number of sites. The last published report providing an assessment is Park (2003).

Regional monitoring data provides assessment of shellfish in terms of bacterial numbers (McIntosh, 1999). An earlier survey also looked at metals and pesticides in addition to a range of bacteria (Park 1992). Bathing suitability is also assessed under Health Department guidelines using bacterial standards for water. Results of this survey based on a site at the estuary entrance are provided in Scholes (2006). General water quality parameters measured every two months at the boat ramp are assessed and presented in Scholes (2005).

Generally water quality in Maketu Estuary meets most environmental guidelines. In terms of bathing the estuary is acceptable but influenced by septic tank seepage from Maketu Township. Shellfish also comply with Health department standards for median values but in recent years the single sample criteria had been exceeded for a cockle sample in 2001 and 2002. Water quality parameters meet guidelines for the protection of aquatic ecosystems but have not been as good as other Bay of Plenty estuaries.

3.2.2 Kaituna River

Water quality at the head of the Kaituna River (Okere outlet) is covered by and reported under Environment Bay of Plenty's Lake monitoring programme (Scholes & Bloxham 2005). Metals in the Kaituna River have been reported by Deely (1995) and arsenic is relatively high due to geothermal sources in the upper catchment. An assessment of general water quality trends can be found in Taylor and Park (2001) and McIntosh (2005) and this report. Scholes (2005) covers the estuarine site at Te Tumu and the impact from the AFFCO discharge is provided in McIntosh (2000). As previously mentioned, McIntosh (2005) also provides an assessment of the future diversion of the Ohau Channel into the Okere Arm of Lake Rotoiti.

In general water quality in the Kaituna River is good in the upper sections of the river but declines in the lower reaches. The report by Taylor and Park (2001) provides water quality scores for each site and Te Tumu was amongst the lowest in the region and deemed in need of action to assess potential water quality issues. The issues would be any effects on river or estuarine use related to excess bacterial or nutrient levels. The Kaituna River also displays an increasing trend in terms of nutrients (nitrogen concentrations) as shown in section 3.1.4 of this report.

The future Ohau Channel diversion wall will increase nutrient levels but not to a level expected to result in any problems in the lower areas of the river or estuary, mainly due to the short residence time. The primary issue with the lakes discharge has been potentially toxic blue-green algae flowing into the river system. Lake remediation actions are largely focused on eliminating these algal blooms from the lakes. This benefit will flow on to the river.

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