New Plymouth District Council Inglewood Oxidation Ponds System Monitoring Programme Annual Report 2015-2016

Technical Report 2016-27

ISSN: 1178-1467 (Online)
Document: 1716901 (Word)
Document: 1725781 (Pdf)

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November 2016

Executive summary

The New Plymouth District Council (NPDC) operates the Inglewood municipal oxidation ponds treatment system located at Inglewood in the Kurapete catchment.

NPDC holds a renewed resource consent allowing for the discharge of treated wastewater overflows to the Kurapete Stream, a small tributary of the Manganui River in the Waitara catchment. Following the successful diversion of all dry weather wastewater inflows from the ponds' system to the New Plymouth wastewater treatment plant (WWTP) in late 1999, the renewed consent authorises only intermittent wet weather overflows of treated wastewater to the Kurapete Stream. The previous consent expired in June 2003 and was renewed in September 2004. The renewed resource consent includes a total of 13 special conditions setting out the requirements that NPDC must satisfy.

During the monitoring period New Plymouth District Council demonstrated an overall high level of environmental performance.

This report for the period July 2015 to June 2016 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the environmental performance during the period under review, and the results and effects of the consent holder's activities.

The Council's monitoring programme included three regular inspections and two biological receiving water surveys. No intermittent wet weather overflows occurred during the period under review.

Regular inspections indicated no problems with the ponds' system maintenance or operation, with no unauthorised overflows to the stream of any nature. Reactivation of an alarmed and telemetered overflow site has worked to alleviate sewage entry to domestic property. Signage requirements have been recognised and provided for should such events re-occur.

Previous pond microfloral monitoring had indicated a trend of improved in-pond conditions under the post-diversion operating regime of maintenance of mainly low main pond levels for stormwater infiltration storage purposes. This monitoring has been superseded by chlorophyll-a monitoring, which although indicating marked variability in microfloral populations, was coincident with relatively high dissolved oxygen saturation levels.

Reduction in stormwater infiltration to the reticulation system had been the subject of completed work, and generally had been successful in reducing the frequency of authorised overflows. Some overflows have continued to occur, but in compliance with the condition authorised by the consent. However, considerable investigative work has been programmed by the consent holder subsequent to more frequent overflow events occurring during the past four monitoring periods, which have indicated more recent direct stormwater inflows to the reticulation. Major sources of stormwater inflows have been found and eliminated, and the pumping system was replaced with improvements made to delivery capabilities via the pipeline to the New Plymouth waste water treatment plant.

The spring and summer biomonitoring surveys in the Kurapete Stream documented maintenance of the marked recovery in biological communities which had been recorded soon after the diversion of all discharges from the stream (in late 1999), and the satisfactory sealing of the new outfall. The evaluation of 19 years of biomonitoring data has highlighted a significant statistical temporal improvement in the biological 'health' of the lower reaches of the Kurapete Stream, attributable to the removal of the continuous discharge. The temporal trend has lessened in significance more recently, but stream biological 'health' has been maintained at an improved level relative to pre-diversion 'health'.

Riparian initiatives have been undertaken by most landowners in the Kurapete Stream catchment (27 plans prepared to date) and the financial contribution provided by the consent holder (as a condition of the previous discharge permit) has been completely utilised.

During the monitoring period, NPDC demonstrated a high level of environmental and administrative performance with the resource consents.

For reference, in the 2015-2016 year, 71% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 24% demonstrated a good level of environmental performance and compliance with their consents.

In terms of overall environmental and compliance performance by the consent holder over the last several years, this report shows that the consent holder's performance remains at a high level.

Recommendations for the 2016-2017 year include continuation of the reduced monitoring programme formulated for the renewed consent, and provision for timely reporting of each overflow event in order that any additional relevant monitoring can be undertaken. This recognises the marked improvement in receiving water conditions documented in recent years and relative infrequency of overflows from the system over the past 11 years, although it has been noted that the number of these consented overflows has increased in the last six year period.

Table of contents

List of tables

List of figures

1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is the Annual Report for the period July 2015 to June 2016 by the Taranaki Regional Council (the Council) on the monitoring programme associated with a resource consent held by New Plymouth District Council (NPDC) for the Inglewood municipal oxidation pond system (the plant) in the Kurapete catchment.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consent held by NPDC that relates to the potential discharge of wastes within the Kurapete catchment.

This is the 29th annual report to be prepared by the Council to cover the treatment and disposal of wastewater from the plant.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the *Resource Management Act 1991* (RMA) and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consents held by NPDC, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted in the Inglewood oxidation ponds system.

Section 2 presents the results of monitoring during the period under review, including scientific and technical data.

Section 3 discusses the results, their interpretations, and their significance for the environment.

Section 4 presents recommendations to be implemented in the 2016-2017 monitoring year.

A glossary of common abbreviations and scientific terms, and a bibliography, are presented at the end of the report.

1.1.3 The Resource Management Act 1991 and monitoring

The RMA primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

(a) the neighbourhood or the wider community around an activity, and may include cultural and social-economic effects;
(b) physical effects on the locality, including landscape, amenity and visual effects;
(c) ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;

(d) natural and physical resources having special significance (for example recreational, cultural, or aesthetic); and
(e) risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each activity. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the RMA to assess the effects of the exercise of consents. In accordance with Section 35 of the RMA, the Council undertakes compliance monitoring for consents and rules in regional plans, and maintains an overview of the performance of resource users and consent holders. Compliance monitoring, including both activity and impact monitoring, enables the Council to continually re-evaluate its approach and that of consent holders to resource management and, ultimately, through the refinement of methods and considered responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and administrative performance

Besides discussing the various details of the performance and extent of compliance by NPDC, this report also assigns them a rating for their environmental and administrative performance during the period under review.

Environmental performance is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year. **Administrative performance** is concerned with NPDC's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

Events that were beyond the control of the consent holder and unforeseeable (that is a defence under the provisions of the RMA can be established) may be excluded with regard to the performance rating applied. For example loss of data due to a flood destroying deployed field equipment.

The categories used by the Council for this monitoring period, and their interpretation, are as follows:

Environmental Performance

- **High:** No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment. The Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.

- **Good:** Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self reports, or in response to unauthorised incident reports, but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and quickly. The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

For example:

- High suspended solid values recorded in discharge samples, however the discharge was to land or to receiving waters that were in high flow at the time;
- Strong odour beyond boundary but no residential properties or other recipient nearby.

- **Improvement required**: Likely or actual adverse effects of activities on the receiving environment were more than minor, but not substantial. There were some issues noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent minor non-compliant activity could elevate a minor issue to this level. Abatement notices and infringement notices may have been issued in respect of effects.

- **Poor:** Likely or actual adverse effects of activities on the receiving environment were significant. There were some items noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent moderate non-compliant activity could elevate an 'improvement required' issue to this level. Typically there were grounds for either a prosecution or an infringement notice in respect of effects.

Administrative performance

- **High:** The administrative requirements of the resource consents were met, or any failure to do this had trivial consequences and were addressed promptly and co-operatively.

- **Good:** Perhaps some administrative requirements of the resource consents were not met at a particular time, however this was addressed without repeated interventions from the Council staff. Alternatively adequate reason was provided for matters such as the no or late provision of information, interpretation of 'best practical option' for avoiding potential effects, etc.

- **Improvement required:** Repeated interventions to meet the administrative requirements of the resource consents were made by Council staff. These matters took some time to resolve, or remained unresolved at the end of the period under review. The Council may have issued an abatement notice to attain compliance.

- **Poor**: Material failings to meet the administrative requirements of the resource consents. Significant intervention by the Council was required. Typically there were grounds for an infringement notice.

For reference, in the 2015-2016 year, 71% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 24% demonstrated a good level of environmental performance and compliance with their consents

1.2 Treatment plant system

1.2.1 Background

Prior to late 1999 municipal wastewater was discharged to the Kurapete Stream following treatment in an oxidation pond system. The present population serviced by this system is close to 3,000 persons and industrial waste is a minimal component of the wastewater loading on the system. Historical problems relating to siltation of the treatment ponds and refurbishment measures undertaken by NPDC have been documented in several Annual Reports prepared by the Council (see Bibliography). These culminated in the consent holder opting to pipe effluent from the Inglewood oxidation pond using the existing Moa-Nui effluent line from Inglewood to Brixton and a new pipeline to Bell Block. Under this option effluent was to be pumped and gravity fed to the New Plymouth WWTP for further treatment prior to discharge to the Tasman Sea. This option utilises the existing ponds at Inglewood for attenuation during peak rainfall events.

During extreme peak flows (i.e. when stormwater and groundwater infiltration is excessive), overflows from the pond were likely to occur given the limited amount of attenuation available. Accordingly, overflow facilities are to be utilised during peak storm flows to treat pond effluent before discharge to the stream occurs. No continuous discharge should therefore occur from the ponds' system in the long term.

The provision and maintenance of up-graded screening of the original outlet from the second pond and the rock filter on the new outfall was intended to improve the aesthetic quality of any overflow discharge of treated effluent by reduction of the debris which had accumulated previously in streamside vegetation to the concern of downstream property owners, particularly following stream freshes.

The capacity of the Moa-Nui pipeline was limited to about 44 L/s. It was estimated that when the capacity of the pipeline was exceeded the average duration of each overflow would be between five and seven days per event, and that 3.3 events would occure per year. Accordingly consent was sought to discharge overflow from the ponds as required during high rainfall events.

In late 1998, a consent was granted to NPDC to provide for the intermittent discharge of screened, oxidation pond treated wastewater to the Kurapete Stream.

Since concrete sealing of the outfall pipe was undertaken in early December 2000, no further discharge has occurred from the outfall pipe into the Kurapete Stream.

Development and implementation of a stormwater infiltration reduction programme, as required by Special Condition 5 of the consent was instigated by the consent holder and progress has been reported at required intervals. Considerable work has been reported by the consent holder and included a manhole replacement programme, lateral replacements, an ongoing sewer patching programme and continued flow monitoring. NPDC have committed to reducing influent volumes to achieve a nil overflow situation. This will achieve the ultimate objective of no wastewater discharges to the Kurapete Stream. Achieving this outcome would depend to some extent on the existing condition of the reticulation. Details of this are contained in earlier annual reports.

The alarm system was overhauled in 1999-2000 and an operating manual updated for the system by NPDC. Self-monitoring of the ponds' system by the consent holder was also being undertaken on a regular basis.

No occurrences of anaerobic pond conditions, nor objectionable odours, have been recorded since an incident in mid 1997 (see TRC 1998 and TRC 1999).

A public health risk assessment was undertaken by the Taranaki Area Health Board (TAHB) in relation to possible public usage of the Kurapete Stream in 2014.. In summary, it was concluded that there was minimal use of the stream for food-gathering or recreational purposes, and that the public health risk was minimal under heavy rain overflow conditions.

Wet weather in August 2015 and September 2015 raised pond levels but not to overflow levels indicating that work done to reduce stormwater infiltration and inflow has had a marked effect.

No additional trade wastes connections to the sewerage reticulation were recorded during this monitoring period. It should be noted that industrial waste disposal tankers are not encouraged to use the plant for disposal and treatment purposes, but preferably to utilise the New Plymouth WWTP (NPDC, pers. comm.). Controlled facilities also exist at the Stratford and Hawera oxidation ponds treatment systems for wastes disposal of this nature from within those districts.

1.3 Resource consents

1.3.1 Water discharge permit

Section 15(1)(a) of the RMA stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations.

NPDC holds water discharge permit **1449-5** to cover the intermittent discharge of treated municipal wastewater into the Kurapete Stream. This permit was issued by the Council on 10 December 1998 as a resource consent under Section 87(e) of the RMA. It expired on 1 June 2015, but continued to operate under Section 124 protection. It was renewed on 28 June 2016 until June 2033 with review dates of June 2019 and every three years following.

A copy of the consent is included as Appendix I. Special conditions attached to the consent require diversion of the normal dry weather wastewater discharges and part of the wet weather component out of the Kurapete Stream to the New Plymouth WWTP. Definition of the discharge periods, requirements for screening the final effluent, record-keeping, operation of the system and appropriate monitoring of both the system and the receiving waters are also provided by special conditions.

Other special conditions require the continued implementation of a stormwater infiltration reduction programme by the consent holder.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets obligations upon the Council to gather information, monitor and conduct research on the exercise of resource consents within the Taranaki region. The Council is also required to assess the effects arising from the exercising of these consents and report upon them.

The Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations, and seek information from consent holders. A monitoring programme appropriate to the renewed consent, for the intermittent discharge of treated, screened municipal wastewater was established during the 1999-2000 period. This programme was reduced in intensity in 2007-2008 in relation to inspection frequency and sampling of wastewater quality and physicochemical water quality effects on the Kurapete Stream, as no overflows to the stream had occurred for several years, and the management of the system had been of a very high standard. Subsequently, there has been some increase in frequency of overflows and the necessary monitoring has been adjusted accordingly where necessary.

The monitoring programme for the 2015-2016 period consisted of the following primary components.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council in:

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- in discussion over monitoring requirements;
- preparation for any reviews;
- renewals;
- new consents;
- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

1.4.3 Site inspections

The Inglewood plant was visited three times as programmed during the monitoring period. The main points of interest were plant operation, maintenance and performance, particularly in relation to the provision of ponds’ buffering capacity in order to prevent and reduce the frequency of treated effluent discharges to the Kurapete Stream.

1.4.4 Chlorophyll-a monitoring

Samples from the secondary pond effluent were collected for chlorophyll-a analysis on all three inspection visits. Chlorophyll-a concentration can be used as a useful indicator of the algal population of the system.

1.4.5 Biomonitoring surveys

Macroinvertebrate biological receiving surveys were performed at two sites in the Kurapete Stream under relatively low flow conditions in spring 2015 and in late summer 2016. The surveys had been reduced in intensity (from four to two sites) in spring 2007 in recognition of the documented recovery of the biological stream communities since the removal of the continuous discharge to the stream. However, provision for extended four site surveys remained if necessitated by prolonged overflow events (e.g. September, 2013). These surveys have also been incorporated within the Council's temporal trending State of the Environment Monitoring programme (see TRC, 2009a and TRC, 2015).

2. Results

2.1 Inspections of treatment system operation

Three regular scheduled inspections of the system were performed during the monitoring period.

Physical features of the system were recorded and the surface dissolved oxygen concentration of the final section of the main pond was measured (by meter) adjacent to the effluent outlet during the three inspections (Table 1). A sample for chlorophyll-a analysis was also collected from the same site at the time of inspection (see Section 2.2.2).

Table 1 Dissolved oxygen measurements from the main pond

Date	Pond level (m)	Time (NZST)	Temperature (°C)	Dissolved oxygen	
				Concentration (g/m^3)	Saturation (%)
11 Sep 2015	1.84	0830	11.2	8.7	82
11 Jan 2016	0.81	0830	23.0	5.8	69
09 May 2016	0.72	0830	15.4	5.1	55

Aerobic conditions were recorded on all inspection occasions (Table 1), despite the lack of wave action on the surface of the main pond and the low pond level that is maintained to provide adequate flow buffering capacity since the effluent discharge was diverted away from the stream. The dissolved oxygen (DO) levels (55% to 82%) were relatively typical of biological treatment systems although no instance of supersaturation was recorded. The relatively narrow range of DO levels can be attributed to the general maintenance of low operating pond levels and low wastes loading on this pond. High saturation levels are generally indicative of additional contributions to DO levels from algal photosynthesis. As DO levels vary on a seasonal and daily basis in response to climatic conditions and biological photosynthetic activity, pond condition and performance were evaluated by confining sampling times to midmorning between the hours of 0730 and 0830 for this monitoring period.

Generally, the surrounds of the entire pond system were maintained in a tidy condition due to maintenance work carried out in earlier years. No significant maintenance had been undertaken during this monitoring period.

Inspections were performed in fine and calm to breezy and showery conditions with minimal surface movement apparent on the primary pond aeration cell or the main pond. Some of the surface movement on the primary cell was caused by mechanical aeration with one aerator operating on each of the three inspection occasions.

The appearance of the primary aeration cell was turbid brown on all three occasions, while the main pond appearance varied from slightly turbid brown to relatively clear, light green. No noticeable odours around the main pond were recorded on any inspection during the period, with only slight localised odours noted downwind of the primary cell.

Moderate numbers of waterfowl [ducks (mallard and paradise), and several black swan] were noted on the main pond each inspection. None were associated with the aeration cell. On two occasions in spring and autumn the aeration cell level was relatively high, discharging a moderate volume into the main oxidation pond. This was due in part to wet weather in the days preceding the inspection.

The main pond was managed at a low wastewater level while diversion of the raw wastewater to the New Plymouth WWTP was occurring. Pond level sat at an operating depth of approximately 0.7 to 1.0 m, more than a metre below the outlet overflow, throughout the majority of the monitoring year. Elevated pond levels occurred after wet weather events in August and September 2015, and June 2016.

Pond level is continuously monitored by the consent holder and reported at monthly intervals. The minimum level of the main pond was maintained at approximately 0.7m below the overflow level which occurs at 2.4 m. Highest pond levels were recorded on 10 August and 4 September 2015, with pond levels reaching maximum heights of 2.20 m and 2.24 m respectively. Another spike in pond level was associated with a period of rain in late May 2016, but levels did not go over 2.0 m during this event. There were no overflows during the year, compared to overflows of 5.8% the previous 2014-2015 year. Rainfall, infiltration, and overflow analyses conducted in the previous monitoring year indicated that overflow events followed substantially larger (intensity and duration) rainfall events, and that ongoing work on identification and rectification of infiltration issues was resulting in continued improvement in the system performance.

Incorporation of the perimeter stormwater and landfill leachate into the primary pond via diversion drains operated successfully through the monitoring period. A relatively clear stream of leachate was observed to be discharging on 11 September 2015, at an estimated rate of 1.5 L/s. The concrete sealing of the old outfall pipe undertaken in December 2000 continued to be effective and no seepage discharge occurred from this outfall into the Kurapete Stream throughout the period under review.

2.2 Results of wastewater treatment plant monitoring

2.2.1 Plant performance

In past monitoring periods, samples of the plant system's effluent have been analysed as a component of summer assessments of effects surveys in the receiving waters of the Kurapete Stream. Since the wastewater diversion to the New Plymouth WWTP was completed prior to the summer of 1999-2000, no summer physicochemical effluent or receiving water sampling has been necessary. Any periods of overflow events are monitored by the consent holder (wastewater only), with samples collected and analysed by NPDC at the time of each event (see Appendix III).

Prior to the wastes diversion, the consent holder had been required to monitor effluent quality on a two-monthly basis, as a special condition of discharge permit 1449, and report these results to the Council. This monitoring commenced in January 1992, continuing at two monthly intervals, until the diversion of the wastewater from the stream discharge. The renewed consent (1449) does not require effluent monitoring by the consent holder. A summary of historical effluent quality from monitoring by the consent holder and the Council is presented in Table 2.

Table 2 **S**ummary of analytical data monitored by NPDC and the Council (1986 to August 1999) and effluent overflows monitored since 1999

Data source		NPDC				TRC				
Parameter	Unit	1992-1999		Overflows (2003-2015)		1986-1999			Overflows (2000 to 2014)	
		N	Range	N	Range	N	Range	Median	N	Range
Dissolved oxygen	g/m^3	45	<0.2-15.0	-	-	74	<0.1-25	5.3	46	2.2-18.1
BOD_5*	g/m^3	45	Aug-57	21	<1-10	25	Nov-56	26	2	1.1-2.5
BOD_5 (filtered)*	g/m^3	45	Feb-24	-	-	19	Apr-17	10	-	-
pH		45	6.8-8.9	27	6.9-8.8	26	6.9-8.9	7.4	2	7.0-7.2
Conductivity @ 20°C	mS/m	-	-	-	-	25	11.8-38.6	25	2	15.0-16.3
Conductivity @ 25°C	mS/m	45	14.7-43.3	27	13.4-21.9	-	-	-	-	-
Ammonia-N	g/m^3N	45	1.2-32	27	0.1-5.5	26	0.71-22	9.17	2	2.74-3.16
Nitrite + nitrate-N	g/m^3N	45	<0.2-13.5	-	-	6	<0.01-0.46	0.08	2	0.62-0.92
Nitrate-N	g/m^3N	-	-	-	-	15	<0.01-0.69	0.06	-	-
Dissolved reactive phosphorus	g/m^3P	-	-	-	-	18	1.08-6.55	2.64	2	0.19-0.22
Suspended solids	g/m^3	45	<5-178	27	<5-38	25	10-160	36	2	3
Faecal coliform bacteria	nos/100ml	45	$1.5x10^2$-$7.2x10^5$	24	$1.3x10^2$-$1.03x10^4$	26	$2.1x10^2$-$1.0x10^6$	$1.2x10^4$	2	190-1,100

[**Notes:** * carbonaceous BOD_5 for NDPC data; DO since 2000 include regular inspection data; N = number of samples]

These data are presented for reference purposes as they provide a comprehensive historical summary of the variability in effluent quality for the Inglewood wastewater treatment system, both pre and post diversion to the NPDC WWTP.

Seasonal variations in system performance account for the ranges in most parameters. Variability in faecal coliform bacteria counts, suspended solids and dissolved oxygen concentrations generally occurred with the season, with increasing microfloral populations during summer months raising pH and dissolved oxygen levels and resulting in increased BOD (total) and suspended solids concentrations. The fluctuations in conductivity levels reflected the degree of stormwater infiltration (i.e., dilution) within the ponds' system, with lower levels particularly apparent following heavy rainfall events.

Plant effluent sampled during overflow events to date has had a relatively clear appearance with very good effluent quality due to the extensive dilution provided by the stormwater infiltration. Nearly all parameters' levels have been well below historical median levels, particularly BOD_5, suspended solids, and faecal coliform bacteria numbers which have shown the influence of considerable stormwater dilution. In this regard, concentrations of BOD_5 and suspended solids have been significantly lower than previously recorded on almost every occasion.

2.2.2 Microflora of the treatment system

Pond microflora are very important for the stability of the symbiotic relation with aerobic bacteria within the facultative pond. These phytoplankton may be used as a bio-indicator of pond conditions. For example, cyanobacteria are often present in under-loaded conditions and chlorophyceae are present in overloaded conditions. To maintain facultative conditions in a pond system there must be an algal community present in the surface layer.

The principal function of algae is the production of oxygen which maintains aerobic conditions while the main nutrients are reduced by biomass consumption. Elevated pH (due to algal photosynthetic activity) and solar radiation combine to reduce faecal bacteria numbers significantly.

Samples of the secondary pond effluent had been collected at the time of most inspections of the Inglewood oxidation ponds system for semi-quantitative microfloral assessment prior to curtailment of this component of the programme during the 2012-2013 period. The microflora present in the secondary oxidation pond have been summarised and discussed in more recent annual reports and historical data have been provided in a previous annual report (TRC, 2009).

Samples of the secondary pond effluent were collected on all three inspection occasions for chlorophyll-a analyses. It has been suggested that a minimum in-pond chlorophyll-a concentration of 300 mg/m³ is necessary to maintain stable facultative conditions (Pearson, 1996). However, seasonal changes in algal populations and also dilution by stormwater infiltration might be expected to occur in any wastewater treatment system which together with fluctuations in waste loading would result in chlorophyll-a variability.

The results of secondary pond effluent analyses are provided in Table 3 together with field observations of pond appearance.

Table 3 Chlorophyll-a measurements from the surface of the Inglewood secondary oxidation pond at the perimeter adjacent to the outlet

Date	Time (NZST)	Appearance	Chlorophyll-a (mg/m³)	Chlorophyll-a (mg/m³) for period July 2014-June 2015		
				N	Median	Range
11 Sep 2015	0830	slightly turbid; brown	44	3	82	7-158
11 Jan 2016	0830	relatively clear; grey	4.6			
09 May 2016	0830	rel. clear; light green	19			

Chlorophyll-a concentrations were low in winter (44 mg/m³) coincident with a dissolved oxygen saturation level of 82%, and even lower in summer and autumn which coincided with moderately low saturation concentrations (69% and 55%). These concentrations (4.6 to 44 mg/m³) may be anticipated to vary widely, not only seasonally, but in response to the fluctuations in pond levels caused by ingress and flushing of stormwater during wet weather events. The range was lower compared to that found over the previous period (Table 3).

2.3 Results of receiving environment monitoring

Physicochemical receiving water surveys no longer are required due to the relative infrequency of overflow events and/or absence of measurable effects on receiving water quality. One component of the receiving water monitoring programme (biological monitoring) was scheduled for the period. This biological monitoring of the

Kurapete Stream was performed on the usual two (spring and summer) occasions and while it will be retained as an on-going component of the programme, it has been reduced in intensity from a four site to a two site survey. As neither survey followed a very recent overflow event, the surveys were performed as two site surveys in accordance with documented receiving water monitoring requirements.

2.3.1 Biomonitoring surveys

Two biomonitoring surveys of the receiving waters of the Kurapete Stream were performed at sites 1 and 4 of those listed in Table 4 and illustrated in Figures 1 and 2.

Table 4 Sampling sites for biological monitoring of the Kurapete Stream

Site No	Site location	GPS reference	Site code	Survey
1	upstream of plant outfall	1705225E-5665510N	KRP000300	spring/summer
2	approximately 75 m d/s of plant outfall	1705337E-5665530N	KRP000311	N/S
3	approximately 300 m d/s of plant outfall	1705481E-5665637N	KRP000330	N/S
4	approximately 6 km d/s of plant -outfall	1709239E-5667481N	KRP000660	spring/summer

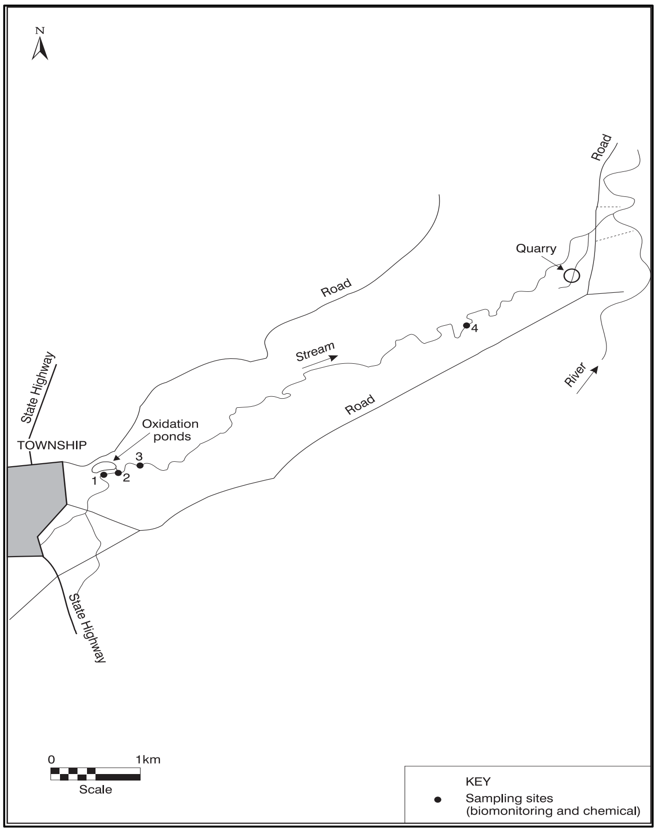

Figure 1 Sampling sites in the Kurapete Stream in relation to Inglewood oxidation ponds

Samples were processed to provide number of taxa (richness), MCI and $SQMCI_S$ scores, and EPT taxa for each site. The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_S$ takes into account taxa abundance as well as sensitivity to pollution, and may reveal more subtle changes in communities.

The first survey was performed in spring (15 October 2015) during relatively low recession flow conditions, and the second survey was undertaken in late summer (31 March 2016) under low flow conditions; with both surveys performed when all wastes discharges were diverted from the stream and no overflow events had occurred since late June 2015. These reports are attached as Appendix II and results summarised in Table 5.

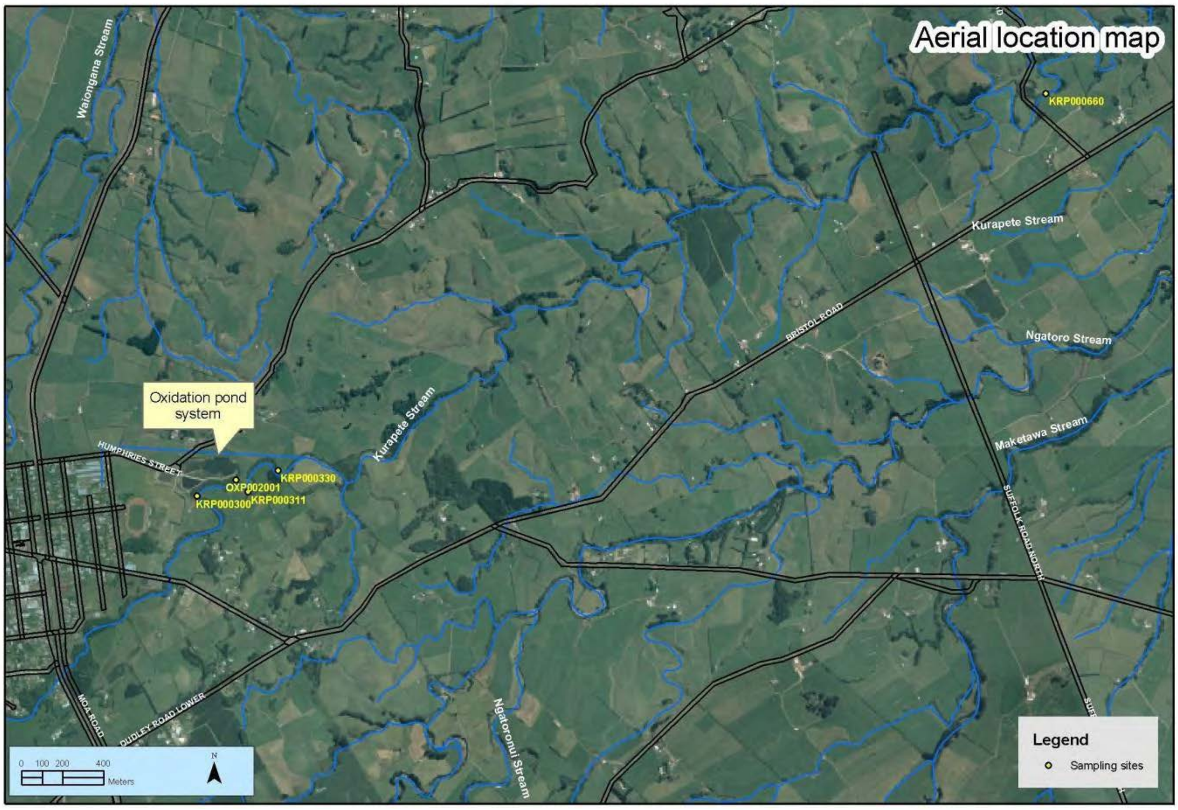

Figure 2 Aerial map showing location of biomonitoring sites

Table 5 Biomonitoring results from the two surveys of the Kurapete Stream

Site No	Macroinvertebrate fauna			
	Taxa numbers		MCI values	
	15 Oct 2015	31 Mar 2016	15 Oct 2015	31 Mar 2016
1	27	22	104	106
4	25	25	105	99

The spring survey was performed under relatively low flow conditions and in the absence of any recent overflow discharge events after heavy rainfall. It continued to record the documented improvement in the biological condition of the stream at the site downstream of the outfall since the diversion the New Plymouth WWTP. The biological 'health' at the downstream site was toward the maximum (in terms of MCI score) of scores recorded post-wastewater diversion. Few community composition changes, coincident with increased periphyton substrate cover and the more open nature of the stream, were recorded at the site nearly 6 km further downstream as illustrated by 58% of the 33 taxa found between the two sites being present at both sites and the two sites' communities sharing nine characteristic taxa. Taxa richnesses were moderately high and the MCI scores had a narrow range, from 104 to 105 units, over the reach of the Kurapete Stream surveyed. MCI scores were higher or very similar to those predicted for sites of similar altitudes in ringplain streams in the region particularly for a stream with its source downstream of the National Park. The presence of significant proportions of 'sensitive' taxa in the communities at both sites and the absence of any 'heterotrophic growths' continued to illustrate the improvements in habitat and physicochemical water quality maintained in this reach of the Kurapete Stream subsequent to wastes diversion. The biological health at the site approximately 6 km below the outfall reflected these improvements, indicative of the significance of municipal wastes discharges removal from this stream, in the absence of recent wet weather overflows of very dilute oxidation pond wastewater to the stream.

The late summer survey was performed under low flow conditions and in the absence of any recent overflow discharge events after heavy rainfall. It continued to record the documented improvement in the biological condition of the stream at the site since the diversion, in that the biological 'health' at the downstream site was towards the maximum (in terms of MCI scores) of scores recorded post-wastewater diversion. Few community composition changes, coincident with increased periphyton substrate cover and the more open nature of the stream, were recorded at the site nearly 6km further downstream as illustrated by 52% of the 31 taxa found between the two sites being present at both sites and the two sites' communities sharing eight characteristic taxa. Taxa richnesses were moderately high and the MCI scores had a moderately high range, from 106 to 99 units, over the reach of the Kurapete Stream surveyed. This was partly due to site 1 recording its highest ever MCI score. MCI scores were slightly higher or very similar to those predicted for sites of similar altitudes in ringplain streams in the region particularly for a stream with its source downstream of the National Park. The presence of significant proportions of 'sensitive' taxa in the communities at both sites and the absence of any 'heterotrophic growths' continued to illustrate the improvements in habitat and physicochemical water quality maintained in this reach of the Kurapete Stream subsequent to wastes diversion. The biological health at the site approximately 6 km below the outfall reflected these improvements, indicative of the significance of municipal wastes discharges removal from this stream, in the absence of recent wet weather overflows of very dilute oxidation pond wastewater to the stream.

The most recent statistical trend analyses of macroinvertebrate data collected over the ten and 19 year periods between 1995 and 2014 (Stark and Fowles, 2006 and TRC, 2015) have identified significant temporal trends of increasing MCI scores at sites 1 and 4, both of which have been ecologically significant. The positive trend was significantly stronger at the downstream site (KRP000660) than at the upstream 'control' site (KRP000300) over the first ten years, but the trend at the downstream site has partly reduced in significance over the longer 19 year period. The improvement upstream was attributed principally to the diversion of the iron-laden tributary draining the old Inglewood landfill, into the oxidation ponds system, while the major influence downstream has been the removal of the wastewater discharge from the stream. In recent years the upstream trend has tended to continue while there has been a very strong trend of improvement between 1999 and 2004 at the downstream site, then a decreasing trend between 2004 and 2007, followed by further steady improvement which overall has reduced the significance of the temporal trend. Stream generic 'health' over this reach remains 'fair' (mainly) to 'good' (occasionally), representing an improvement from the 'poor' health consistently recorded at the downstream site when wastewater was discharged into the Kurapete Stream prior to 2000.

Biological monitoring of the stream will continue to be performed on the reduced basis in terms of fewer sites (upstream 'control' site 1 and downstream site 4), in order to document temporal trends in stream 'health', particularly as riparian improvements and dairy wastes disposal to land initiatives are implemented in the catchment. A return to the four site survey (as performed on specific survey occasions in the past) would occur only in order to assess any impacts of discharges in high rainfall events, should such events be prolonged.

2.4 Investigations, interventions, and incidents

The monitoring programme for the year was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the consent holder. During the year matters may arise which require additional activity by the Council, for example provision of advice and information, or investigation of potential or actual courses of non-compliance or failure to maintain good practices. A pro-active approach that in the first instance avoids issues occurring is favoured.

The Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The Incident Register includes events where the Company concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

Complaints may be alleged to be associated with a particular site. If there is potentially an issue of legal liability, the Council must be able to prove by investigation that the identified company is indeed the source of the incident (or that the allegation cannot be proven).

In the 2015-2016 period, the Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with NPDC's exercise of resource consent 1449.

2.5 Riparian mitigation in the catchment

Special condition 12 of consent 1449 (prior to its expiry in June 2003) required:

> *'that by agreement of the consent holder, the consent holder shall mitigate the effects of the discharge to the Kurapete Stream, below the discharge point, to the reasonable satisfaction of the General Manager. Mitigation for the purpose of this condition shall include:*
>
> *a) removing objectionable debris from the stream after 30 June 1999; and*
> *b) riparian fencing and/or planting;*
> *c) the total cost to be a minimum of $20,000 [plus GST].'*

The consent holder reported that minimal debris required removal from the stream in the vicinity of the original discharge following the diversion of the wastewater. No debris has been deposited in or near the stream on any occasions of intermittent stormwater-related overflow discharges since 1999.

The consent holder made a $20,000 financial contribution to the Taranaki Tree Trust which had been spent by the end of the 2003-2004 financial year. Twenty-six individual riparian plans (two previous plans were merged in 2014-15) and one conservation plan have been prepared for landowners in the Kurapete Stream catchment by July 2016 (Figure 3). The quarry owner had fenced a section of the true right bank of the stream's lower reaches upstream of the Everett Road bridge and riparian planting had been undertaken. This vegetation was well established at the time of the 2015-2016 period.

Streambank length in the Kurapete catchment equates to 88 km. Currently, 65 km of banks are protected by existing and completed fencing with 35 km protected by existing/completed vegetation. Since the preparation of riparian plans, 28 km of fencing and 12 km of planting have been completed in the catchment.

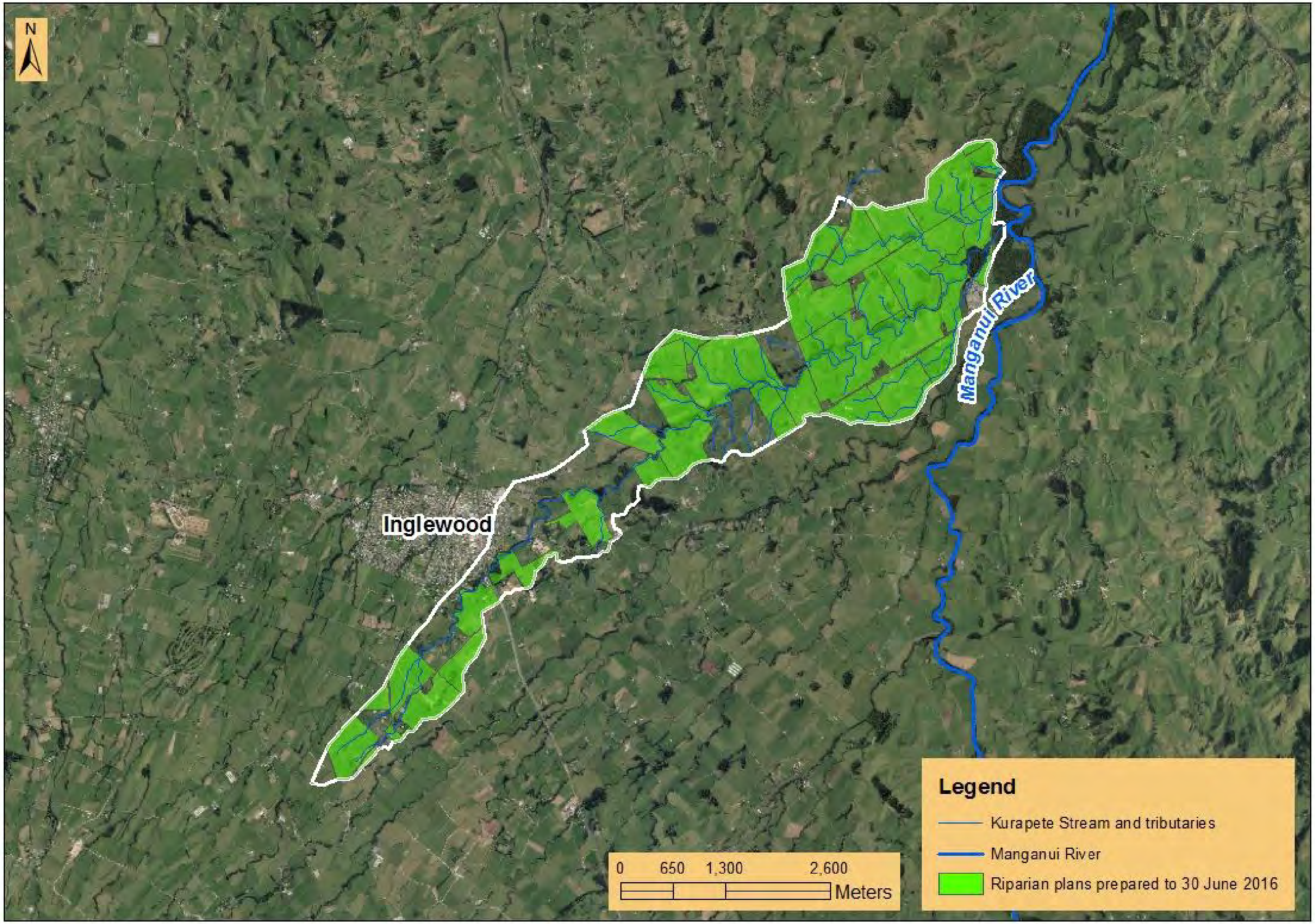

Figure 3 Riparian plans prepared in the Kurapete Stream catchment to June 2016

3. Discussion

3.1 Discussion of site performance

No oxidation pond treated effluent was discharged into the stream during the monitoring year. No leakages around the outfall gate structure have occurred since successful resealing in March, 2002. Pond level management (for storage purposes) was good during this period as was maintenance of the pond system with continued aeration of the primary cell and regular maintenance of the treatment system. Localised leachate drainage continued to be diverted into the pond system following investigative works and maintenance by the consent holder.

Chlorophyll-a monitoring showed variable concentrations which were coincident with moderately high dissolved oxygen saturation levels.

There were no periods of intermittent wet weather overflows during the year. To date, alarm system and reporting procedures have ensured that the Council has been informed almost immediately following each overflow discharge event when these have occurred and signage at a nearby recreational area (Everett Park) was instigated following concerns by the TAHB in association with possible human health risks.

Over previous years, there have been a number of overflow events. These have been reported on and documented in several previous annual reports prepared by the Council.

Work associated with reduction in stormwater infiltration into the Inglewood township sewerage reticulation required by consent conditions has been reported as it has been completed, with the longer term aim of removal of all oxidation pond discharges from the Kurapete Stream.

A straight maintenance regime will also continue to be followed in the future.

NPDC has noted its commitments for monitoring and reporting of overflow events including:

- continuous measurements of the inflow and outflow at the ponds’ system, and the level of the pond system;
- operating manual procedures requiring immediate notification to the Council of the activation of the secondary pond overflow;
- twice weekly visual inspections to supplement the automated supervisory control of the oxidation ponds system; and
- development of a Management Information System to allow automatic collection, archiving and reporting of data including flow data and overflow timing and duration.

Improvements to reporting commitments are discussed as necessary with the consent holder, who continues to provide a comprehensive report for the monitoring year including improvements in relation to alarms and reporting requirements and regular monthly reporting.

3.2 Environmental effects of exercise of consents

All wastewater from the Inglewood oxidation pond system was contained and diverted to the New Plymouth WWTP.

The improved biological communities present in the stream subsequent to the diversion of treated wastewater discharges from the Kurapete Stream were again documented by two surveys performed (in spring and late summer) under low flow conditions. Neither survey followed a recent overflow event.

The biological community of the site nearly 6 km downstream of the original outfall continued to maintain this improvement, with a statistically significant trend of long term improvement in stream 'health' (although less significant in more recent years), an indication of the significance of waste discharge being removed from the stream, particularly under low flow conditions.

3.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Table 6.

Table 6 Summary of performance for Consent 1449-4

Purpose: ***To intermittently discharge treated wastewater into the Kurapete Stream***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Requires diversion of majority of discharge away from receiving waters	Inspections of site and supply of records	Yes
2. Restricts timing of discharges	Inspections and perusal of consent holder's records	Yes
3. Provision of outlet screening	Inspections of treatment system	Yes
4. Provision of wastewater management plan	Plan received by Council and approved in 2001	Yes
5. Provision of overflow records	Records provided to Council as required	Yes
6. Notification of overflows to Taranaki Health	Liaison with consent holder, perusal of records	N/A
7. Implementation of a stormwater reduction programme	Completed report, but requiring on-going updates	Yes (further investigations)
8. Operation of the system	Inspections of treatment system	Yes
9. Provision of trained operator	Liaison with consent holder	Yes
10. Limits on receiving water effects	Inspections and biological surveys showed no impacts	Yes
11. Provision for a monitoring programme	Performance of programme	Yes
12. Consultation in respect of additional loadings on system	Liaison with consent holder	N/A (no additions)
13. Optional review provision re	No further reviews prior to consent expiry in June 2015	N/A

Purpose: *To intermittently discharge treated wastewater into the Kurapete Stream*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
environmental effects		
Overall assessment of consent compliance and environmental performance		**High**
Overall assessment of administrative performance in respect of this consent		**High**

During the year NPDC demonstrated a high level of environmental performance and high administrative performance with the resource consents as defined in Section 1.1.4.

3.4 Recommendations from the 2014-2015 Annual Report

In the 2014-2015 Annual Report, it was recommended:

1. THAT the monitoring of the Inglewood oxidation ponds system be performed in 2015-2016 by continuation of a programme identical in format to the programme undertaken in 2014-2015.
2. THAT regular maintenance of the oxidation pond system is performed by the consent holder (i.e., screen clearance, waveband maintenance, floating debris and weed removal);
3. THAT the consent holder advises the Council whenever industrial waste connections are made to the sewerage reticulation system;
4. THAT the consent holder continues to liaise with and advise Council immediately of the occurrence of each overflow event to the Kurapete Stream.

Compliance with recommendations 1 to 4 was achieved during the monitoring period. Monitoring included two biomonitoring surveys and programmed inspections and there was no need for any requisite or additional inspections. Reporting procedures by the consent holder have been appropriate (with regular monthly reporting).

3.5 Alterations to monitoring programmes for 2016-2017

In designing and implementing the monitoring programmes for water discharges in the region, the Council has taken into account:

- the extent of information made available by previous authorities;
- its relevance under the RMA;
- the obligations of the Act in terms of monitoring discharges and effects; and
- subsequent reporting to the regional community;

The Council also takes into account the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki discharging to the environment.

As a result of the absence of overflow events over the 2005 to 2008 period and excellent maintenance of the treatment system, a reduction in the intensity of the monitoring programme was made. However, the consent holder was advised that reinstatement of a full biomonitoring survey would need to be considered, should overflows occur to the Kurapete Stream and that this would be considered on a case-by-case basis.

For the 2016-2017 programme, it is proposed that monitoring continue at the same level as that in the 2015-2016 period.

4. Recommendations

As a consequence of the results of the 2015-2016 monitoring programme for consent 1449-5 the following recommendations are made:

1 THAT the monitoring of the Inglewood oxidation ponds system for 2016-2017 continues in the same manner as for 2015-2016.

2 THAT regular maintenance of the oxidation pond system is performed by the consent holder (i.e., screen clearance, waveband maintenance, floating debris and weed removal);

3 THAT the consent holder advises the Council whenever industrial waste connections are made to the sewerage reticulation system;

4 THAT the consent holder continues to liaise with and advise Council immediately of the occurrence of each overflow event to the Kurapete Stream.

5. Acknowledgements

The Job Manager for the programme was Rae West (Technical Officer) who was the author of this Annual Report. Macroinvertebrate surveys were performed by Chris Fowles and Darin Sutherland (Scientific Officers). Field inspections were undertaken by Ray Harris (Technical Officer) with physicochemical wastewater analyses performed by the Taranaki Regional Council ISO-9000 accredited laboratory.

Glossary of common terms and abbreviations

The following abbreviations and terms may be used within this report:

Biomonitoring	Assessing the health of the environment using aquatic organisms.
Conductivity	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
DO	Dissolved oxygen.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
g/m^3	Grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
Incident Register	The Incident Register contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
L/s	Litres per second.
MCI	Macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats.
MfCI	Microflora Community Index; a numerical indication of the state of the treatment pond biological life which takes into account the sensitivity of floral taxa to wastewater quality.
mS/m	Millisiemens per metre.
Mixing zone	The zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	Measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment.
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).
RMA	*Resource Management Act* 1991 and including all subsequent amendments.
SQMCI	Semi quantitative macroinvertebrate community index.
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.

For further information on analytical methods, contact the Council's laboratory.

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Appendix I

Resource consents held by New Plymouth District Council

(For a copy of the signed resource consent please contact the TRC consent department)

Discharge Permit
Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	New Plymouth District Council Private Bag 2025 New Plymouth 4342
Decision Date:	28 June 2016
Commencement Date:	28 June 2016

Conditions of Consent

Consent Granted:	To intermittently discharge treated municipal wastewater from the Inglewood oxidation ponds system into the Kurapete Stream
Expiry Date:	1 June 2033
Review Date(s):	June 2019 and 3-yearly intervals thereafter
Site Location:	Lincoln Road, Inglewood
Grid Reference (NZTM)	1705219E-5665557N
Catchment:	Waitara
Tributary:	Manganui Kurapete

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General condition

a. The consent holder shall pay to the Taranaki Regional Council all the administration, monitoring and supervision costs of this consent, fixed in accordance with section 36 of the Resource Management Act 1991.

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent.

2. The discharge shall only occur at times when inflow to the plant exceeds the rate that effluent can be pumped to the New Plymouth Waste Water Treatment Plant, and there is no available storage.

3. The discharge shall pass through a screen with a maximum aperture of 6 mm.

4. The site shall be operated in accordance with a ‘Management Plan’ prepared by the consent holder and approved by the Chief Executive, Taranaki Regional Council, acting in a certification capacity. The plan shall detail how the site will be managed to achieve compliance with the conditions of this consent.

5. The consent holder shall record the time and duration of each overflow to the Kurapete Stream, as authorised by special condition 2, and report these records to the Chief Executive, Taranaki Regional Council, at six monthly intervals.

6. The consent holder shall immediately notify the Taranaki District Health Board of any discharge.

7. The consent holder shall continue to implement a stormwater infiltration reduction investigation for the township of Inglewood and report annually on progress to the Chief Executive, Taranaki Regional Council for the period up to 30 June.

8. The overflow discharges shall not give rise to all or any of the following effects in the receiving waters of the Kurapete Stream 100 metres downstream of the discharge:
   a) the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
   b) any conspicuous change in the colour or visual clarity;
   c) any emission of objectionable odour;
   d) the rendering of fresh water unsuitable for consumption by farm animals;
   e) any significant adverse effect on aquatic life.

9. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice or review during the month of June 2019 and at 3-yearly intervals thereafter, for the purpose of for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 28 June 2016

For and on behalf of
Taranaki Regional Council

____

A D McLay
Director - Resource Management

Appendix II

Biomonitoring reports

To	R West, Technical Officer
From	C R Fowles, Scientific Officer
Document	1591626
Report No	CF647
Date	October 2015

Biomonitoring of the Kurapete Stream in relation to the New Plymouth District Council's Inglewood oxidation ponds' system, October 2015

Introduction

This spring survey was the first of two surveys programmed for the 2015-2016 monitoring period. Since spring 2007, biomonitoring surveys have been reduced from four sites to two sites in recognition of the minimal usage of the WWTP overflow facility to the Kurapete Stream in recent years. However, a wet winter and very wet early spring to mid summer (2011-2012) period, caused a series of overflows of very dilute, treated wastewater to the Kurapete Stream over several periods until approximately two weeks prior to the mid-summer survey (see CRF541). In response to additional receiving water monitoring requirements associated with significant overflow events, an extended four site mid-summer biomonitoring survey was undertaken at all four established sites at that time. Two brief overflow events occurred between early and mid March 2012 and another in July 2012. At the time of the October 2012 survey, more than ten weeks since any overflow, the storage pond wastewater had been reduced (by pumping to the New Plymouth treatment plant) to a level approximately 1.5 m below the overflow level. No subsequent overflows occurred prior to the February 2013 (summer) biomonitoring survey. However, a wet winter and early spring period caused a series of overflows of very dilute, treated wastewater to the Kurapete Stream over several periods with an overflow event ceasing only two weeks prior to the spring 2013 survey. At the time of that survey (in October 2013), the storage pond wastewater had been reduced (by pumping to the New Plymouth treatment plant) to a level approximately 1m below the overflow level. In response to additional receiving water monitoring requirements associated with significant overflow events, an extended four site spring biomonitoring survey was undertaken at all four established sites [which had been last fully surveyed in January, 2012 (CF541, 2012)]. No extended four site surveys have been required since that spring 2013 survey. The most recent overflow event followed an intensive wet weather period in late June 2015.

Methods

The standard '400 ml kick sampling' technique was used to collect streambed (benthic) macroinvertebrates from two established sampling sites in the Kurapete Stream (illustrated in Figure 1) on 15 October 2015.

These sites were:

Site No	Site Code	GPS reference	Location
1	KRP000300	1705087E 5665510N	Upstream of oxidation ponds' discharge
4	KRP000660	1709239E 5667481N	Approx 6km downstream of oxidation ponds' discharge

This 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al, 2001).

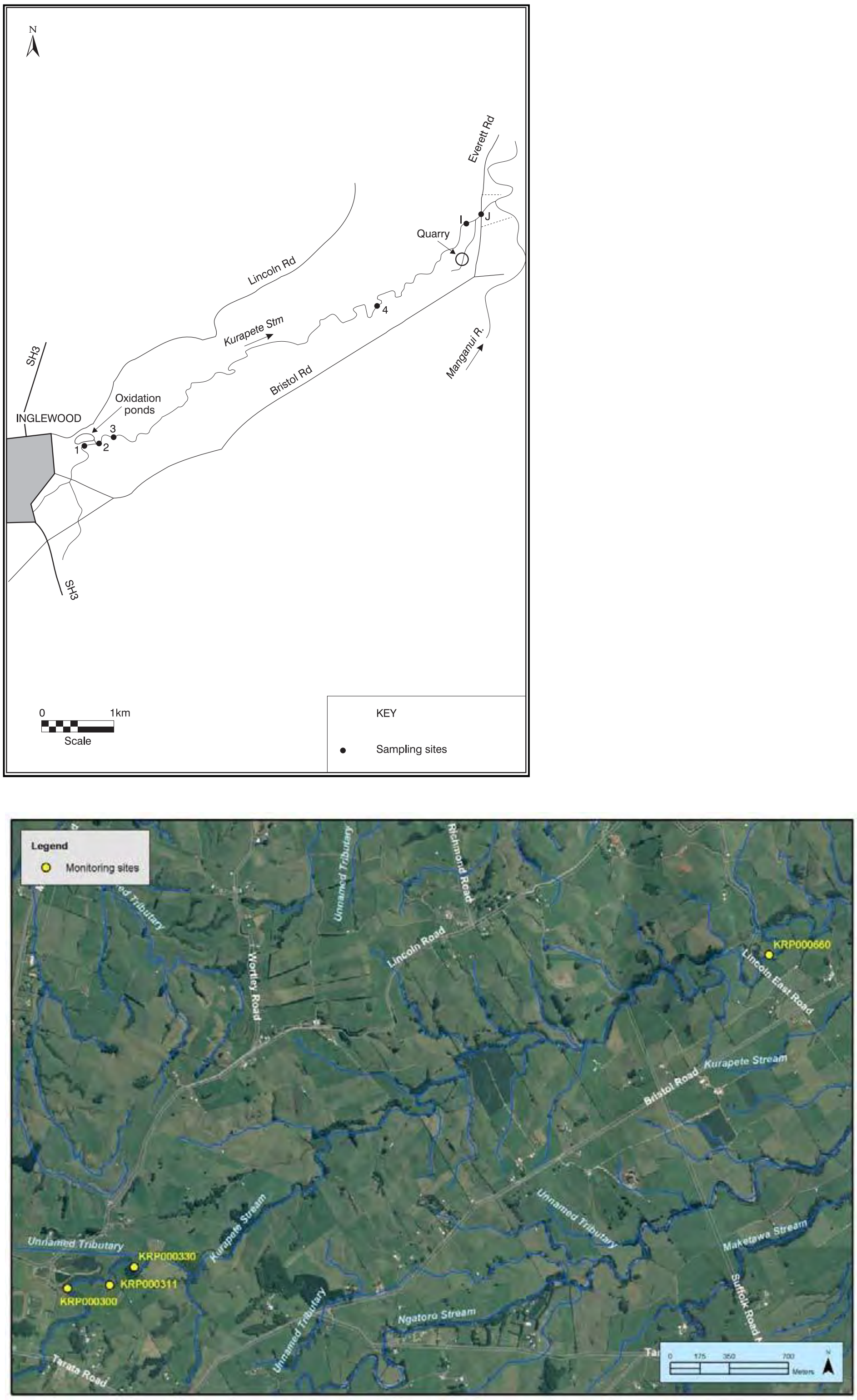


Figure 1 Sampling sites in the Kurapete Stream in relation to Inglewood oxidation ponds

Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 500 or more individuals.

Macroinvertebrate Community Index (MCI) values were calculated for taxa present at each site (Stark 1985) with certain taxa scores modified in accordance with Taranaki experience.

A semi-quantitative MCI value, $SQMCI_S$ (Stark 1999) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these scores, and dividing by the sum of the loading factors. The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA), and 500 for extremely abundant (XA).

Sub-samples of algal and detrital material taken from the macroinvertebrate samples where necessary, were scanned under 40-400x magnification to determine the presence or absence of any mats, plumes or dense growths of bacteria, fungi or protozoa (‘undesirable biological growths’) at a microscopic level. The presence of masses of these organisms is an indicator of organic enrichment within a stream.

Results and discussion

This spring survey was performed during relatively low (recession) flow conditions, 14 days after a fresh greater than 3x median flow and in excess of 7x median flow but followed several earlier wet weather periods. Water temperatures ranged from 11.4 °C to 13.6 °C during this late morning survey.

Refurbishment of the pond system had been performed in late 1999 and completed by the consent holder early in 2000 with all wastes diverted to the New Plymouth Carrousel Treatment Plant. Subsequently, several consented overflows have occurred following very heavy rainfall periods. More recently several overflows occurred in the late winter-spring of 2011, early January 2012, two further short duration overflows in early to mid March 2012, in July 2012, and in October 2013 after a series of wet weather events. No subsequent overflows to the stream had occurred until April 2015 with the most recent overflow following wet weather in late June 2015.

The diversion of the small left bank tributary draining the old landfill area, by a cut-off drain into the primary oxidation pond, had significantly reduced the extent of orange-brown iron-oxide deposits on the bed of the Kurapete Stream at site 1 upstream of the effluent discharge although more recently reticulation work in the vicinity of this diversion had altered the drainage pattern. The predominantly gravel-cobble-boulder substrate at this site had minor silt and sand deposition. Patchy mats of periphyton and moss, but no filamentous algal growth, were recorded at site 1, in the riffle at this partially shaded site. The low flow was clear and uncoloured in appearance at the time of the survey.

The low flow at site 4, approximately 6 km downstream of the discharge, was also clear and uncoloured in appearance in the absence of any overflow from the WWTP at the time of the survey. Widespread periphyton mats and patchy filamentous algae and moss, were recorded at this partly shaded site where the substrate was mainly gravel-cobble-boulder, with some sand and silt components.

Macroinvertebrate communities

Survey results for the period prior to the February 2000 survey are summarised in Table 1, including those from site 2 which was established in July 1997. This period coincided with the duration of discharges of treated effluent to the Kurapete Stream.

Table 1 Summary of macroinvertebrate taxa numbers and MCI values for previous surveys performed between June 1986 and August 1999 (pre effluent diversion)

Site	Site code	No of surveys	Taxa numbers		MCI values	
			Range	Median	Range	Median
1	KRP000300	28	10-29	20	78-94	87
2	KRP000311	5	12-18	15	53-78	72
3	KRP000330	27	8-19	14	52-86	64
4	KRP000660	14	14-24	20	66-93	78

The results of the thirty-one surveys performed following cessation of the permanent discharge to the stream and prior to the current survey are summarised for comparative purposes in Table 2.

Table 2 Summary of macroinvertebrate taxa numbers and MCI values for post effluent diversion surveys performed between February 2000 and February 2015

Site	Site code	No of surveys	Taxa numbers		MCI values	
			Range	Median	Range	Median
1	KRP000300	31	13-32	22	80-104	95
2	KRP000311	18	15-33	24	80-101	94
3	KRP000330	18	15-28	23	84-103	92
4	KRP000660	31	21-30	26	83-112	96

The results of the current survey are summarised for comparative purposes in Table 3.

Table 3 Summary of macroinvertebrate results from the October 2015 survey

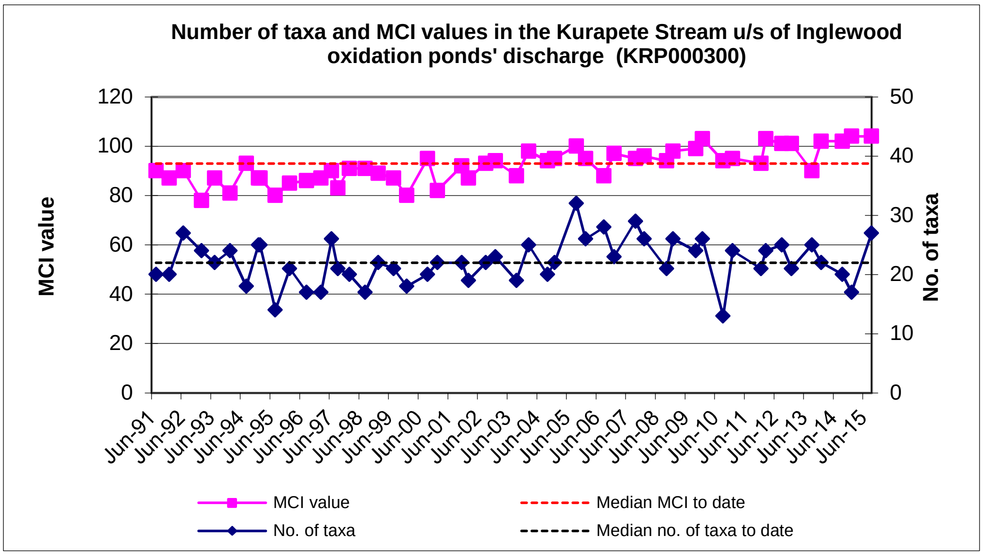
Site	Site code	Macroinvertebrate fauna	
		Taxa number	MCI
1	KRP000300	27	104
4	KRP000660	25	105

Survey results from June 1986 to date for each site are illustrated in Figure 2. This current survey’s faunal results are presented in Table 4 and discussed on a site-by-site basis.

Table 4 Macroinvertebrate fauna of the Kurapete Stream in relation to the Inglewood oxidation ponds system sampled on 15 October 2015

Taxa List	Site Number	MCI score	1	4
	Site Code		KRP000300	KRP000660
	Sample Number		FWB15300	FWB15301
NEMERTEA	Nemertea	3	R	-
NEMATODA	Nematoda	3	R	R
ANNELIDA (WORMS)	Oligochaeta	1	VA	VA
	Lumbricidae	5	R	-
MOLLUSCA	*Potamopyrgus*	4	A	A
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	A
	Coloburiscus	7	A	A
	Deleatidium	8	A	VA
	Zephlebia group	7	VA	A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	R
	Spaniocerca	8	-	R
	Zelandobius	5	R	A
COLEOPTERA (BEETLES)	Elmidae	6	A	VA
	Ptilodactylidae	8	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	C
	Costachorema	7	R	R
	Hydrobiosis	5	C	C
	Hydrobiosella	9	-	R
	Neurochorema	6	-	R
	Hydropsyche (Orthopsyche)	9	R	-
	Psilochorema	6	R	-
	Pycnocentria	7	R	R
	Pycnocentrodes	5	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C
	Eriopterini	5	C	-
	Maoridiamesa	3	R	A
	Orthocladiinae	2	VA	XA
	Polypedilum	3	R	-
	Tanypodinae	5	R	-
	Empididae	3	-	R
	Austrosimulium	3	C	C
	Tanyderidae	4	-	R
		No of taxa	27	25
		MCI	104	105
		SQMCIs	4.3	3.6
		EPT (taxa)	12	14
		%EPT (taxa)	44	56
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant



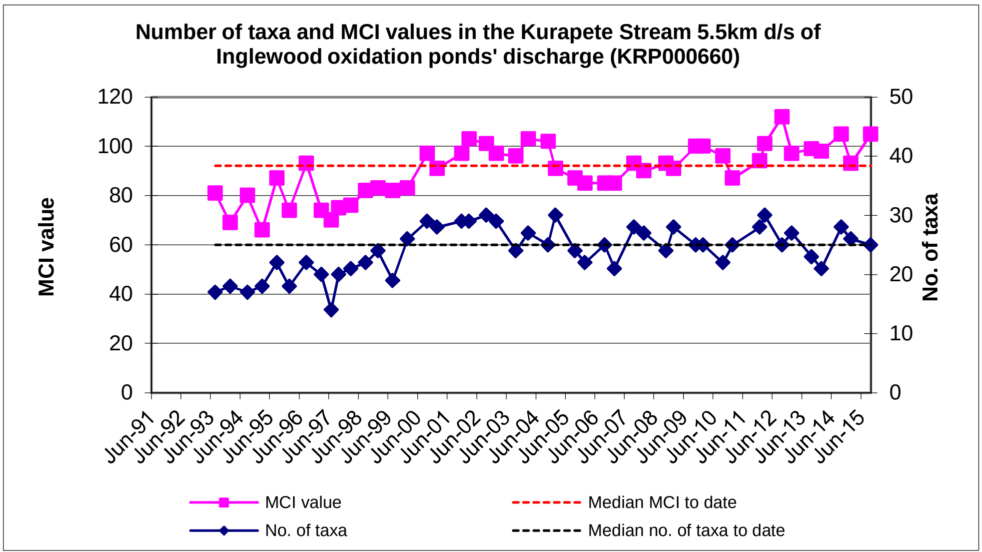


Figure 2 Taxa richness and MCI scores recorded to date at each of the sites in the Kurapete Stream

Site 1 – upstream of the oxidation ponds' discharge

A higher than long term (1986-2015) median (22 taxa) macroinvertebrate community richness of 27 taxa was recorded at this site, which was also toward the higher end of the range of richnesses recorded by the surveys since 2000 (Tables 1 and 2 and Figure 2). Three 'highly sensitive' taxa were found (although two taxa were rarities) with the site characterised by one 'highly sensitive' taxon [mayfly (*Deleatidium*)], five 'moderately sensitive' taxa [mayflies (*Austroclima*, *Coloburiscus*, and *Zephlebia* group), elmid beetles, and dobsonfly (*Archichauliodes*)] and three 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), and orthoclad midges]. This was several taxa more than the number of characteristic taxa recorded by the previous spring survey. The relatively high proportion of higher scoring 'sensitive' taxa (67% of the fauna) comprising this community was reflected in the MCI score of 104 units which was equal with the historical maximum score (recorded in the previous summer) and significantly higher than the long-term median recorded (59 surveys) for this site (90 units) and nine units higher than the median score for surveys since February 2000 (Table 2 and Figure 2). Generally, the faunal composition was similar to those found at the time of the majority of previous summer and spring surveys with relatively similar numbers of dominant taxa (TRC, 2015). The MCI score was one unit above the predicted MCI score for a ringplain seepage stream site at an altitude of 180 m asl (Stark and Fowles, 2009) and was indicative of ‘good’ generic health and ‘expected’ predictive health for the mid reaches of a ringplain seepage stream (TRC, 2015).

Site 4 – approximately 6 km downstream of the oxidation ponds’ discharge

A relatively high taxa richness (25 taxa) was recorded at this site, six taxa more than the median of taxa numbers previously recorded from fourteen surveys prior to wastes diversion (Table 1), and one taxon less than the median richness found since this diversion (Table 2 and Figure 2). This was coincident with the presence of widespread filamentous algae and patchy periphyton mats and moss on this site’s substrate. Only three ‘highly sensitive’ taxa were found at this site (two as rarities), the same number of ‘highly sensitive’ taxa as found upstream at site 1. The community was characterised by one ‘highly sensitive’ taxon [mayfly (*Deleatidium*)], six ‘moderately sensitive’ taxa [mayflies (*Austroclima*, *Coloburiscus*, and *Zephlebia* group), stonefly (*Zelandobius*), elmid beetles, and dobsonfly (*Archichauliodes*)]; and four ‘tolerant’ taxa [oligochaete worms, snail (*Potamopyrgus*), and midges (orthoclads and *Maoridiamesa*)]. Most of the ‘tolerant’ taxa are generally associated with periphyton substrate cover which was widespread at this site under moderately low flow conditions at the time of this survey.

Significant individual taxon differences in downstream abundances included increases within two ‘moderately sensitive’ and four ‘tolerant’ taxa and a decrease within one ‘moderately sensitive’ taxon which contributed to a decrease in $SQMCI_s$ scores of 0.7 unit between sites 1 and 4.

The moderate proportion of ‘tolerant’ taxa (36% of the richness) was reflected in the MCI score of 105 units. This score was very significantly (Stark, 1998) 27 units above the median of all surveys prior to wastes diversion (Table 1 and Figure 2), and one unit higher than the score at the upstream ‘control’ site. This increase in scores between sites 1 and 4 was atypical of that expected through the mid reaches of a Taranaki stream sourced outside the National Park (TRC, 2015) and dissimilar to the median average rate of decline (1.5 units/km) between these sites found prior to wastewater diversion (Table 1). The score at site 4 was nine units above the median of scores found since wastes diversion from the stream (Figure 3), and was indicative of much improved water quality conditions following wastes diversion throughout this reach of the Kurapete Stream (Figure 2). It was also indicative of an atypical lack of downstream deterioration in stream ‘health’ under spring low flow conditions in the absence of recent overflows of very dilute wastewater to the stream. The MCI score was eight units above the predicted score for a ringplain seepage stream site at an altitude of 120 m asl (Stark and Fowles, 2009) and was indicative of ‘good’ generic health and ‘expected’ predictive health for the lower mid-reaches of such a stream (TRC, 2015).

Microscopic heterotrophic assessment

Microscopic examination of subsamples from the two sites found no evidence of significant heterotrophic growths at any site confirming visual field observations. These results were consistent with the diversion of the oxidation pond system discharges out of the Kurapete Stream and coincident with recovery of the faunal communities of the receiving waters subsequent to this diversion and the absence of any diluted wastewater overflow events over a three month period prior to this survey.

Conclusions

This survey was performed in spring under relatively low flow conditions more than sixteen years since the diversion of the oxidation pond system effluent discharge from the Kurapete Stream into the New Plymouth District Council Carrousel Treatment Plant, and in the absence of any recent overflow discharge events after heavy rainfall. It continued to record the documented improvement in the biological condition of the stream at the site downstream of the outfall since the diversion, in that the biological 'health' at the downstream site was toward the maximum (in terms of MCI score) of scores recorded post-wastewater diversion. Few community composition changes, coincident with increased periphyton substrate cover and the more open nature of the stream, were recorded at the site nearly six km further downstream as illustrated by 58% of the 33 taxa found between the two sites being present at both sites and the two sites' communities sharing nine characteristic taxa. Taxa richnesses were moderately high and the MCI scores had a narrow range, from 104 to 105 units, over the reach of the Kurapete Stream surveyed. MCI scores were higher or very similar to those predicted for sites of similar altitudes in ringplain streams in the region particularly for a stream with its source downstream of the National Park. The presence of significant proportions of 'sensitive' taxa in the communities at both sites and the absence of any 'heterotrophic growths' continued to illustrate the improvements in habitat and physicochemical water quality maintained in this reach of the Kurapete Stream subsequent to wastes diversion. The biological health at the site approximately 6 km below the outfall reflected these improvements, indicative of the significance of municipal wastes discharges removal from this stream, in the absence of recent wet weather overflows of very dilute oxidation pond wastewater to the stream.

The most recent statistical trend analyses of macroinvertebrate data collected over the ten and nineteen year periods between 1995 and 2014 (Stark and Fowles, 2006 and TRC, 2015) have identified significant temporal trends of increasing MCI scores at sites 1 and 4, both of which have been ecologically significant. The positive trend was significantly stronger at the downstream site (KRP000660) than at the upstream 'control' site (KRP000300) over the first ten years, but the trend at the downstream site has partly reduced in significance over the longer nineteen year period. The improvement upstream was attributed principally to the diversion of the iron-laden tributary draining the old Inglewood landfill, into the oxidation ponds system, while the major influence downstream has been the removal of the wastewater discharge from the stream (TRC, 2006 and 2015). In recent years the upstream trend has tended to continue while there has been a very strong trend of improvement between 1999 and 2004 at the downstream site, then a decreasing trend between 2004 and 2007, followed by further steady improvement which overall has reduced the significance of the temporal trend. Stream generic 'health' over this reach remains 'fair' (mainly) to 'good' (occasionally), representing an improvement from the 'poor' health consistently recorded at the downstream site when wastewater was discharged into the Kurapete Stream prior to 2000.

Biological monitoring of the stream will continue to be performed on the reduced basis in terms of fewer sites (upstream 'control' site 1 and downstream site 4), in order to document temporal trends in stream 'health', particularly as riparian improvements and dairy wastes disposal to land initiatives are implemented in the catchment. A return to the four site survey (as performed on specific survey occasions in the past e.g. spring 2013) would occur only in order to assess any impacts of consented (1449) extreme rainfall associated discharges, should such events be prolonged.

Summary

The Council's standard 'kick-sampling' technique was used at two established site to collect streambed macroinvertebrates from the Kurapete Stream. Samples were processed to provide the number of taxa (richness), MCI score, $SQMCI_S$ score, and %EPT taxa for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_S$ takes into account taxa abundance as well as sensitivity to pollution, and may reveal more subtle changes in communities. It may provide more relevant information in relation to non-organic impacts. Differences in either the MCI or the $SQMCI_S$ between sites indicate the degree of adverse effects (if any) of the discharges being monitored.

This spring macroinvertebrate survey indicated that, in the absence of any recent (consented) discharges of treated oxidation ponds' wastes from the Inglewood Wastewater Treatment Plant, the macroinvertebrate community of the Kurapete Stream at the site some 6 km downstream of the original discharge point had maintained the improvement in condition ('health') consistent with that documented since wastes diversion from the stream.

The macroinvertebrate communities of the stream contained moderate (predominant) proportions of 'sensitive' taxa at both sites and the communities were dominated by a combination of mainly 'sensitive' and a few 'tolerant' taxa with a similar percentage of 'sensitive' taxa and slightly greater numerical abundances within two 'tolerant' taxa at the more open downstream site coincident with more extensive periphyton substrate cover and more typical of that found previously (particularly in summer). Taxonomic richnesses (numbers of taxa) and MCI scores indicated that this post-wastes diversion improvement had been maintained at the time of this spring relatively low flow survey when compared with the surveys conducted prior to wastes diversion from the stream.

MCI scores indicated that the stream communities at both sites were of 'good' health and generally equivalent with typical conditions recorded in similar reaches of Taranaki seepage-sourced ringplain streams.

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To	Rae West, Job Manager
From	Darin Sutherland, Scientific Officer
Document	1689906
Report No	DS050
Date	June 2016

Biomonitoring of the Kurapete Stream in relation to the New Plymouth District Council's Inglewood oxidation ponds' system, March 2016

Introduction

This summer survey was the second of two surveys programmed for the 2015-2016 monitoring period. Since spring 2007, biomonitoring surveys have been reduced from four sites to two sites in recognition of the minimal usage of the WWTP overflow facility to the Kurapete Stream in recent years. However, a wet winter and very wet early spring to mid summer (2011-2012) period, caused a series of overflows of very dilute, treated wastewater to the Kurapete Stream over several periods until approximately two weeks prior to the mid-summer survey (see CRF541). In response to additional receiving water monitoring requirements associated with significant overflow events, an extended four site mid-summer biomonitoring survey was undertaken at all four established sites at that time. Two brief overflow events occurred between early and mid March 2012 and another in July 2012. At the time of the October 2012 survey, more than ten weeks since any overflow, the storage pond wastewater had been reduced (by pumping to the New Plymouth treatment plant) to a level approximately 1.5 m below the overflow level. No subsequent overflows occurred prior to the February 2013 (summer) biomonitoring survey. However, a wet winter and early spring period caused a series of overflows of very dilute, treated wastewater to the Kurapete Stream over several periods with an overflow event ceasing only two weeks prior to the spring 2013 survey. At the time of that survey (in October 2013), the storage pond wastewater had been reduced (by pumping to the New Plymouth treatment plant) to a level approximately 1m below the overflow level. In response to additional receiving water monitoring requirements associated with significant overflow events, an extended four site spring biomonitoring survey was undertaken at all four established sites [which had been last fully surveyed in January, 2012 (CF541, 2012)]. No extended four site surveys have been required since that spring 2013 survey. The most recent overflow event followed an intensive wet weather period in late June 2015.

Methods

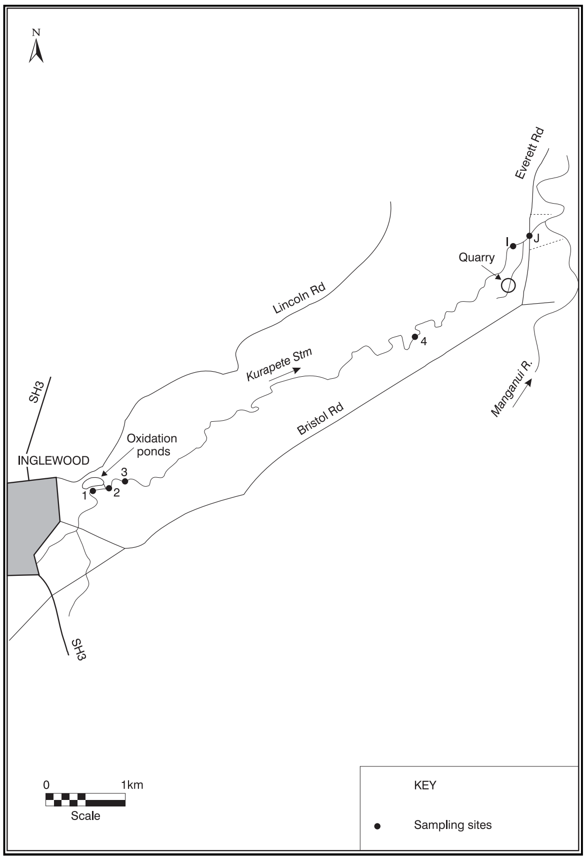
The standard '400 ml kick sampling' technique was used to collect streambed (benthic) macroinvertebrates from two established sampling sites in the Kurapete Stream (illustrated in Figure 1) on 31 March 2016.

These sites were:

Site No	Site Code	GPS reference	Location
1	KRP000300	1705087E 5665510N	Upstream of oxidation ponds' discharge
4	KRP000660	1709239E 5667481N	Approx 6km downstream of oxidation ponds' discharge

This ‘kick-sampling’ technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Samples were preserved with Kahle’s Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al, 2001). Macroinvertebrate taxa abundances scored based on the categories presented in Table 1.



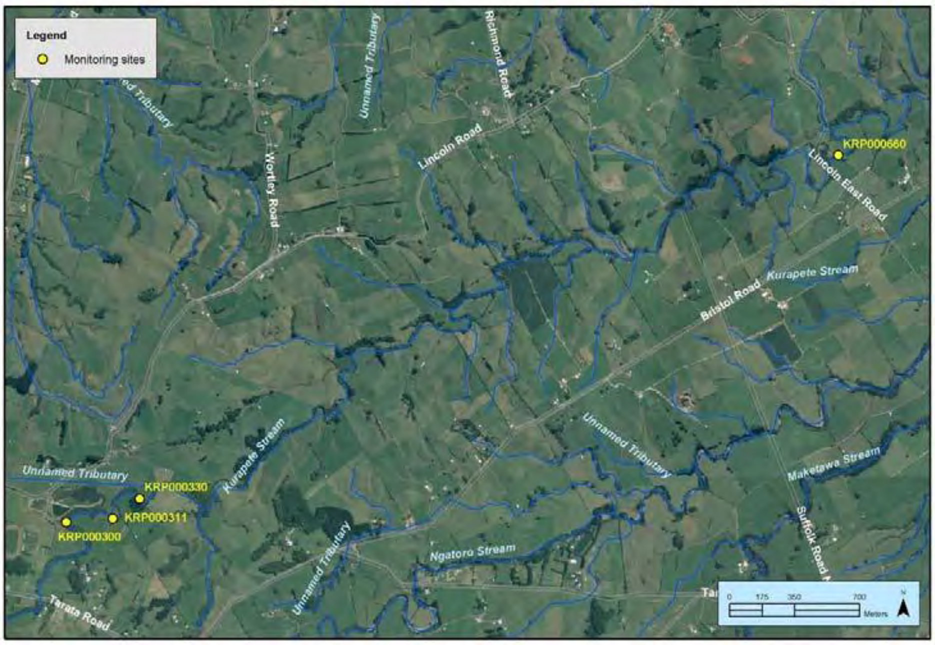


Figure 1 Sampling sites in the Kurapete Stream in relation to Inglewood oxidation ponds

Table 1 Macroinvertebrate abundance categories

Abundance category	**Number of individuals**
R (rare)	1-4
C (common)	5-19
A (abundant)	20-99
VA (very abundant)	100-499
XA (extremely abundant)	500+

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly `sensitive' taxa were assigned the highest scores of 9 or 10, while the most `tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. By averaging the scores obtained from a list of taxa collected from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. A gradation of biological water quality conditions based upon MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985 and Boothroyd and Stark, 2000) (Table 2). More 'sensitive' communities inhabit less polluted waterways. A difference of 10.83 units or more in MCI values is considered significantly different (Stark 1998).

Table 2 Macroinverbrate health based on MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985 and Boothroyd and Stark, 2000)

Grading	**MCI**
Excellent	>140
Very Good	120-140
Good	100-119
Fair	80-99
Poor	60-79

A semi-quantitative MCI value, $SQMCI_S$ (Stark 1999) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these scores, and dividing by the sum of the loading factors. The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA), and 500 for extremely abundant (XA). A difference of 0.83 units or more in $SQMCI_s$ values is considered significantly different (Stark 1998).

Sub-samples of algal and detrital material taken from the macroinvertebrate samples where necessary, were scanned under 40-400x magnification to determine the presence or absence of any mats, plumes or dense growths of bacteria, fungi or protozoa ('undesirable biological growths') at a microscopic level. The presence of masses of these organisms is an indicator of organic enrichment within a stream.

Results

Site habitat characteristics and hydrology

This summer survey was performed under low flow conditions (approximately quarter of median flow), 7 days after a fresh in excess of 3 times median flow and 42 days after a fresh of 7 times median flow (flow gauge at the Mangaoraka Stream at Corbett Rd). The survey followed a relatively dry summer period with only two significant river freshes recorded over the preceding month, two freshes both in excess of 3x median flows. The water temperature was 14.5°C at site 1 and 15.1°C at site 2. At site 1 the water speed was swift, water uncoloured and cloudy while at site 4 the water speed was swift, water uncoloured and cloudy.

The stream at site 1 had slippery periphyton mats and no filamentous algae. Moss and leaves were patchy on the streambed. There was complete bed shading from overhanging vegetation. The substrate was predominately cobbles. Site 4 had patchy mats and widespread filamentous algae. Moss and leaves were patchy on the streambed. There was partial bed shading from overhanging vegetation. The substrate was also predominately cobbles.

Macroinvertebrate communities

Survey results for the period prior to the February 2000 survey are summarised in Table 3, including those from site 2 which was established in July 1997. This period coincided with the duration of discharges of treated effluent to the Kurapete Stream.

Table 3 Summary of macroinvertebrate taxa numbers and MCI values for previous surveys performed between June 1986 and August 1999 (pre effluent diversion)

Site	Site code	No of surveys	Taxa numbers		MCI values	
			Range	Median	Range	Median
1	KRP000300	28	10-29	20	78-94	87
2	KRP000311	5	12-18	15	53-78	72
3	KRP000330	27	8-19	14	52-86	64
4	KRP000660	14	14-24	20	66-93	78

The results of the thirty-two surveys performed following cessation of the permanent discharge to the stream and prior to the current survey are summarised for comparative purposes in Table 4.

Table 4 Summary of macroinvertebrate taxa numbers and MCI values for post effluent diversion surveys performed between February 2000 and March 2016

Site	Site code	No of surveys	Taxa numbers		MCI values		SQMCI	
			Range	Median	Range	Median	Range	Median
1	KRP000300	32	13-32	23	80-104	95	2.8-6.4	4.4
2	KRP000311	18	15-33	24	80-101	94	2.5-6.4	3.5
3	KRP000330	18	15-28	23	84-103	92	2.5-6.1	3.7
4	KRP000660	32	21-30	26	83-112	97	1.7-5.6	4.0

Survey results from June 1986 to date for each site are illustrated in Figure 2. This current survey's faunal results are presented in Table 4 and discussed on a site-by-site basis.

Table 5 Macroinvertebrate fauna of the Kurapete Stream in relation to the Inglewood oxidation ponds system sampled on 31 March 2016

Taxa List	Site Number	MCI score	1	4
	Site Code		KRP000300	KRP000660
	Sample Number		FWB16185	FWB16186
NEMERTEA	Nemertea	3	-	C
ANNELIDA (WORMS)	Oligochaeta	1	A	VA
	Lumbricidae	5	R	-
MOLLUSCA	*Potamopyrgus*	4	A	A
CRUSTACEA	Isopoda	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	A
	Coloburiscus	7	VA	A
	Deleatidium	8	-	R
	Zephlebia group	7	VA	C
COLEOPTERA (BEETLES)	Elmidae	6	VA	A
	Ptilodactylidae	8	R	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	VA
	Costachorema	7	-	R
	Hydrobiosis	5	R	C
	Neurochorema	6	R	C
	Hydropsyche (Orthopsyche)	9	R	-
	Beraeoptera	8	-	R
	Oxyethira	2	-	R
	Pycnocentria	7	A	A
	Pycnocentrodes	5	-	A
	Triplectides	5	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C
	Eriopterini	5	R	-
	Limonia	6	C	-
	Orthocladiinae	2	R	A
	Polypedilum	3	-	R
	Tanytarsini	3	-	R
	Empididae	3	R	R
	Muscidae	3	-	R
	Austrosimulium	3	C	C
		No of taxa	22	25
		MCI	106	99
		SQMCIs	6.3	4.0
		EPT (taxa)	9	11
		%EPT (taxa)	41	44
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 1 – upstream of the oxidation ponds' discharge

A moderately high macroinvertebrate community richness of 22 taxa was found at site 1 ('control' site) at the time of the summer survey. This was one less than the historical median for this site and five taxa lower than the previous survey on October 2015 (Table 4, Table 5).

The MCI score of 106 units indicated a community of 'good' biological health which was significantly higher (Stark, 1998) than the historical median MCI score of 95 units. The MCI score was not significantly different (Stark, 1998) to the preceding survey (104 units) but was the highest MCI score recorded at the site in 32 post discharge surveys.

The SQMCI$_S$ score of 6.3 units was significantly higher (Stark, 1998) than the median MCI score of 4.4 units (Stark, 1998) (Table 4, Table 5).

There were a relatively large number of 'very abundant' and 'abundant' taxa. The community was characterised by four 'very abundant' taxa ['moderately sensitive' mayflies (*Austroclima*, *Coloburiscus* and *Zephlebia* group) and beetle (Elmidae). There were also five 'abundant' taxa (Table 5).

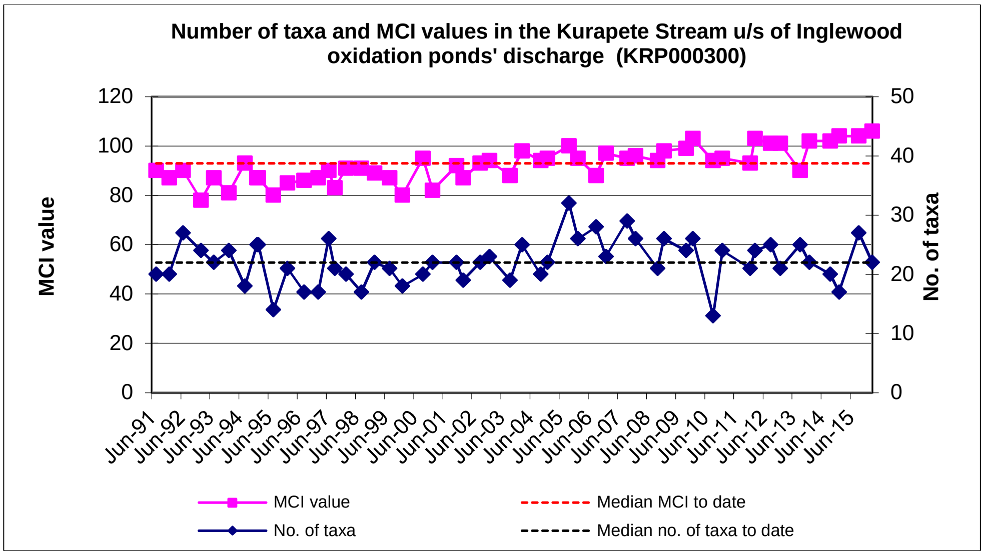


Figure 2 Taxa richness and MCI scores recorded to date for site 1 in the Kurapete Stream

Site 4 – approximately 6 km downstream of the oxidation ponds' discharge

A moderately high macroinvertebrate community richness of 25 taxa was found at site 4 ('impact' site) at the time of the summer survey. This was one less than the historical median for this site and the same number as the previous survey on October 2015 (Table 4, Table 5).

The MCI score of 99 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the historical median MCI score of 97 units. The MCI score was also not significantly different (Stark, 1998) to the preceding survey (105 units).

The SQMCI$_S$ score of 4.0 units was the same as the median MCI score of 4.0 units (Stark, 1998) (Table 4, Table 5).

The community was characterised by two ‘very abundant’ taxa [‘tolerant’ oligochaete worms and caddisfly (*Hydropsyche / Aoteapsyche*)]. There were also eight ‘abundant’ taxa (Table 5).

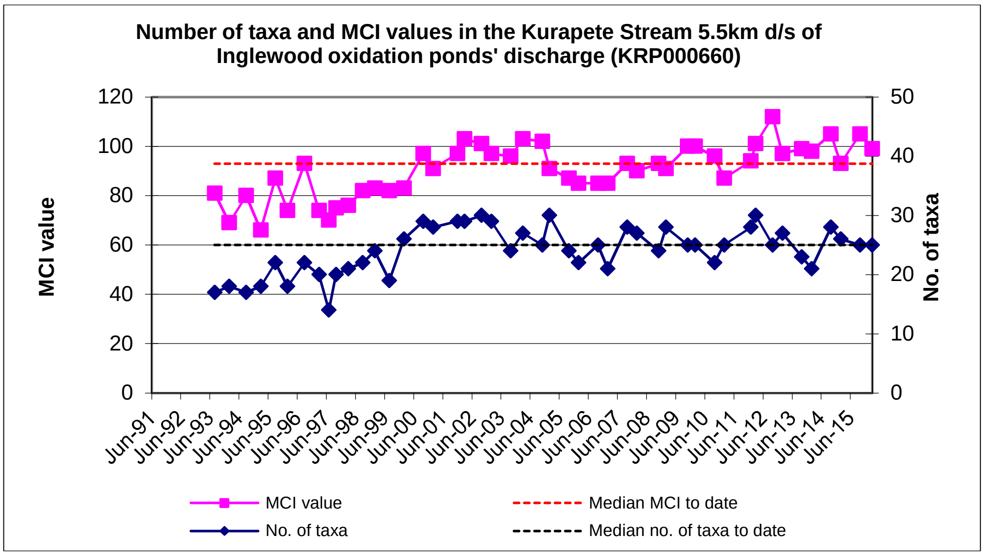


Figure 3 Taxa richness and MCI scores recorded to date for site 4 in the Kurapete Stream

Microscopic heterotrophic assessment

Microscopic examination of subsamples from the two sites found no evidence of significant heterotrophic growths at any site confirming visual field observations. These results were consistent with the diversion of the oxidation pond system discharges out of the Kurapete Stream.

Discussion and conclusions

Refurbishment of the pond system had been performed in late 1999 and completed by the consent holder early in 2000 with all wastes diverted to the New Plymouth Carrousel Treatment Plant. Subsequently, several consented overflows have occurred following very heavy rainfall periods. More recently several overflows occurred in the late winter-spring of 2011, early January 2012, two further short duration overflows in early to mid March 2012, in July 2012, and in October 2013 after a series of wet weather events. No subsequent overflows to the stream had occurred until April 2015 with the most recent overflow following wet weather in late June 2015.

The diversion of the small left bank tributary draining the old landfill area, by a cut-off drain into the primary oxidation pond, had significantly reduced the extent of orange-brown iron-oxide deposits on the bed of the Kurapete Stream at site 1 upstream of the effluent discharge although subsequent reticulation work in the vicinity of this diversion had altered the drainage pattern.

This survey was performed in summer under relatively low flow conditions more than sixteen years since the diversion of the oxidation pond system effluent discharge from the Kurapete Stream into the New Plymouth District Council Carrousel Treatment Plant, and in the absence of any recent overflow discharge events after heavy rainfall. It continued to record the documented improvement in the biological condition of the stream at the site downstream of the outfall since the diversion, in that the biological ‘health’ at the downstream site was toward the maximum (in terms of MCI score) of scores recorded post-wastewater diversion.

Macroinvertebrate richness at the ‘impact’ site (site 4) was similar (three taxa higher) to the ‘control’ site (site 1) and to the historical median suggesting no effects of any toxic discharges. Community composition was similar between the sites but site 1 did have significantly more ‘very abundant’ ‘moderately sensitive’ species compared with site 4 which was dominated by ‘tolerant’ species.

The ‘control’ site was healthier than the ‘impact’ site and it recorded its highest ever MCI score indicating ‘good’ health. The improvement at the upstream site can be attributed to the diversion of the iron-laden tributary draining the old Inglewood landfill. The lower health at the ‘impact’ site was related to increased periphyton cover and the less shaded, sunnier, site and possibly diffuse agricultural inputs rather than any discharges from the Inglewood WWTP.

The presence of significant proportions of ‘sensitive’ taxa in the communities at both sites and the absence of any ‘heterotrophic growths’ continued to illustrate the improvements in habitat and physicochemical water quality maintained in this reach of the Kurapete Stream subsequent to wastes diversion. The biological health at the site approximately 6 km below the outfall reflected these improvements, indicative of the significance of municipal wastes discharges removal from this stream, in the absence of recent wet weather overflows of very dilute oxidation pond wastewater to the stream.

Biological monitoring of the stream will continue to be performed on the reduced basis in terms of fewer sites (upstream ‘control’ site 1 and downstream ‘impact’ site 4), in order to document temporal trends in stream ‘health’, particularly as riparian improvements and dairy wastes disposal to land initiatives are implemented in the catchment. A return to the four site survey (as performed on specific survey occasions in the past e.g. spring 2013) would occur only in order to assess any impacts of consented (1449) extreme rainfall associated discharges, should such events be prolonged.

Summary

The Council’s standard ‘kick-sampling’ technique was used at two established site to collect streambed macroinvertebrates from the Kurapete Stream. Samples were processed to provide the number of taxa (richness), MCI score, $SQMCI_S$ score, and %EPT taxa for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_S$ takes into account taxa abundance as well as sensitivity to pollution, and may reveal more subtle changes in communities. It may provide more relevant information in relation to non-organic impacts. Differences in either the MCI or the $SQMCI_S$ between sites indicate the degree of adverse effects (if any) of the discharges being monitored.

This summer macroinvertebrate survey indicated that, in the absence of any recent (consented) discharges of treated oxidation ponds’ wastes from the Inglewood Wastewater Treatment Plant, the macroinvertebrate community of the Kurapete Stream at the site some

6 km downstream of the original discharge point had maintained the improvement in condition ('health') consistent with that documented since wastes diversion from the stream.

MCI scores indicated that the stream community at the 'control' site was of 'good' health while the 'impact' site was of 'fair' health. The $SQMCI_S$ score at the 'impact' site was significantly worse than the 'control' site and reflected the numerical dominance of 'tolerant' taxa at the site. The lower MCI and $SQMCI_S$ scores at the downstream site was a reflection of the higher periphyton levels at the site caused by less shading and possibly diffuse pollution from agricultural inputs.

Overall, there was no evidence that discharges from the Inglewood waste water treatment plant had had any significant detrimental impacts on the macroinvertebrate communities of the Kurapete Stream.

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