Inglewood Metal Limited
Quarry Monitoring Programme
Annual Report
2015-2016

Technical Report 2016-119

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Executive summary

Inglewood Metal Limited (the Company) operates a quarry located at Everett Road in the Kurapete catchment. The Company holds a resource consent to allow it to discharge treated washwater, stormwater and groundwater into an unnamed tributary of the Kurapete Stream. 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 Company's environmental performance during the period under review. The report also details the results of the monitoring undertaken and assesses the environmental effects of the Company's activities.

During the monitoring period, the Company demonstrated an overall level of environmental performance which required improvement.

The Council's monitoring programme included four scheduled inspections (including on-site liaison with management staff), four discharge and three receiving water physicochemical surveys, and one biological survey of receiving waters.

The monitoring indicated that discharges from the Company's quarry site were having a significant adverse effect in the receiving waters of the Kurapete Stream. The likely factors contributing to the poor quality discharge included the introduction of washwater into the stormwater treatment pond system and also the increased stormwater catchment. There was one non-compliant discharge during the period under review.

During the year, the Company demonstrated a level of environmental performance which required improvement. The Company demonstrated a high level of administrative performance over the same period.

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.

This report includes recommendations for the 2016-2017 year.

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period July 2015 to June 2016 by the Council describing the monitoring programme associated with resource consents held by the Company. The Company operates a quarry situated on Everett Road, Inglewood.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consent held by the Company that relate to the discharge of water in the Kurapete catchment. This is the 21st annual report to be prepared by the Council to cover the Company's water discharges and their effects.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about:

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites through annual programmes;
- the resource consents held by the Company in the Kurapete catchment;
- the nature of the monitoring programme in place for the period under review; and
- a description of the activities and operations conducted at the Company's site.

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 the Company, 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 the Company'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 Process description

The Company's quarrying operation is located adjacent to the true right of the Kurapete Stream at Everett Road, near Inglewood. Some washing is performed at the site and the machinery includes a dry crusher and a washing and screening plant.

Waste washwater is directed through a series of settling ponds before being either recirculated for use in washing or discharged via a further series of ponds to the head of the unnamed tributary. The quarrying area is contoured and bunded so that groundwater and stormwater are directed back to the settling ponds in the base of the quarry floor (Figure 1) before being pumped to the pond system for washing, or discharging through to the final pond and then to an unnamed tributary of the Kurapete Stream. Over recent years there has been some variability in the configuration of the upper settlement ponds system receiving the quarry floor wastewater prior to discharge to the stream.

Discharge from the final treatment pond is via a steel pipe access culvert to the unnamed tributary of the Kurapete Stream which flows approximately 600 m before joining the Kurapete Stream upstream of the Everett Road Bridge.

Gravel filtered surface runoff from the entrance to the quarry, off Everett Road, and the upstream farm drainage enter the northern boundary drain which discharges into the unnamed tributary (Figure 1).

Quarry management had advised that the quarry face would continue to be excavated and in recent years larger ponds have been constructed on the quarry floor for improved retention and settlement of turbid groundwater and stormwater prior to pumping to the upper ponds' treatment system. The configuration of the quarry floor pond system has remained essentially the same as that illustrated in Figure 1.

1.3 Resource consents

1.3.1 General

In the past, a large percentage of aggregate production came from river-based sites within Taranaki. The Waiwhakaiho River supplied much of New Plymouth's requirements as far back as the 1950s with the Waitara River, Waiongana River, Kapuni Stream and Waingongoro River also providing a valuable source of aggregate. The aggregate source within these rivers was often over-exploited. The protective armouring of the boulders and gravel was removed in places, exposing the underlying erodible ash beds and creating deep narrow channels, which moved progressively upstream with no noticeable recovery. This brought about the need for the Shingle Extraction Bylaw introduced in 1974. Aggregate extraction from rivers was then controlled through the issue of permits accompanied by a set of conditions, with the removal of river-based aggregate being restricted to that for river control purposes only.

Historically, land-based sites required steady markets to compete with the easily won river-based extraction operations. However, in the early 1980s, due to the restriction placed on river-based aggregate extraction (and the completion of various major river

control programmes and 'Think Big' projects) land-based sites became more widespread (Taranaki Regional Council, 1992).

Twenty-nine operating quarries presently supplying aggregate in Taranaki are monitored for consent compliance. These quarries are generally located in reasonable proximity to urban areas, from which the greatest demand for aggregate stems.

Provision of aggregate to meet longer-term demand will continue to be dominated by several large quarry operations. Extra demand on alluvial terraces and laharic deposits has occurred due to the controlled river bed extraction. These resources are of good quality and are relatively plentiful, although Taranaki aggregates are known to have a lower crushing strength [85 kN] than aggregates from most other parts of New Zealand. Importation of various aggregates may need to continue to meet the requirement for aggregate types not available in Taranaki.

Quarrying and shingle extraction in Taranaki is covered by the RMA and, if the minerals in question are Crown owned, by the Crown Minerals Act 1991.

Regional councils have no control over the provision of exclusive rights to minerals. However, they do have control over the environmental effects of aggregate extraction from river and lake beds, and land in certain circumstances, and these controls may act as a constraint or limitation on allocation decisions.

Sections 15 and 30 of the RMA give regional councils responsibility for the discharge of contaminants into the environment. Discharges of water into water, contaminants onto or into land that may result in water contamination, and contaminants from industrial premises into air or onto/into land, may not take place unless expressly allowed by a rule in a regional plan, a resource consent, or regulations.

Aggregate extraction usually involves washing aggregates, and therefore requires the discharge of wastes. Other discharges, such as emissions to air from crushing and processing plants, disposal of spoil and solid wastes, and discharges of stormwater are also the responsibility of regional councils.

Figure 1 Quarry operations, wastewater treatment system

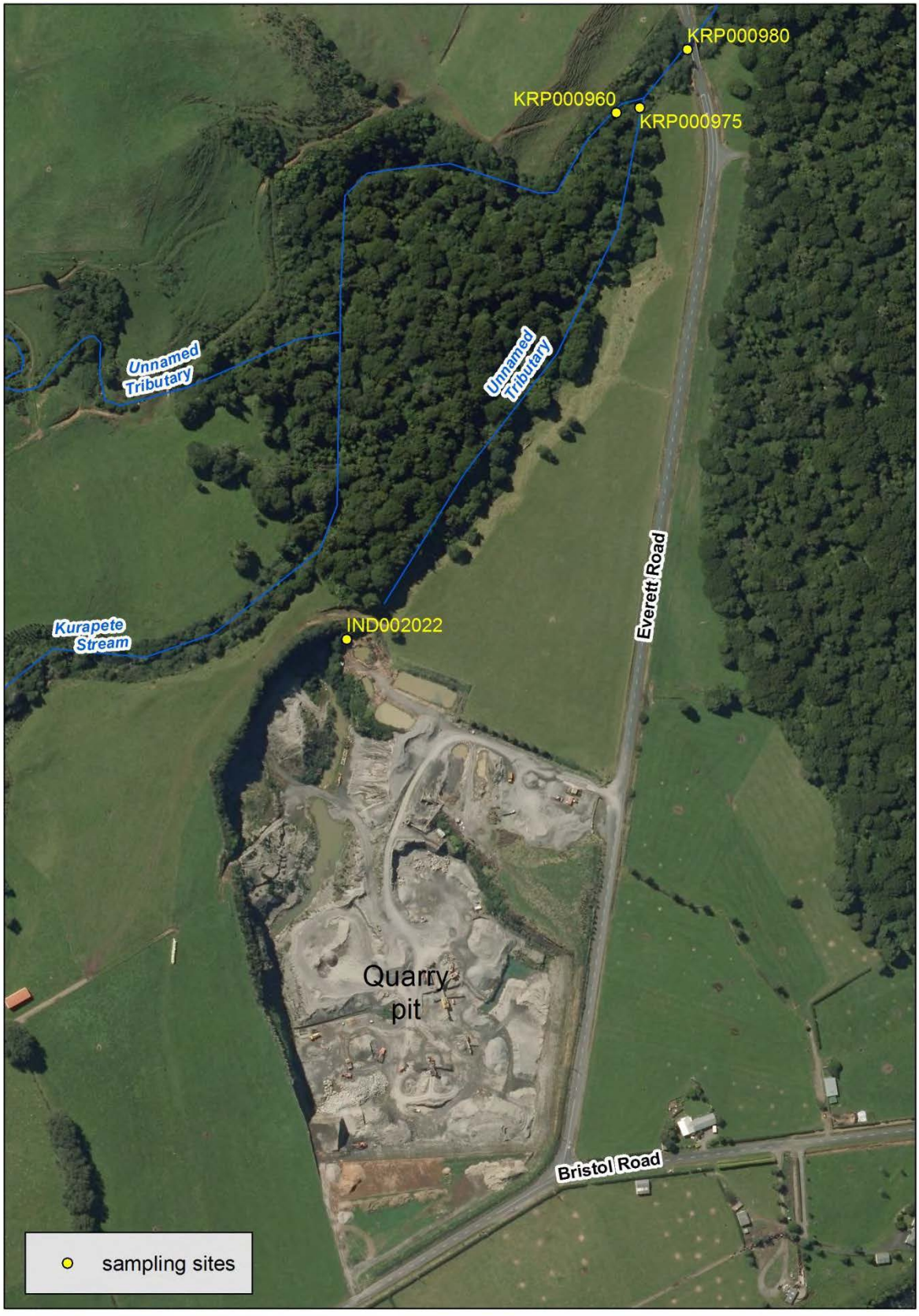

Figure 2 Aerial location map showing sampling sites' locations in relation to the quarry site.

1.3.2 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.

Water quality is a primary concern to the Council with regard to aggregate extraction. A quarry can operate as either a 'dry' quarry discharging only stormwater, or a 'washing' quarry, where aggregate washing facilities are in place. Many of the quarries in Taranaki have some form of washing facility and also operate in the vicinity of a water body, or have some form of discharge into a water body.

Waste water from aggregate washing has a high silt concentration. Discharge of this water into a waterbody, particularly to a stream during low flow, can result in smothering of instream life and deterioration in aesthetic conditions and can affect downstream abstractions of water, local fisheries and recreational activity.

Stormwater is generally less contaminated (in terms of silt concentration) and run-off tends to occur when rivers and streams are in higher flow. This means that the effect of silt contamination is reduced due to lower quantities, greater dilution, and increased carrying capacity. The installation of appropriate stormwater diversion structures, together with construction and maintenance of contaminated stormwater and aggregate washing discharge treatment facilities, are most important in maintaining water quality.

The company currently holds discharge consent **1113-4** to cover the discharge of treated stormwater (including groundwater seepage) and treated washwater into an unnamed tributary of the Kurapete Stream. This consent (see Appendix I) was renewed by the Council on 20 May 2004 under Section 87(e) of the RMA. It expired on 1 June 2015 and an application for consent renewal is currently being processed.

There are 15 special conditions associated with the discharge permit 1113-4. Of these, eight conditions relate to the operation and management of quarrying activities and the treatment system (including recirculation of washwater to minimise this component of the discharge); two conditions are related to reinstatement requirements; one condition requires provision of contingency planning; and three conditions relate to treated wastewater quality and limit effects of the discharge on the receiving water (Kurapete Stream) quality. A further condition provides for review of the consent should this be necessary.

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.

The monitoring programme for the Company's quarry site consisted of four 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

There were four routine inspections of the Company's site during the monitoring period. An additional sampling inspection was carried out in association with an abatement notice that was issued during the monitoring period. With regard to consents for the abstraction of or discharge to water, the main points of interest were plant processes with potential or actual discharges to receiving watercourses, including contaminated stormwater and process wastewaters. Air inspections focused on plant processes with associated actual and potential emission sources and characteristics, including potential odour, dust, noxious or offensive emissions. The neighbourhood was surveyed for environmental effects.

1.4.4 Physicochemical sampling

The Council undertook sampling of both the discharges from the site and the water quality upstream and downstream of the mixing zone in the Kurapete Stream.

Samples were taken from the Company's discharge during routine inspections on three occasions. On all three of these occasions samples of the receiving waters were also collected at the end of the unnamed tributary prior to the confluence with the Kurapete Stream, and in the Kurapete Stream upstream of the tributary discharge and downstream beyond the 25 m mixing zone. An additional discharge sample was collected in association with an abatement notice that was issued during the monitoring period. All samples were analysed for pH, turbidity, conductivity and suspended solids.

1.4.5 Biomonitoring surveys

One biomonitoring survey of the Kurapete Stream was conducted at two sites, one upstream and one downstream of the confluence with the unnamed tributary. This survey was conducted in March 2016, seven days after the most recent stream fresh and during an early autumn low flow period.

2. Results

2.1 Water

2.1.1 Inspections and sample results

Details from the four routine inspections and the associated sample results are reported below. Sampling locations are described in Table 1 and Figure 2.

Table 1 Location of sampling sites

Site	Location	GPS location	Site code
Kurapete Stream	100 m u/s of Everett Road bridge (upstream of quarry tributary)	1710640E 5668709N	KRP000960
Quarry washwater / stormwater	At discharge outlets (NB sw included after Feb 1998)	1710431E 5668301N	IND002022
Unnamed tributary	5m u/s of the Kurapete Stream confluence (600 m downstream of discharges at quarry)	1710658E 5668713N	KRP000975
Kurapete Stream	At the Everett Road bridge (approximately 100 m d/s of quarry tributary)	1710695E 5668758N	KRP000980

25 August 2015

The inspection was undertaken in wet weather conditions. The quarry manager was met onsite. There was little activity taking place at the time of the inspection. The wash plant was not in use and there was no material being processed in the quarry pit. Rubbish had been dumped on site. The Company were informed that a resource consent would be required as per rule 31 of the Regional Air Quality Plan for Taranaki if they intended to burn material on site.

Water was being pumped from the quarry pit stormwater ponds to the third silt pond. There was a high flow discharge from the final pond into the unnamed tributary. Samples were collected of the discharge and the receiving waters (Table 2). The Kurapete Stream was at a high flow and turbid.

Table 2 Results from samples collected on 25 August 2015

Site location		IND002022 Quarry discharge	KRP000975 Tributary downstream	KRP000960 Kurapete Stream upstream	KRP000980 Kurapete Stream downstream
Parameter	Unit				
Time	NZST	08:40	09:15	09:20	09:10
Conductivity @20°C	mS/m	23.8	20.1	9.7	11.2
pH	pH	7.4	7.3	7.3	7.4
Suspended solids	g/m^3	30	44	35	38
Turbidity	NTU	33	41	25	25
Appearance		High flow	High flow, turbid grey	High flow, turbid brown	High flow, turbid brown

Note: There was no noticeable hydrocarbon sheen on the final pond therefore there was no requirement for such analytical measurements for compliance purposes.

All samples were compliant with resource consent conditions.

27 November 2016

Conditions were overcast with occasional showers. The quarry had undergone a change in management since the previous inspection. The new manager was met with

onsite during this inspection. Future plans for reinstatement were discussed. The manager stated that the clay pile in the quarry pit would be used to re-instate where the existing stormwater pond was. A new pond would then be constructed. The wash plant was not operating at the time of inspection. The ring drains were clean and clear.

Stormwater was being pumped up from the quarry pit into the third settling pond. The final pond was discharging into the unnamed tributary. Samples of the discharge and receiving waters were collected for analysis (Table 3).

Table 3 Results from samples collected on 27 November 2015

Site location		IND002022 Quarry discharge	KRP000975 Tributary downstream	KRP000960 Kurapete Stream upstream	KRP000980 Kurapete Stream downstream
Parameter	Unit				
Time	NZST	08:00	08:15	08:20	08:10
Conductivity @20°C	mS/m	23.7	23.1	11.4	13.5
pH	pH	7.7	7.6	7.7	7.7
Suspended solids	g/m^3	33	30	<2	6
Turbidity	NTU	26	24	1.2	4
Appearance		Moderate flow, light brown	Slightly turbid	Clean, clear	Clean, clear

Note: There was no noticeable hydrocarbon sheen on the final pond therefore there was no requirement for such analytical measurements for compliance purposes.

All samples were compliant with the associated resource consent conditions. Overall, the site was tidy and compliant with resource consent 1113-4.

1 April 2016
Conditions were overcast with light winds. The quarry manager was met onsite. The planned reinstatement works had been halted whilst management awaited Worksafe approval. Quarrying of the new extraction area had also been delayed for this reason. Instead, further excavation was taking place in the pit floor. The wash pond had recently been cleaned out. The wash plant was not operating at the time of inspection.

Groundwater was being pumped from the pit up into the stormwater ponds. The ponds appeared to be working well. The final pond was not discharging at the time of the inspection; no water samples were collected. Upon inspection, the Kurapete Stream was flowing clean and clear.

Overall, the site was tidy and compliant with resource consent 1113-4.

19 May 2016
The inspection was undertaken in showery conditions following recent heavy rain. The quarry was not operating at the time of inspection.

The wash pond level was low and was not discharging into the second pond. Stormwater was being pumped from the quarry pit to the third pond. The ponds were very turbid from this activity and were discharging at a high flow rate. Samples were collected of the discharge and the receiving waters for analysis (Table 4). The unnamed tributary was turbid until the confluence with the Kurapete Stream. The Kurapete Stream was at a moderate flow and was clean and clear at the Everett Road bridge.

Table 4 Results from samples collected on 19 May 2016

Site location		IND002022 Quarry discharge	KRP000975 Tributary downstream	KRP000960 Kurapete Stream upstream	KRP000980 Kurapete Stream downstream
Parameter	**Unit**				
Time	NZST	08:42	8:55	09:00	08:50
Conductivity @20°C	mS/m	23.9	25.4	11.5	11.7
pH	pH	7.6	7.5	7.5	7.6
Suspended solids	g/m^3	**390**	27	4	4
Turbidity	NTU	470	39	4.2	3.3
Appearance		High discharge rate, turbid milky colour	Low flow, slightly turbid milky colour	Moderate flow, clean, clear	Moderate flow, clean, clear

Note: There was no noticeable hydrocarbon sheen on the final pond therefore there was no requirement for such analytical measurements for compliance purposes.
Consent limit exceedances in bold.

The discharge sample was non-compliant with special condition 10 of resource consent 1113-4 (Table 2). The suspended solids concentration in this sample was nearly four times greater than the consent limit (100 g/m^3). The Kurapete Stream samples remained compliant with special condition 12.

The follow up monitoring undertaken by the Council in response to this non-compliance is detailed in section 2.3.

2.1.2 Biomonitoring

2.1.2.1 Introduction

One of a number of recommendations contained in the 1995-1996 Annual Report (TRC 96-15c) stated that the monitoring programme should include a summer biomonitoring survey performed in the lower reaches of the Kurapete Stream. This requirement was made in recognition of the fisheries importance of the lower reaches of this stream, and because the consent compliance record at that time indicated a need for a form of monitoring which provided longer-term evaluation of potential siltation effects on receiving water quality.

Some subsequent biomonitoring surveys (see TRC, 2004 , TRC, 2008, and TRC, 2010) have found evidence of macroinvertebrate faunal community deterioration in the Kurapete Stream, beyond the boundary of the mixing zone, 50 m downstream of the confluence with the small tributary which drained the quarry area. However, other surveys have found limited, but insignificant, impacts on this reach of the Kurapete Stream. Some of these improvements were coincidental with the upgrade to quarry wastewater treatment systems instigated in the 1998-99 monitoring period and improved maintenance of these systems since this time.

From time-to-time, variability in the impacts on the macroinvertebrate communities of the Kurapete Stream may have been related to confounding issues of upstream water quality improvement subsequent to the diversion of the Inglewood oxidation pond systems wastes out of the catchment. Cattle access and lack of riparian vegetation in the proximity of the downstream site, on some occasions may have accentuated the variability of these impacts. An additional site was included in some recent biomonitoring surveys to assess the extent of such effects (TRC, 2004, TRC, 2005, TRC, 2007, TRC, 2008, TRC, 2009, and TRC, 2010) but it was not required for the current

survey because of the relative absence of visual impacts on the receiving waters and limited substrate sedimentation noted at the time of the survey during a period of very low flow conditions in late summer.

2.1.2.2 2015-2016 Survey

One freshwater biological survey was performed under low flow conditions during the 2015-2016 monitoring period in early autumn (31 March 2016). This survey was performed at the two established sites in the Kurapete Stream, one upstream and the other downstream of the confluence of the tributary with the Kurapete Stream (Table 5 and Figure 2).

Table 5 Biomonitoring survey sites

Site number	Site code	GPS Map reference	Location
I	KRP000960	1710640E 5668709N	Upstream of quarry tributary stream
J	KRP000980	1710695E 5668758N	Everett Road bridge, approximately 25 m d/s of the designated mixing zone with the tributary stream

The full biomonitoring report, which includes details of the location of the sampling sites, is attached to this report in Appendix II. The results from this survey are summarised in Table 6 with the historical quarry monitoring data to date.

Table 6 Summary of biomonitoring results for the Kurapete Stream in relation to the Company's quarry from March 1997 to March 2016

Site	Taxa numbers				MCI values		
	1996-2015			2015-16 result	1996-2015		2015-16 result
	No. of surveys	Range	Median	Mar 2016	Range	Median	Mar 2016
I	21	19-32	26	25	80-107	95	107
J	21	18-32	26	22	71-101	87	89
K	8	22-35	29	-	87-103	94	-

The results from this survey indicated that the discharge of treated quarry wastewaters from the Company's quarry site had recent detrimental effects on the macroinvertebrate communities of the Kurapete Stream. This was illustrated by the Macroinvertebrate Community Index (MCI) values that were recorded at the upstream (control) and downstream (impact) sites. The macroinvertebrate communities at the control site on the Kurapete Stream contained relatively high proportions of 'sensitive' taxa indicating 'good' health while the impact site was in 'fair' health (Table 6). There was also a marked reduction in EPT taxa (mayflies, stoneflies and caddisflies), a group which are particularly sensitive to sedimentation, from the control site to the impact site. There was a general reduction in taxa abundances but not taxa richness, between sites. In addition to these results, it was observed at the time of the survey that the in stream turbidity was greater at the impact site, relative to the control site.

Overall, the survey indicated a significant impact on the macroinvertebrate community in the Kurapete Stream downstream of the confluence with the quarry's discharge tributary.

2.2 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 Company. 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 required to record an incident in association with the Company's resource consent.

During an inspection undertaken on 19 May 2016, a sample was collected from the discharge of the final settlement pond which recorded a non-compliant suspended solids concentration. The sample had a suspended solids concentration of 390 g/m^3; nearly four times over the associated consent limit (100 g/m^3).

An abatement notice was issued (EAC-21162) on the 23 May 2016 requiring the Company to undertake works to the stormwater treatment ponds to ensure compliance with resource consent 1113-4.

A follow-up inspection was undertaken on 21 June 2016 to collect a sample of the discharge to ascertain compliance with the abatement notice and resource consent conditions. Analysis of the sample showed compliance with resource consent conditions (Table 7).

Table 7 Results from follow up sample collected on 21 June 2016

Site location		IND002022 Quarry discharge	IND002022 Consent limits
Parameter	Unit		
Time	NZST	08:30	-
Conductivity @20^{o}C	mS/m	26.5	-
pH	pH	7.7	6.0 – 9.0
Suspended solids	g/m^3	24	100
Turbidity	NTU	33	-

Note: There was no noticeable hydrocarbon sheen on the final pond therefore there was no requirement for such analytical measurements for compliance purposes.

3. Discussion

3.1 Discussion of site performance

In relation to the conditions stated in resource consent 1113-4, the site was generally well managed during the 2015-2016 monitoring period. Aside from the non-compliant discharge, no major issues were observed during any of the four routine inspections. Rubbish had been dumped on site prior to the first inspection, however this was a sole occurrence, and the quarry has since changed management.

As has been emphasised in previous reports, the importance of a closed washwater re-circulation ponding system is paramount. A system design such as this would greatly improve stormwater discharge quality, and subsequently help to ensure consent compliance and minimise any impact on the receiving waters. Currently, although the system is re-circulated, it is not isolated from the remaining water that collects from various sources on site (including groundwater, surface water and stormwater). Substantial volumes of water are pumped up from the settlement lagoons in the quarry pit and directed into the pond system on the top site before discharging to the unnamed tributary. This water is mixing with the washwater where it enters the pond system, creating a large volume of turbid water which is then discharged from site. The problem is enhanced due to the size of the quarry's stormwater catchment, which is now in exceedance of the consent limit. As the catchment increases, more water must be directed through the ponds. Again, if the washwater system is not isolated, there is potential for the quarry to discharge greater volumes of inadequately treated water.

Although the site's environmental performance has improved in recent years, the results from this monitoring period indicate that the current water management system is failing to prevent adverse environmental effects. An improvement in site performance will be required for the remainder of the quarry's operating lifespan. The necessary requirements for improved site performance will be addressed in the renewed discharge consent and the newly created abstraction consent.

3.2 Environmental effects of exercise of consents

The main potential environmental effect of quarrying activities on waterways is associated with discharges of washwater and stormwater containing fine silt particles and high suspended solids concentrations. Such discharges may result in discolouration of the receiving waters near the discharge point and smothering of benthic life forms, form a barrier to fish movement, and/or affect fish spawning habitats. This is particularly relevant in the lower reaches of the Kurapete Stream near its confluence with the Manganui River.

The Council monitors for possible effects on stream biota and aesthetic quality by conducting a visual inspection of the stream both up and downstream of the quarry, and measuring physicochemical properties of the wastewater discharge and receiving environment. Biological monitoring surveys have also been undertaken at established sites under low flow conditions to provide longer term assessment of receiving water quality in terms of biological 'health'.

The monitoring that was undertaken during the 2015-2016 year indicated that the Company's site had impacted the receiving waters of the Kurapete Stream. This

conclusion was reached due to the results of both the annual biomonitoring survey as well as the routine discharge sampling. The results from the biomonitoring survey indicated that the quarry discharge had had detrimental effects on the macroinvertebrate communities of the Kurapete Stream. Later in the monitoring period, a quarry discharge sample recorded a suspended solids concentration nearly four times over the associated consent limit. Considered together, these independent events illustrate the potential cause and effect of the quarry's environmental impact.

It has been previously noted that a combination of factors can increase the impact that the quarry discharge has on the receiving Kurapete Stream (Photo 1). The factors include a discharge that is laden with very fine sediment, limited dilution of the tributary in the receiving waters under low flow conditions, and the possible re-suspension of accumulated sediment previously deposited on the tributary stream bed. Of these factors, stream flow can be useful in interpreting monitoring results and estimating the likely severity of any incidents.

Photo 1 A: Unnamed tributary near the confluence with the Kurapete Stream. B: Turbid plume in Kurapete Stream at confluence with unnamed tributary.

As scheduled, the biomonitoring survey was undertaken during a period of low flow in the Kurapete Stream. This meant that around this time there would have been less potential for dilution and mixing where the tributary joined the Kurapete Stream. Additionally, the lower flow velocities would have allowed for sediment to settle out of suspension onto the streambed sooner. Therefore, the Kurapete Stream was particularly vulnerable to sedimentation during this period. As indicated by the survey, the quarry discharge had significantly impacted the streambed macroinvertebrate communities. This impacted was represented by a decrease in MCI values, sediment sensitive EPT taxa, and taxa abundances at the impact site relative to the control site. However, due to a fresh that occurred just seven days prior to the survey, the full extent of any deposited sediment was not likely recorded.

In the instance of the non-compliant discharge sample, this event followed a period of heavy rainfall with moderate flow in the Kurapete Stream. Relative to the period surrounding the biomonitoring survey, the stream was likely less vulnerable to impacts from the quarry at the time of this discharge. This is reflected in the results from the receiving water samples, which were compliant. Furthermore, observations of the Kurapete Stream noted that the water appeared clean and clear at both the upstream

and downstream sites. On this occasion, the quarry discharge was likely subjected to adequate dilution and mixing as it entered the Kurapete Stream.

Finally, the values of the receiving waters must also be considered when evaluating the environmental effects of the quarry discharges. The Kurapete Stream holds high ecological values, particularly as habitat for native fish and possibly trout spawning. Elevated sediment levels are thought to adversely impact spawning in trout. Approximately 400 m downstream from the confluence with the unnamed tributary, the Kurapete Stream joins the Manganui River. The Manganui River is included in Appendix IA of the *Regional Fresh Water Plan for Taranaki* (RFWP) as it holds high natural, ecological and amenity values.

The findings of this report have indicated that the operation of the Company's quarry is having an undesirable level of impact in the receiving environment. In light of these results, further emphasise is placed on the importance of the site's water management prior to discharge. As discussed in section 3.1, isolation of the washwater system will be critical in maintaining a compliant discharge and minimising environmental effects as the site continues to operate. It is also acknowledged that some of the existing resource consent conditions may no longer be adequate to prevent these impacts from occurring. This is in part due to the significant development and expansion that the quarry has undergone since the consent was first granted in 2004. The current consent renewal process has provided a timely opportunity to review and adjust the consent conditions in order to address the potential for environmental effects in the future of the quarry's operation.

3.3 Evaluation of performance

A tabular summary of the Company's compliance record for the year under review is set out in Table 8.

Table 8 Example Summary of performance for consent 1113-4

Purpose: ***For discharge of treated quarry groundwater, stormwater and washwater to a tributary of the Kurapete Stream***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Exercise methodology	Inspections of activities and treatment systems	Yes
2. Best practicable options to minimise effects	Liaison and inspections of treatment system and receiving waters	Yes
3. Limit to active quarry site	Inspections	**No** **Quarry has exceeded 2 ha**
4. No direct discharges	Inspections	Yes
5. Washwater treatment and recirculation requirements	Inspections	**No** **System receiving stormwater from pit and not minimising discharges from site**
6. Quarry site stormwater treatment provision	Inspections	Yes
7. Minimisation of silt discharged	Inspections and sampling surveys	Yes Discharge was compliant following abatement notice
8. Minimisation of exposed areas of quarry and reinstatement requirements	Some reinstatement begun (and will continue to be addressed during quarry life)	N/A
9. Silt control operation	Inspections and sampling surveys	**No** **Discharge exceeded consent limit**
10. Concentration limits on contaminants	Physicochemical sampling	**No** **Discharge exceeded consent limit**
11. Limits on effects on receiving waters	Physicochemical and biological sampling	**No** **Adverse effects detected with biomonitoring**
12. Limits on turbidity effects in receiving waters	Physicochemical sampling	Yes (on all occasions)
13. Reinstatement provision	Scheduled for consideration at end of active quarry life	N/A
14. Maintenance of contingency plan	Liaison with management (plan last received in 2012)	Yes (updated plan

Purpose: *For discharge of treated quarry groundwater, stormwater and washwater to a tributary of the Kurapete Stream*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
		has been requested)
15. Optional review provision re environmental effects	Currently in consent renewal process	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**Improvement required**
Overall assessment of administrative performance in respect of this consent		**High**

N/A = not applicable

During the year, the Company demonstrated a level of environmental performance which required improvement. Inadequacies in the treatment of washwater and the remaining water collected onsite resulted in turbid discharges to the unnamed tributary. There was one non-compliant discharge during the monitoring period. Results from the biomonitoring survey indicated that the quarry was having a significantly adverse effect on macroinvertebrate communities in the Kurapete Stream. Environmental performance ratings are 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 monitoring of discharges from the Company's Everett Road Quarry in the 2015-2016 year continues at the same (reduced) level as in the 2014-2015 period;

2. THAT turbidity and sedimentation effects on receiving waters be minimised by operating and maintaining the settlement ponds system in accordance with best quarry management practices;

3. THAT the consent holder and staff of the Council continue to liaise with respect to matters contained in Recommendation 2 (particularly when personnel changes occur amongst these officers).

These recommendations were carried out.

3.5 Alterations to monitoring programmes for 2016-2017

In designing and implementing the monitoring programmes for air/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;
- its obligations to monitor emissions/discharges and effects under the RMA; and
- to report 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 emitting to the atmosphere/discharging to the environment.

It is proposed that in the 2016-2017 monitoring year the additional biomonitoring site (KRP000983) is included in the summer low flow survey in conjunction with the two standard sites (KRP000960 and KRP000980).

No further alterations are required for the 2016-2017 monitoring programme.

4. Recommendations

1. THAT monitoring of consented activities at the Company's Everett Road Quarry in the 2016-2017 year is amended from that undertaken in 2015-2016, by including the additional biomonitoring site in the annual compliance survey.

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.
Bund	A wall around a structure to contain its contents in the case of leakage.
Condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
g/m^3	Grammes per cubic metre, and equivalent to milligrammes per litre (mg/L). In water, this is also equivalent to parts per million (ppm).
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.
Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.
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. It takes into account the sensitivity of the taxa present to organic pollution in stony habitats.
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.
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
O&G	Oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons).
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Values 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 subsequent amendments.
SS	Suspended solids.

Temp	Temperature, measured in °C.
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.

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

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Appendix I

Resource consent held by Inglewood Metal Limited

(For a copy of the signed resource consent please contact the TRC Consents 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:	Inglewood Metal Limited P O Box 44 INGLEWOOD
Consent Granted Date:	20 May 2004

Conditions of Consent

Consent Granted:	To discharge treated stormwater, treated groundwater and treated shingle washwater from quarry activities into an unnamed tributary of the Kurapete Stream a tributary of the Manganui River in the Waitara catchment at or about GR: Q19:206-299
Expiry Date:	1 June 2015
Review Date(s):	June 2009, June 2012
Site Location:	Everett Road, Inglewood
Legal Description:	Pt Secs 15, 16 & 17 Blk XIII Waitara SD
Catchment:	Waitara
Tributary:	Manganui Kurapete

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

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. The exercise of this consent shall be conducted in accordance with the information submitted in support of the application and to ensure that the conditions of this consent are met at all times.

2. At all times the consent holder shall adopt the best practicable option [as defined in Part 2 of the Act] to prevent or minimise any actual or likely adverse effect on the environment associated with the discharges including, but not limited to, the water quality and aquatic habitat of the receiving waters of the Kurapete Stream.

3. The active quarry stormwater catchment shall have a maximum area of no more than 2 hectares.

4. There shall be no direct discharge of untreated stormwater, groundwater or waste washwater from the active quarry site into the unnamed tributary of the Kurapete Stream as a result of the exercise of this consent.

5. The washing and washwater treatment system shall be bunded to prevent the inflow of stormwater and groundwater from other areas of the quarry. In addition the consent holder shall implement appropriate recirculatory systems so as to minimise the volume of washwater required to be discharged.

6. The active quarry site shall be contoured/bunded so that all water generated in this area is directed to silt retention systems for treatment prior to discharge, and to prevent the flow of uncontaminated stormwater into the quarry, as far as is practicable.

7. The consent holder shall undertake measures to minimise the amounts of silt and sediment that could be contained in the discharge licensed by this consent.

8. The consent holder shall operate and progressively reinstate the quarry in a manner that minimises the quarry stormwater catchment area and ensures that the area of exposed unvegetated earth within the quarry stormwater catchment is kept to a minimum at all times.

9. The consent holder shall properly and efficiently maintain and operate the silt control structures in such a manner that any discharge which may occur shall not breach the conditions of this consent. The silt control structures shall be operated, as far as practicable, so as to maximise the treatment of the stormwater and minimise the duration, frequency and rate of the discharge.

10. The following concentrations shall not be exceeded in any discharge:

Component	**Concentration**
pH (range)	6-9
Suspended solids	100gm^{-3}
Total recoverable hydrocarbons	15gm^{-3}

This condition shall apply prior to the entry of any discharge into the receiving waters of the unnamed tributary of the Kurapete Stream, at a designated sampling point approved by the Chief Executive.

11. After allowing for reasonable mixing, within a mixing zone extending 25 metres downstream of the confluence of the unnamed tributary with the Kurapete Stream, the discharge shall not give rise to any of the following effects in the receiving waters of the Kurapete Stream:

a) the production of any 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 effects on aquatic life.

12. After allowing for reasonable mixing, within a mixing zone extending 25 metres downstream of the confluence of the unnamed tributary with the Kurapete Stream, the discharge shall not give rise to either of the following effects in the receiving waters of the of the Kurapete Stream:

a) an increase in suspended solids concentration in excess of 10 gm^{-3}, when the stream turbidity as measured immediately upstream of the confluence of the unnamed tributary with the Kurapete Stream is equal to or less than 5 NTU [nephelometric turbidity units]; or

b) an increase in turbidity of more than 50% when the stream turbidity as measured immediately upstream of the confluence of the unnamed tributary with the Kurapete Stream is greater than 5 NTU [nephelometric turbidity units].

13. On cessation of quarrying operations at the site licensed by this consent, the active quarry area, including the silt control structures, and surrounding areas shall be reinstated satisfactorily, prior to the surrender or lapsing of this consent.

14. The consent holder shall maintain a contingency plan to the satisfaction of the Chief Executive, outlining measures and procedures to be undertaken to prevent the spillage or accidental discharge of contaminants in the stormwater catchment, and measures to avoid, remedy, or mitigate the environmental effects of such a spillage or discharge.

15. 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 of review during the month of June 2009 and/or June 2012, 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 20 May 2004

For and on behalf of
Taranaki Regional Council

_____

Director-Resource Management

Appendix II

Biomonitoring report

To	Thomas McElroy, Job manager
From	Darin Sutherland, Scientific Officer
Document	1690753
Report No	DS051
Date	June 2016

Biomonitoring of the lower reaches of the Kurapete Stream, in relation to Inglewood Metal Ltd Quarry discharges, surveyed in March 2016

General Introduction

A formal consent monitoring programme established for Inglewood Metal Ltd, Everett Road in the lower Kurapete Stream catchment, has been the subject of twenty TRC Annual Reports to date (e.g. TRC, 2015). Various impacts of the consent holder's quarrying activities have been noted from a programme of regular inspections and physicochemical receiving water sampling. One of the recommendations of these reports required:

"That monitoring be continued …….. with an appropriate programme formulated in accordance with the requirements of existing consents and taking into account matters addressed in these Annual Reports. This programme to include a limited summer biomonitoring survey undertaken at two sites in the lower reach of the Kurapete Stream (upstream and downstream of the confluence of the quarry tributary stream)."

This requirement recognised the biological importance of the lower reaches of the Kurapete Stream and the need for a form of monitoring which provided longer-term indications of receiving water quality.

Therefore, late summer-autumn low flow biomonitoring surveys have been undertaken in the lower reaches of the Kurapete Stream situated upstream and downstream of the small tributary receiving quarry run-off and wastes discharges. In addition to these biomonitoring surveys, other surveys were performed in May 1997, in response to an unauthorised incident report (CF145), and in October 2002 (CF259), as a follow-up to the previous summer biomonitoring survey (March 2002) performed under low recession flow conditions in the lower reaches of the Kurapete Stream which indicated a significant impact on the faunal community of the stream below the small turbid tributary draining the quarry area.

In more recent years, confounding issues of significant upstream water quality improvement (due to removal of the Inglewood oxidation ponds effluent discharge from the Kurapete Stream (TRC, 2014a)), together with cattle access in the proximity of the Everett Road bridge site, necessitated the addition of a third monitoring site (KRP000983) some 150 m downstream of the bridge for effects assessment. However, significant progress in terms of riparian fencing and plantings have improved habitat in the short reach of the stream between the small tributary (receiving quarry stormwater) confluence and the Everett Road Bridge.

The current March 2016 survey continued the summer biomonitoring component of the formal consent monitoring programme but did not require the inclusion of this additional site following an inspection of the substrate composition which indicated that the majority

of the riffle substrate where sampling occurred was composed of cobbles and gravel as opposed to soft sediment from the quarry discharge.

Method

The standard `400 ml kick sampling' technique was used to collect streambed (benthic) macroinvertebrates from the two established sites (I and J) in the lower reaches of the Kurapete Stream, near Everett Park on 31 March 2016 (Figure 1).

These sites were:

Site No	Site code	GPS Reference	Location
I	KRP000960	1710640E 5668709N	Upstream of quarry tributary stream
J	KRP000980	1710695E 5668758N	Everett Road bridge, d/s of tributary stream

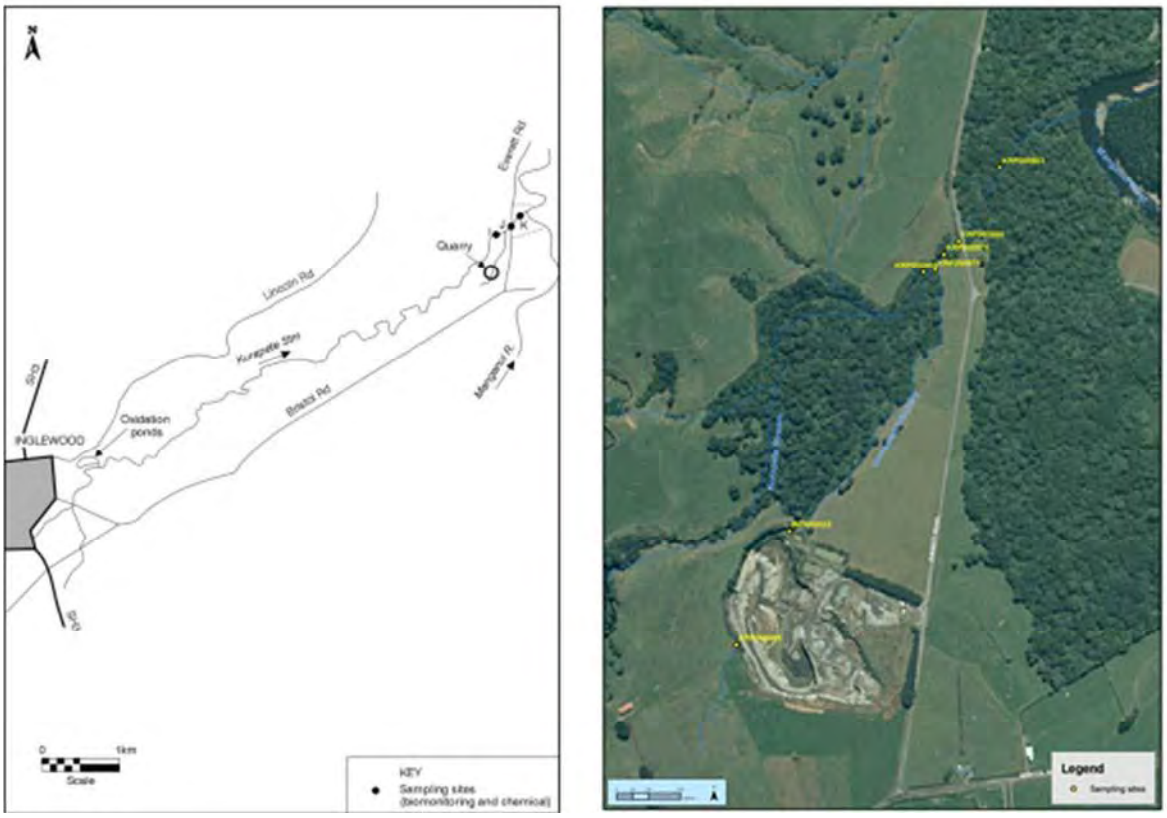

Figure 1 Sampling sites in the Kurapete Stream in relation to Inglewood Metals Ltd, quarry

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.

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, 2015) 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 ($SQMCI_s$) 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 products, and dividing by the sum of the loading factors (Stark 1998 and 1999). 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). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower. A difference of 0.83 units or more in $SQMCI_s$ values is considered significantly different (Stark 1998).

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 both 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 14.4°C at site I and 15.0°C at site J. At site I the water speed was swift, water uncoloured and slightly cloudy while at site J the water speed was swift, water was grey in colour and cloudy. It was noted that turbidity was noticeably higher at the downstream site J compared with the upstream site I.

The stream at site I had slippery periphyton mats and no filamentous algae. Moss and leaves were patchy on the streambed. There was complete bed shading from overhanging vegetation. Substrate was predominately cobbles (65%) with some boulder (15%) and course gravel (10%). Sand (5%) and fine gravel (5%) made up the remaining substrate. No silt was detected. Site J had slippery mats and no filamentous algae. Moss and leaves were patchy on the streambed. There was partial bed shading from overhanging vegetation. Substrate was predominately cobbles (70%) with some course gravel (10%). Boulder (5%), sand (5%), fine gravel (5%) and silt (5%) made up the remaining substrate.

Macroinvertebrate communities

Biomonitoring of the impacts of quarrying activities on the Kurapete Stream has been performed previously on twenty occasions and site I had been surveyed as a component of the Inglewood oxidation pond system monitoring programme between early 1989 and March 1993.

A summary of comparative data for all three sites since quarry biomonitoring commenced is presented in Table 2. (Eight surveys have been performed at site K to date).

Table 3 Summary of macroinvertebrate taxa numbers and MCI values for previous surveys performed between January 1997 and February 2015

Site	No. of surveys	Taxa Numbers		MCI Values		SQMCI Values	
		Range	Median	Range	Median	Range	Median
I	21	19-32	26	80-107	95	3.1-6.2	4.1
J	21	18-32	26	71-101	87	1.7-5.3	3.6
K	8	22-35	29	87-103	94	2.1-5.7	3.3

The results of the recent survey are presented in Table 3.

Table 4 Macroinvertebrate fauna of the Kurapete Stream in relation to Inglewood Metal Ltd's quarry discharge sampled on 31 March 2016

Taxa List	Site Number	MCI score	I	J
	Site Code		KRP000960	KRP000980
	Sample Number		FWB16187	FWB16188
NEMERTEA	Nemertea	3	R	R
ANNELIDA (WORMS)	Oligochaeta	1	A	A
MOLLUSCA	*Latia*	5	C	-
	Potamopyrgus	4	VA	C
	Sphaeriidae	3	R	-
CRUSTACEA	Ostracoda	1	-	C
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	C
	Coloburiscus	7	VA	C
	Deleatidium	8	C	-
	Ichthybotus	8	R	-
	Zephlebia group	7	C	C
PLECOPTERA (STONEFLIES)	*Zelandoperla*	8	R	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	A
	Hydraenidae	8	-	R
	Ptilodactylidae	8	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	VA	C
	Costachorema	7	R	-
	Neurochorema	6	R	R
	Confluens	5	R	R
	Pycnocentria	7	C	-
	Pycnocentrodes	5	C	C
	Triplectides	5	R	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C
	Orthocladiinae	2	R	A
	Polypedilum	3	R	C
	Tanytarsini	3	-	R
	Empididae	3	-	R
	Muscidae	3	-	R
	Austrosimulium	3	A	A
		No of taxa	25	22
		MCI	107	89
		SQMCIs	5.1	3.8
		EPT (taxa)	13	8
		%EPT (taxa)	52	36

'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa

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

Site I: upstream of quarry tributary

A moderately high macroinvertebrate community richness of 25 taxa was found at site I ('control' site) at the time of the summer survey. This was one less than the historical median for this site and two taxa lower than the previous survey on February 2015 (Table 3, Table 4).

The MCI score of 107 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 (99 units) but was the equal highest MCI score recorded at the site in 21 surveys monitored in relation o the quarry (Figure 2).

The $SQMCI_S$ score of 5.1 units was significantly higher (Stark, 1998) than the median MCI score of 4.1 units (Stark, 1998) (Table 3, Table 4).

The community was characterised by four 'very abundant' taxa ['tolerant' snail (*Potamopyrgus*) and caddisfly (*Hydropsyche* / *Aoteapsyche*) and 'moderately sensitive' mayfly (*Coloburiscus*) and beetle (Elmidae)] (Table 4).

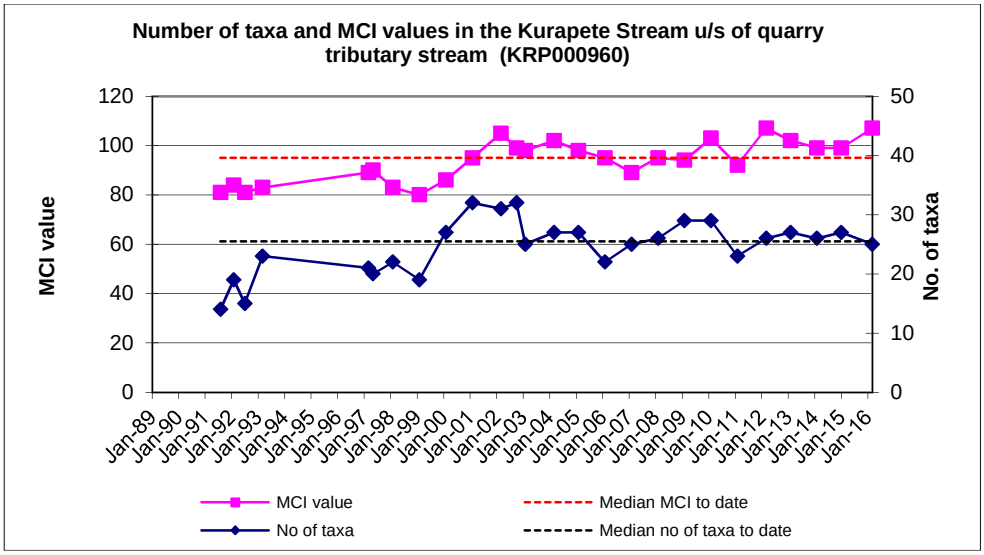

Figure 2 Taxa richness and MCI scores recorded to date at site I

Site J: Everett Road bridge (downstream of quarry tributary)

A moderately high macroinvertebrate community richness of 22 taxa was found at site I ('impact' site) at the time of the summer survey. This was four less than the historical median for this site and two taxa lower than the previous survey on February 2015 (Table 3, Table 4).

The MCI score of 89 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) than the historical median MCI score of 87 units. The MCI score was significantly lower (Stark, 1998) than the preceding survey (102 units), however, that was the highest MCI score recorded at the site in 21 surveys (Figure 2).

The $SQMCI_S$ score of 3.8 units was not significantly different (Stark, 1998) than the median MCI score of 3.6 units (Stark, 1998) (Table 3, Table 4).

The community was characterised by four 'abundant' taxa ['tolerant' oligochaete worms, orthoclad midges and sandflies (*Austrosimulium*) and 'moderately sensitive' beetle (Elmidae)] (Table 4).

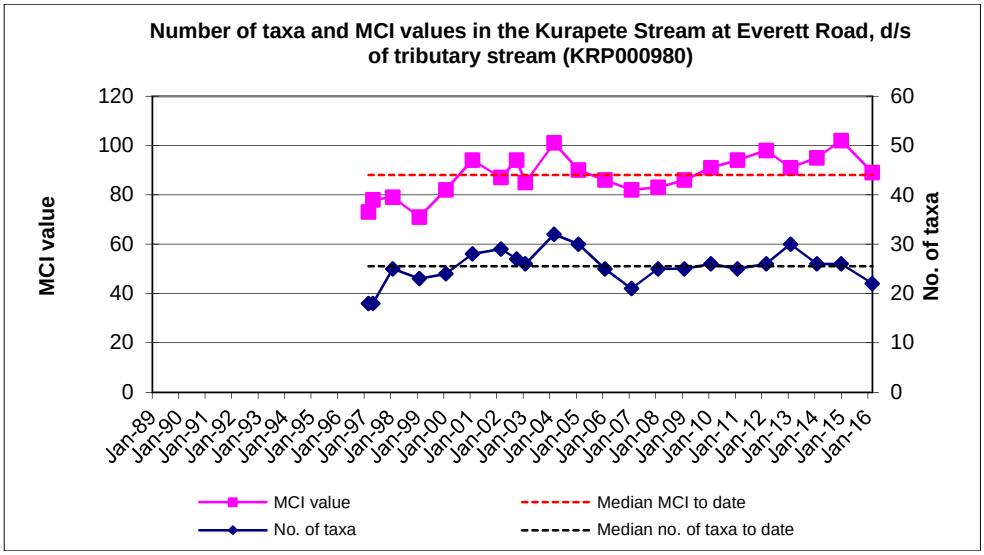

Figure 3 Taxa richness and MCI scores recorded to date at site J

Discussion and conclusions

This early autumn biomonitoring survey was performed under a period of low recession flow conditions in the lower reaches of the Kurapete Stream. The 'control' site (site J) had 'good' macroinvertebrate health and was significantly healthier than the 'impact' site (site I). The 'control' site recorded its highest equal ever MCI score which continued to reflect the general improvement in stream conditions (physicochemical water quality and physical habitat) consistent with the cessation of the Inglewood oxidation ponds system's discharge (which has been diverted to the New Plymouth Wastewater Treatment Plant) and in the absence of any recent (consented) overflows from the system during wet weather periods. In contrast, the 'impact' site had a MCI score significantly lower (18 MCI units) than the 'control' site score and the preceding survey score (13 units). The $SQMCI_s$ score at the 'impact' site was also significantly lower (Stark, 1998) than the 'control' site score (1.3 $SQMCI_s$ units) indicating that the downstream impact site was significantly less healthy than the upstream 'control' site.

The MCI and $SQMCI_s$ indexes are indicators of organic pollution but are also usually correlated with deposited sediment so that sites with high levels of silt tend to have lower MCI and $SQMCI_s$ scores which makes them useful for determining impacts of discharges that are predominately fine sediment such as quarry discharges. However, macroinvertebrate sampling occurs in riffles which have high flow velocities compared with runs and pools and are therefore far less likely to accumulate deposited sediment. During the current survey only minor differences in deposited sediment were evident; the 'control' site had no silt and 5% sand while the 'impact' site had 5% silt and sand and no silt coating was observed at either site but water speed was recorded as swift (highest category) for both sites as well. Furthermore, the survey was preformed after the minimum time possible after a 3x median flow fresh (7 days) which would have removed any deposited fine sediment at both sites prior to the fresh.

Macroinvertebrate richness at the 'impact' site was similar (three taxa lower) to the 'control' site and to the historical median suggesting no effects of any acute toxic discharges. Site I had significantly more 'very abundant' taxa (four taxa) compared with site J (zero taxa) and abundances at the 'control' site were generally greater than the 'impact' site. Generally, lower abundances could suggest either limited habitat or food availability. Deposited fine

silt can fill up gaps between rocks, a key macroinvertebrate habitat, thus reducing habitat availability. Furthermore, long periods of high suspended sediments will reduce light penetration which will reduce benthic primary production (algae growth). Though the 'impact' site was less shaded than the 'control' site which had complete shading of the streambed, the amount of observed periphyton between the two sites was the same, both very limited, suggesting light attenuation at the 'impact' site. The 'impact' site was noticeably cloudier than the 'control' site at the time of the survey. Furthermore, in past surveys, it has been noted that significantly higher periphyton levels were found at the downstream site (CF635).

The community composition at the 'impact' site showed a marked decrease in abundances and percentages of EPT (mayflies, stoneflies and caddisflies) taxa. Most of the EPT taxa decreased or at best had the same abundance from the 'control' site to the 'impact' site. In particular, the mayfly *Coloburiscus* and caddisfly *Hydropsyche* both decreased from 'very abundant' to 'common', a decrease from over a hundred to less than twenty individuals, and five of the thirteen ETP taxa recorded at the 'control' site disappeared altogether from the 'impact' site. EPT taxa are generally more sensitive to fine suspended sediment (Clapcott, et al. 2011) compared with other macroinvertebrate taxa and are therefore particularly useful indicators of potentially harmful sediment discharges. Changes in EPT composition between the two sites was therefore a strong indicator of sediment discharges negatively affecting the macroinvertebrate communities.

Overall, the survey indicated that there had been an impact on the faunal community at the downstream site which was located a short distance beyond the boundary of the permitted mixing zone which was probably caused by quarry discharges entering the stream from a small tributary draining the quarry area.

Summary

The Council's standard 'kick-sampling' technique was used at two established sites to collect streambed macroinvertebrates from the Kurapete Stream. Samples were processed to provide 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 also provide more relevant information than the MCI 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 early autumn macroinvertebrate survey indicated that the discharge of treated quarry wastewaters from the Inglewood quarry site had recent detrimental effects on the macroinvertebrate communities of the Kurapete Stream. The macroinvertebrate communities at the 'control' site on the Kurapete Stream contained relatively high proportions of 'sensitive' taxa indicating 'good' health while the 'impact' site was in 'fair' health. $SQMCI_s$ scores were congruent with MCI scores.

Changes in the macroinvertebrate communities were noted between the upstream 'control' site and the downstream 'impact' site downstream of the discharge, beyond the designated 25 m mixing zone, coincident with an increase in turbidity of the stream at the time of the

survey. Changes in macroinvertebrate composition between sites included a marked reduction in EPT taxa (mayflies, stoneflies and caddisflies) and a general reduction in taxa abundances but not taxa richness.

Overall, the survey indicated an impact on the macroinvertebrate community downstream of the quarry discharge which was probably attributable to quarry discharge impacts below the small tributary draining the quarry area.

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