

Greymouth Petroleum Ltd
Kaimiro Production Station
Monitoring Programme
Annual Report
2014-2015

Technical Report 2015-108

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Executive summary

Greymouth Petroleum Acquisitions Company Limited (GPL) operates the Kaimiro Production Station located at Inglewood, in the Waiongana catchment, and the associated Ngatoro-A and Ngatoro-B producing wellsites at Inglewood, in the Waitara catchment. This report for the period July 2014 to June 2015 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess GPL's environmental performance during the period under review, and the results and environmental effects of their activities.

GPL holds seven resource consents for production activities at the three sites, which include a total of 110 conditions setting out the requirements that they must satisfy. GPL holds one consent to allow it to take and use water, three consents to discharge stormwater and treated wastewater into the Mangaoraka and Ngatoro Streams, one consent to discharge sand waste to land for storage, and three consents to discharge emissions into the air.

During the monitoring period, GPL demonstrated an overall high level of environmental performance at the sites.

The Council's monitoring programme included six inspections of the Kaimiro Production Station; five inspections of the Ngatoro sites; an annual inspection of the associated wellsites; six water samples collected for physicochemical analysis; three biological surveys of receiving waters; and two ambient air quality surveys.

Results of samples collected of the discharge and receiving waters were within the limits prescribed by the consents and, along with the results of biomonitoring carried out in the Mangaoraka and Ngatoro Streams, indicated that the discharges were not having a significant adverse effect on the downstream water quality.

There were no adverse effects on the environment resulting from the exercise of the air discharge consents. The ambient air quality monitoring at the Kaimiro Production Station showed that levels of carbon monoxide, combustible gases, PM10 particulates and nitrogen oxides were all below levels of concern at the time of sampling. No offensive or objectionable odours were detected beyond the boundary during inspections and there were no complaints in relation to air emissions from the site.

During the period under review, GPL demonstrated an overall high level of both environmental performance and administrative compliance with the resource consents. There were no unauthorised incidents recorded by the Council in relation to GPL's activities. The Kaimiro Production Station and associated wellsites were well managed and maintained.

For reference, in the 2014-2015 year, 75% 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 22% demonstrated a good level of environmental performance and compliance with their consents.

This report includes a recommendation for the 2015-2016 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 the Annual Report for the period July 2013-June 2014 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Greymouth Petroleum Acquisition Company Limited (GPL). GPL operates the Kaimiro Production Station situated on Upland Road at Inglewood, in the Waiongana catchment. GPL also operates the Ngatoro-A and Ngatoro-B producing wellsites. The Ngatoro-A wellsite is located on Upper Dudley Road and the Ngatoro-B wellsite is located on Bedford Road. Both of these sites are at Inglewood, in the Waitara catchment. A further 20 wellsites are monitored annually in conjunction with the Kaimiro Production Station.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by GPL that relate to abstractions and discharges of water within the Waiongana and Waitara catchments, and the air discharge permits held to cover emissions to air from the sites.

One of the intents of the *Resource Management Act 1991* (RMA) is that environmental management should be integrated across all media, so that a consent holder's use of water, air and land should be considered from a single comprehensive environmental perspective. Accordingly, the Council generally implements integrated environmental monitoring programmes and reports the results of the programmes jointly. This report discusses the environmental effects of GPL's use of water, land and air, and is the eleventh combined annual report by the Council for the Kaimiro and Ngatoro sites.

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 RMA and the Council's obligations and general approach to monitoring sites through annual programmes, and a description of the activities and operations conducted at the Kaimiro and Ngatoro sites.

Sections 2 and 3 present the resource consents held by GPL in the Waiongana and Waitara catchments, the nature of the monitoring programme in place for the period under review, and the results of monitoring during the period under review, including scientific and technical data.

Section 4 discusses the results, their interpretations, and their significance for the environment.

Section 5 presents recommendations to be implemented in the 2015-2016 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 a discharger, 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):
- (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 consent holder during the period under review, this report also assigns a rating as to GPL's environmental and administrative performance.

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 GPL'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 (i.e. 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 compliance

- **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 2014-2015 year, 75% 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 22% demonstrated a good level of environmental performance and compliance with their consents.

1.2 Process descriptions

1.2.1 Kaimiro Production Station

The Kaimiro Production Station was commissioned in 1985. The production station separates and treats oil and gas from wells in the Kaimiro and Ngatoro fields. Oil is piped to the Omata tank farm and gas is piped into the national grid. Wellsites associated with the Kaimiro Production Station are as follows: Kaimiro: B, C, D, F, G, H, J, K, L, M, O; Ngatoro: A, B, C, D, E, F; Goldie; Windsor and Surrey.

The site's BTEX vapour incinerator was replaced in October 2007 with a more efficient unit. A new gas compressor was commissioned in June 2008 and upgrades made to all existing compressor PLC control systems. These measures have resulted in a significant sustained improvement in plant energy efficiency at the Kaimiro site.



Photo 1 Kaimiro Production Station

Stormwater from the Kaimiro Production Station passes through a separator system and a skimmer pit before discharging to an unnamed tributary of the Mangaoraka Stream. All chemical storage is contained within bunds and isolated from the stormwater system.

1.2.2 Ngatoro producing wellsites



Photo 2 Ngatoro-A wellsite

Ngatoro-A was established in July 1992. The site consists of five wells (Ngatoro-1, -6, -7, -8, and -14), storage facilities for recovered oil and a bunded earth flare pit. In July 1999 the north-east skimmer pit at the site was decommissioned. The south-west skimmer pit now receives all treated stormwater, treated production water and treated wastewater from oil well drilling and production operations. Recovered oil and gas is piped off site to the Kaimiro Production Station, consequently flaring has been reduced.

The Ngatoro-B site was established in 1991 and consists of four wells (Ngatoro-2, -5, -9 and -11), storage facilities for recovered oil and a bunded earth flare pit. Produced water is piped to Kaimiro and re-injected. There are two sumps with a combined capacity of 1,290 m³ to which stormwater and wastewater are directed, and a skimmer pit with a 243 m³ capacity is used for treatment prior to discharge to an unnamed tributary of the Ngatoro Stream. Produced gas and liquids are piped to the Kaimiro Production Station for processing.



Photo 3 Ngatoro-B wellsite

2. Kaimiro Production Station

2.1 Resource consents

2.1.1 Water abstraction permit

Section 14 of the RMA stipulates that no person may take, use, dam or divert any water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or it falls within some particular categories set out in Section 14.

GPL holds water abstraction permit **5384-2** to take groundwater from the Matemateaonga Formation for use in enhanced hydrocarbon recovery activities at the Kaimiro-O wellsite. This permit was first issued by the Council on 18 September 1998 under Section 87(e) of the RMA. It was renewed during the monitoring period, on 24 July 2014. It is due to expire on 1 June 2032.

Condition 1 sets limits on the volume and rate of abstraction.

Condition 2 requires that the bore is labelled.

Conditions 3 to 7 deal with installation of a water meter and datalogger, recording and provision of data, accuracy of the equipment, access, and repairs and maintenance.

Condition 8 requires the consent holder to adopt the best practicable option to prevent or minimise adverse environmental effects.

Conditions 9 and 10 deal with lapse and review of the consent.

The permit is attached to this report in Appendix I.

2.1.2 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.

GPL holds water discharge permit **1334-3** to cover discharge of treated stormwater from the Kaimiro Production Station into an unnamed tributary of the Mangaoraka Stream in the Waiongana Catchment. This permit was issued by the Council on 10 January 2002 under Section 87(e) of the RMA. It was transferred to GPL on 10 April 2002. An application for change of consent conditions was approved on 5 September 2012 to remove three redundant conditions relating to operational and management planning. A further change of consent was approved on 8 April 2014 to increase the catchment area, move the discharge point and increase the discharge chloride limit to 230 g/m³. It is due to expire on 1 June 2020.

Condition 1 requires the consent holder to adopt the best practicable option to prevent or minimise adverse effects of the discharge on any waterbody.

Condition 2 imposes a limit on the stormwater catchment size.

Condition 3 requires site specific details relating to contingency planning for the site.

Condition 4 requires all stormwater be directed through a stormwater treatment system.

Condition 5 requires that design, management and maintenance of the stormwater system be undertaken in accordance with information submitted in the application.

Condition 6 requires that hazardous substance storage areas be bunded with drainage to appropriate recovery systems, and not to the stormwater catchment.

Conditions 7, 8 and 9 impose limits on contaminants in the discharge, and stipulate effects the discharge shall not give rise to in the unnamed tributary of the Mangaoraka Stream.

Condition 10 requires that the consent holder prepare and annually maintain a contingency plan in relation to spillages at the site.

Condition 11 requires that the Council be advised of reinstatement of the site.

Condition 12 provides for review of the consent.

The permit is attached to this report in Appendix I.

2.1.3 Air discharge permit

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

GPL holds air discharge permit **4048-3** to cover discharge of emissions into the air from the flaring of hydrocarbons arising from hydrocarbon production and hydrocarbon processing operations together with miscellaneous emissions at the Kaimiro Production Station. This permit was first issued by the Council on 20 June 1995 under Section 87(e) of the RMA. It was transferred to GPL on 10 April 2002 and renewed on 10 January 2008. The current permit covers emissions from Kaimiro Production Station only and is due to expire on 1 June 2026. Separate air discharge permits were issued for the associated wellsites.

Condition 1 limits the duration of flaring during well testing.

Conditions 2, 3 and 4 specify the requirements for notification prior to flaring and before undertaking alterations to equipment or processes which may substantially alter the nature or quantity of the discharge.

Conditions 5 to 10 stipulate the required equipment and processes for undertaking flaring, and limit the substances which may be flared to gases from the well stream.

Conditions 11 to 16 stipulate limits on contaminants and effects from flaring and any other emissions from the production station.

Conditions 17 to 21 specify the requirements for the recording and reporting of information relating to flaring and the details of any measures undertaken to reduce or mitigate emissions from the production station.

Condition 22 provides for review of the consent.

The permit is attached to this report in Appendix I.

2.2 Monitoring programme

2.2.1 Introduction

Section 35 of the RMA sets out obligation/s upon the Council to gather information, monitor, and conduct research on the exercise of resource consents, and the effects arising, within the Taranaki region and report upon these.

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 Kaimiro Production Station consisted of four primary components, as set out sections 2.2.2 to 2.2.5.

2.2.2 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.

2.2.3 Site inspections

Kaimiro Production Station was visited six times during the monitoring period. Producing wellsites associated with the production station are inspected annually. 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. Sources of data being collected by the consent holder were identified and accessed, so that performance in respect of operation, internal monitoring, and supervision could be reviewed by the Council. The neighbourhood was surveyed for environmental effects.

2.2.4 Chemical sampling

The Council undertook sampling of the discharges from the site as well as the water quality upstream and downstream of the discharge point. The treated stormwater discharge was sampled on one occasion, along with two sites in the unnamed tributary of the Mangaoraka Stream. Samples were analysed for hydrocarbons, suspended solids, conductivity, pH, turbidity and chloride.

The Council also undertook sampling of the ambient air quality outside the boundary of the site. Passive absorption discs were placed at two sites on one occasion to measure nitrogen oxides. A multi-gas meter was also deployed on one occasion in the vicinity of the plant, with monitoring consisting of continuous measurements of gas concentrations for the gases of interest (carbon monoxide and combustible gases).

2.2.5 Biomonitoring surveys

Two biological surveys were performed in the unnamed tributary of the Mangaoraka Stream to determine whether or not the discharge of treated stormwater from the site has had a detrimental effect upon the communities of the stream.

2.3 Results: water

2.3.1 Inspections

Six inspections were carried out at the Kaimiro Production Station and associated sites in the 2014-2015 year. The following was found during the inspections:

9 July 2014

The site was found to be neat and tidy during the inspection. No odours or smoke were observed. Ring drains and bunds were clear of obstructions and contaminants. The skimmer pits were being lined. There was no off-site discharge noted.

7 October 2014

The site was neat and tidy. Work on the skimmer pits had been completed and these were being fenced off. No flaring was observed and there were no odours.

13 March 2015

The site was neat and tidy and well managed. No flaring was being undertaken and no odours or off site effects were observed. The skimmer pits were not discharging and the contents of the pits appeared to be clean. The stream was checked and there was no evidence of impacts in the receiving waters of any previous discharge.

29 April 2015 – annual wellsite inspection

Inspection of the associated wellsites was undertaken with Allan Crawford (environmental advisor to GPL). Sites were inspected to ensure compliance with resource consents held for discharges to water, land and air, with particular attention to stormwater/wastewater management, flaring activities, deep well injection, and mix bury cover activities.

In general the sites were found to be neat and tidy. All of the sites inspected showed that the stormwater systems, ring drains and skimmer pits had handled excessive stormwater run off during high rainfall events recently experienced, there were no

signs of any constructional or design failures within these systems. Some of the skimmer pits remained unlined, but this will be addressed whenever further exploration or re-entry work takes place. Silt retention and control measures, where required, were in place.

The flare pits were well sited to minimise off site effects, including odour, noise and light issues. Most of these had not been used recently.

Sites where deep well injection operations had been undertaken showed no effects of the exercise of this activity. Mix bury cover sites were clear of any seepages or visual effects and these areas were generally well vegetated, with no detrimental effects to growth.

11 June 2015

A site inspection was conducted after the recent fracturing operation. It was noted that the Baker Hughes fracturing equipment and associated chemicals had been removed from site. The well was being flowed back with all flow back fluids being stored in tanks on site prior to transportation for disposal via deep well injection at a nearby consented facility.

No flaring had been undertaken in association with the operation, however flaring was anticipated to occur in the coming days.

The skimmer pits were full and discharging at the time of the inspection. Samples were collected from the discharge and the receiving waters to ensure compliance with resource consent conditions. Fracturing samples were also collected. It was noted that the skimmer pit liner was in need of repair and the consent holder was informed of this.

25 June 2015

The site and storm water systems were checked following an extreme high rainfall event that resulted in a 'State of Emergency' situation being declared for Taranaki. The design, management, and maintenance of the storm water system ensured that no off site effects had occurred. No contaminants were evident in the skimmer pit and only evidence of elevated suspended solids had occurred (as would be expected.) No off site effects of any flaring, odours or smoke, were noted.

2.3.2 Results of discharge monitoring

Sampling of the discharge from the Kaimiro Production Station was undertaken once during the 2014-2015 monitoring period, on 2 June 2015. Table 1 below presents the results along with a summary of previous results and limits stipulated by consent 1334-3. The sampling sites are shown in Figure 1.

Table 1 Physicochemical results for discharge from the Kaimiro Production Station with a summary of previous monitoring data (TRC site code STW002016)

| Parameter | Units | 2 June 15 | Consent limits | N | Min | Max | Median |
|------------------|------------------|-----------|----------------|----|-------|------|--------|
| Chloride | g/m ³ | 47.8 | 230 | 38 | 2.2 | 590 | 12 |
| Conductivity | mS/m | 22.5 | - | 40 | 2.3 | 190 | 6.8 |
| Hydrocarbons | g/m ³ | <0.5 | 15 | 42 | < 0.5 | 38 | < 0.5 |
| pH | | 6.6 | 6.5-8.5 | 40 | 6.0 | 9.1 | 6.6 |
| Suspended solids | g/m ³ | 13 | 100 | 39 | < 2 | 1600 | 34 |
| Temperature | Deg. C | 11.4 | - | 37 | 6.6 | 41.2 | 12.6 |
| Turbidity | NTU | 50 | | 1 | 640 | 640 | 640 |

Chloride, hydrocarbons, pH and suspended solid concentrations all complied with consent conditions.



Figure 1 Water quality monitoring sites in relation to the Kaimiro Production Station

2.3.3 Results of receiving environment monitoring

Chemical

Chemical water quality sampling of the unnamed tributary of the Mangaoraka Stream was undertaken in conjunction with discharge monitoring on 2 June 2015. These results are presented in Table 2, and the sampling sites are shown in Figure 1.

Table 2 Results of receiving environment monitoring of an unnamed tributary of the Mangaoraka Stream in relation to the Kaimiro Production Station 2 June 2015

| Parameter | Units | Consent limits | 2 June 2015 | |
|------------------|------------------|----------------|---------------------------|-----------------------------|
| | | | Upstream (site MRK000200) | Downstream (site MRK000202) |
| Chloride | g/m ³ | 50 | 16.0 | 20.9 |
| Conductivity | mS/m | - | 11.6 | 13.3 |
| Hydrocarbons | g/m ³ | - | <0.5 | <0.5 |
| pH | pH | - | 6.5 | 6.6 |
| Suspended solids | g/m ³ | - | 9 | 3 |
| Temperature | °C | <2° increase | 14.5 | 14.1 |
| Turbidity | NTU | - | 6.6 | 12 |

The results complied with the limits set by consent conditions for chloride and temperature increase.

Biomonitoring

Two biomonitoring surveys were undertaken at three sites in October 2014 and February 2015. The surveys were conducted in two tributaries of the Mangaoraka Stream, to monitor the health of the macroinvertebrate communities of these tributaries in relation to the discharge of treated stormwater from the Kaimiro Production Station. Site 1 is the 'control' site which is located in a major tributary of the Mangaoraka Stream, upstream of the confluence with a more minor tributary. Site 2 is situated in the minor tributary which receives the stormwater discharge from the production station and Site 3 is approximately 50 metres downstream of the confluence of this tributary. The Council's standard 'kick' sampling technique was used to collect the stream bed macroinvertebrate samples from each site. Samples were processed to provide number of taxa (richness), MCI and SQMCI_s scores 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 abundances as well as sensitivity to pollution. It may indicate subtle changes in communities, and therefore be more relevant index if non-organic impacts are occurring. Significant differences in either the MCI or the SQMCI_s between sites indicate the degree of adverse effects (if any) of the discharges being monitored.

25 October 2014

Most of the previous surveys undertaken in relation to the Kaimiro Production Station stormwater discharge have shown that the larger tributary of the Mangaoraka Stream (sites 1 and 3) supports higher taxonomic richness and healthier macroinvertebrate communities. The results of this spring survey were consistent with these trends with taxa richnesses and MCI scores recorded at sites 1 and 3 higher than those recorded at site 2 in the unnamed tributary. Site 2 has been affected to some extent by sedimentation of the streambed and iron-oxide deposits under low, warmer flow conditions. Site 3 also had silt, but not iron oxide deposits, recorded on the streambed at the time of the survey.

The SQMCI_s scores for sites 1 and 2 were not significantly different to each other but both scores were significantly lower than the site 3 score at the time of the survey. As Site 1 is the 'control' site which had a low score while site 3 is an 'impacted' site which had a high score the SQMCI_s scores recorded at the three sites would not be related to discharges from the Kaimiro Production Station and would be likely due to habitat variation among the sites. The low scores at site 1 are probably a reflection of the weedy nature of the site which usually favours low scoring taxa while site 2 has sediment issues which also favours low scoring taxa.

3 February 2015

As in previous surveys, taxa richnesses and MCI scores recorded at sites 1 and 3 were again higher than those recorded at site 2 in the unnamed tributary. Site 2 (primary 'impacted site) has been affected to some extent by sedimentation of the streambed and iron-oxide deposits under low, warmer flow conditions. In this survey the site's substrate was composed of 50% silt and the water levels were extremely low which made obtaining a sample difficult. The very low flows probably contributed to the low taxa abundances found at the site though taxa richness remained surprisingly unchanged from the previous survey. The absence of any abundant 'tolerant' taxa at site 2 during the survey was likely the main factor in the SQMCI_s score being significantly higher than the previous survey score as opposed to an increase in the abundance of 'sensitive' taxa which would indicate an improvement in the health of the macroinvertebrate community. This is further reinforced by the MCI score for site 2 decreasing by nine units since the previous survey.

Taxonomic richness between site 1, the 'control' site and site 3, the secondary 'impacted' site was markedly different (by 16 taxa) at the time of the survey unlike the previous survey where site 3 had only four taxa less than site 1. Normally site 1 has only slightly more taxa recorded than site 3 (site 1 median taxa richness of 27 versus site 3 median taxa richness of 24). However, the large decrease in taxa richness was not caused by a large decrease in taxa richness at site 3 which might indicate impacts from production station discharges but rather a moderate increase at site 1 by seven taxa coupled with a moderate decrease at site 3 by five taxa. Furthermore site 3 had an insignificantly higher MCI score and a significantly higher SQMCI_s score indicating that the health of the macroinvertebrate community was equal to or better than site 1. The increase in taxa richness at site 1 may be partially attributable to the addition of the 'vegetation sweep' technique in conjunction with the 'kick sampling' technique. The two techniques sample different habitat types and increasing the amount of habitat diversity in a sample may increase the number of taxa found.

Overall, the results of both the October 2014 and February 2015 surveys suggest that the Kaimiro Production Station had not had any recent detrimental effects on the macroinvertebrate communities of the main tributary of the Mangaoraka Stream. Poorer macroinvertebrate indices found at the minor tributary would be a reflection of habitat differences, most likely from naturally occurring iron oxide deposition and differences in taxa richness between sites 1 and 3 may be a reflection of the level of habitat diversity in conjunction with differences in sampling techniques between the two sites.

The full survey reports are attached in Appendix II.

2.4 Results: air

2.4.1 Inspections

Air inspections were carried out in conjunction with site inspections as discussed in section 2.3.1 above. On all occasions air discharges complied with consent conditions.

2.4.2 Results of discharge monitoring

2.4.2.1 Carbon monoxide and combustible gases

During the monitoring year, a multi-gas meter was deployed on one occasion in the vicinity of the plant. The deployment lasted approximately 60 hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continuous measurements of gas concentrations for the gases of interest (carbon monoxide and combustible gases). The monitoring sites used in the year under review are shown in Figure 2.

Because of the nature of the activities on the site, it was considered that the primary information of interest in respect of gases potentially emitted from the site was the average downwind concentration, rather than any instantaneous peak value. That is, the long-term exposure levels, rather than short-term maxima, are of most interest. The gas meter was therefore set up to create a data set based on recording the average concentration measured during each minute as raw data.



Figure 2 Air monitoring sites at Kaimiro Production Station for 2014-2015

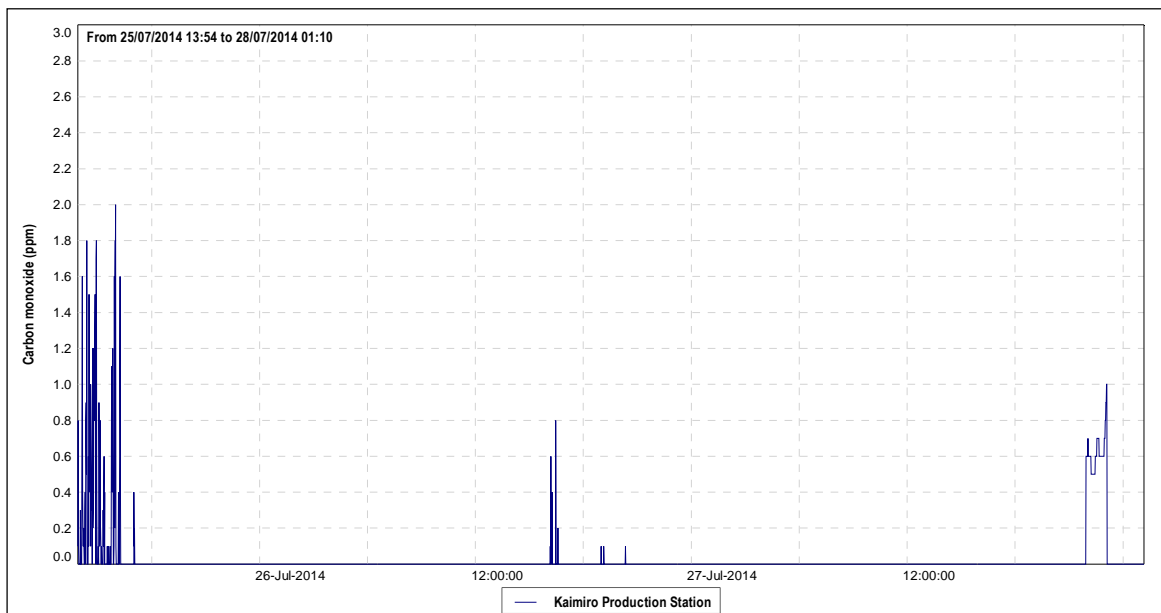
The details of the sample run are summarised in Table 3 and the data from the sample run are presented graphically in Figure 3.

The consents covering air discharges from the Kaimiro Production Station have specific limits related to particular gases. Special condition 13 of consent 4048-3 sets a limit on the carbon monoxide concentration at or beyond the production station's boundary. The limit is expressed as 10 mg/m³ for an eight hour average or 30 mg/m³ for a one hour average exposure. The maximum concentration of carbon monoxide found during the monitoring run was 2.3 mg/m³ while the average concentration for the entire dataset was only 0.10 mg/m³ which comply with consent conditions. This is in line with the pattern found in previous years.

Table 3 Results of carbon monoxide and LEL monitoring at Kaimiro Production Station

| Period | | 25/07/2014 13:54 to 28/07/2014 01:10 |
|--------|---------|--------------------------------------|
| Max | CO(ppm) | 2.30 |
| | LEL(%) | 0.10 |
| Mean | CO(ppm) | 0.00 |
| | LEL(%) | 0.00 |
| Min | CO(ppm) | 0.00 |
| | LEL(%) | 0.00 |

Notes: (1) the instrument records in units of ppm. At 25°C and 1 atm, 1ppm CO = 1.145 mg/m³
(2) because the LEL of methane is equivalent to a mixture of approximately 5% methane in air, then the actual concentration of methane in air can be obtained by dividing the percentage LEL by 20.

**Figure 3** Ambient CO levels in the vicinity of Kaimiro Production Station

Lower Explosive Limit (LEL) gives the percentage of the lower explosive limit, expressed as methane that is detected in the air sampled. The sensor on the instrument reacts to gases and vapours such as acetone, benzene, butane, methane, propane, carbon monoxide, ethanol, and higher alkanes and alkenes, with varying degrees of sensitivity. The Council's Regional Air Quality Plan has a typical requirement that no discharge shall result in dangerous levels of airborne contaminants, including any risk of explosion. At no time did the level of explosive gases downwind of the Kaimiro Production Station reach any more than a trivial level.

2.4.2.2 PM10 particulates

In September 2004 the Ministry for the Environment enacted National Environmental Standards (NESs) relating to certain air pollutants. The NES for PM10 particulates is 50 µg/m³ (24-hour average).

Particulates can be derived from many sources, including motor vehicles (particularly diesel), solid and oil-burning processes for industry and power generation, incineration

and waste burning, photochemical processes, and natural sources such as pollen, abrasion, and sea spray.

PM10 particles are linked to adverse health effects that arise primarily from the ability of particles of this size to penetrate the defences of the human body and enter deep into the lungs, significantly reducing the exchange of gases across the lung walls. Health effects from inhaling PM10 include increased mortality and the aggravation of existing respiratory and cardiovascular conditions such as asthma and chronic pulmonary diseases.

During the reporting period, a DustTrak PM10 monitor was deployed on one occasion in the vicinity of Kaimiro Production Station. The deployment lasted approximately 53 hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continual measurements of PM10 concentrations. The location of the DustTrak monitor during the sampling run is shown in Figure 2. The results of the sample run are presented in Figure 4 and Table 4.

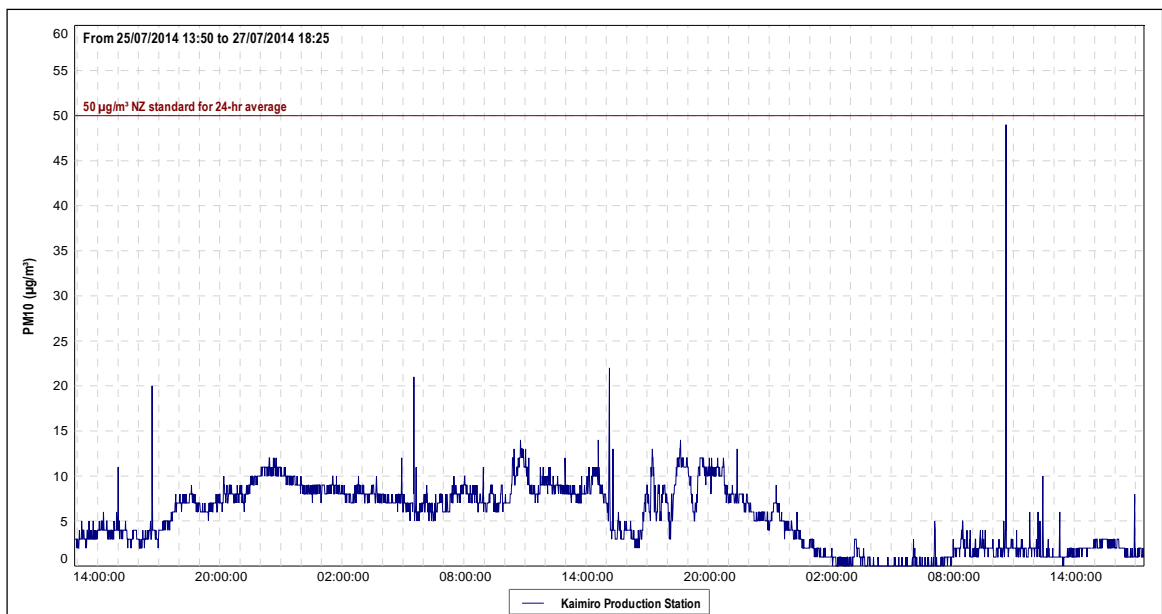


Figure 4 PM10 concentrations ($\mu\text{g}/\text{m}^3$) at Kaimiro Production Station

Table 4 Daily averages of PM10 results from monitoring at Kaimiro Production Station

| | 53 hours 25-27/07/2014 | |
|-----------------------------|-------------------------------|-------------------------------|
| 24 hr. set | Day 1 | Day 2 |
| Daily average | 7.27 $\mu\text{g}/\text{m}^3$ | 3.23 $\mu\text{g}/\text{m}^3$ |
| NES limit (24 hour average) | 50 $\mu\text{g}/\text{m}^3$ | |

During the 53 hour run, from 25 July to 27 July 2014, the average recorded PM10 concentration was 7.27 $\mu\text{g}/\text{m}^3$ for the first 24 hour period and 3.23 $\mu\text{g}/\text{m}^3$ for the second 24 hour period. These daily averages equate to 14.5% and 6.5%, respectively, of the 50 $\mu\text{g}/\text{m}^3$ value that is set by the NES. Background levels of PM10 in the region have been found to be typically around 11 $\mu\text{g}/\text{m}^3$.

2.4.2.3 Nitrogen oxides

From 2014 onwards, the Council implemented a coordinated region-wide compliance monitoring programme to measure nitrogen oxides (NO_x). The programme involves deploying measuring devices at 28 NO_x monitoring sites (including two sites in the vicinity of Kaimiro Production Station) on the same day, with retrieval three weeks later. This approach assists the Council in further evaluating the effects of local and regional emission sources and ambient air quality in the region.

The consent covering air discharges from the Kaimiro Production Station has specific limits related to particular gases. Special condition 14 of consent 4048-3 sets a limit on the nitrogen dioxide concentration at or beyond the production station's boundary. The limit is expressed as 200 µg/m³ for a 1-hour average or 100 µg/m³ for a 24-hour average exposure.

NO_x passive adsorption discs were placed at two locations in the vicinity of the Kaimiro Production Station on one occasion during the year under review. The discs were left in place for a period of 21 days. The calculated 1-hour and 24-hour theoretical maximum NO_x concentrations found at Kaimiro Production Station during the year under review equate to 11.25 µg/m³ and 5.9 µg/m³, respectively. The results show that the ambient ground level concentration of NO_x is well below the limits set out by consent 4048-3.

The full air monitoring reports are attached to this report in Appendix III.

2.5 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 (IR) 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 2014-2015 period, the Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with GPL's conditions in resource consents or provisions in Regional Plans.

3. Ngatoro producing wellsites

3.1 Resource consents

3.1.1 Water discharge permits

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.

GPL holds water discharge permit **4073-2** to cover the discharge of up to 100 m³/day of treated stormwater, treated production water and treated wastewater from oil well drilling and production operations and a truck turning area at the Ngatoro-A wellsite into the Ngatoro Stream in the Waitara Catchment. This permit was issued by the Council on 4 February 1998 under Section 87(e) of the RMA. It expired on 1 June 2015 and is currently in the process of being renewed.

Conditions 1 to 5 require the establishment of a permanent mixing zone below the point of discharge and stipulate the limits of contaminants in the discharge, and effects the discharge shall not give rise to in both the receiving waters and the Ngatoro Stream.

Condition 6 requires that the consent holder provide a contingency plan in relation to spills at the site.

Condition 7 requires advance notification of the drilling of additional wells at the site.

Condition 8 requires advance notification of the disposal of production water via the stormwater system.

Condition 9 provides for review of the consent.

GPL also holds water discharge permit **3951-3** to discharge treated wastewater and treated stormwater from hydrocarbon exploration and production operations at the Ngatoro-B wellsite into an unnamed tributary of the Ngatoro Stream in the Waitara catchment. This permit was issued by the Council on 23 April 2009 under Section 87(e) of the RMA and is due to expire on 1 June 2027.

Condition 1 requires the consent holder to adopt the best practicable option to prevent or minimise adverse effects of the discharge on the environment.

Condition 2 imposes a limit on the stormwater catchment size.

Condition 3 requires written notification to the Council prior to commencement of site works and drilling operations.

Condition 4 requires that the consent holder prepare and maintain a contingency plan in relation to spillages at the site.

Condition 5 requires that management and maintenance of the stormwater system be undertaken in accordance with information submitted in the application.

Condition 6 requires all stormwater be directed through the stormwater treatment system.

Condition 7 requires that hazardous substance storage areas be bunded with drainage to appropriate recovery systems, and not to the stormwater catchment.

Conditions 8, 9 and 10 impose limits on contaminants in the discharge, and stipulate effects the discharge shall not give rise to in the receiving water.

Condition 11 requires that the Council be advised of reinstatement of the site.

Conditions 12 and 13 are lapse and review provisions.

These permits are attached to this report in Appendix I.

3.1.2 Air discharge permits

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

GPL holds air discharge permit **7295-1** to cover discharge of emissions to air during flaring from well workovers and in emergency situations and miscellaneous emissions associated with production activities at the Ngatoro-A site. This permit was issued by the Council on 12 May 2008 under Section 87(e) of the RMA and is due to expire on 1 June 2027.

Twenty-two special conditions are attached to the consent regarding: information and notification (Council and neighbourhood notification, alteration to plant equipment or processes); emissions from the site (regard to wind speed, solid and liquid separation and recovery, best practicable option, offensive odour or smoke, vapour recovery systems, smoke opacity, noxious gases, other contaminants); recording and reporting information (gas stream analysis, visible smoke log, flaring log, annual air discharge report); and lapse of consent and review of conditions.

GPL also holds air discharge permit **7220-1** to cover discharge of emissions to air during flaring from well workovers and in emergency situations and miscellaneous emissions associated with production activities at the Ngatoro-B site. This permit was issued by the Council on 9 May 2008 under Section 87(e) of the RMA and is due to expire on 1 June 2027.

The twenty-two special conditions attached to the consent are identical to those for consent 7295-1 above.

These permits are attached to this report in Appendix I.

3.2 Monitoring programme

3.2.1 Introduction

Section 35 of the RMA sets out an obligation for the Council to gather information, monitor and conduct research on the exercise of resource consents, and the effects arising, within the Taranaki region.

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 Ngatoro wellsites consisted of four primary components, as set out sections 3.2.2 to 3.2.5.

3.2.2 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.

3.2.3 Site inspections

The Ngatoro-A and B wellsites were visited five times during the monitoring period. Other producing wellsites associated with the Kaimiro Production Station are inspected annually. 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. Sources of data being collected by the consent holder were identified and accessed, so that performance in respect of operation, internal monitoring, and supervision could be reviewed by the Council. The neighbourhood was surveyed for environmental effects.

3.2.4 Chemical sampling

The Council undertook sampling of the discharges from the Ngatoro-A wellsite as well as the water quality upstream of the discharge point and downstream below the mixing zone.

The discharge from Ngatoro-A was sampled on one occasion during the year. The sample was analysed for hydrocarbons, suspended solids, conductivity, pH, chloride, turbidity and temperature.

The Ngatoro Stream tributary which receives discharges from the Ngatoro-A site was sampled on one occasion at two sites, and the samples were analysed for hydrocarbons, suspended solids, conductivity, pH, chloride, turbidity and temperature.

3.2.5 Biomonitoring

A three-site biological survey was performed in the Ngatoro Stream and an unnamed tributary to determine whether or not the discharge of treated stormwater from the Ngatoro-B wellsite has had a detrimental effect upon the communities of the stream.

3.3 Results: water

3.3.1 Inspections

Five inspections were carried out at each of the Ngatoro sites in the 2014-2015 year. An annual inspection of associated wellsites was undertaken on 29 April 2015 (refer to section 2.3.1). The following was found during the inspections:

7 July 2014

The sites were inspected following heavy rainfall. The Ngatoro-A site was neat and tidy. The recently lined skimmer pits contained very clean water. Discharge to the nearby stream was not causing any visual effects. The Ngatoro-B site was inspected from the perimeter. The site was neat and tidy with very little activity. There was no evidence of any contaminants in the skimmer pits.

26 August 2014

Site inspections of Ngatoro-A and Ngatoro-B were undertaken from outside the perimeter fences. Both sites showed that stormwater treatment systems were effective with no effects of any previous discharges noted. A high, naturally occurring (as evidenced by upstream site inspection), iron oxide deposition was evident. The sites were observed to be neat and tidy, with no flaring or off-site odours noted.

7 October 2014

Both Ngatoro -A and Ngatoro-B sites were found to be neat and tidy. The skimmer pits at Ngatoro-A were clear of contaminants and pit liners were secure. The Ngatoro-B site was inspected from the perimeter down to stream with no effects of any discharge noted. Flaring was not occurring at either site.

13 March 2015

Both Ngatoro sites were inspected from the perimeter as there were no staff present on either site. The skimmer pits appeared clean and were not discharging at the time of the inspections. No flaring was being undertaken and no odours or off-site effects were noted.

25 June 2015

The sites and storm water systems were checked following an extreme high rainfall event that resulted in a 'State of Emergency' declaration being declared for Taranaki. The design management and maintenance of the storm water systems ensured that no off site effects had occurred. No contaminants were evident in the skimmer pits and only evidence of elevated suspended solids had occurred (as would be expected).

3.3.2 Results of discharge monitoring

The location of water quality sampling sites in relation to both Ngatoro-A and Ngatoro-B sites are shown in Figure 5.

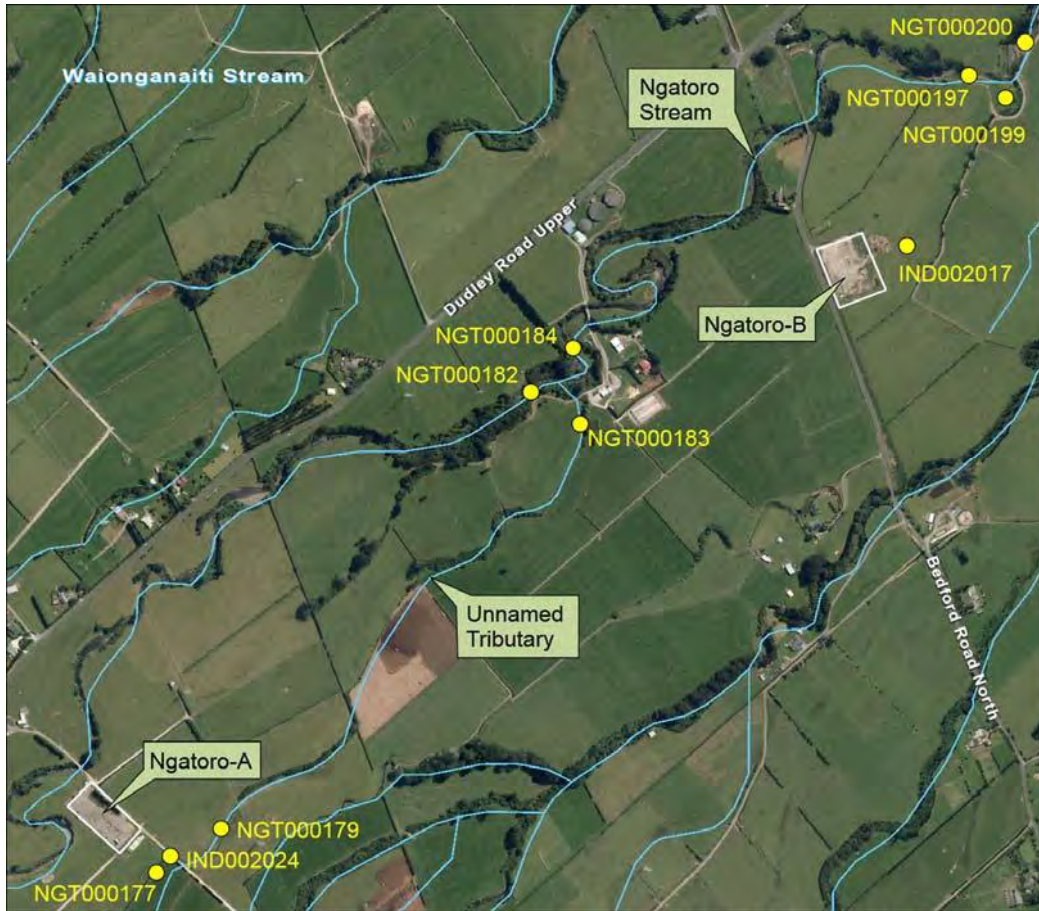


Figure 5 Monitoring sites in relation to the Ngatoro wellsites

Ngatoro-A

Chemical water sampling of the discharge from Ngatoro-A was undertaken on one occasion during the 2014-2015 monitoring period. Table 5 presents the results along with a summary of previous results.

Table 5 Results of discharge monitoring from Ngatoro-A (site IND002024) during the period under review with a summary of previous monitoring data

| Parameter | Units | 2 June 2015 | Previous results | | | |
|------------------|------------------|-------------|------------------|--------|--------|--------|
| | | | Min | Max | Median | Number |
| Chloride | g/m ³ | 180 | 27 | 25,400 | 4,180 | 43 |
| Conductivity | mS/m | 68.1 | 2.1 | 5,320 | 560 | 43 |
| Hydrocarbons | g/m ³ | <0.5 | < 0.5 | 22 | 0.6 | 43 |
| pH | | 6.6 | 6.2 | 7.3 | 6.8 | 43 |
| Suspended solids | g/m ³ | 13 | < 2 | 260 | 31 | 43 |
| Turbidity | NTU | 37 | 3.2 | 510 | 35 | 35 |
| Temperature | °C | 13.9 | 6.5 | 24.0 | 13.7 | 43 |

The chloride concentration in the discharges was significantly lower than previous years because GPL is no longer discharging treated production water via the stormwater system. No hydrocarbons were detected in the sample.

3.3.3 Results of receiving environment monitoring

Chemical

Chemical water quality sampling of the receiving environment was undertaken in conjunction with discharge monitoring on 2 June 2015 (see Table 4 for an explanation of sites). The results are presented in Table 7 below. Table 6 sets out the water quality standards relating to consent 4073-2.

The receiving water (below mixing zone) limits apply within the Ngatoro Stream itself at site NGT000184, not in the tributary. However, two sites in the tributary of the Ngatoro Stream, upstream and downstream of the discharge point (NGT000177 and NGT000179), were sampled as with the upcoming renewal of consent 4073-2 it is expected that the tributary itself will be designated as the receiving waters and these sites will be used to monitor the effect of the stormwater discharge from Ngatoro-A.

Table 6 Water quality standards below the mixing zone at Ngatoro-A according to consent 4073-2

| Parameter | Unit | Must not exceed |
|------------------|------------------|--|
| Chloride | g/m ³ | 50 |
| pH range | g/m ³ | 6.5-8.5 |
| Suspended solids | g/m ³ | An increase of 10 (when turbidity upstream is ≤ 5 NTU) |
| Turbidity | NTU | An increase of 50 % (if turbidity upstream is ≥ 5 NTU) |

The results indicate that the discharge was having minimal effect on the water quality of the Ngatoro Stream at the times of sampling (refer to the difference between the upstream NGT000177 and downstream NGT000179 site results). Chloride levels, suspended solids, pH and turbidity below the mixing zone were all within consent limits on both occasions.

Table 7 Results of receiving environment monitoring in relation to Ngatoro-A on 2 June 2015

| Site | Chloride g/m ³ | Conductivity mS/m | Hydrocarbons g/m ³ | pH | Suspended solids g/m ³ | Temp °C | Turbidity NTU |
|---------------|------------------------------|----------------------|----------------------------------|-----|---|------------|------------------|
| NGT000177 u/s | 22.8 | 15.4 | <0.5 | 6.9 | 12 | 13.4 | 19 |
| NGT000179 d/s | 25.9 | 19.1 | <05 | 6.9 | 6 | 13.9 | 7.3 |

Biomonitoring at Ngatoro-B

On 16 October 2014, the Council's standard 'kick-sampling' technique was used at two established sites in the Ngatoro Stream and a combination of 'kick-sampling and 'vegetation sweeping' was used in an unnamed tributary of the Ngatoro Stream to collect streambed macroinvertebrates. Samples were sorted and identified and the number of taxa (richness) and MCI and SQMCI_s scores were obtained 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, particularly if non-organic impacts are occurring. Significant differences in either the MCI or the SQMCI_S between site indicate the degree of adverse effects (if any) of the discharges being monitored.

The survey indicated that discharges from the Ngatoro-B Production Station site had not had any recent detrimental effects on the macroinvertebrate communities of the Ngatoro Stream. Minimal, insignificant differences in the macroinvertebrate communities were recorded between the upstream 'control' site and the site downstream of the receiving tributary confluence.

The macroinvertebrate communities of the Ngatoro Stream contained significant proportions of 'sensitive' taxa at both sites and the communities were generally dominated by 'sensitive' taxa. Taxonomic richnesses (numbers of taxa) were very similar to medians at both sites at the time of this spring survey.

MCI scores indicated that the stream communities were of 'good' health, and generally typical of conditions recorded in similar reaches of ringplain Taranaki streams. The unnamed tributary had abundant iron-oxide deposits which smothered the substrate and contributed to the low SQMCI_S score and taxa richness and reduced abundances within the majority of individual taxa present at this site.

Overall, the low salinity discharges from the Ngatoro-B site were found to have had no recent detrimental impacts on the macroinvertebrate communities of the Ngatoro Stream beyond the designated mixing zone downstream of the tributary confluence.

The full survey report is attached in Appendix II.

3.4 Results: air

3.4.1 Inspections

Air inspections were carried out in conjunction with site inspections as discussed in section 3.3.1 above. On all occasions air discharges complied with consent conditions.

3.5 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 (IR) 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 2014-2015 period, the Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with GPL's conditions in resource consents or provisions in Regional Plans.

4. Discussion

4.1 Discussion of site performance

Inspections of the Kaimiro and Ngatoro sites during the 2014-2015 monitoring year found that they were largely well managed and the stormwater systems were maintained to a satisfactory standard. Emissions to air were well controlled.

4.2 Environmental effects of exercise of consents

4.2.1 Kaimiro Production Station

Results of samples collected of the discharge and receiving waters were within the limits prescribed by the consents and, along with the results of biomonitoring carried out in the Mangaoraka Stream, indicated that the discharges were not having a significant adverse effect on the downstream water quality.

There were no adverse effects on the environment as a result of the exercise of the air discharge permit at the Kaimiro Production Station. Measurements of ambient air quality at the site showed that the concentrations of carbon monoxide, nitrogen oxide, volatile organic compounds and combustible gases were below levels of concern.

4.2.2 Ngatoro producing wellsites

Results of samples collected of the discharge and receiving waters were within the limits prescribed by the consents and, along with the results of biomonitoring carried out in the Ngatoro Stream, indicated that the discharges were not having a significant adverse effect on the downstream water quality.

Flaring was not undertaken at Ngatoro-A and B during the monitoring period.

4.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Tables 8-14.

4.3.1 Kaimiro Production Station

Table 8 Summary of performance for Consent 1334-3

| Purpose: To discharge treated stormwater from the Kaimiro Production Station site into an unnamed tributary | | |
|--|---|-----------------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 1. Best practicable option to prevent effects on environment | Site inspections | Yes |
| 2. Maximum stormwater catchment | Site inspections | Yes |
| 3. Contingency plan provided prior to commencement | Received | Yes |
| 4. Site water directed for treatment through stormwater treatment system | Site inspections | Yes |
| 5. Design, management and maintenance of stormwater system in accordance with application | Site inspections | Yes |
| 6. Hazardous storage areas bunded with drainage to sumps | Site inspections | Yes |
| 7. Limits on contaminants in the discharge | Sample collection | Yes |
| 8. Limits on chloride, BOD and temperature increase below mixing zone | Sample collection | Yes |
| 9. Effects on receiving water below mixing zone | Inspection and sample collection | Yes |
| 10. Annual preparation and maintenance of contingency plan relating to spills at the site | Update of plan approved 20 Aug 2014 | Yes |
| 11. Council advised prior to reinstatement of the site | Site not reinstated during period under review | N/A |
| 12. Provisions for review of consent conditions | No further provision for review prior to expiry | N/A |
| Overall assessment of environmental performance and compliance in respect of this consent | | High |
| Overall assessment of administrative performance in respect of this consent | | High |

N/A = not applicable

Table 9 Summary of performance for Consent 4048-3

| Purpose: To discharge emissions into the air from the flaring of hydrocarbons | | |
|--|---|-----------------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 1. Limit on flaring duration | Site inspections and company logs | Yes |
| 2. Neighbours notified prior to flaring | No complaints received from neighbours | Yes |
| 3. Council notified of continuous flaring | Notifications received | Yes |
| 4. Consultation prior to alteration to plant equipment or processes | Site inspections and liaison with consent holder | Yes |
| 5. Regard given to wind conditions during flaring | No complaints received from neighbours | Yes |
| 6. Gas treated by liquid and solid separation and recovery | Site inspections | Yes |
| 7. No liquid or solid hydrocarbons combusted through gas flare | Site inspections | Yes |
| 8. Flare only used to dispose of substances from the well stream | Site inspections | Yes |
| 9. Hydrocarbon storage vessels fitted with vapour recovery systems | Site inspections | Yes |
| 10. Best practicable option to prevent effects on environment | Site inspections | Yes |
| 11. No offensive odour or smoke at boundary of site | Site inspections | Yes |
| 12. Limit on smoke opacity | Site inspections | Yes |
| 13. Limit on carbon monoxide emissions | Ambient gas monitoring | Yes |
| 14. Limit on nitrogen dioxide emissions | Ambient gas monitoring | Yes |
| 15. No discharge of contaminant that is hazardous, toxic or noxious beyond boundary | Site inspections and ambient gas monitoring | Yes |
| 16. No discharge of contaminant that exceeds specific WES limits | Ambient gas monitoring | Yes |
| 17. Record of smoke emitting incidents | Annual air report received | Yes |
| 18. Provision of flaring logs to Council | Flaring logs received | Yes |
| 19. Maintenance of flaring logs | Flaring logs received | Yes |
| 20. Provision of annual air emissions report | Report received | Yes |
| 21. Analysis of gas and crude oil stream | Not requested during period under review | N/A |

| Purpose: To discharge emissions into the air from the flaring of hydrocarbons | | |
|---|---|-----------------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 22. Provisions for review of consent conditions | Review not scheduled during the monitoring period | N/A |
| Overall assessment of environmental performance and compliance in respect of this consent | | High |
| Overall assessment of administrative performance in respect of this consent | | High |

Table 10 Summary of performance for Consent 5384-2

| Purpose: To take groundwater from the Matemateaonga Formation | | |
|---|---|-----------------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 1. Total volume abstracted not to exceed 550m ³ /day or 6.4 l/s | Review of data provided by consent holder | Yes |
| 2. Bore to be labelled | Site inspections | Yes |
| 3. Installation and maintenance of water meter and datalogger | Site inspections | Yes |
| 4. Provision of data annually by 31 July | Data provided | Yes |
| 5. Documentation proving equipment has been installed and is accurate | Certification achieved | Yes |
| 6. Water meter and datalogger to be accessible to Council staff | Site inspections | Yes |
| 7. Council to be notified if equipment breaks down | No issues during the period | Yes |
| 8. Best practicable option to prevent or minimise adverse environmental effects | Site inspections and liaison with consent holder | Yes |
| 9. Lapse of consent | | N/A |
| 10. Provisions for review of consent conditions | Not scheduled during the monitoring period | N/A |
| Overall assessment of environmental performance and compliance in respect of this consent | | High |
| Overall assessment of administrative performance in respect of this consent | | High |

4.3.2 Ngatoro-A wellsite

Table 11 Summary of performance for Consent 4073-2

| Purpose: To discharge up to 100 cubic metres/day of treated stormwater, treated production water and waster water | | |
|--|---|-----------------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 1. Establishment of permanent mixing zone 25 m below discharge | Mixing zone established prior to monitoring period | N/A |

| Purpose: To discharge up to 100 cubic metres/day of treated stormwater, treated production water and waster water | | |
|--|---|-----------------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 2. Effects on stream below mixing zone | Inspections and sampling | Yes |
| 3. Limit on hydrocarbons in discharge | Sampling | Yes |
| 4. Limits on chloride and pH in receiving waters | Sampling | Yes |
| 5. Suspended solid and turbidity levels below mixing zone | Sampling | Yes |
| 6. Provision of contingency plan | Updated plan provided in November 2014 with consent renewal documents | Yes |
| 7. Advise Council prior to drilling of additional wells | No drilling undertaken during monitoring period | N/A |
| 8. Notification prior to discharge of production water | No discharge of produced water during monitoring period | N/A |
| 9. Provisions for review of consent conditions | Consent has expired | N/A |
| Overall assessment of environmental performance and compliance in respect of this consent | | High |
| Overall assessment of administrative performance in respect of this consent | | High |

Table 12 Summary of performance for Consent 7295-1

| Purpose: To discharge emissions to air during flaring | | |
|--|---|-----------------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 1. Council notified of continuous flaring | No flaring at site during monitoring period | N/A |
| 2. Neighbours notified prior to flaring | No flaring at site during monitoring period | N/A |
| 3. Consultation prior to alteration to plant equipment or processes | Site inspections | Yes |
| 4. Regard given to wind conditions during flaring | No flaring at site during monitoring period | N/A |
| 5. Gas treated by liquid and solid separation and recovery | Site inspections | Yes |
| 6. Notify Council of any failure to maintain liquid and solid separation | No flaring at site during monitoring period | N/A |
| 7. No liquid or solid hydrocarbons combusted through gas flare | No flaring at site during monitoring period | N/A |
| 8. Best practicable option to prevent effects on environment | Site inspections | Yes |

| Purpose: To discharge emissions to air during flaring | | |
|---|---|-----------------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 9. Flare only used to dispose of substances from the well stream | No flaring at site during monitoring period | N/A |
| 10. No offensive odour or smoke at boundary of site | No flaring at site during monitoring period | N/A |
| 11. Hydrocarbon storage vessels fitted with vapour recovery systems | Site inspections | Yes |
| 12. Limit on smoke opacity | No flaring at site during monitoring period | N/A |
| 13. Limit on carbon monoxide emissions | No flaring at site during monitoring period | N/A |
| 14. Limit on nitrogen dioxide emissions | No flaring at site during monitoring period | N/A |
| 15. No discharge of contaminant that is hazardous, toxic or noxious beyond boundary | No flaring at site during monitoring period | N/A |
| 16. No discharge of contaminant that exceeds specific WES limits | No flaring at site during monitoring period | N/A |
| 17. Analysis of gas and crude oil stream | No flaring at site during monitoring period | N/A |
| 18. Record of smoke emitting incidents | No flaring at site during monitoring period | N/A |
| 19. Maintenance of flaring logs | No flaring at site during monitoring period | N/A |
| 20. Provision of annual air emissions report | Report received | Yes |
| 21. Lapse of consent | Consent exercised within lapse period | N/A |
| 22. Provisions for review of consent conditions | Review not scheduled during the monitoring period | N/A |
| Overall assessment of environmental performance and compliance in respect of this consent | | High |
| Overall assessment of administrative performance in respect of this consent | | High |

4.3.3 Ngatoro-B wellsite

Table 13 Summary of performance for Consent 3951-3

| Purpose: To discharge treated stormwater and wastewater | | |
|--|---|-----------------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 1. Best practicable option to prevent effects on environment | Site inspections | Yes |
| 2. Maximum stormwater catchment | Site inspections | Yes |

| Purpose: To discharge treated stormwater and wastewater | | |
|---|---|-----------------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 3. Notification prior to site works or drilling activities | Site inspections (no works during period) | Yes |
| 4. Contingency plan provided to Council | Update of plan received August 2012 | Yes |
| 5. Activity undertaken in accordance with application | Site inspections | Yes |
| 6. All stormwater and waste water to be directed through treatment system | Site inspections and sampling | Yes |
| 7. Hazardous substance areas to be isolated from the stormwater system | Site inspections | Yes |
| 8. Limits on contaminants in the discharge | Not assessed during period under review | N/A |
| 9. Limit on temperature increase below the mixing zone | Not assessed during period under review | N/A |
| 10. Effects on receiving water below mixing zone | Inspections and biomonitoring | Yes |
| 11. Reinstatement to the satisfaction of the Council | Site not reinstated during the period under review | N/A |
| 12. Lapse of consent | Consent exercised within lapse period | N/A |
| 13. Review provisions | Review not scheduled during the monitoring period | N/A |
| Overall assessment of environmental performance and compliance in respect of this consent | | High |
| Overall assessment of administrative performance in respect of this consent | | High |

Table 14 Summary of performance for Consent 7220-1

| Purpose: To discharge emissions to air | | |
|---|---|-----------------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 1. Council notified of continuous flaring | No flaring at site during monitoring period | N/A |
| 2. Neighbours notified prior to flaring | No flaring at site during monitoring period | N/A |
| 3. Consultation prior to alteration to plant equipment or processes | Site inspections and liaison with consent holder | Yes |
| 4. Regard given to wind conditions during flaring | No flaring at site during monitoring period | N/A |
| 5. Gas treated by liquid and solid separation and recovery | No flaring at site during monitoring period | N/A |

| Purpose: To discharge emissions to air | | |
|---|---|-----------------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 6. Notify Council of any failure to maintain liquid and solid separation | No flaring at site during monitoring period | N/A |
| 7. No liquid or solid hydrocarbons combusted through gas flare | No flaring at site during monitoring period | N/A |
| 8. Best practicable option to prevent effects on environment | Site inspections | Yes |
| 9. Flare only used to dispose of substances from the well stream | No flaring at site during monitoring period | N/A |
| 10. No offensive odour or smoke at boundary of site | No flaring at site during monitoring period | N/A |
| 11. Hydrocarbon storage vessels fitted with vapour recovery systems | Site inspections | Yes |
| 12. Limit on smoke opacity | No flaring at site during monitoring period | N/A |
| 13. Limit on carbon monoxide emissions | No flaring at site during monitoring period | N/A |
| 14. Limit on nitrogen dioxide emissions | No flaring at site during monitoring period | N/A |
| 15. No discharge of contaminant that is hazardous, toxic or noxious beyond boundary | No flaring at site during monitoring period | N/A |
| 16. No discharge of contaminant that exceeds specific WES limits | No flaring at site during monitoring period | N/A |
| 17. Analysis of gas and crude oil stream | No flaring at site during monitoring period | N/A |
| 18. Record of smoke emitting incidents | No flaring at site during monitoring period | N/A |
| 19. Maintenance of flaring logs | No flaring at site during monitoring period | N/A |
| 20. Provision of annual air emissions report | Report received | Yes |
| 21. Lapse of consent | Consent exercised within lapse period | N/A |
| 22. Provisions for review of consent conditions | Review not scheduled during the monitoring period | N/A |
| Overall assessment of environmental performance and compliance in respect of this consent | | High |
| Overall assessment of administrative performance in respect of this consent | | High |

4.3.4 Summary

During the period under review, GPL demonstrated an overall high level of both environmental performance and administrative compliance with the resource consents

as defined in Section 1.1.4. There were no unauthorised incidents recorded by the Council in relation to GPL's activities. The Kaimiro Production Station and associated wellsites were well managed and maintained.

4.4 Recommendation from the 2013-2014 Annual Report

In the 2013-2014 Annual Report, it was recommended:

1. THAT for 2014-2015 the monitoring programme for consented activities at the Kaimiro and Ngatoro sites is amended from that in 2013-2014 by reducing the level of monitoring at Ngatoro-A and Ngatoro-B to reflect the consolidation of the majority of production activities for the Kaimiro/Ngatoro assets at Kaimiro Production Station in recent years.
2. THAT the option for review of resource consents 3951-3, 7220-1 and 7295-1 in June 2015, as set out in conditions 13 (3951) and 22 (7220 and 7295), not be exercised on the grounds that the current conditions are considered adequate to deal with any adverse effects on the environment arising from the exercise of these resource consents.

These recommendations were implemented.

4.5 Alterations to monitoring programmes for 2015-2016

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, the obligations of the Act in terms of monitoring emissions/discharges and effects, and subsequently 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 emitting to the atmosphere/discharging to the environment.

It is proposed that for 2015-2016 the monitoring programme for consented activities at the Kaimiro and Ngatoro sites is slightly altered from that of 2014-2015 by removing the macroinvertebrate survey in the Ngatoro Stream. A recommendation to this effect is attached to this report.

5. Recommendation

1. THAT for 2015-2016 the monitoring programme for consented activities at the Kaimiro and Ngatoro sites is amended from that in 2014-2015 with the removal of the macroinvertebrate survey undertaken in the Ngatoro Stream to reflect the consolidation of the majority of production activities for the Kaimiro/Ngatoro assets at Kaimiro Production Station in recent years.

Glossary of common terms and abbreviations

The following abbreviations and terms are used within this report:

| | |
|------------------|---|
| Biomonitoring | Assessing the health of the environment using aquatic organisms. |
| BOD | Biochemical oxygen demand. A measure of the presence of degradable organic matter, taking into account the biological conversion of ammonia to nitrate. |
| Conductivity | Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m. |
| Cumec | A volumetric measure of flow- 1 cubic metre per second (1 m ³ s ⁻¹). |
| 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 | 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. |
| IR | 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. |
| 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. 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. |
| PM ₁₀ | Relatively fine airborne particles (less than 10 micrometre diameter). |
| 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 | <i>Resource Management Act 1991</i> and including all subsequent amendments. |
| SS | Suspended solids. |
| SQMCI | Semi quantitative macroinvertebrate community index. |
| Temp | Temperature, measured in °C (degrees Celsius). |
| Turb | Turbidity, expressed in NTU. |
| UI | Unauthorised Incident. |

Bibliography and references

- Taranaki Regional Council (2015): Greymouth Petroleum Kaimiro and Ngatoro Production Stations Monitoring Programme Annual Report 2013-2014. Technical Report 2014-69
- Taranaki Regional Council (2014): Greymouth Petroleum Kaimiro and Ngatoro Production Stations Monitoring Programme Annual Report 2012-2013. Technical Report 2013-89.
- Taranaki Regional Council (2013): Greymouth Petroleum Kaimiro and Ngatoro Production Stations Monitoring Programme Annual Report 2011-2012. Technical Report 2012-64.
- Taranaki Regional Council (2012): Greymouth Petroleum Kaimiro and Ngatoro Production Stations Monitoring Programme Annual Report 2010-2011. Technical Report 2011-62.
- Taranaki Regional Council (2011): Greymouth Petroleum Kaimiro and Ngatoro Production Stations Monitoring Programme Annual Report 2009-2010. Technical Report 2010-108.
- Taranaki Regional Council (2010): Greymouth Petroleum Kaimiro and Ngatoro Production Stations Monitoring Programme Annual Report 2008-2009. Technical Report 2009-57.
- Taranaki Regional Council (2009): Greymouth Petroleum Kaimiro and Ngatoro Production Stations Monitoring Programme Annual Report 2007-2008. Technical Report 2008-104.
- Taranaki Regional Council (2007): Greymouth Petroleum Kaimiro and Ngatoro Production Stations Monitoring Programme Annual Report 2006-2007. Technical Report 2007-26.
- Taranaki Regional Council (2006): Greymouth Petroleum Kaimiro and Ngatoro Production Stations Monitoring Programme Annual Report 2005-2006. Technical Report 2006-15.
- Taranaki Regional Council (2005): Greymouth Petroleum Kaimiro and Ngatoro Production Stations Monitoring Programme Annual Report 2004-2005. Technical Report 2005-11.
- Taranaki Regional Council (2004): NZOG & Greymouth Petroleum Ngatoro Production Stations Monitoring Programme Annual Report 2003-2004. Technical Report 2004-20.
- Taranaki Regional Council (2004): Greymouth Kaimiro Production Station Monitoring Programme Annual Report 2003-2004. Technical Report 2004-78.
- Taranaki Regional Council (2003): New Zealand Oil and Gas Production Stations (Ngatoro A and B) Annual Report 2002-2003. Technical Report 2003-77.
- Taranaki Regional Council (2003): Greymouth Petroleum Acquisitions Company Limited Monitoring Programme Annual Report 2002-2003. Technical Report 2003-68.
- Taranaki Regional Council (2002): New Zealand Oil and Gas Production Stations (Ngatoro A and B) Annual Report 2001-2002. Technical Report 2002-37.
- Taranaki Regional Council (2002): Fletcher Challenge Energy Monitoring Programmes Annual Report 2001-2002. Technical Report 2002-47.

- Taranaki Regional Council (2001): New Zealand Oil and Gas Production Stations (Ngatoro A and B) Annual Report 2000-2001. Technical Report 2001-24.
- Taranaki Regional Council (2001): Fletcher Challenge Energy Taranaki Ltd Monitoring Programme Annual Report 2000-2001. Technical Report 01-83.
- McWilliam H (2000): Biomonitoring of the Ngatoro Stream sampled in relation to a wastewater discharge from the Ngatoro-A production site, October 1999. TRC report HM199.
- Taranaki Regional Council (2000): New Zealand Oil and Gas Production Stations (Ngatoro A and B) Annual Report 1999-2000. Technical Report 2000-20.
- Taranaki Regional Council (2000): Fletcher Challenge Energy Taranaki Ltd Monitoring Programme Annual Report 1999-2000. Technical Report 00-24.
- Taranaki Regional Council (1999): New Zealand Oil and Gas Production Stations (Ngatoro A and B) Annual Report 1998-99. Technical Report 99-23.
- Taranaki Regional Council (1999): Fletcher Challenge Energy Taranaki Ltd Monitoring Programme Annual Report 1998-1999. Technical Report 99-16.
- Taranaki Regional Council (1998): New Zealand Oil and Gas Production Stations (Ngatoro A and B) Annual Report 1997-98. Technical Report 98-86.
- Taranaki Regional Council (1998): Fletcher Challenge Energy Taranaki Ltd Air and Water Monitoring Report 1997/98. Technical Report 98-61.
- Taranaki Regional Council (1997): New Zealand Oil and Gas Production Stations (Ngatoro 1 and 2) Annual Report 1996-97. Technical Report 97-90.
- Taranaki Regional Council (1997): Fletcher Challenge Energy Taranaki Ltd Air and Water Monitoring Report 1996/97. Technical Report 97-51.
- Taranaki Regional Council (1996): New Zealand Oil and Gas Production Stations (Ngatoro 1 and 2) Annual Report 1995-96. Technical Report 96-42.
- Taranaki Regional Council (1996): Petrocorp Exploration Ltd Air and Water Monitoring Report 1995/96. Technical Report 96-60.
- Taranaki Regional Council (1995): New Zealand Oil and Gas Production Stations (Ngatoro 1 and 2) Annual Report 1994-95. Technical Report 95-62.
- Taranaki Regional Council (1995): Petrocorp Exploration Ltd Air and Water Monitoring Report 1994/95. Technical Report 95-54.
- Taranaki Regional Council (1994): New Zealand Oil and Gas Production Stations (Ngatoro 1 and 2) Annual Report 1993-94. Technical Report 94-75.
- Taranaki Regional Council (1994): Petrocorp Exploration Ltd Air and Water Monitoring Report 1993/94. Technical Report 94-73.

Taranaki Regional Council (1993): Petrocorp Exploration Ltd Air and Water Monitoring Report 1992/93. Technical Report 93-35A.

Taranaki Regional Council (1992): Petrocorp Exploration Ltd Air and Water Monitoring Report 1991/92. Technical Report 92-25.

Taranaki Regional Council (1991): Petrocorp Exploration Ltd Air and Water Monitoring Report 1990/91. Technical Report 91-25.

Taranaki Regional Council (1990): Petrocorp Exploration Ltd Air and Water Monitoring Report 1989/90. Technical Report 90-14.

Appendix I

Resource consents held by Greymouth Petroleum

**(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: Greymouth Petroleum Acquisition Company Limited
P O Box 3394
Fitzroy
NEW PLYMOUTH 4341

Decision Date
(Change): 8 April 2014

Commencement Date
(Change): 8 April 2014 (Granted: 10 January 2002)

Conditions of Consent

Consent Granted: To discharge treated stormwater from the Kaimiro
Production Station site into an unnamed tributary of the
Mangaoraka Stream in the Waiongana catchment

Expiry Date: 1 June 2020

Review Date(s): June 2014

Site Location: Kaimiro Production Station, Upland Road, Inglewood

Legal Description: Lot 4 DP 436344 (Discharge source)
Lot 2 DP 19651 (Discharge site)

Grid Reference (NZTM) 1699783E–5664369N

Catchment: Waiongana

Tributary: Mangaoraka

*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 of the discharge on any water body.
2. The maximum stormwater catchment area shall be no more than 25,000 m².
3. Prior to the exercise of this consent, the consent holder shall provide for the written approval of the Chief Executive, Taranaki Regional Council, site specific details relating to contingency planning for the production site.
4. All site water to be discharged under this permit shall be directed for treatment through the stormwater treatment system for discharge in accordance with the specific conditions of this permit.
5. The design, management and maintenance of the stormwater system shall be generally undertaken:
 - in accordance with the stormwater management plan submitted to Taranaki Regional Council on 16 August 2012, in response to the request for further information for application 7156; and
 - as amended by the stormwater design report submitted with the application for consent 1334-3.2, prepared by BTW Company Limited and dated 28 February 2014.

These plans shall be followed at all times. If changes are proposed, the consent holder shall advise the Taranaki Regional Council one month prior to the changes to the plan.

6. Any above ground hazardous substances storage areas shall be bunded with drainage to sumps, or other appropriate recovery systems, and not to the stormwater catchment.
7. Constituents of the discharge shall meet the standards shown in the following table.

| Constituent | Concentration |
|---|----------------------|
| pH (range) | 6.5 – 8.5 |
| suspended solids | 100 gm ⁻³ |
| total recoverable hydrocarbons (infrared spectroscopic technique) | 15 gm ⁻³ |
| chloride | 230 gm ⁻³ |

This condition shall apply before entry of the treated stormwater, at a designated sampling point approved by the Chief Executive, Taranaki Regional Council.

Consent 1334-3.2

8. After allowing for reasonable mixing, within a mixing zone extending 15 metres downstream of the discharge point, the discharge shall not give rise to any of the following effects in the receiving waters of the unnamed tributary of the Mangaoraka Stream:
 - a. an increase in temperature of more than 2 degrees Celsius; and
 - b. filtered carbonaceous biochemical oxygen demand shall not exceed 2.00 gm⁻³; or
 - c. shall not cause the chloride concentration to exceed 50 gm⁻³
9. After allowing for reasonable mixing, within a mixing zone extending 15 metres downstream of the discharge point, the discharge shall not give rise to any of the following effects in the receiving waters of the unnamed tributary of the Mangaoraka 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; and
 - e. any significant adverse effects on aquatic life.
10. The consent holder shall prepare annually and maintain a contingency plan to the satisfaction of the Chief Executive, Taranaki Regional Council, outlining measures and procedures undertaken to prevent spillage or accidental discharge of contaminants, and procedures to be carried out should such a spillage or discharge occur.
11. The Chief Executive, Taranaki regional Council, shall be advised in writing at least 48 hours prior to the reinstatement of the site and the reinstatement shall be carried out so as to minimise effects on stormwater quality.
12. 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 2008 and/or June 2014, 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 8 April 2014

For and on behalf of
Taranaki Regional Council

A D McLay
Director-Resource Management

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

Name of
Consent Holder: Greymouth Petroleum Limited
P O Box 3394
NEW PLYMOUTH 4341

Consent Granted
Date: 23 April 2009

Conditions of Consent

Consent Granted: To discharge treated wastewater and treated stormwater from hydrocarbon exploration and production operations into an unnamed tributary of the Ngatoro Stream a tributary of the Manganui River in the Waitara catchment at or about (NZTM) 1702355E-5660948N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Ngatoro-B wellsite, Bedford Road, Inglewood
[Property owner: GD & CJ Alexander]

Legal Description: Pt Sec 127 Moa Dist Blk VIII Egmont SD

Catchment: Waitara

Tributary: Manganui
Ngatoro

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 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 actual or likely adverse effect on the environment associated with the discharge of contaminants from the site.
2. Stormwater discharged shall be collected from a catchment area of no more than 12,000 m².
3. The Chief Executive, Taranaki Regional Council, shall be advised in writing at least 7 days prior to any site works commencing, and again in writing at least 7 days prior to any well drilling operation commencing. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
4. The consent holder shall maintain a contingency plan that, to the satisfaction of the Chief Executive, Taranaki Regional Council, details measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not authorised by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge.
5. The management and maintenance of the stormwater system shall be undertaken in accordance with the information submitted in support of the consent application [application 5221].

Consent 3951-3

6. All stormwater and wastewater shall be directed for treatment through the stormwater treatment system before being discharged.
7. Any above ground hazardous substances storage areas shall be bunded with drainage to sumps, or other appropriate recovery systems, and not to the stormwater catchment.
8. Constituents in the discharge shall meet the standards shown in the following table.

| Constituent | Standard |
|--------------------------------|--|
| pH | Within the range 6.0 to 9.0 |
| suspended solids | Concentration not greater than 100 gm ⁻³ |
| total recoverable hydrocarbons | Concentration not greater than 15 gm ⁻³ [as determined by infrared spectroscopic technique] |
| chloride | Concentration not greater than 50 gm ⁻³ |

This condition shall apply prior to the entry of the treated stormwater into the receiving waters at a designated sampling point approved by the Chief Executive, Taranaki Regional Council.

9. After allowing for a mixing zone of 25 metres, the discharge shall not give rise to an increase in temperature of more than 2 degrees Celsius.
10. After allowing for a mixing zone of 25 metres, the discharge shall not give rise to any of the following effects in the receiving water:
 - 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.
11. The consent holder shall advise the Chief Executive, Taranaki Regional Council, in writing at least 48 hours prior to the reinstatement of the site and the reinstatement shall be carried out so as to minimise effects on stormwater quality. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
12. This consent shall lapse on 30 June 2014, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

Consent 3951-3

13. 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 2015 and/or June 2021, 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 23 April 2009

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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

Name of
Consent Holder: Greymouth Petroleum Acquisition Company Limited
P O Box 3394
NEW PLYMOUTH 4341

Consent Granted
Date: 10 January 2008

Conditions of Consent

Consent Granted: To discharge emissions into the air from the flaring of hydrocarbons arising from hydrocarbon production and processing operations, together with miscellaneous emissions, at the Kaimiro Production Station at or about 2609726E-6225978N

Expiry Date: 1 June 2026

Review Date(s): June 2014, June 2020

Site Location: Upland Road, Inglewood

Legal Description: Pt Sec 115 Tarurutangi Dist Blk III Egmont SD

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

Duration

1. Flaring of gas from each well during well testing shall not occur on more than 30 days.

Information and notification

2. At least 24 hours before any flaring, other than in emergencies, the consent holder shall provide notification to all residents within 1000 metres of the site of the commencement of flaring. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and complaints received.
3. The consent holder shall notify the Chief Executive, Taranaki Regional Council, whenever the continuous flaring of hydrocarbons [other than purge gas] is expected to occur for more than five minutes in duration. Notification shall be no less than 24 hours before the flaring commences. Notification shall include the consent number and be emailed to worknotification@trc.govt.nz. Notification by fax or post is acceptable if the consent holder does not have access to email.
4. No alteration shall be made to plant equipment or processes which may substantially alter the nature or quantity of flare emissions or other site emissions, including but not limited to the recovery of produced gas, other than as authorised by this consent, without prior consultation with the Chief Executive, Taranaki Regional Council.

Emissions from the site

5. Other than for the maintenance of a pilot flare flame, the consent holder shall have regard to the prevailing and predicted wind speed and direction at the time of initiation of, and throughout, any episode of flaring so as to minimise offsite effects.

Consent 4048-3

6. All gas that is flared must first be treated by effective liquid and solid separation and recovery to ensure that smoke emission during flaring is minimised.
7. No liquid or solid hydrocarbons shall be combusted through the gas flare system.
8. Only substances originating from the well stream and treated as outlined by conditions 6 and 7 shall be combusted within the flare pit.
9. All hydrocarbon storage vessels shall be fitted with vapour recovery systems.
10. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air from the flare or any other emissions to air from the Kaimiro Production Station.
11. There shall not be any offensive odour or smoke at or beyond the boundary of the property where the production station is located.
12. The opacity of any smoke emissions shall not exceed a level of 1 as measured on the Ringelmann Scale.
13. The consent holder shall control all emissions of carbon monoxide to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the production station, the maximum ground level concentration of carbon monoxide arising from the exercise of this consent measured under ambient conditions does not exceed 10 milligrams per cubic metre [mg/m^3] [eight-hour average exposure], or 30 mg/m^3 one-hour average exposure] at or beyond the boundary of the property.
14. The consent holder shall control all emissions of nitrogen oxides to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the production station, the maximum ground level concentration of nitrogen dioxide arising from the exercise of this consent measured under ambient conditions does not exceed 100 micrograms per cubic metre [$\mu\text{g}/\text{m}^3$] [24-hour average exposure], or 200 $\mu\text{g}/\text{m}^3$ [1-hour average exposure] at or beyond the boundary of the of the property.
15. The consent holder shall control emissions to the atmosphere, from the production station and flare, of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides so that, whether alone or in conjunction with any other emissions from the production station, is not hazardous or toxic or noxious at or beyond the boundary of the property.
16. The consent holder shall control emissions to the atmosphere from the production station and flare of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides so that, whether alone or in conjunction with any emissions from the flare, the maximum ground level concentration for any particular contaminant arising from the exercise of this consent measured at or beyond the boundary of the property, is not increased above background levels:

Consent 4048-3

- a) by more than 1/30th of the relevant Occupational Threshold Value-Time Weighted Average, or by more than the Short Term Exposure Limit at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour]; or
- b) if no Short Term Exposure Limit is set, by more than three times the Time Weighted Average at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour].

Recording and reporting information

17. Each time there is visible smoke as a result of the exercise of this consent, the consent holder shall record the time, duration and cause. The consent holder shall make the record available to the Chief Executive, Taranaki Regional Council, upon request.
18. Each month, the consent holder shall supply to the Chief Executive, Taranaki Regional Council a record of flaring information in relation to the production station, and each wellsite. The flaring information supplied shall comprise: the type and amount of material flared [including any gas used to maintain a pilot flame], the date this was flared, the reason why flaring was undertaken, and an indication of whether smoke was produced from the flaring events.
19. The consent holder shall record and maintain a log of all continuous flaring events longer than five minutes duration, and any intermittent flaring lasting for an aggregate of ten minutes or longer in any 120-minute period. The log shall contain the date, the start and finish times of the flaring event, the quantity and type of material flared, and the reason for flaring. The log shall be made available to the Chief Executive, Taranaki Regional Council, upon request, and summarised annually in the report required under condition 20.
20. The consent holder shall provide to the Taranaki Regional Council during May of each year, for the duration of this consent, a report:
 - i) detailing any energy efficiency measures implemented on the site;
 - ii) detailing smoke emissions as required under condition 17;
 - iii) detailing any measures undertaken or proposed to reduce smoke emissions;
 - iv) detailing any measures undertaken or proposed to reduce flaring;
 - v) addressing any other issue relevant to the minimisation or mitigation of emissions from the flare;
 - vi) detailing any complaints received and any measures undertaken to address complaints; and
 - vii) reviewing all options and technological advances relevant to the reduction or mitigation of any discharge to air from the site, how these might be applicable and/or implemented at the site, and the benefits and costs of these advances.
21. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure C₆ or higher number of compounds.

Review

22. 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 within six months of receiving a report prepared by the consent holder pursuant to condition 20 of this consent, and/or by giving notice of review during the month of June 2014 and/or June 2020, for any of the following purposes:
- a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time;
 - b) requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge;
 - c) to alter, add or delete limits on mass discharge quantities or discharge or ambient concentrations of any contaminant;
 - d) taking into account any Act of Parliament, regulation, national policy statement or national environmental standard which relates to limiting, recording, or mitigating emissions of gases which are products of combustion, and which is relevant to the air discharge from the Kaimiro Production Station.

Signed at Stratford on 10 January 2008

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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

Name of
Consent Holder: Greymouth Petroleum Acquisition Company Limited
P O Box 3394
Fitzroy
NEW PLYMOUTH

Consent Granted
Date: 4 February 1998

Conditions of Consent

Consent Granted: To discharge up to 100 cubic metres/day of treated stormwater, treated production water and treated wastewater from oil well drilling and production operations and a truck turning area into the Ngatoro Stream a tributary of the Manganui River in the Waitara Catchment at or about GR: Q19:110-217

Expiry Date: 1 June 2015

Review Date(s): June 2003, June 2009

Site Location: Ngatoro-1 Wellsite, Dudley Road, Inglewood
[Property owner: I & EE Jones]

Legal Description: Sec 11 Pt Sec 17 Blk VIII Egmont SD

Catchment: Waitara

Tributary: Manganui
Ngatoro

Consent 4073-2

General conditions

- a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) That 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) That 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. That the consent holder, in conjunction with the Taranaki Regional Council, shall establish a permanent mixing zone for the discharge, which is 25 metres below the point of discharge into the receiving waters of the Ngatoro Stream.
2. That, after allowing for a mixing zone established for special condition 1, the discharge shall not give rise to any of the following effects in the receiving water:
 - 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.
3. That the discharge shall not contain total recoverable hydrocarbons [infrared spectroscopic technique] in excess of 15 gm^{-3} at any time.
4. That the discharge shall not cause the receiving waters of the Ngatoro Stream to exceed the following limits, outside of the mixing zone established in special condition 1, at any time:

| | |
|----------|----------------------|
| chloride | 50 gm^{-3} |
| pH range | 6.5 - 8.5 |
5. That after allowing for the mixing zone established for special condition 1, the discharge shall not give rise to either of the following effects in the receiving waters of the Ngatoro Stream:
 - i) an increase in suspended solids concentration in excess of 10 gm^{-3} when the stream turbidity as measured immediately upstream of the discharge point is equal to or less than 5 nephelometric turbidity units [NTU]; or
 - ii) an increase in turbidity of more than 50% when the stream turbidity as measured immediately upstream of the discharge point is greater than 5 NTU.
6. That the consent holder shall provide, for the written approval of the Chief Executive, a contingency plan outlining measures and procedures undertaken to prevent a spillage, or accidental discharge of materials and/or waters not licensed by this consent and procedures to be carried out should such a spillage or discharge occur.
7. That the consent holder shall advise the Chief Executive two weeks prior to the drilling of additional wells on the site.

Consent 4073-2

8. That the consent holder shall advise the Chief Executive two weeks prior to discharging production water to the Ngatoro Stream as licensed by this consent.
9. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June 2003 and/or June 2009, for the purpose of ensuring that the conditions are adequate to deal with any significant adverse effects of the discharge on the environment arising from the exercise of this consent, which were not foreseen at the time the application was considered and which it was not appropriate to deal with at that time.

Transferred at Stratford on 23 February 2004

For and on behalf of
Taranaki Regional Council

Director – Resource Management

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

Name of
Consent Holder: Greymouth Petroleum Acquisition Company Limited
PO Box 3394
New Plymouth 4341

Decision Date: 24 July 2014

Commencement Date: 24 July 2014

Conditions of Consent

Consent Granted: To take groundwater from the Matemateaonga Formation for use in enhanced hydrocarbon recovery activities at the Kaimiro-O wellsite

Expiry Date: 01 June 2032

Review Date(s): June 2020, June 2026

Site Location: Kaimiro-O wellsite, 455 Alfred Road, Egmont Village
(Property owner: St Leger Manning Reeves & Robert Baker)

Legal Description: Pt Sec 115-116 Hua & Waiwhakaiho Hun (Site of take)

Grid Reference (NZTM) 1698651E-5663191N

Catchment: Waiwhakaiho

*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 total volume of water taken from the bore shall not exceed 550 cubic metres per day and/or 6.4 litres/second.
2. The bore shall be easily identifiable by permanent labels, which may be welded or engraved on the casing, or on the equivalent fixed part of the bore construction or associated building. The numbering on the label shall be the bore number assigned by the Taranaki Regional Council (GND2456).
3. Prior to exercising this consent the consent holder shall install, and thereafter maintain a water meter and a datalogger at the site of taking. The water meter and datalogger shall be tamper-proof and shall measure and record the rate and volume of water taken to an accuracy of $\pm 5\%$.

Note: Water meters and dataloggers must be installed, and regularly maintained, in accordance with manufacturer's specifications in order to ensure that they meet the required accuracy. Even with proper maintenance water meters have a limited lifespan.

4. The records of water taken shall:
 - a. be in a format that, in the opinion of the Chief Executive, Taranaki Regional Council, is suitable for auditing;
 - b. specifically record the water taken as 'zero' when no water is taken; and
 - c. for each 12-month period ending on 30 June, be provided to the Chief Executive, Taranaki Regional Council within one month after end of that period.
5. Within 30 days of the installation of a water meter or datalogger, and at other times when reasonable notice is given, the consent holder shall provide the Chief Executive, Taranaki Regional Council with a document from a suitably qualified person certifying that:
 - a. water measuring or recording equipment required by the conditions of this consent has been installed and/or maintained in accordance with the manufacturer's specifications; and/or
 - b. water measuring or recording equipment required by the conditions of this consent has been tested and shown to be operating to an accuracy of $\pm 5\%$.
6. The water meter and datalogger shall be accessible to Taranaki Regional Council officer's at all reasonable times for inspection and/or data retrieval.
7. If any measuring or recording equipment breaks down, or for any reason is not operational, the consent holder shall advise the Chief Executive, Taranaki Regional Council immediately. Any repairs or maintenance to this equipment must be undertaken by a suitably qualified person.

Consent 5384-2.0

8. At all times the consent holder shall adopt the best practicable option (BPO) to prevent or minimise any actual or likely adverse effect on the environment associated with the abstraction of groundwater, including, but not limited to, the efficient and conservative use of water.
9. This consent shall lapse on 30 September 2019, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
10. 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 2020 and/or June 2026 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 24 July 2014

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

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

Name of
Consent Holder: Greymouth Petroleum Limited
P O Box 3394
NEW PLYMOUTH 4341

Consent Granted
Date: 9 May 2008

Conditions of Consent

Consent Granted: To discharge emissions to air during flaring from well workovers and in emergency situations and miscellaneous emissions associated with production activities at the Ngatoro-B wellsite at or about 2612457E-6222691N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Ngatoro-B wellsite, Bedford Road North, Inglewood
[Property owner: CJ & GD Alexander]

Legal Description: Sec 128 Pt Secs 126 & 127 Moa Dist Blk VIII Egmont SD

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

Information and notification

1. The consent holder shall notify the Chief Executive, Taranaki Regional Council, whenever the continuous flaring of hydrocarbons [other than purge gas] is expected to occur for more than five minutes in duration. Notification shall be no less than 24 hours before the flaring commences. Notification shall include the consent number and be emailed to worknotification@trc.govt.nz. Notification by fax or post is acceptable if the consent holder does not have access to email.
2. At least 24 hours before any flaring, other than in emergencies, the consent holder shall provide notification to all residents within 1000 metres of the site of the commencement of flaring. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and complaints received in respect of any flaring activity.
3. No alteration shall be made to plant equipment or processes which may substantially alter the nature or quantity of flare emissions or other site emissions, including but not limited to the recovery of produced gas, other than as authorised by this consent, without prior consultation with the Chief Executive, Taranaki Regional Council.

Emissions from the site

4. Other than for the maintenance of a pilot flare flame, the consent holder shall have regard to the prevailing and predicted wind speed and direction at the time of initiation of, and throughout, any episode of flaring so as to minimise offsite effects.
5. All gas that is flared must first be treated by effective liquid and solid separation and recovery to ensure that smoke emission during flaring is minimised.

Consent 7220-1

6. If separation required by special condition 5 cannot be implemented or maintained at any time while there is a flow from the well, whether natural or induced, then the consent holder shall immediately advise the Compliance Manager, Taranaki Regional Council, and shall in any case re-establish liquid and solid separation and recovery within three hours.
7. Subject to special condition 6, no liquid or solid hydrocarbons shall be combusted through the gas flare system, other than in an emergency.
8. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air from the flare or any other emissions to air from the Ngatoro-B wellsite [including use of a separator during well clean-up].
9. Only substances originating from the well stream and treated as outlined by conditions 5, 6, 7, and 8 shall be combusted within the flare pit.
10. There shall not be any offensive odour or smoke, as determined by an enforcement officer of the Taranaki Regional Council, at or beyond the boundary of the property where the wellsite is located.
11. All hydrocarbon storage vessels shall be fitted with vapour recovery systems.
12. The opacity of any smoke emissions shall not exceed a level of 1 as measured on the Ringelmann Scale.
13. The consent holder shall control all emissions of carbon monoxide to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of carbon monoxide arising from the exercise of this consent measured under ambient conditions does not exceed 10 milligrams per cubic metre [mg/m^3] [eight-hour average exposure], or 30 mg/m^3 one-hour average exposure] at or beyond the boundary of the property where the wellsite is located.
14. The consent holder shall control all emissions of nitrogen oxides to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of nitrogen dioxide arising from the exercise of this consent measured under ambient conditions does not exceed 100 micrograms per cubic metre [$\mu\text{g}/\text{m}^3$] [24-hour average exposure], or 200 $\mu\text{g}/\text{m}^3$ [1-hour average exposure] at or beyond the boundary of the of the property where the wellsite is located.
15. The consent holder shall control emissions to the atmosphere, from the production station and flare, of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides so that, whether alone or in conjunction with any other emissions from the production station, is not hazardous or toxic or noxious at or beyond the boundary of the property.

Consent 7220-1

16. The consent holder shall control emissions to the atmosphere from the wellsite and flare of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides so that, whether alone or in conjunction with any emissions from the flare, the maximum ground level concentration for any particular contaminant arising from the exercise of this consent measured at or beyond the boundary of the property where the wellsite is located, is not increased above background levels:
- a) by more than 1/30th of the relevant Occupational Threshold Value-Time Weighted Average, or by more than the Short Term Exposure Limit at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour]; or
 - b) if no Short Term Exposure Limit is set, by more than three times the Time Weighted Average at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour].

Recording and reporting information

17. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure C₆ or higher number of compounds.
18. Each time there is visible smoke as a result of the exercise of this consent, the consent holder shall record the time, duration and cause. The consent holder shall make the record available to the Chief Executive, Taranaki Regional Council, upon request.
19. The consent holder shall record and maintain a log of all continuous flaring events longer than five minutes duration, and any intermittent flaring lasting for an aggregate of ten minutes or longer in any 120-minute period. The log shall contain the date, the start and finish times of the flaring event, the quantity and type of material flared, and the reason for flaring. The log shall be made available to the Chief Executive, Taranaki Regional Council, upon request, and summarised annually in the report required under condition 20.
20. The consent holder shall provide to the Taranaki Regional Council during May of each year, for the duration of this consent, a report:
- i) detailing any energy efficiency measures implemented on the site;
 - ii) detailing smoke emissions as required under condition 18;
 - iii) detailing any measures undertaken or proposed to reduce smoke emissions;
 - iv) detailing any measures undertaken or proposed to reduce flaring;
 - v) addressing any other issue relevant to the minimisation or mitigation of emissions from the flare;
 - vi) detailing any complaints received and any measures undertaken to address complaints; and
 - vii) reviewing all options and technological advances relevant to the reduction or mitigation of any discharge to air from the site, how these might be applicable and/or implemented at the site, and the benefits and costs of these advances.

Lapse and Review

21. This consent shall lapse five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
22. 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 within six months of receiving a report prepared by the consent holder pursuant to condition 20 of this consent, and/or by giving notice of review during the month of June 2015 and/or June 2021, for any of the following purposes:
 - a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time;
 - b) requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge;
 - c) to alter, add or delete limits on mass discharge quantities or discharge or ambient concentrations of any contaminant;
 - d) taking into account any Act of Parliament, regulation, national policy statement or national environmental standard which relates to limiting, recording, or mitigating emissions of gases which are products of combustion, and which is relevant to the air discharge from the Ngatoro-B wellsite.

Signed at Stratford on 9 May 2008

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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

Name of
Consent Holder: Greymouth Petroleum Limited
P O Box 3394
NEW PLYMOUTH 4341

Consent Granted
Date: 12 May 2008

Conditions of Consent

Consent Granted: To discharge emissions to air during flaring from well workovers and in emergency situations and miscellaneous emissions associated with production activities at the Ngatoro-A wellsite at or about 2611074E-6221732N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Ngatoro-A wellsite, Dudley Road, Inglewood
[Property owners: GD & VK Robinson]

Legal Description: Sec 11 Blk VIII Egmont SD

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

Information and notification

1. The consent holder shall notify the Chief Executive, Taranaki Regional Council, whenever the continuous flaring of hydrocarbons [other than purge gas] is expected to occur for more than five minutes in duration. Notification shall be no less than 24 hours before the flaring commences. Notification shall include the consent number and be emailed to worknotification@trc.govt.nz. Notification by fax or post is acceptable if the consent holder does not have access to email.
2. At least 24 hours before any flaring, other than in emergencies, the consent holder shall provide notification to all residents within 1000 metres of the site of the commencement of flaring. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and complaints received in respect of any flaring activity.
3. No alteration shall be made to plant equipment or processes which may substantially alter the nature or quantity of flare emissions or other site emissions, including but not limited to the recovery of produced gas, other than as authorised by this consent , without prior consultation with the Chief Executive, Taranaki Regional Council.

Emissions from the site

4. Other than for the maintenance of a pilot flare flame, the consent holder shall have regard to the prevailing and predicted wind speed and direction at the time of initiation of, and throughout, any episode of flaring so as to minimise offsite effects.
5. All gas that is flared must first be treated by effective liquid and solid separation and recovery to ensure that smoke emission during flaring is minimised.

Consent 7295-1

6. If separation required by special condition 5 cannot be implemented or maintained at any time while there is a flow from the well, whether natural or induced, then the consent holder shall immediately advise the Compliance Manager, Taranaki Regional Council, and shall in any case re-establish liquid and solid separation and recovery within three hours.
7. Subject to special condition 6, no liquid or solid hydrocarbons shall be combusted through the gas flare system, other than in an emergency.
8. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air from the flare or any other emissions to air from the Ngatoro-A wellsite [including use of a separator during well clean-up].
9. Only substances originating from the well stream and treated as outlined by conditions 5, 6, 7, and 8 shall be combusted within the flare pit.
10. There shall not be any offensive odour or smoke, as determined by an enforcement officer of the Taranaki Regional Council, at or beyond the boundary of the property where the wellsite is located.
11. All hydrocarbon storage vessels shall be fitted with vapour recovery systems.
12. The opacity of any smoke emissions shall not exceed a level of 1 as measured on the Ringelmann Scale.
13. The consent holder shall control all emissions of carbon monoxide to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of carbon monoxide arising from the exercise of this consent measured under ambient conditions does not exceed 10 milligrams per cubic metre [mg/m^3] [eight-hour average exposure], or 30 mg/m^3 one-hour average exposure] at or beyond the boundary of the property where the wellsite is located.
14. The consent holder shall control all emissions of nitrogen oxides to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of nitrogen dioxide arising from the exercise of this consent measured under ambient conditions does not exceed 100 micrograms per cubic metre [$\mu\text{g}/\text{m}^3$] [24-hour average exposure], or 200 $\mu\text{g}/\text{m}^3$ [1-hour average exposure] at or beyond the boundary of the of the property where the wellsite is located.
15. The consent holder shall control emissions to the atmosphere, from the production station and flare, of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides so that, whether alone or in conjunction with any other emissions from the production station, is not hazardous or toxic or noxious at or beyond the boundary of the property.

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16. The consent holder shall control emissions to the atmosphere from the wellsite and flare of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides so that, whether alone or in conjunction with any emissions from the flare, the maximum ground level concentration for any particular contaminant arising from the exercise of this consent measured at or beyond the boundary of the property where the wellsite is located, is not increased above background levels:
- a) by more than 1/30th of the relevant Occupational Threshold Value-Time Weighted Average, or by more than the Short Term Exposure Limit at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour]; or
 - b) if no Short Term Exposure Limit is set, by more than three times the Time Weighted Average at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour].

Recording and reporting information

17. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure C₆ or higher number of compounds.
18. Each time there is visible smoke as a result of the exercise of this consent, the consent holder shall record the time, duration and cause. The consent holder shall make the record available to the Chief Executive, Taranaki Regional Council, upon request.
19. The consent holder shall record and maintain a log of all continuous flaring events longer than five minutes duration, and any intermittent flaring lasting for an aggregate of ten minutes or longer in any 120-minute period. The log shall contain the date, the start and finish times of the flaring event, the quantity and type of material flared, and the reason for flaring. The log shall be made available to the Chief Executive, Taranaki Regional Council, upon request, and summarised annually in the report required under condition 20.
20. The consent holder shall provide to the Taranaki Regional Council during May of each year, for the duration of this consent, a report:
- i) detailing any energy efficiency measures implemented on the site;
 - ii) detailing smoke emissions as required under condition 18;
 - iii) detailing any measures undertaken or proposed to reduce smoke emissions;
 - iv) detailing any measures undertaken or proposed to reduce flaring;
 - v) addressing any other issue relevant to the minimisation or mitigation of emissions from the flare;
 - vi) detailing any complaints received and any measures undertaken to address complaints; and
 - vii) reviewing all options and technological advances relevant to the reduction or mitigation of any discharge to air from the site, how these might be applicable and/or implemented at the site, and the benefits and costs of these advances.

Lapse and Review

21. This consent shall lapse five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
22. 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 within six months of receiving a report prepared by the consent holder pursuant to condition 20 of this consent, and/or by giving notice of review during the month of June 2015 and/or June 2021, for any of the following purposes:
 - a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time;
 - b) requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge;
 - c) to alter, add or delete limits on mass discharge quantities or discharge or ambient concentrations of any contaminant;
 - d) taking into account any Act of Parliament, regulation, national policy statement or national environmental standard which relates to limiting, recording, or mitigating emissions of gases which are products of combustion, and which is relevant to the air discharge from the Ngatoro-A wellsite.

Signed at Stratford on 12 May 2008

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Appendix II

Biomonitoring reports

To Job Manager, Callum MacKenzie
From Freshwater Biologist, Darin Sutherland
Report No DS018
Doc No 1533920
Date July 2015

Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, October 2014

Introduction

This was the first of two biomonitoring surveys scheduled to be undertaken in the 2014-2015 monitoring year for the Kaimiro Production Station of Greymouth Petroleum (previously owned by Fletcher Challenge Energy Taranaki Limited). The Taranaki Regional Council has undertaken surveys since January 1985 in the tributaries of the Mangaoraka Stream that receive stormwater and wastewater from the production station area. During 1987 and 1988 oil seepage to these streams disrupted the aquatic communities. Biomonitoring was not undertaken for nearly four years following the oil seepage period, until 1992. The results of surveys performed since the 1998-99 monitoring year are discussed in the references at the end of this report.

Methods

This survey was undertaken on 9 October 2014 at three sites in two unnamed tributaries of the Mangaoraka Stream. Figure 1 shows the location of these sampling sites. Site 1 is the 'control' site which is located in a major tributary of the Mangaoraka Stream, upstream of the confluence with a more minor tributary. Site 2 is situated in the minor tributary which receives the stormwater discharge from the production station and site 3 is approximately 50 metres downstream of the confluence of this tributary (Table 1).

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from these sites in this survey. 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).

Table 1 Biomonitoring sites in two tributaries of the Mangaoraka Stream in relation to discharges from the Kaimiro Production Station

| Site | Site code | GPS reference (NZTM) | Location |
|------|------------|----------------------|--|
| 1 | MRK 000198 | E1700117 N5664652 | Major tributary approx. 50m u/s of confluence with minor tributary |
| 2 | MRK 000204 | E1700054 N5664636 | Minor tributary (receives discharge) 150m d/s of Upland Road |
| 3 | MRK 000207 | E1700171 N5665679 | Major tributary approx. 50m d/s of confluence with minor tributary |

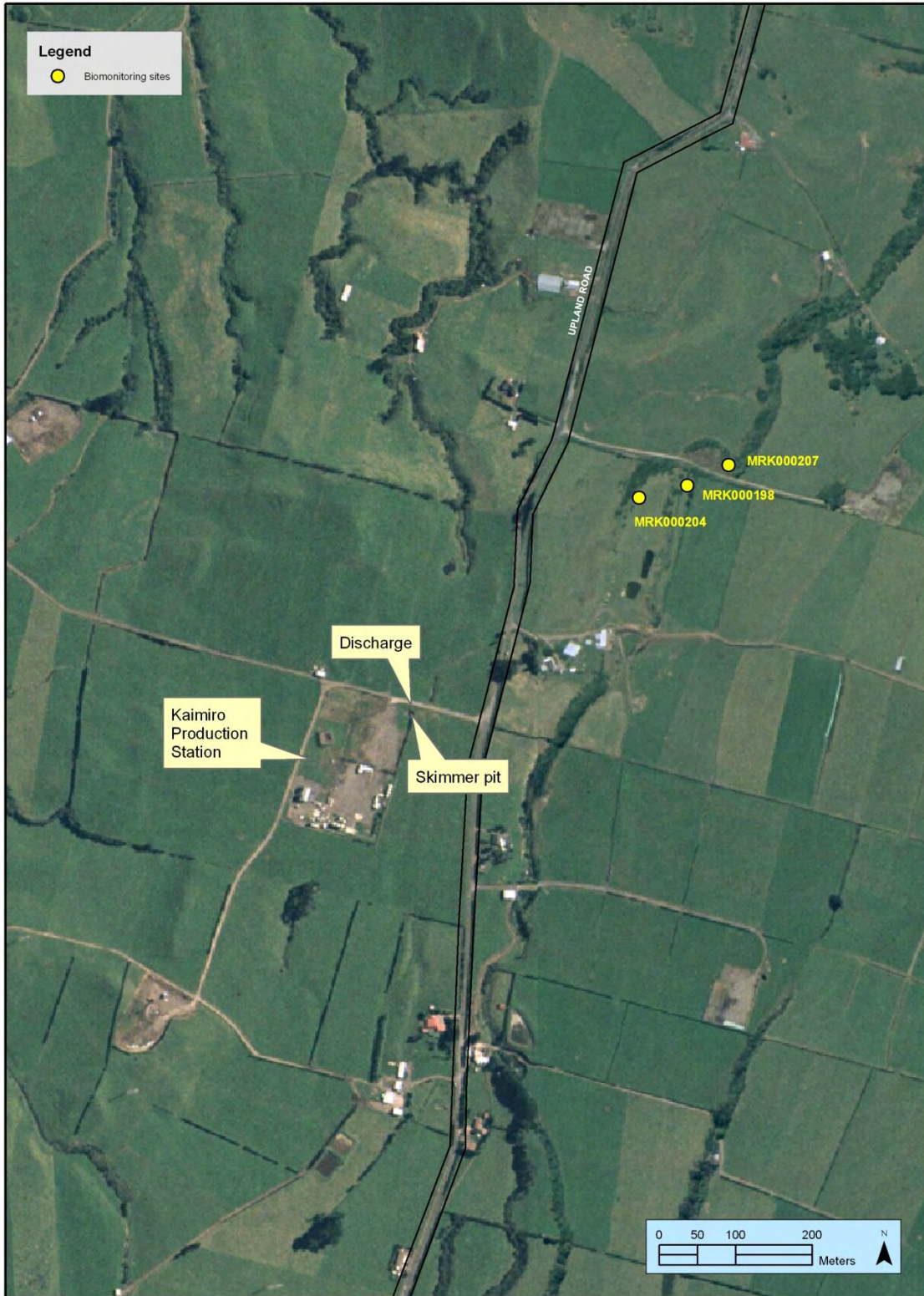


Figure 1 Biomonitoring sites in two unnamed tributaries of the Mangaoraka Stream related to the Kaimiro Production Station

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 found in each sample were recorded as:

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

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. Averaging the scores from a list of taxa taken from one site and multiplying by a scaling factor of 20 produces a Macroinvertebrate Community Index (MCI) value. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

The MCI was designed for use in stony streams, and all sites sampled in this survey provided stony substrate. The MCI was designed as a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution, though sedimentation, temperatures, current speed, dissolved oxygen levels and some toxins can also affect the index values, because the taxa capable of tolerating extremes in these variables generally have low sensitivity scores. Usually more 'sensitive' communities inhabit less polluted waterways.

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, therefore SQMCI_s values range from 1 to 10, while MCI values range from 20 to 200. A difference of 0.9 units or more in SQMCI_s is considered significantly different (Stark, 1998).

Results

Site habitat characteristics and hydrology

This October 2014 survey followed a period of 11 days since a fresh in excess of three times median flow, and 67 days since a fresh in excess of seven times median flow. In the month prior to this survey, there had been eight fresh events, two of which exceeded the three times median flow.

There was evidence of slumping of the banks and stock damage at site 1 which most likely had been caused by stock accessing the stream. This had been noted previously at the site in the May 2012 survey. The water temperatures were moderately cool (12.6-14.0°C). Water levels were moderate and water speeds were steady. Water was uncoloured and clear for all sites during the survey (Table 2). Site 1 had a substrate composition comprised mostly of silt and fine gravel, site 2 had a substrate composition which was mainly silt, fine gravel and cobbles, and site 3 had predominately cobble and boulder substrate. Some iron oxide deposits were found on the stream bed at site 2 which was similar to previous occurrences in this and many small seepage streams in Taranaki. Typically such deposits result from the oxidation of dissolved ferrous iron in groundwater seepage, upon contact with atmospheric oxygen. Small streams may often have insufficient flow to flush these deposits away. No iron oxide deposits

were recorded at sites 1 and 3 at the time of this survey. There was evidence of sediments deposited on parts of the tributary stream bed at site 3 at the time of this survey which had also been noted in the previous summer survey.

There were slippery periphyton mats at sites 1 and 3 and patchy periphyton mats at site 2. There were no filamentous algae at any of the sites. Moss was patchy at all the sites. Site 1 had no leaves and wood while sites 2 and 3 had patchy leaves and wood. Site 1 had macrophytes on the bed of the stream while sites 2 and 3 had no macrophytes. Site 1 had no shade or overhanging vegetation while sites 2 and 3 had complete shading and there was overhanging vegetation.

Table 2 Summary of time of sampling and some water variables collected at three sites in two unnamed tributaries of the Mangaoraka Stream, sampled in relation to the Kaimiro Production Station on 9 October 2014 and a summary of historical data for these sites.

| Site | Time (NZST) | Temperature (°C) | Water Colour | Water Clarity | Flow Conditions | Water Speed |
|------|-------------|------------------|--------------|---------------|-----------------|-------------|
| 1 | 1130 | 12.6 | Uncoloured | Clear | Moderate | Steady |
| 2 | 1155 | 14.0 | Uncoloured | Clear | Moderate | Steady |
| 3 | 1105 | 12.6 | Uncoloured | Clear | Moderate | Steady |

Macroinvertebrate communities

Most past surveys have shown that the larger tributary supports richer macroinvertebrate communities, including abundances of 'sensitive' mayflies. These results reflect the good habitat conditions normally provided by faster-flowing, stony-bedded streams on the upper to mid reaches of the ring plain. The smaller tributary has tended to support communities with lower numbers of taxa and smaller proportions of 'sensitive' taxa. This in part has been due to the slower flow and/or iron oxide deposition on the more sedimented stream bed of this tributary.

Table 3 provides a summary of the results from previous surveys sampled in relation to the Kaimiro Production Station discharges along with current survey results.

Table 3 Number of taxa, MCI and SQMCI_s values for two unnamed tributaries of the Mangaoraka Stream, sampled in relation to the Kaimiro Production Station on 9 October 2014 and a summary of historical data for these sites.

| Site No. | N | No of taxa | | | MCI value | | | SQMCI _s value | | |
|----------|----|------------|-------|----------|-----------|--------|----------|--------------------------|---------|----------|
| | | Median | Range | Oct 2014 | Median | Range | Oct 2014 | Median | Range | Oct 2014 |
| 1 | 55 | 27 | 18-37 | 25 | 97 | 83-110 | 99 | 3.5 | 1.9-5.1 | 2.2 |
| 2 | 51 | 15 | 3-26 | 15 | 81 | 55-103 | 89 | 2.2 | 1.2-4.1 | 1.6 |
| 3 | 55 | 24 | 14-33 | 21 | 99 | 71-111 | 109 | 4.1 | 1.7-6.2 | 6.0 |

Table 4 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park. The full results from the current survey are presented in Table 5.

Table 4 Range and median number of taxa, MCI values and SQMCI_s scores for 'control' sites (Taranaki ring plain rivers/streams with sources outside Egmont National Park) at altitudes 200-249 m asl (TRC, 2015).

| | No. of taxa | MCI value | SQMCI _s value |
|-------------|-------------|-----------|--------------------------|
| No. Samples | 103 | 103 | 43 |
| Range | 2-37 | 60-116 | 1.9-6.7 |
| Median | 24 | 95 | 4.0 |

Table 5 Macroinvertebrate fauna of two unnamed tributaries of the Mangaoraka Stream in relation to Kaimiro Production Station sampled on 9 October 2014.

| Taxa List | Site Number | MCI score | 1 | 2 | 3 |
|----------------------------------|----------------------------------|------------------------------------|-----------|--------------------------------|-----------|
| | Site Code | | MRK000198 | MRK000204 | MRK000207 |
| | Sample Number | | FWB14243 | FWB14244 | FWB14245 |
| ANNELIDA (WORMS) | Oligochaeta | 1 | XA | VA | A |
| HIRUDINEA (LEECHES) | Hirudinea | 3 | R | - | - |
| MOLLUSCA | <i>Potamopyrgus</i> | 4 | A | - | R |
| | Sphaeriidae | 3 | R | - | - |
| CRUSTACEA | Copepoda | 5 | - | C | - |
| | Ostracoda | 1 | - | R | - |
| | Isopoda | 5 | - | - | R |
| | Paraleptamphopidae | 5 | - | - | R |
| | <i>Paranephrops</i> | 5 | R | R | - |
| EPHEMEROPTERA (MAYFLIES) | <i>Austroclima</i> | 7 | R | - | R |
| | <i>Coloburiscus</i> | 7 | R | - | C |
| | <i>Deleatidium</i> | 8 | C | R | C |
| | <i>Zephlebia group</i> | 7 | VA | R | VA |
| PLECOPTERA (STONEFLIES) | <i>Acroperla</i> | 5 | - | R | C |
| | <i>Zelandobius</i> | 5 | C | - | - |
| COLEOPTERA (BEETLES) | Elmidae | 6 | C | - | C |
| | Ptilodactylidae | 8 | R | R | R |
| MEGALOPTERA (DOBSONFLIES) | <i>Archichauliodes</i> | 7 | C | R | C |
| TRICHOPTERA (CADDISFLIES) | <i>Hydropsyche (Aoteapsyche)</i> | 4 | C | - | R |
| | Ecnomidae/Psychomyiidae | 6 | - | R | - |
| | <i>Hydrobiosis</i> | 5 | R | - | - |
| | <i>Hydropsyche (Orthopsyche)</i> | 9 | C | - | C |
| | <i>Oxyethira</i> | 2 | C | R | - |
| | <i>Pycnocentria</i> | 7 | - | - | R |
| | <i>Triplectides</i> | 5 | R | - | - |
| DIPTERA (TRUE FLIES) | <i>Zelolessica</i> | 7 | R | - | - |
| | <i>Aphrophila</i> | 5 | C | - | C |
| | <i>Limonia</i> | 6 | - | - | R |
| | <i>Maoridiamesa</i> | 3 | R | - | - |
| | Orthoclaadiinae | 2 | XA | A | R |
| | <i>Polypedilum</i> | 3 | - | - | R |
| | Tanypodinae | 5 | R | - | - |
| | Empididae | 3 | R | R | - |
| <i>Austrosimulium</i> | 3 | C | R | C | |
| Tanyderidae | 4 | - | R | - | |
| ACARINA (MITES) | Acarina | 5 | - | - | R |
| No of taxa | | | 25 | 15 | 21 |
| MCI | | | 99 | 89 | 109 |
| SQMCIs | | | 2.2 | 1.6 | 6.0 |
| EPT (taxa) | | | 10 | 4 | 8 |
| %EPT (taxa) | | | 40 | 27 | 38 |
| 'Tolerant' taxa | | 'Moderately sensitive' taxa | | 'Highly sensitive' taxa | |

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

Site 1

A moderately high macroinvertebrate community richness of 25 taxa was found at site 1 ('control' site) at the time of the survey which was two less than the median number recorded for the site (median taxa richness 27; Table 3). Taxa richness was also very similar to the median calculated from similar sites (median taxa richness 24; Table 4) and the previous sample (taxa richness 21; Figure 2)

The MCI score of 99 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 97; Table 3) or compared with the previous survey (taxa richness 98; Figure 2). The SQMCI_s score of 2.2 units was significantly lower (Stark, 1998) than the median value calculated from previous surveys at the same site (median SQMCI_s score of 3.5 units; Table 3).

The community was characterised by three 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*) and orthoclad midges] and one 'moderately sensitive' taxon [mayfly (*Zephlebia* group)] (Table 5).

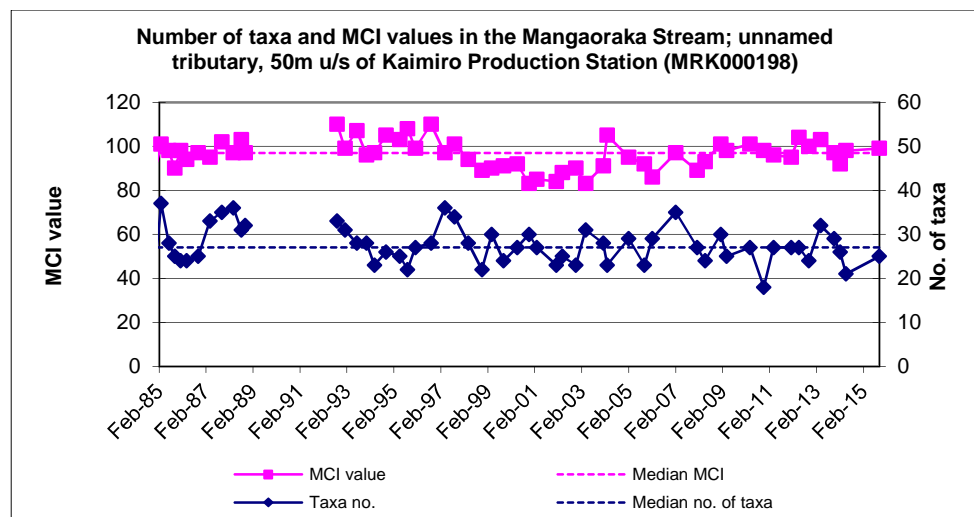


Figure 2 Number of taxa and MCI values in an unnamed tributary of the Mangaoraka Stream, 50 m upstream of Kaimiro Production Station (MRK000198)

Site 2

A moderate macroinvertebrate community richness of 15 taxa was found at site 2 ('primary impacted') at the time of the survey which was the same as the median number recorded for the site (median taxa richness 15; Table 3). Taxa richness was also the same as the previous survey score (taxa richness 15; Figure 3). However, taxa richness was substantially lower than the median calculated from similar sites (taxa richness 24; Table 4).

The MCI score of 89 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 81; Table 3). However, there was a significant decrease (Stark, 1998) of 12 units from the previous survey (MCI score 101 units; Figure 3). The SQMCI_s

score of 1.6 units was not significantly lower (Stark, 1998) than the median value calculated from previous surveys at the same site (median SQMCI_s score of 2.2 units; Table 3).

The community was characterised by two 'tolerant' taxa (oligochaete worms and orthoclad midges) (Table 5).

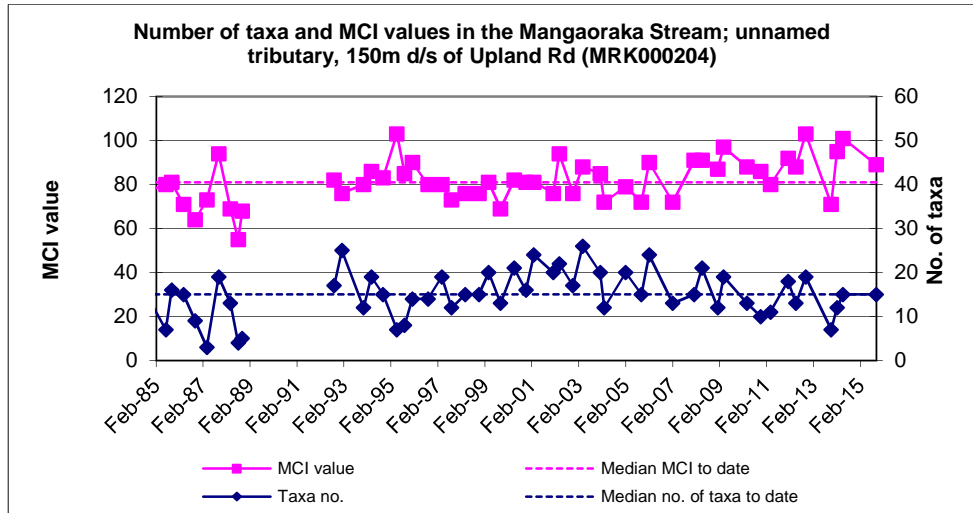


Figure 3 Number of taxa and MCI values in an unnamed tributary of the Mangaoraka Stream, 150 m d/s of Upland Road (MRK000204)

Site 3

A moderate macroinvertebrate community richness of 21 taxa was found at site 3 at the time of the survey which was three taxa less than the median number recorded for the site and the median calculated from similar sites (median taxa richness 24; Table 3; Table 4). Taxa richness was one taxon lower than the previous survey.

The MCI score of 109 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 99; Table 3). However, there was a significant increase of 12 MCI units from the previous survey (MCI score 97 units; Figure 3). The SQMCI_s score of 6.0 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median SQMCI_s score of 4.1 units; Table 3).

The community was characterised by one 'tolerant' taxon (oligochaete worms) and one 'moderately sensitive' taxon [mayfly (*Zephlebia* group)] (Table 5).

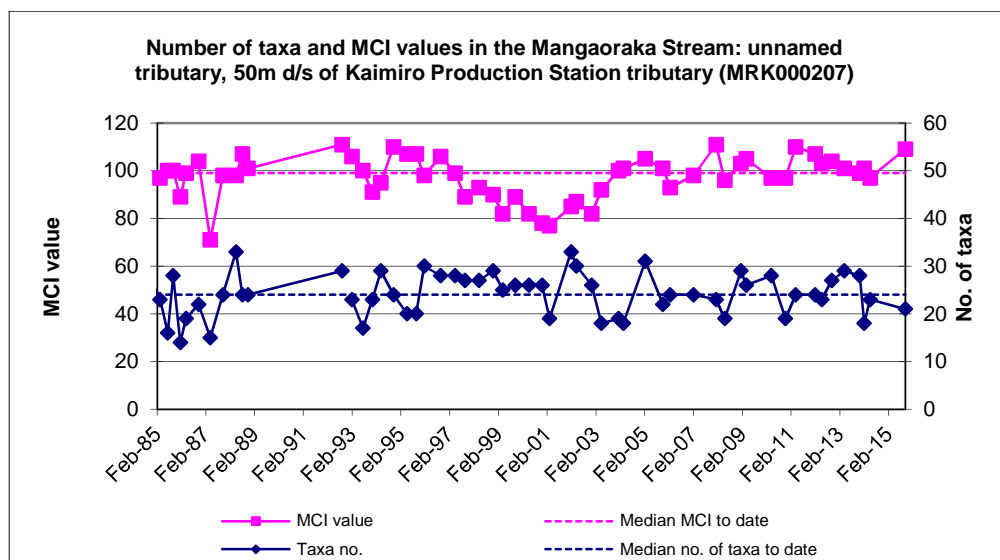


Figure 4 Number of taxa and MCI values in an unnamed tributary of the Mangaoraka Stream, 50 m d/s of Kaimiro Production Station tributary (MRK000207)

Discussion

The Council's 'kick-sampling' technique was used at three sites to collect streambed macroinvertebrates from two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station. This has provided data to assess any potential impacts the consented activities have had on the macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCI_s scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges. Macroinvertebrates when exposed to toxic chemicals may die and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). 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 abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the SQMCI_s between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

Most of the previous surveys undertaken in relation to the Kaimiro Production Station stormwater discharge have shown that the larger tributary of the Mangaoraka Stream (sites 1 and 3) supports higher taxonomic richness and healthier macroinvertebrate communities. The results of this spring survey were consistent with these trends with taxa richnesses and MCI scores recorded at sites 1 and 3 higher than those recorded at site 2 in the unnamed tributary. Site 2 has been affected to some extent by sedimentation of the streambed and iron-oxide deposits under low, warmer flow conditions. Site 3 also had silt, but not iron oxide deposits, recorded on the streambed at the time of the survey.

The SQMCI_s scores for sites 1 and 2 were not significantly different to each other but both scores were significantly lower than the site 3 score at the time of the survey. As site 1 is the 'control' site which had a low score while site 3 is an 'impacted' site which had a high score

the SQMCI_s scores recorded at the three sites would not be related to discharges from the Kaimiro Production Station and would be likely due to habitat variation among the sites. The low scores at site 1 are probably a reflection of the weedy nature of the site which usually favours low scoring taxa while site 2 has sediment issues which also favours low scoring taxa.

Overall, the results of this October 2014 survey suggest that the Kaimiro Production Station had not had any recent detrimental effects on the macroinvertebrate communities of the main tributary of the Mangaoraka Stream. Poorer macroinvertebrate indices found at the minor tributary would be a reflection of habitat differences, most likely from naturally occurring iron oxide deposition.

Summary

- A macroinvertebrate survey was performed at three sites in two unnamed tributaries of the Mangaoraka Stream in relation to stormwater discharges from the Kaimiro Production Station.
- There were insignificant or positive differences in the macroinvertebrate indices examined between the 'control' site and the secondary 'impacted' site at the time of the survey but the primary 'impacted' site had lower macroinvertebrate indices which were likely due to habitat variation.
- In general the results are consistent with previous sampling results with only insignificant differences found for taxa richnesses and MCI scores for the 3 sites compared with median values obtained from previous surveys.
- There was no evidence for the Kaimiro Production Station discharges having had any recent detrimental effects on the macroinvertebrate communities of the main tributary of the Mangaoraka Stream.

References

Colgan, B, 2003: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, April 2003. BC005.

Dunning KJ, 2001a: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, November 2000. KD28.

Dunning KJ, 2001b: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, March 2001. KD55.

Dunning KJ, 2002a: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, January 2002. KD96.

Dunning KJ, 2002b: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, November 2002. KD120.

Hope KJ, 2006: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, October 2005. KH057.

Hope KJ, 2006: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, February 2006. KH075.

Fowles, CR and Hope, KJ, 2005: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, February 2005. TRC report CF378.

Fowles, CR and Jansma, B, 2008a: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, January 2008, CF459.

Fowles, CR and Jansma, B, 2008b: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, May 2008, CF464.

Fowles, CR and Jansma, B, 2014: Post-well drilling biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, May 2014. CF617.

Fowles, CR and Moore, SC, 2004: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, March 2004. CF320.

Fowles, CR and Smith, K, 2013: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, October 2012. CF583

Fowles, CR and Thomas, BR, 2014: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, November 2013. CF614.

Fowles, CR and Thomas, BR, 2014: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, February 2014. CF615.

- Jansma B, 2007: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, February 2007. TRC report BJ019.
- Jansma B, 2009a: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, January 2009. TRC report BJ077.
- Jansma B, 2009b: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, April 2009. TRC report BJ078.
- Jansma B, 2010: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, April 2010. TRC report BJ099.
- Jansma B, 2011a: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, November 2010 TRC report BJ150.
- Jansma B, 2011b: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, April 2011 TRC report BJ151.
- Jansma B, 2013: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, April 2013 TRC report BJ221.
- McWilliam H, 1999a: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, November 1998. HM153.
- McWilliam H, 1999b: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, April 1999. HM165.
- McWilliam H, 2000: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, October 1999. HM200.
- Moore, SC, 2004: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, January 2004. SM589.
- Smith K, 2012: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, January 2012. TRC report KS013.
- Smith K, 2012: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, May 2012. TRC report KS014.
- Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. *Water and Soil Miscellaneous Publication No. 87*.
- Stark JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. *New Zealand Journal of Marine and Freshwater Research* 32(1): 55-66.
- Stark JD, 1999: An evaluation of Taranaki Regional Council's SQMCI biomonitoring index. Cawthron Institute, Nelson. Cawthron Report No. 472.
- Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate

Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

TRC, 2015: Some statistics from the Taranaki Regional Council database (Esam) of freshwater macroinvertebrate surveys performed during the period from January 1980 to 30 September 2014. Technical Report 2014-105.

To Job Manager, Callum MacKenzie
From Freshwater Biologist, Darin Sutherland
Report No DS019
Doc No 1537195
Date July 2015

Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, February 2015

Introduction

This was the second of two biomonitoring surveys scheduled to be undertaken in the 2014-2015 monitoring year for the Kaimiro Production Station of Greymouth Petroleum (previously owned by Fletcher Challenge Energy Taranaki Limited). The Taranaki Regional Council has undertaken surveys since January 1985 in the tributaries of the Mangaoraka Stream that receive stormwater and wastewater from the production station area. During 1987 and 1988 oil seepage to these streams disrupted the aquatic communities. Biomonitoring was not undertaken for nearly four years following the oil seepage period, until 1992. The results of surveys performed since the 1998-99 monitoring year are discussed in the references at the end of this report.

Methods

This survey was undertaken on 24 February 2015 at three sites in two unnamed tributaries of the Mangaoraka Stream. Figure 1 shows the location of these sampling sites. Site 1 is the 'control' site which is located in a major tributary of the Mangaoraka Stream, upstream of the confluence with a more minor tributary. Site 2 is situated in the minor tributary which receives the stormwater discharge from the production station and site 3 is approximately 50 metres downstream of the confluence of this tributary (Table 1).

The Council's standard '400ml kick-sampling' technique was used at sites 2 and 3 and a combination of the 'kick-sampling' and 'vegetation sweep' sampling techniques were used at site 1 (Table 1). The 'kick-sampling' and 'vegetation sweep' techniques are very similar to Protocol C1 (hard-bottomed, semi-quantitative) and C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1 Biomonitoring sites in two tributaries of the Mangaoraka Stream in relation to discharges from the Kaimiro Production Station

| Site | Site code | GPS reference (NZTM) | Location |
|------|------------|----------------------|--|
| 1 | MRK 000198 | E1700117 N5664652 | Major tributary approx. 50m u/s of confluence with minor tributary |
| 2 | MRK 000204 | E1700054 N5664636 | Minor tributary (receives discharge) 150m d/s of Upland Road |
| 3 | MRK 000207 | E1700171 N5665679 | Major tributary approx. 50m d/s of confluence with minor tributary |

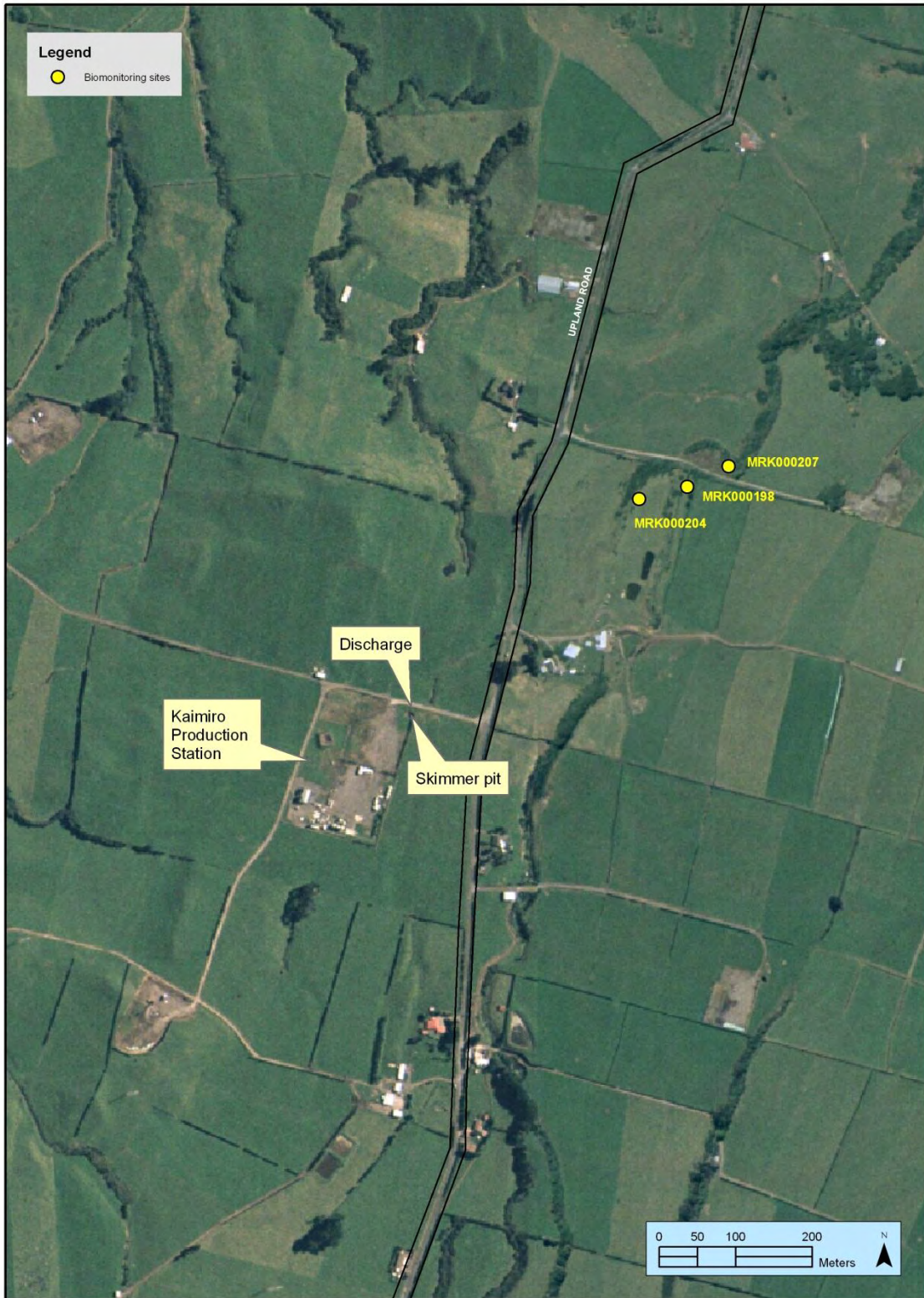


Figure 1 Biomonitoring sites in two unnamed tributaries of the Mangaoraka Stream related to the Kaimiro Production Station

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 found in each sample were recorded as:

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

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. Averaging the scores from a list of taxa taken from one site and multiplying by a scaling factor of 20 produces a Macroinvertebrate Community Index (MCI) value. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

The MCI was designed for use in stony streams, and all sites sampled in this survey provided stony substrate. The MCI was designed as a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution, though sedimentation, temperatures, current speed, dissolved oxygen levels and some toxins can also affect the index values, because the taxa capable of tolerating extremes in these variables generally have low sensitivity scores. Usually more 'sensitive' communities inhabit less polluted waterways.

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, therefore SQMCI_s values range from 1 to 10, while MCI values range from 20 to 200. A difference of 0.9 units or more in SQMCI_s is considered significantly different (Stark, 1998).

Results

Site habitat characteristics and hydrology

This February 2015 survey followed a period of 22 days since a fresh in excess of three times median flow, and 76 days since a fresh in excess of seven times median flow. In the month prior to this survey, there had been two fresh events which both exceeded the three times median flow.

There was no evidence of slumping of the banks upstream and downstream of site 1 which had been noted previously at the site in the October 2014 and May 2012 surveys. The water temperatures were moderate (15.1-16.2°C). Water levels were very low and water speeds were variable among sampling sites. Water was uncoloured and clear for all sites during the survey (Table 2). Site 1 had a substrate composition comprised mostly of silt and cobble, site 2 had a substrate composition which was mainly silt, cobbles and boulders and site 3 had predominately silt, cobble and boulder substrate. There was evidence of sediments deposited on parts of the tributary stream bed at all three sites at the time of this survey.

There were slippery periphyton mats at sites 1 and 2 and patchy periphyton mats at site 3. There were no filamentous algae at any of the sites. Moss was patchy at all the sites. Site 1 had patchy leaves, no wood and macrophytes on the streambed, site 2 had widespread leaves and

wood and no macrophytes, and site 3 had patchy leaves and wood and no macrophytes. Site 1 had no shade or overhanging vegetation while sites 2 and 3 had complete shading and there was overhanging vegetation.

Table 2 Summary of time of sampling and some water variables recorded at three sites in two unnamed tributaries of the Mangaoraka Stream, sampled in relation to the Kaimiro Production Station on 24 February 2015 and a summary of historical data for these sites.

| Site | Time (NZST) | Temperature (°C) | Water Colour | Water Clarity | Flow Conditions | Water Speed |
|------|-------------|------------------|--------------|---------------|-----------------|-------------|
| 1 | 0915 | 15.3 | Uncoloured | Clear | Very Low | Steady |
| 2 | 0940 | 16.2 | Uncoloured | Clear | Very Low | Slow |
| 3 | 0930 | 15.1 | Uncoloured | Clear | Very Low | Swift |

Macroinvertebrate communities

Most past surveys have shown that the larger tributary supports richer macroinvertebrate communities, including abundances of 'sensitive' mayflies. These results reflect the good habitat conditions normally provided by faster-flowing, stony-bedded streams on the upper to mid reaches of the ring plain. The smaller tributary has tended to support communities with lower numbers of taxa and smaller proportions of 'sensitive' taxa. This in part has been due to the slower flow and/or iron oxide deposition on the more sedimented stream bed of this tributary.

Table 3 provides a summary of the results from previous surveys sampled in relation to the Kaimiro Production Station discharges along with current survey results.

Table 3 Number of taxa, MCI and SQMCI_s values for two unnamed tributaries of the Mangaoraka Stream, sampled in relation to the Kaimiro Production Station on 24 February 2015 and a summary of historical data for these sites.

| Site No. | N | No of taxa | | | MCI value | | | SQMCI _s value | | |
|----------|----|------------|-------|----------|-----------|--------|----------|--------------------------|---------|----------|
| | | Median | Range | Feb 2015 | Median | Range | Feb 2015 | Median | Range | Feb 2015 |
| 1 | 56 | 27 | 18-37 | 32 | 97 | 83-110 | 98 | 3.4 | 1.9-5.1 | 5.2 |
| 2 | 52 | 15 | 3-26 | 15 | 81 | 55-103 | 80 | 2.2 | 1.2-4.1 | 3.4 |
| 3 | 56 | 24 | 14-33 | 16 | 99 | 71-111 | 103 | 4.1 | 1.7-6.2 | 6.3 |

Table 4 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park. The full results from the current survey are presented in Table 5.

Table 4 Range and median number of taxa, MCI values and SQMCI_s scores for 'control' sites (Taranaki ring plain rivers/streams with sources outside Egmont National Park) at altitudes 200-249 m asl (TRC, 2015).

| | No. of taxa | MCI value | SQMCI _s value |
|-------------|-------------|-----------|--------------------------|
| No. Samples | 103 | 103 | 43 |
| Range | 2-37 | 60-116 | 1.9-6.7 |
| Median | 24 | 95 | 4.0 |

Table 5 Macroinvertebrate fauna of two unnamed tributaries of the Mangaoraka Stream in relation to Kaimiro Production Station sampled on 24 February 2015

| Taxa List | Site Number | MCI score | 1 | 2 | 3 |
|---------------------------|---|-----------------------------|--------------------|-------------------------|-----------|
| | Site Code | | MRK000198 | MRK000204 | MRK000207 |
| | Sample Number | | FWB15177 | FWB15178 | FWB15179 |
| NEMERTEA | Nemertea | 3 | R | R | - |
| ANNELIDA (WORMS) | Oligochaeta | 1 | VA | C | C |
| | Lumbricidae | 5 | - | - | R |
| MOLLUSCA | <i>Gyraulus</i> | 3 | R | - | - |
| | <i>Potamopyrgus</i> | 4 | C | R | R |
| CRUSTACEA | Ostracoda | 1 | C | - | - |
| | Isopoda | 5 | - | R | - |
| | Paraleptamphopidae | 5 | R | R | - |
| | <i>Paranephrops</i> | 5 | R | - | - |
| EPHEMEROPTERA (MAYFLIES) | <i>Austroclima</i> | 7 | C | - | A |
| | <i>Coloburiscus</i> | 7 | R | R | R |
| | <i>Deleatidium</i> | 8 | C | - | - |
| | <i>Nesameletus</i> | 9 | R | - | - |
| | <i>Zephlebia</i> group | 7 | XA | R | VA |
| HEMIPTERA (BUGS) | <i>Microvelia</i> | 3 | - | R | - |
| COLEOPTERA (BEETLES) | Elmidae | 6 | C | - | - |
| | Ptilodactylidae | 8 | C | - | - |
| MEGALOPTERA (DOBSONFLIES) | <i>Archichauliodes</i> | 7 | C | - | - |
| TRICHOPTERA (CADDISFLIES) | <i>Hydropsyche</i> (<i>Aoteapsyche</i>) | 4 | A | - | C |
| | <i>Hydrobiosis</i> | 5 | A | - | C |
| | <i>Hydropsyche</i> (<i>Orthopsyche</i>) | 9 | - | - | A |
| | <i>Polypectropus</i> | 6 | C | - | - |
| | <i>Psilochorema</i> | 6 | R | - | R |
| | Oeconesidae | 5 | - | R | - |
| | <i>Oxyethira</i> | 2 | A | - | - |
| | <i>Pycnocentria</i> | 7 | - | - | C |
| DIPTERA (TRUE FLIES) | <i>Triplectides</i> | 5 | C | - | - |
| | <i>Zelolessica</i> | 7 | C | - | - |
| | <i>Aphrophila</i> | 5 | C | - | - |
| | Eriopterini | 5 | R | - | - |
| | Hexatomini | 5 | R | - | R |
| | <i>Limonia</i> | 6 | - | - | R |
| | <i>Corynoneura</i> | 3 | - | R | - |
| Orthoclaadiinae | 2 | VA | C | - | |
| <i>Polypedilum</i> | 3 | C | C | A | |
| Tanypodinae | 5 | C | - | - | |
| <i>Paradixa</i> | 4 | C | C | - | |
| Empididae | 3 | C | R | R | |
| <i>Austrosimulium</i> | 3 | A | - | C | |
| ACARINA (MITES) | Acarina | 5 | C | C | - |
| No of taxa | | | 32 | 15 | 16 |
| MCI | | | 98 | 80 | 103 |
| SQMCIs | | | 5.2 | 3.4 | 6.3 |
| EPT (taxa) | | | 11 | 3 | 8 |
| %EPT (taxa) | | | 34 | 20 | 50 |
| 'Tolerant' taxa | | 'Moderately sensitive' taxa | | 'Highly sensitive' taxa | |
| R = Rare | C = Common | A = Abundant | VA = Very Abundant | XA = Extremely Abundant | |

Site 1

A high macroinvertebrate community richness of 32 taxa was found at site 1 ('control' site) at the time of the survey which was five more than the median number recorded for the site (median taxa richness 27; Table 3). Taxa richness was also higher than the median calculated from similar sites (median taxa richness 24; Table 4) and the previous sample (taxa richness 25; Figure 2).

The MCI score of 98 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 97; Table 3) or compared with the previous survey (taxa richness 99; Figure 2). The SQMCI_s score of 5.2 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median SQMCI_s score of 3.4 units; Table 3).

The community was characterised by five 'tolerant' taxa [oligochaete worms, caddisflies (*Hydropsyche/Orthopsyche*) and (*Oxyethira*), orthoclad midges and sandfly (*Austrosimulium*)] and two 'moderately sensitive' taxa [mayfly (*Zephlebia* group and caddisfly (*Hydrobiosis*)] (Table 5).

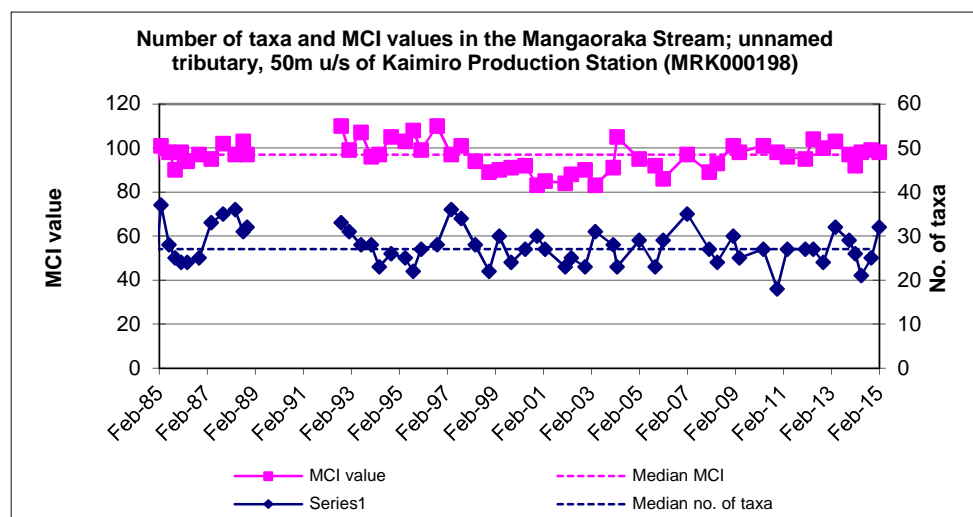


Figure 2 Number of taxa and MCI values in an unnamed tributary of the Mangaoraka Stream, 50 m upstream of Kaimiro Production Station (MRK000198)

Site 2

A moderate macroinvertebrate community richness of 15 taxa was found at site 2 ('primary impacted') at the time of the survey which was the same as the median number recorded for the site (median taxa richness 15; Table 3). Taxa richness was also the same as the previous survey score (taxa richness 15; Figure 3). However, taxa richness was substantially lower than the median calculated from similar sites (taxa richness 24; Table 4).

The MCI score of 80 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 81; Table 3). There was a insignificant decrease (Stark, 1998) of 9 units from the previous survey (MCI score 89 units; Figure 3). The SQMCI_s score of 3.4

units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median SQMCI_s score of 2.2 units; Table 3).

The community was characterised by having low taxa abundances with no taxa present having an abundance class higher than common (Table 5).

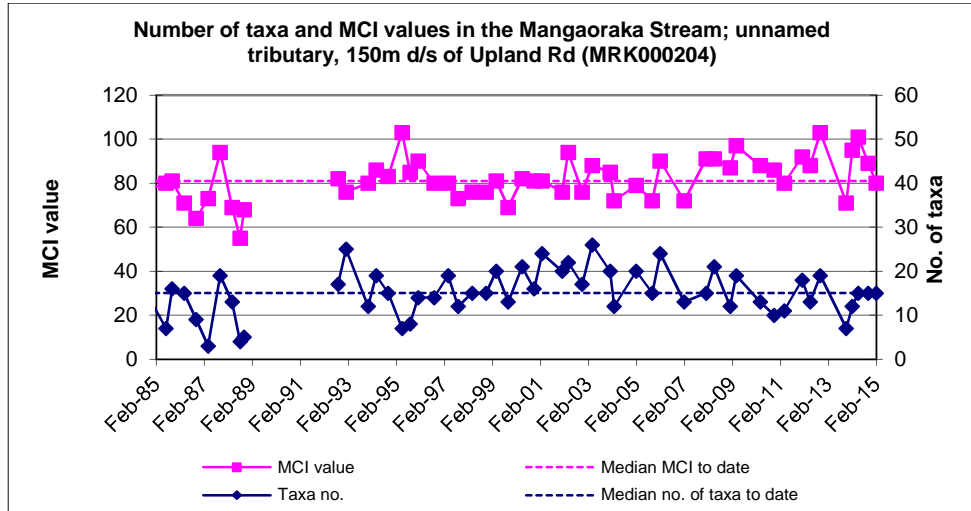


Figure 3 Number of taxa and MCI values in an unnamed tributary of the Mangaoraka Stream, 150 m d/s of Upland Road (MRK000204)

Site 3

A moderate macroinvertebrate community richness of 16 taxa was found at site 3 at the time of the survey which was eight taxa less than the median number recorded for the site and the median calculated from similar sites (median taxa richness 24; Table 3; Table 4). Taxa richness was also lower by five taxa since the previous survey.

The MCI score of 103 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 99; Table 3). There was an insignificant decrease (Stark, 1998) of seven MCI units from the previous survey (MCI score 109 units; Figure 3). The SQMCI_s score of 6.3 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median SQMCI_s score of 4.1 units; Table 3).

The community was characterised by one 'tolerant' taxon [midge (*Polypedilum*)], two 'moderately sensitive' taxa [mayflies (*Austroclima*) and (*Zephlebia* group)], and one 'highly' sensitive taxon [caddisfly (*Hydropsyche/Orthopsyche*)] (Table 5).

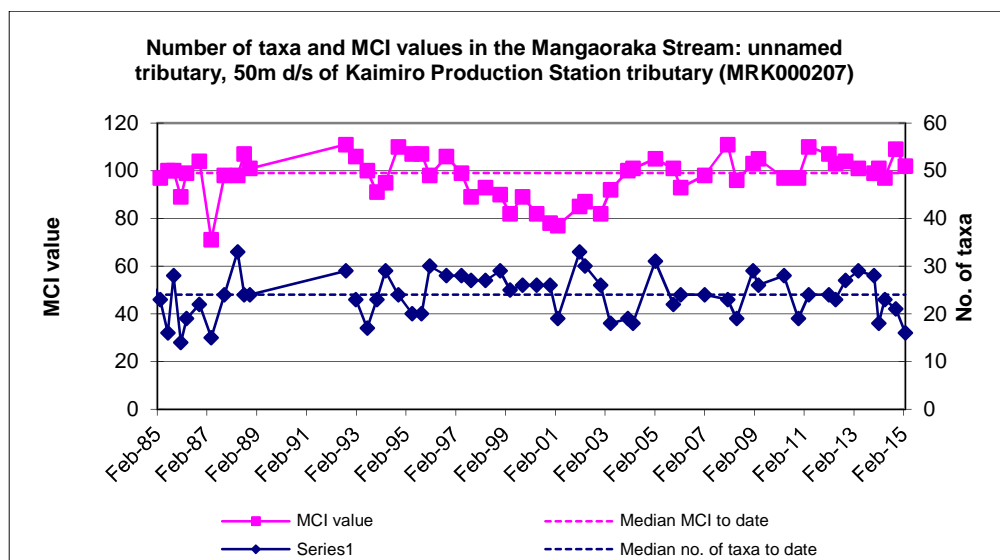


Figure 4 Number of taxa and MCI values in an unnamed tributary of the Mangaoraka Stream, 50 m d/s of Kaimiro Production Station tributary (MRK000207)

Discussion

The Council's 'kick-sampling' and 'vegetation sweep' techniques were used at three sites to collect streambed macroinvertebrates from two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station. This has provided data to assess any potential impacts the consented activities have had on the macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCI_s scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges. Macroinvertebrates when exposed to toxic chemicals may die and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). 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 abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the SQMCI_s between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

Most of the previous surveys undertaken in relation to the Kaimiro Production Station stormwater discharge have shown that the larger tributary of the Mangaoraka Stream (sites 1 and 3) supports higher taxonomic richness and healthier macroinvertebrate communities. The results of this summer survey were largely consistent with these trends with taxa richnesses and MCI scores recorded at sites 1 and 3 higher than those recorded at site 2 in the unnamed tributary. Site 2 (primary 'impacted site') has been affected to some extent by sedimentation of the streambed and iron-oxide deposits under low, warmer flow conditions. In this survey the site's substrate was composed of 50% silt and the water levels were extremely low which made obtaining a sample difficult. The very low flows probably contributed to the low taxa abundances found at the site though taxa richness remained surprisingly unchanged from the previous survey. The absence of any abundant 'tolerant'

taxa at site 2 during the survey was likely the main factor in the SQMCI_s score being significantly higher than the previous survey score as opposed to an increase in the abundance of 'sensitive' taxa which would indicate an improvement in the health of the macroinvertebrate community. This is further reinforced by the MCI score for site 2 decreasing by nine units since the previous survey.

Taxonomic richness between site 1, the 'control' site and site 3, the secondary 'impacted' was markedly different (by 16 taxa) at the time of the survey unlike the previous survey where site 3 had only four taxa less than site 1. Normally site 1 has only slightly more taxa recorded than site 3 (site 1 median taxa richness of 27 versus site 3 median taxa richness of 24). However, the large decrease in taxa richness was not caused by a large decrease in taxa richness at site 3 which might indicate impacts from production station discharges but rather a moderate increase at site 1 by seven taxa coupled with a moderate decrease at site 3 by five taxa. Furthermore site 3 had an insignificantly higher MCI score and a significantly higher SQMCI_s score indicating that the health of the macroinvertebrate community was equal to or better than site 1. The increase in taxa richness at site 1 may be partially attributable to the addition of the 'vegetation sweep' technique in conjunction with the 'kick sampling' technique. The two techniques sample different habitat types and increasing the amount of habitat diversity in a sample may increase the number of taxa found.

Overall, the results of this February 2015 survey suggest that the Kaimiro Production Station had not had any recent detrimental effects on the macroinvertebrate communities of the main tributary of the Mangaoraka Stream. Poorer macroinvertebrate indices found at the minor tributary would be a reflection of habitat differences, most likely from naturally occurring iron oxide deposition and differences in taxa richness between sites 1 and 3 may be a reflection of the level of habitat diversity in conjunction with differences in sampling techniques between the two sites.

Summary

- A macroinvertebrate survey was performed at three sites in two unnamed tributaries of the Mangaoraka Stream in relation to stormwater discharges from the Kaimiro Production Station.
- There were insignificant or positive differences in MCI and SQMCI_s scores between the 'control' site and the secondary 'impacted' site at the time of the survey but taxa number was markedly higher at the 'control' site which may be due to the variation in level of habitat diversity in conjunction with differences in sampling techniques between the two sites.
- In general the results are consistent or higher than previous sampling results with only insignificant differences found for MCI scores and significant improvements found for SQMCI_s scores for the three sites at the time of the survey compared with median values obtained from previous surveys.
- Overall, there was no evidence for the Kaimiro Production Station discharges having had any recent detrimental effects on the macroinvertebrate communities of the main tributary of the Mangaoraka Stream.

References

Colgan, B, 2003: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, April 2003. BC005.

Dunning KJ, 2001a: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, November 2000. KD28.

Dunning KJ, 2001b: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, March 2001. KD55.

Dunning KJ, 2002a: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, January 2002. KD96.

Dunning KJ, 2002b: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, November 2002. KD120.

Hope KJ, 2006: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, October 2005. KH057.

Hope KJ, 2006: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, February 2006. KH075.

Fowles, CR and Hope, KJ, 2005: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, February 2005. TRC report CF378.

Fowles, CR and Jansma, B, 2008a: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, January 2008, CF459.

Fowles, CR and Jansma, B, 2008b: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, May 2008, CF464.

Fowles, CR and Jansma, B, 2014: Post-well drilling biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, May 2014. CF617.

Fowles, CR and Moore, SC, 2004: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, March 2004. CF320.

Fowles, CR and Smith, K, 2013: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, October 2012. CF583

Fowles, CR and Thomas, BR, 2014: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, November 2013. CF614.

Fowles, CR and Thomas, BR, 2014: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, February 2014. CF615.

- Jansma B, 2007: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, February 2007. TRC report BJ019.
- Jansma B, 2009a: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, January 2009. TRC report BJ077.
- Jansma B, 2009b: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, April 2009. TRC report BJ078.
- Jansma B, 2010: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, April 2010. TRC report BJ099.
- Jansma B, 2011a: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, November 2010 TRC report BJ150.
- Jansma B, 2011b: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, April 2011 TRC report BJ151.
- Jansma B, 2013: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, April 2013 TRC report BJ221.
- McWilliam H, 1999a: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, November 1998. HM153.
- McWilliam H, 1999b: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, April 1999. HM165.
- McWilliam H, 2000: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, October 1999. HM200.
- Moore, SC, 2004: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, January 2004. SM589.
- Smith K, 2012: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, January 2012. TRC report KS013.
- Smith K, 2012: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, May 2012. TRC report KS014.
- Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. *Water and Soil Miscellaneous Publication No. 87*.
- Stark JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. *New Zealand Journal of Marine and Freshwater Research* 32(1): 55-66.
- Stark JD, 1999: An evaluation of Taranaki Regional Council's SQMCI biomonitoring index. Cawthron Institute, Nelson. Cawthron Report No. 472.
- Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate

Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Sutherland DL, 2014: Biomonitoring of two unnamed tributaries of the Mangaoraka Stream in relation to the Kaimiro Production Station, October 2014. TRC report DS018.

TRC, 2015: Some statistics from the Taranaki Regional Council database (Esam) of freshwater macroinvertebrate surveys performed during the period from January 1980 to 30 September 2014. Technical Report 2014-105.

To Callum MacKenzie, Scientific Officer
From Freshwater Biologists, Darin Sutherland and Brooke Thomas
Document 1559952
Report No DS031
Date 25 August 2015

Biomonitoring of the Ngatoro Stream and an unnamed tributary, in relation to the saline discharge from the Ngatoro-B production site, October 2014

Introduction

This survey is related to monitoring the effects of a discharge of saline water from the Ngatoro-B oil production site (operated by Greymouth Petroleum Ltd) on the streambed communities of the Ngatoro Stream and an unnamed tributary of the Ngatoro Stream. The results of previous routine surveys are discussed in the references at the end of this report. The results of two surveys performed in relation to drilling at the Ngatoro-9 well site are detailed in McWilliam (1998b and 1998c). The current survey was performed as a component of the 2014-2015 monitoring programme.

Methods

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from two sites in the Ngatoro Stream and a combination of the 400 ml kick-sampling' and 'sweep-net' sampling techniques were used to collect streambed macroinvertebrates from an unnamed tributary of the Ngatoro Stream (Table 1, Figure 1) on 16 October 2014.

The 'kick-sampling' and 'vegetation sweep' techniques are very similar to Protocol C1 (hard-bottomed, semi-quantitative) and C2 (soft-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 found in each sample were recorded as:

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

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 taken 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. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

Table 1 Biomonitoring sites in the Ngatoro Stream and a tributary of the stream.

| Site No. | Site Code | GPS location | Location |
|----------|-----------|-------------------|---|
| 2 | NGT000197 | E1702558 N5661243 | Ngatoro Stream 60 m upstream of drain |
| 3 | NGT000200 | E1702596 N5661277 | Ngatoro Stream 40 m downstream of drain |
| T | NGT000199 | E1702593 N5661220 | Drain tributary near confluence with Ngatoro Stream |



Figure 1 Sampling sites in relation to the production water/stormwater discharges from the Ngatoro B production station.

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). 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.

Results

Site habitat characteristics and hydrology

This October 2014 survey followed a period of 10 days since a fresh in excess of three times median flow, and 17 days since a fresh in excess of seven times median flow. In the month prior to this survey there had been seven fresh events, three of which exceeded three times median flow and four that had exceeded seven times median flow.

Water temperatures ranged from 10.9°C-12.0°C. Water levels were moderate and flows swift at sites 2 and 3 while site T had a low slow flow. Water was clear and uncoloured for all three sites. Sites 2 and 3 had a substrate comprised mostly of cobbles and boulders, and site T had a substrate comprised of cobble, fine gravel, silt and sand.

Sites 2 and 3 had patchy mats, filamentous algae and patchy moss while site T had slippery mats, patchy filamentous algae and no moss. All three sites did not have any leaves, wood and macrophytes within the stream. Sites 2 and 3 had no shading while site T had shading from overhanging long grasses. Site T had abundant iron oxide smothering the streambed. Chloride levels were relatively low preceding the survey (Figure 2 and Figure 3).

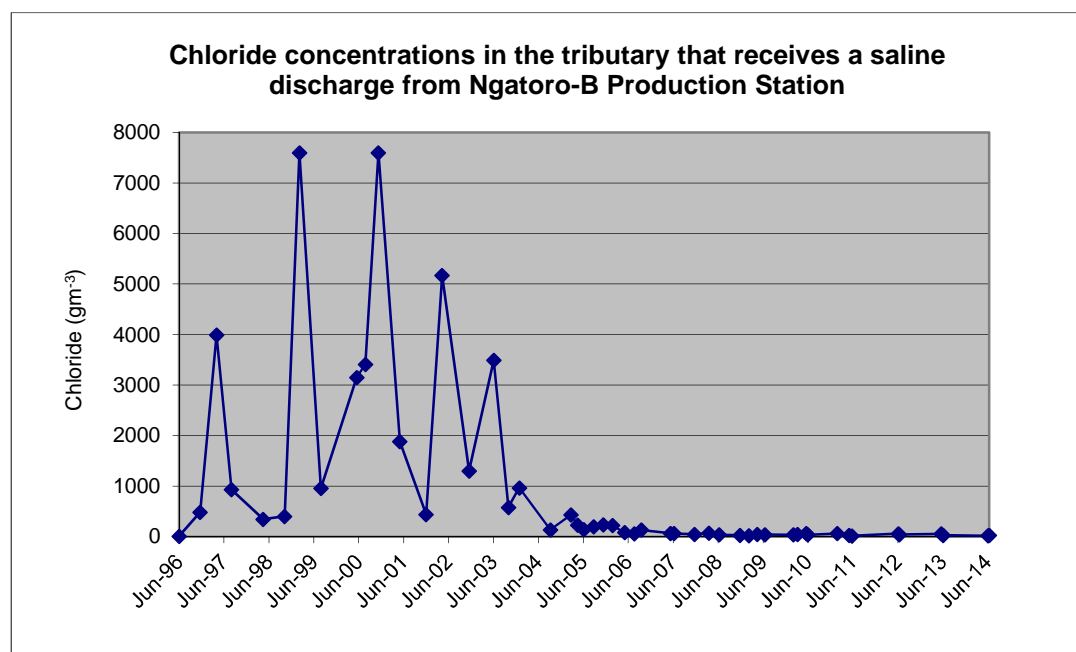


Figure 2 Chloride concentrations (g/m³) recorded in the tributary of the Ngatoro Stream that receives a saline discharge from the Ngatoro-B Production Station, 1995-current.

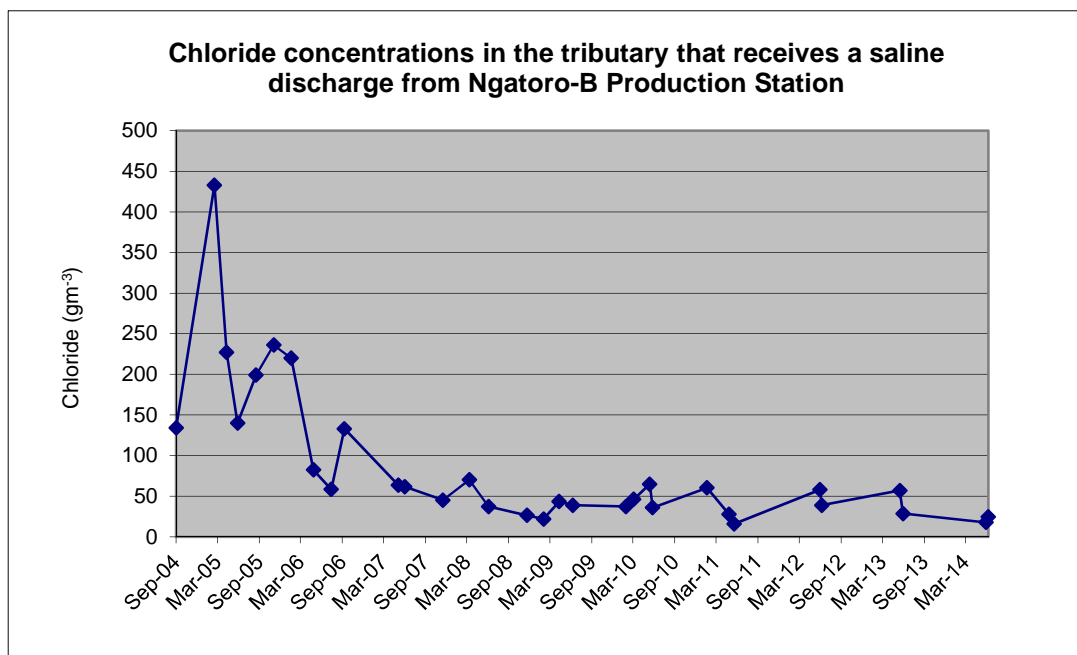


Figure 3 Chloride concentrations (g/m³) recorded in the tributary of the Ngatoro Stream that receives a saline discharge from the Ngatoro-B Production Station, 2004 – current.

Macroinvertebrate communities

Table 2 provides a summary of the results from previous surveys sampled in relation to the Ngatoro-B Production Station discharges along with current survey results.

Table 2 Numbers of taxa and MCI values recorded in the current survey, together with results from previous surveys.

| Site No | No. Taxa | | | | MCI values | | | | SQMCI _s values | | | |
|---------|-------------|-------|--------|----------------|-------------|--------|--------|----------------|---------------------------|---------|--------|----------------|
| | No. samples | Range | Median | Current result | No. Samples | Range | Median | Current result | No. samples | Range | Median | Current result |
| 2 | 22 | 20-34 | 26 | 28 | 22 | 99-130 | 115 | 119 | 14 | 3.1-7.8 | 6.8 | 7.2 |
| 3 | 22 | 17-34 | 27 | 27 | 22 | 95-128 | 114 | 113 | 14 | 3.0-7.4 | 6.6 | 6.7 |
| T | 20 | 3-28 | 11 | 8 | 20 | 65-101 | 80 | 93 | 14 | 1.4-4.9 | 3.5 | 1.4 |

The full macroinvertebrate survey results are presented in Table 3.

Table 3 Macroinvertebrate fauna of the Ngatoro Stream in relation to Ngatoro-B production station (sites 2 and 3) and tributary (site T) sampled on 16 October 2014.

| Taxa List | Site Number | MCI score | 2 | 3 | T |
|---------------------------|----------------------------------|-----------------------------|-----------|-------------------------|-----------|
| | Site Code | | NGT000197 | NGT000200 | NGT000199 |
| | Sample Number | | FWB14310 | FWB14312 | FWB14311 |
| ANNELIDA (WORMS) | Oligochaeta | 1 | R | R | VA |
| MOLLUSCA | <i>Potamopyrgus</i> | 4 | - | R | C |
| CRUSTACEA | Isopoda | 5 | - | - | R |
| | Paraleptamphopidae | 5 | - | - | R |
| EPHEMEROPTERA (MAYFLIES) | <i>Austroclima</i> | 7 | C | C | - |
| | <i>Coloburiscus</i> | 7 | VA | VA | - |
| | <i>Deleatidium</i> | 8 | XA | XA | R |
| | <i>Nesameletus</i> | 9 | A | A | - |
| PLECOPTERA (STONEFLIES) | <i>Acroperla</i> | 5 | R | - | - |
| | <i>Megaleptoperla</i> | 9 | R | - | - |
| | <i>Stenoperla</i> | 10 | R | - | - |
| | <i>Zelandobius</i> | 5 | R | C | - |
| | <i>Zelandoperla</i> | 8 | A | R | - |
| COLEOPTERA (BEETLES) | Elmidae | 6 | A | VA | - |
| | Hydraenidae | 8 | C | R | - |
| | Ptilodactylidae | 8 | R | - | - |
| MEGALOPTERA (DOBSONFLIES) | <i>Archichauliodes</i> | 7 | C | A | - |
| TRICHOPTERA (CADDISFLIES) | <i>Hydropsyche (Aoteapsyche)</i> | 4 | A | A | - |
| | <i>Costachorema</i> | 7 | C | A | - |
| | <i>Hydrobiosis</i> | 5 | - | R | - |
| | <i>Hydrobiosella</i> | 9 | - | R | - |
| | <i>Neurochorema</i> | 6 | R | C | - |
| | <i>Plectrocnemia</i> | 8 | R | - | - |
| | <i>Polypectropus</i> | 6 | - | - | R |
| | <i>Beraeoptera</i> | 8 | A | VA | - |
| | <i>Confluens</i> | 5 | C | - | - |
| | <i>Olinga</i> | 9 | - | R | - |
| DIPTERA (TRUE FLIES) | <i>Pycnocentroides</i> | 5 | A | A | - |
| | <i>Aphrophila</i> | 5 | A | VA | - |
| | Eriopterini | 5 | R | R | - |
| | <i>Zelandotipula</i> | 6 | - | - | R |
| | <i>Maoridiamesa</i> | 3 | A | A | - |
| | Orthoclaadiinae | 2 | A | VA | R |
| | Tanypodinae | 5 | - | R | - |
| | Tanytarsini | 3 | C | C | - |
| | Dolichopodidae | 3 | - | R | - |
| | Empididae | 3 | R | R | - |
| | Ephydriidae | 4 | R | - | - |
| No of taxa | | | 28 | 27 | 8 |
| MCI | | | 119 | 113 | 93 |
| SQMCIs | | | 7.2 | 6.7 | 1.4 |
| EPT (taxa) | | | 16 | 14 | 2 |
| %EPT (taxa) | | | 57 | 52 | 25 |
| 'Tolerant' taxa | | 'Moderately sensitive' taxa | | 'Highly sensitive' taxa | |

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

Site 2 (NGT000197)

A moderately high macroinvertebrate community richness of 28 taxa was found at site 2 ('control' site) at the time of the survey which was three more than the median number recorded for the site (median taxa richness 26; Table 2) and the same number as the previous sample (taxa richness 28; Figure 4).

The MCI score of 119 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 115 units; Table 2) or to the previous survey score (MCI score 115 units; Figure 4). The SQMCI_s score of 7.2 units was similar to the median value calculated from previous surveys at the same site (median SQMCI_s score 6.8 units; Table 2) and was lower than the previous survey score (SQMCI_s score 6.5 units).

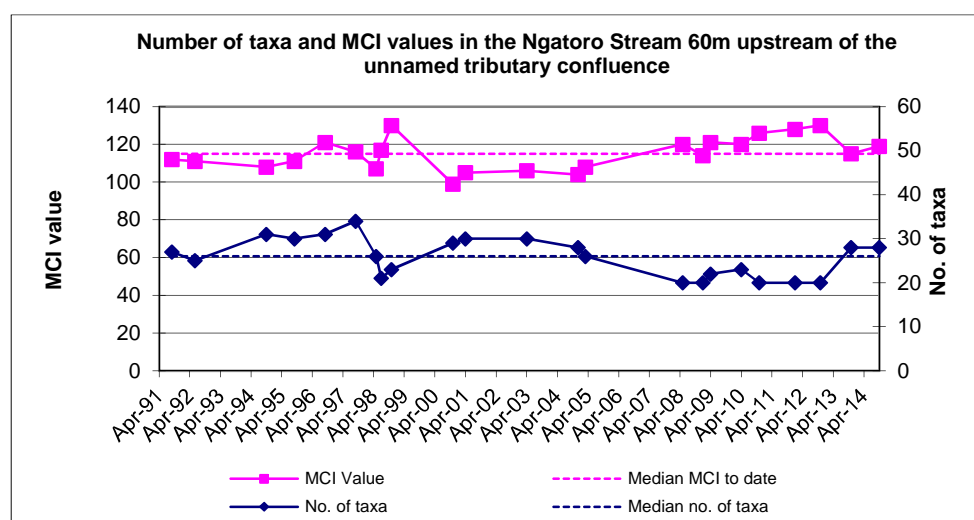


Figure 4 Number of taxa and MCI values in the Ngatoro Stream 60m upstream of the unnamed tributary confluence.

The community was characterised by three 'tolerant' taxa [caddisfly (*Hydropsyche* - *Aoteapsyche*), and midges (*Maoridiamesa* and orthoclads)], four 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, caddisfly (*Pycnocentroides*) and crane fly (*Aphrophila*)], and four 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*), stonefly (*Zelandoperla*), and caddisfly (*Beraeoptera*)] (Table 3).

Site 3 (NGT000200)

A moderately high macroinvertebrate community richness of 27 taxa was found at site 3 at the time of the survey which was the same number as the median number recorded for the site (median taxa richness 27; Table 2) and one less than the previous sample (taxa richness 28; Figure 5).

The MCI score of 113 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 114 units; Table 2) or to the previous survey score (MCI score 113 units; Figure 5). The SQMCI_s score of 6.7 units was similar to the median value calculated from previous surveys at the same site (median SQMCI_s score 6.6 units; Table 2) and was also similar to the previous survey score (SQMCI_s score 6.5 units).

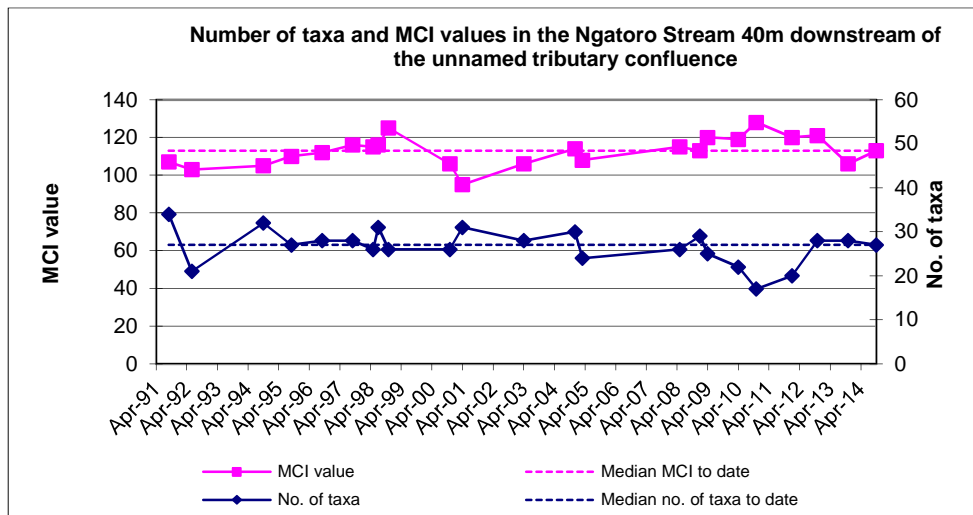


Figure 5 Number of taxa and MCI values in the Ngatoro Stream 40m downstream of the unnamed tributary confluence.

The community was characterised by three 'tolerant' taxa [caddisfly (*Hydropsyche - Aoteapsyche*) and midges (*Maoridiamesa* and orthoclads)], six 'moderately sensitive' taxa [mayfly (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), caddisflies (*Pycnocentroides* and *Costachorema*) and crane fly (*Aphrophila*), and three 'highly sensitive' taxa [mayflies (*Deleatidium* and *Nesameletus*), and caddisfly (*Beraeoptera*)] (Table 3).

Site T (NGT000199)

A very low macroinvertebrate community richness of eight taxa was found at site T at the time of the survey which was three less than the median number recorded for the site (median taxa richness 11; Table 2) and 20 taxa less than the previous sample (taxa richness 28; Figure 4).

The MCI score of 93 units indicated a community of 'fair' biological health which was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median MCI score 80 units; Table 2) but not significantly different (Stark, 1998) to the previous survey score (MCI score 101 units; Figure 4). The SQMCI_s score of 1.4 units was markedly lower than the median value calculated from previous surveys at the same site (median SQMCI_s score 3.5 units; Table 2) and was also markedly lower than the previous survey score (SQMCI_s score 4.6 units).

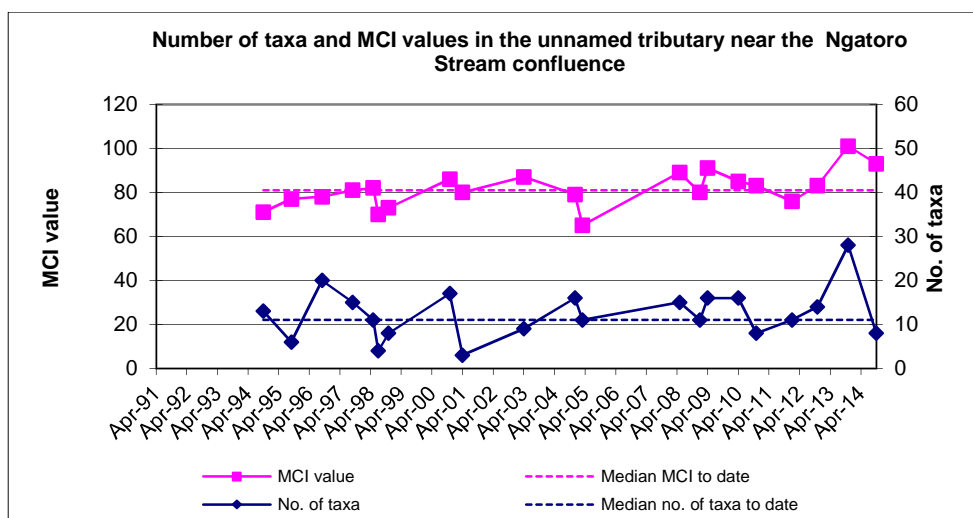


Figure 6 Number of taxa and MCI values in the unnamed tributary near the Ngatoro Stream confluence.

The community was characterised by one 'tolerant' taxon [oligochaete worms] (Table 3).

Discussion

The results of the survey indicated that the macroinvertebrate communities of the Ngatoro Stream were in 'good' health and the assemblages were typical of the mid-reaches of a ringplain stream during spring conditions. The community composition at site 3 was very similar to that found at the upstream 'control' site (site 2). There was no evidence that the macroinvertebrate communities had been detrimentally affected by discharges of saline water from the Ngatoro-B Production Station.

The macroinvertebrate community in the tributary that receives the discharge from the production station was in a poor condition. Though the MCI score suggested it was in 'fair' health the SQMCI_s score suggested that it was in fact in poorer condition. The 'sensitive' taxa present at the site were all at very low abundances (all rare). The macroinvertebrate community was dominated by very 'tolerant' oligochaete worms while the 'tolerant' snail (*Potamopyrgus*) was the only other taxon present at the site that was recorded as being more than 'rare'. Taxa richness was also low but not markedly lower than the median number recorded at the site. Taxa richness had dropped by 20 taxa since the preceding survey from 28 taxa to eight taxa but this was more of a reflection of the abnormally high taxa richness recorded during the previous survey (the historical maximum) rather than a significant change in typical taxa richness for the site. Chloride levels (Figure 2 and Figure 3) have all been relatively low for several years at the time of physiochemical sampling preceding this survey and therefore the poor condition of the macroinvertebrate community was more likely due to the abundant iron oxide smothering the streambed.

Special condition 5 of the consent 3951 requires that the wastewater discharge shall not cause a significant adverse effect on freshwater biological communities of the receiving water. As the consent specifies that the point of discharge is located at the confluence of the receiving tributary and the Ngatoro Stream, the Ngatoro Stream is therefore defined as the receiving water. The saline discharge had had minimal recent effects upon the high quality macroinvertebrate community of the Ngatoro Stream below the discharge point. Therefore the discharge was in compliance with Special Condition 5 of the consent.

Summary

The Council's standard 'kick-sampling' technique was used at two established sites in the Ngatoro Stream and a combination of 'kick-sampling' and 'vegetation sweeping' was used in an unnamed tributary of the Ngatoro Stream to collect streambed macroinvertebrates. Samples were sorted and identified and the number of taxa (richness) and MCI and SQMCI_s scores were obtained 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, particularly if non-organic impacts are occurring. Significant differences in either the MCI or the SQMCI_s between site indicate the degree of adverse effects (if any) of the discharges being monitored.

This October 2014 macroinvertebrate survey indicated that discharges from the Ngatoro-B Production Station site had not had any recent detrimental effects on the macroinvertebrate

communities of the Ngatoro Stream. Minimal, insignificant differences in the macroinvertebrate communities were recorded between the upstream 'control' site and the site downstream of the receiving tributary confluence.

The macroinvertebrate communities of the Ngatoro Stream contained significant proportions of 'sensitive' taxa at both sites and the communities were generally dominated by 'sensitive' taxa. Taxonomic richnesses (numbers of taxa) were very similar to medians at both sites at the time of this spring survey.

MCI scores indicated that the stream communities were of 'good' health, and generally typical of conditions recorded in similar reaches of ringplain Taranaki streams. The unnamed tributary had abundant iron-oxide deposits which smothered the substrate and contributed to the low SQMCI_s score and taxa richness and reduced abundances within the majority of individual taxa present at this site.

Overall, the low salinity discharges from the Ngatoro-B Production Station were found to have had no recent detrimental impacts on the macroinvertebrate communities of the Ngatoro Stream beyond the designated mixing zone downstream of the tributary confluence.

References

- Colgan BG, 2003: Biomonitoring of the Ngatoro Stream and an unnamed tributary above and below the saline discharge from the Ngatoro-B production site, April 2003. TRC report BC004.
- Dunning K D, 2001: Biomonitoring of the Ngatoro Stream and an unnamed tributary, above and below the saline discharge from the Ngatoro-B production site, November 2000. TRC report KD30.
- Fowles CR, 2005: Biomonitoring of the Ngatoro Stream and an unnamed tributary above and below the saline discharge from the Ngatoro-B production site, December 2004. TRC report CF349.
- Fowles CR and Hope KD, 2007: Biomonitoring of the Ngatoro Stream and an unnamed tributary above and below the saline discharge from the Ngatoro-B production site, March 2005. TRC report CF382.
- Fowles CR and Jansma B, 2008: Biomonitoring of the Ngatoro Stream and an unnamed tributary, in relation to the saline discharge from the Ngatoro-B production site, May 2008. TRC report CF456.
- Fowles CR and Smith K, 2013: Biomonitoring of the Ngatoro Stream and an unnamed tributary, in relation to the saline discharge from the Ngatoro-B production site, January 2012. TRC Report CF578.
- Fowles CR and Thomas B, 2014: Biomonitoring of the Ngatoro Stream and an unnamed tributary, in relation to the saline discharge from the Ngatoro-B production site, November 2013. TRC report CF609.
- Jansma B, 2009a: Biomonitoring of the Ngatoro Stream and an unnamed tributary, in relation to the saline discharge from the Ngatoro-B production site, January 2009. TRC report BJ079.

- Jansma B, 2009b: Biomonitoring of the Ngatoro Stream and an unnamed tributary, in relation to the saline discharge from the Ngatoro-B production site, April 2009. TRC report BJ080.
- Jansma B, 2010: Biomonitoring of the Ngatoro Stream and an unnamed tributary, in relation to the saline discharge from the Ngatoro-B production site, April 2010. TRC report BJ100.
- Jansma B, 2011: Biomonitoring of the Ngatoro Stream and an unnamed tributary, in relation to the saline discharge from the Ngatoro-B production site, November 2010. TRC report BJ152.
- Jansma B, 2013: Biomonitoring of the Ngatoro Stream and an unnamed tributary, in relation to the saline discharge from the Ngatoro-B production site, November 2012. TRC report BJ193.
- McWilliam H, 1996: Biomonitoring of the Ngatoro Stream and an unnamed tributary, above and below the saline discharge from the Ngatoro-2 drilling (now production) site, September 1996. TRC report HM22.
- McWilliam H, 1998a: Biomonitoring of the Ngatoro Stream and an unnamed tributary, above and below the saline discharge from the Ngatoro-2 production site, September 1997. TRC report HM96.
- McWilliam H, 1998b: Biomonitoring of the Ngatoro Stream and an unnamed tributary, prior to drilling of the Ngatoro-9 well, May 1998. TRC report HM125.
- McWilliam H, 1998c: Biomonitoring of the Ngatoro Stream and an unnamed tributary, following drilling of the Ngatoro-9 well, July 1998. TRC report HM138.
- McWilliam H, 1999: Biomonitoring of the Ngatoro Stream and an unnamed tributary, above and below the saline discharge from the Ngatoro-2 production site, November 1998. TRC report HM150.
- McWilliam H, 2001: Biomonitoring of the Ngatoro Stream and an unnamed tributary, above and below the saline discharge from the Ngatoro-2 production site, April 2001. TRC report HM251.
- Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. *Water and Soil Miscellaneous Publication No. 87.*
- Stark JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. *New Zealand Journal of Marine and Freshwater Research* 32(1): 55-66.
- Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Appendix III

Air monitoring reports

Memorandum

To Job Manager, Callum MacKenzie
From Scientific Officer - Air Quality, Brian Cheyne
File 1637005
Date February 19, 2016

Ambient Gas (PM10, NOx, CO and LEL) Monitoring at Kaimiro Production Stations during 2014-2015 monitoring year

Introduction

In July 2014 and January 2015 as part of the compliance monitoring programme for the Kaimiro production station, a survey of ambient air quality sampling was carried out by the Taranaki Regional Council (the Council) in the vicinity of the plant. The main objectives were to measure:

- The concentrations of PM10 using a portable data logging TSI 'DustTrak';
- To measure the concentrations of the nitrogen oxides (NOx) using a passive sampling method, that gives a result for average exposure;
- And to measure carbon monoxide (CO) using a portable multi gas meter that provides instantaneous data throughout the monitoring period.

The findings of this study are presented in this memorandum, together with the locations of the monitoring sites which are provided in Figure 1.

Carbon monoxide (CO) and Lower explosive limit (LEL)

During the monitoring year, a multi-gas meter was deployed on one occasion in the vicinity of the plant. The deployment lasted approximately 60 hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continuous measurements of gas concentrations for the gases of interest (carbon monoxide and combustible gases).

Because of the nature of the activities on the site, it was considered that the primary information of interest in respect of gases potentially emitted from the site was the average downwind concentration, rather than any instantaneous peak value. That is, the long-term exposure levels, rather than short-term maxima, are of most interest. The gas meter was therefore set up to create a data set based on recording the average concentration measured during each minute as raw data.



Figure 1 Air monitoring sites at Kaimiro production station (2014-2015)

The details of the sample run are summarised in Table 1 and the data from the sample run are presented graphically in Figure 2.

The consents covering air discharges from the Kaimiro production station have specific limits related to particular gases. Special condition 13 of consent 4048-3 set a limit on the carbon monoxide concentration at or beyond the production station's boundary. The limit is expressed as 10 mg/m³ for an eight hour average or 30 mg/m³ for a one hour average exposure. The maximum concentration of carbon monoxide found during the monitoring run was 2.3 mg/m³ with average concentration for the entire dataset was only 0.10 mg/m³ which comply with consent conditions. This is in line with the pattern found in previous years.

Table 1 Results of carbon monoxide and LEL monitoring at Kaimiro production station

| Period (from-to) | | 25/07/2014 13:54 to 28/07/2014 01:10 | |
|------------------|---------|--------------------------------------|--|
| Max | CO(ppm) | 2.30 | |
| | LEL(%) | 0.10 | |
| Mean | CO(ppm) | 0.00 | |
| | LEL(%) | 0.00 | |
| Min | CO(ppm) | 0.00 | |
| | LEL(%) | 0.00 | |

- Note:
- (1) the instrument records in units of ppm. At 25°C, 1 atm.
1ppm CO = 1.145 mg/m³
 - (2) See text for explanation of LEL. Because the LEL of methane is equivalent to a mixture of approximately 5% methane in air, then the actual concentration of methane in air can be obtained by dividing the percentage LEL by 20.

LEL gives the percentage of the lower explosive limit, expressed as methane that is detected in the air sampled. The sensor on the instrument reacts to gases and vapours such as acetone, benzene, butane, methane, propane, carbon monoxide, ethanol, and higher alkanes and alkenes, with varying degrees of sensitivity. The Council's Regional Air Quality Plan has a typical requirement that no discharge shall result in dangerous levels of airborne contaminants, including any risk of explosion. At no time did the level of explosive gases downwind of the Kaimiro production station reach any more than a trivial level.

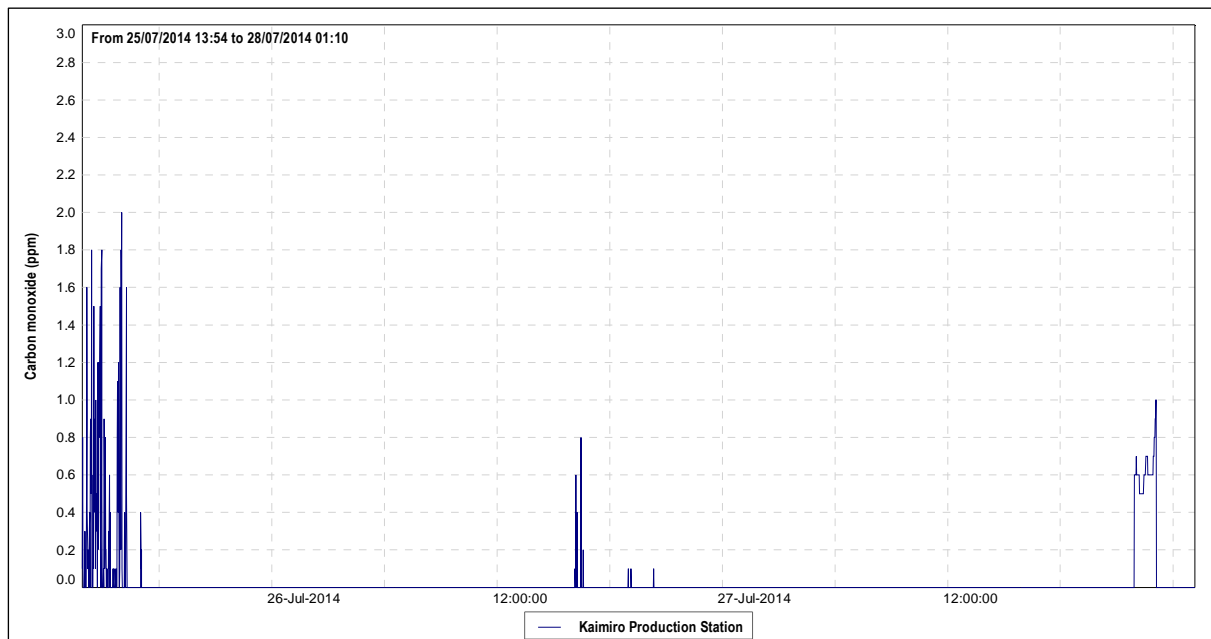


Figure 2 Graph of ambient CO levels in the vicinity of the Kaimiro Production Station

PM10

In September 2004 the Ministry for the Environment made public National Environmental Standards (NESs) relating to certain air pollutants. The NES for PM10 is 50 $\mu\text{g}/\text{m}^3$ (24-hour average).

Particulates can be derived from many sources, including motor vehicles (particularly diesel), solid and oil-burning processes for industry and power generation, incineration and waste burning, photochemical processes, and natural sources such as pollen, abrasion, and sea spray.

PM10 particles are linked to adverse health effects that arise primarily from the ability of particles of this size to penetrate the defences of the human body and enter deep into the lungs significantly reducing the exchange of gases across the lung walls. Health effects from inhaling PM10 include increased mortality and the aggravation of existing respiratory and cardiovascular conditions such as asthma and chronic pulmonary diseases.

During the reporting period, a “DustTrak” PM10 monitor was deployed on one occasion in the vicinity of the Kaimiro production station. The deployment lasted approximately 53 hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continual measurements of PM10 concentrations. The location of the “DustTrak” monitor during the sampling run is shown in Figure 1.

The details of the sample run are presented in Figure 3 and Table 2.

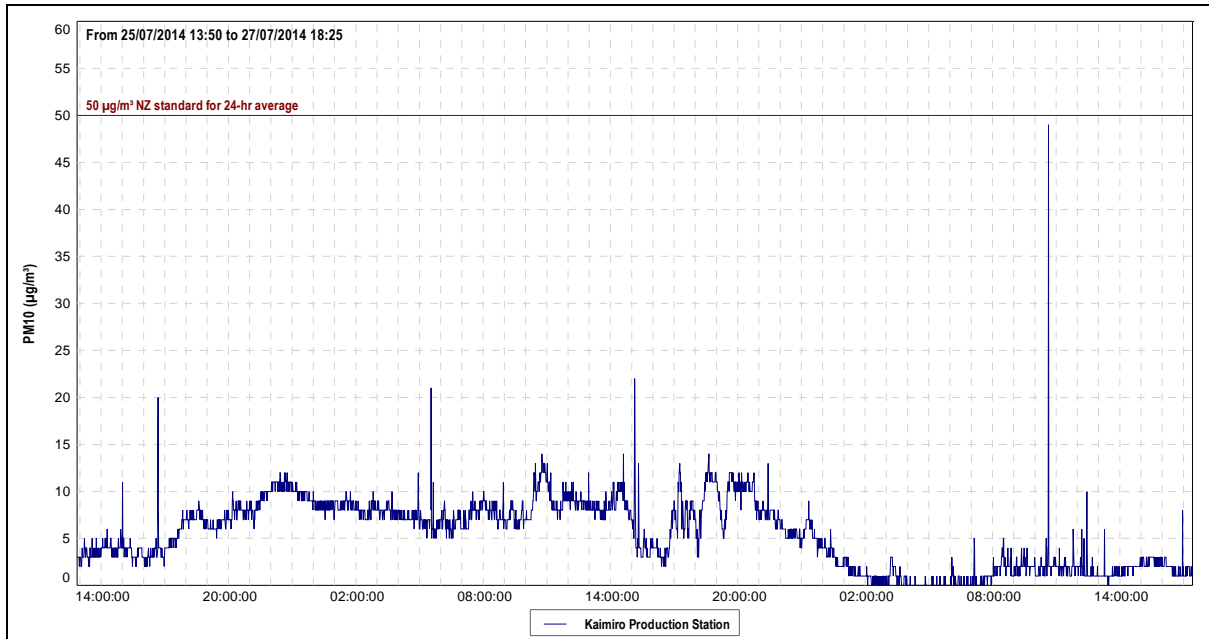


Figure 2 PM10 concentrations ($\mu\text{g}/\text{m}^3$) at the Kaimiro production station (2014-15)

| | (53 hours) (25-27/07/2014) | |
|---------------|-------------------------------|-------------------------------|
| 24 hr. set | Day 1 | Day 2 |
| Daily average | 7.27 $\mu\text{g}/\text{m}^3$ | 3.23 $\mu\text{g}/\text{m}^3$ |
| NES | 50 $\mu\text{g}/\text{m}^3$ | |

Table 1 Daily mean of PM10 results during two days' monitoring at Kaimiro production station

During the 53-hour run, from 25th of July to 27th of July 2014, the average recorded PM₁₀ concentration for the 24 hour period was 7.27 $\mu\text{g}/\text{m}^3$ and 3.23 $\mu\text{g}/\text{m}^3$ for the second 24 hour period. These daily means equate to 14.5% and 6.5%, respectively, of the 50 $\mu\text{g}/\text{m}^3$ value that is set by the National Environmental Standard.

Background levels of PM₁₀ in the region have been found to be typically around 11 $\mu\text{g}/\text{m}^3$.

Nitrogen oxides (NOx)

From 2014 onwards, the Council has implemented a coordinated region-wide compliance monitoring programme to measure NOx. The programme involves deploying all measuring devices at 28 NOx monitoring sites (including two sites in the vicinity of the Kaimiro production station) on the same day, with retrieval three weeks later. This approach assists the Council in further evaluating the effects of local and regional emission sources and ambient air quality in the region.

The complete report covering region-wide NOx monitoring is attached in the Appendix to this memorandum and can also be found at the following link:

<http://www.trc.govt.nz/assets/Publications/state-of-the-environment-monitoring/environmental-monitoring-technical-reports/1541533.pdf>

The consents covering air discharges from the Kaimiro production station have specific limits related to particular gases. Special condition 14 of consent 4048-3 set a limit on the nitrogen dioxide concentration at or beyond the production station's boundary. The limit is

expressed as $100 \mu\text{g}/\text{m}^3$ for a 24 hour average or $200 \mu\text{g}/\text{m}^3$ for a one hour average exposure.

NO_x passive adsorption discs were placed at two locations in the vicinity of the Kaimiro production station on one occasion during the year under review. The discs were left in place for a period of 21 days.

The calculated 1-hour and 24-hour theoretical maximum NO_x concentrations found at the Kaimiro production station during the year under review equates to $11.25 \mu\text{g}/\text{m}^3$ and $5.9 \mu\text{g}/\text{m}^3$ respectively. The results show that the ambient ground level concentration of NO_x is well below the limits set out by consent 4048-3.

Memorandum

To Fiza Hafiz, Scientific Officer – State of the Environment
Job Managers - Callum MacKenzie, Emily Roberts, James Kitto
From Brian Cheyne, Scientific Officer – Air Quality
File Frodo # 1545133
Date 29 July 2015

Monitoring of nitrogen oxides (NO_x) levels in Taranaki near the NO_x emitting sites, year 2014-2015

From 2014 onwards, the Taranaki Regional Council (TRC) has implemented a coordinated region-wide monitoring programme to measure NO_x, not only at individual compliance monitoring sites near industries that emit NO_x, but simultaneously at the urban sites (the Council regional state of the environment programme). The programme involves deploying all measuring devices on the same day, with retrieval three weeks later. This approach will assist the Council to further evaluate the effects of local and regional emission sources and ambient air quality in the region.

Nitrogen oxides

Nitrogen oxides (NO_x), a mixture of nitrous oxide (N₂O), nitric oxide (NO) and nitrogen dioxide (NO₂), are produced from natural sources, motor vehicles and other fuel combustion processes. Indoor domestic appliances (gas stoves, gas or wood heaters) can also be significant sources of nitrogen oxides, particularly in areas that are poorly ventilated. NO and NO₂ are of interest because of potential effects on human health.

Nitric oxide is colourless and odourless and is oxidised in the atmosphere to form nitrogen dioxide. Nitrogen dioxide is an odorous, brown, acidic, highly corrosive gas that can affect our health and environment. Nitrogen oxides are critical components of photochemical smog – nitrogen dioxide produces the yellowish-brown colour of the smog.

Environmental and health effects of nitrogen oxides

Nitrogen dioxide is harmful to vegetation, can fade and discolour fabrics, reduce visibility, and react with surfaces and furnishings. Vegetation exposure to high levels of nitrogen dioxide can be identified by damage to foliage, decreased growth or reduced crop yield.

Nitric oxide does not significantly affect human health. On the other hand, elevated levels of nitrogen dioxide cause damage to the mechanisms that protect the human respiratory tract and can increase a person's susceptibility to, and the severity of, respiratory infections and asthma. Long-term exposure to high levels of nitrogen dioxide can cause chronic lung disease. It may also affect sensory perception, for example, by reducing a person's ability to smell an odour.

National environmental standards and guidelines

In 2004, national environmental standards (NES) for ambient (outdoor) air quality were introduced in New Zealand to provide a guaranteed level of protection for the health of New Zealanders. The national standard for nitrogen dioxide (NO₂) is set out below.

In any 1-hour period, the average concentration of nitrogen dioxide in the air should not be more than 200 µg/m³.

Before the introduction of the national environmental standards, air quality was measured against the national air quality guidelines. The national guidelines were developed in 1994 and revised in 2002 following a comprehensive review of international and national research and remain relevant. The national guideline for nitrogen dioxide (NO₂) is set out below.

In any 24-hour period, the average concentration of nitrogen dioxide in the air should not be more than 100 µg/m³.

Nitrogen dioxide limits are also set in the special conditions of the resource consents. The consents limits are the same as those imposed under the NES and MfE's guideline.

Measurement of nitrogen oxides

The Taranaki Regional Council has been monitoring nitrogen oxides (NO_x) in the Taranaki region since 1993 using passive absorption discs. Research to date indicates that this is an accurate method, with benefits of simplicity of use and relatively low cost. To date 527 samplers of nitrogen oxides have been collected in Taranaki region. Discs are sent to EUROFINs ELS Ltd. Lower Hutt for analysis. Passive absorption discs are placed at the nominated sites. The gases diffuse into the discs and any target gases (nitrogen dioxide or others) are captured.

In the 2014-15 year, passive absorption discs were placed on one occasion at twenty eight sites, staked about two metres off the ground for a period of 21 days, for the purpose of Compliance Monitoring and SEM studies.

Conversion of exposure result to standardised exposure time period

From the average concentration measured, it is possible to calculate a theoretical maximum daily or one hour concentrations that may have occurred during the exposure period. Council data on NO_x is gathered over a time period other than exactly 24 hours or one hour. There are mathematical equations used by air quality scientists to predict the maximum concentrations over varying time periods. These are somewhat empirical, in that they take little account of local topography, micro-climates, diurnal variation, etc. Nevertheless, they are applied conservatively and have some recognition of validity.

One formula in general use is of the form:

$$C(t_2) = C(t_1) \times \left(\frac{t_1}{t_2}\right)^p$$

where C(t) = the average concentration during the time interval t, and p = a factor lying between 0.17 and 0.20. When converting from longer time periods to shorter time periods, using p = 0.20 gives the most conservative estimate (i.e. the highest calculated result for time period t₂ given a measured concentration for time period t₁). Using the 'worst case' factor of p = 0.20, the monitoring data reported above has been converted to equivalent 'maximum' 1-hour and 'maximum' 24-hour exposure levels.

Results

The location of the NO_x monitoring sites are shown in Figure 1 and the details of the NO_x results are presented in Table 1 and Figure 2.

Table 1 Actual (laboratory) and recalculated ambient NO_x results, NES and MfE guideline.

| | Survey at | Site code | NO _x (µg/m ³) Lab. results | NO _x 1/hr (µg/m ³) Theoretical max. | NO _x 24/hr (µg/m ³) Theoretical max. |
|--|---------------|---------------|--|---|--|
| Petrochemical | McKee PS | AIR007901 | 4.5 | 15.6 | 8.3 |
| | | AIR007902 | 8.8 | 30.5 | 16.2 |
| | Turangi PS | AIR007922 | 2.9 | 10.1 | 5.3 |
| | | AIR007824 | 3.5 | 12.1 | 6.4 |
| | Kaimiro PS | AIR007817 | 1.8 | 6.2 | 3.3 |
| | | AIR007818 | 4.7 | 16.3 | 8.6 |
| | Sidewinder PS | AIR007831 | 1.1 | 3.8 | 2.0 |
| | | AIR007832 | 0.8 | 2.8 | 1.2 |
| | Maui PS | AIR008201 | 1.6 | 5.6 | 2.9 |
| | | AIR008214 | 2.1 | 7.3 | 3.9 |
| | Kupe PS | AIR007827 | Lost | N/A* | N/A* |
| | | AIR007830 | 2.3 | 8.0 | 4.2 |
| | Kapuni PS | AIR003410 | 5.5 | 19.1 | 10.1 |
| | | AIR003411 | 7.9 | 27.4 | 14.5 |
| | Cheal PS | AIR007841 | 5.7 | 19.8 | 10.5 |
| | | AIR007842 | 5.8 | 20.1 | 10.7 |
| Waihapa PS | AIR007815 | 1.8 | 6.2 | 3.3 | |
| | AIR007816 | 0.5 | 1.7 | 0.9 | |
| Ballance AUP | AIR003401 | 7.2 | 25.0 | 13.2 | |
| | AIR003404 | 6.0 | 21.0 | 11.0 | |
| Dairy factory | Fonterra | AIR002410 | 3.2 | 11.1 | 5.9 |
| | | AIR002711 | 6.8 | 23.6 | 12.5 |
| | | AIR002412 | 4.7 | 16.3 | 8.6 |
| | | AIR002413 | 3.2 | 11.1 | 5.9 |
| SEM | NPGHS | AIR000012(NW) | 7.5 | 26.0 | 13.8 |
| | | AIR000012(NE) | 5.4 | 18.7 | 9.9 |
| | | AIR000012(SW) | 6.2 | 21.5 | 11.4 |
| | | AIR000012(SE) | 8.2 | 28.5 | 15.1 |
| National Environmental Standard (NES) and MfE guideline | | | | 200 (NES) | 100 (guideline) |

*no results

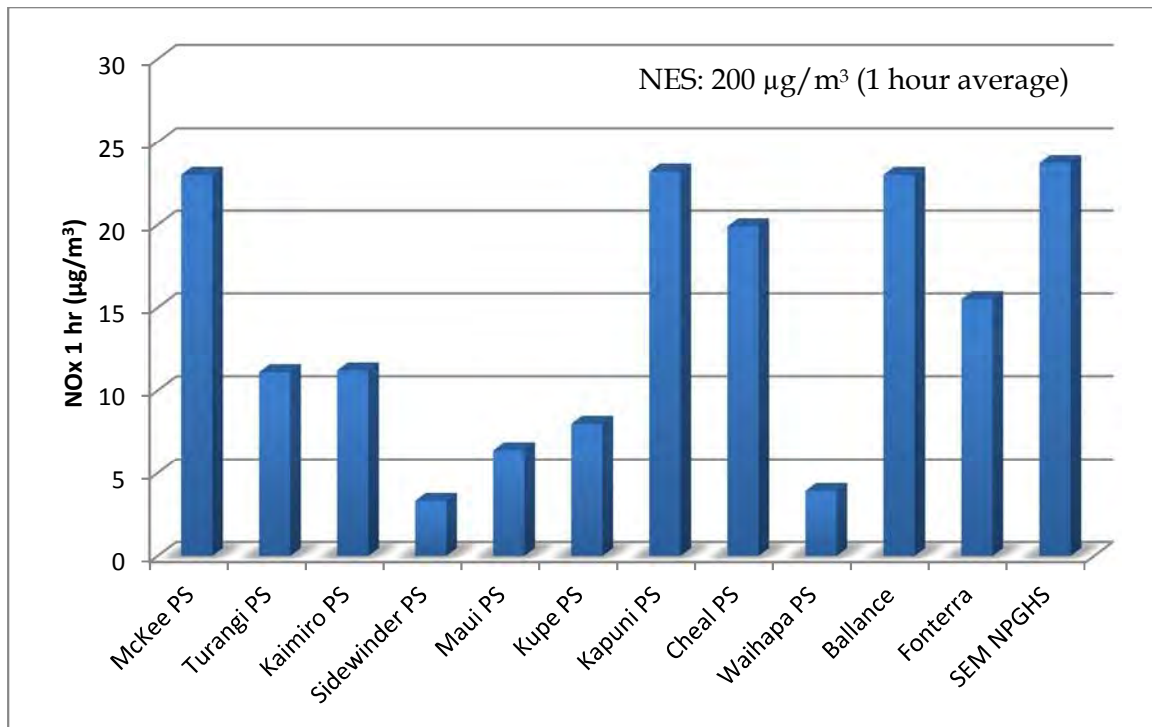


Figure 2 Average NOx levels at 12 surveyed locations throughout the region (year 2014-2015).

Discussion

The calculated 1-hour and 24-hour theoretical maximum concentrations (using a power law exponent of 0.2) ranged from 1.7 µg/m³ to 30.5 µg/m³ and 0.9 µg/m³ to 16.2 µg/m³ respectively. The highest results were obtained from the NOx emitting sites at four different locations:

1. In New Plymouth's urban area near a busy traffic intersection and next to the heavy road realignment works.
2. Around the Fonterra's Whareroa co-generation plant.
3. In Kapuni heavy industrial area around the STOS production station and Ballance ammonia/urea plant.
4. And from the sites at McKee production station and power generation plant.

All values were within the National Environmental Standards, Ministry for the Environment Ambient Air Quality Guidelines and the respective resource consents limits. This continues the pattern found in previous years.

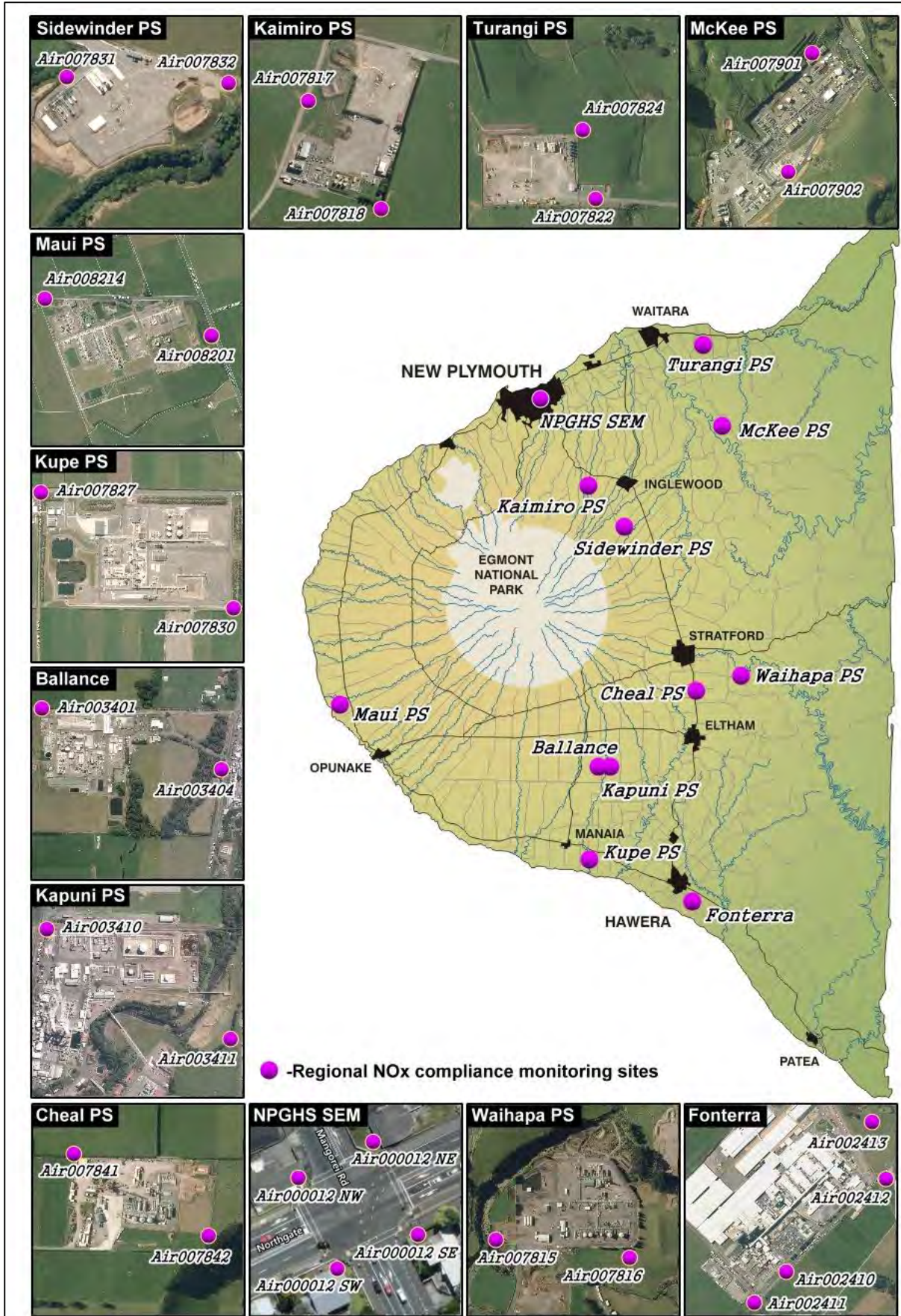


Figure 1 NOx monitoring sites in Taranaki Region, 2014-2015

Ministry for the Environment environmental performance indicator

Ministry for the Environment uses an environmental performance indicator to categorise air quality. These categories are set out in Table 2 and further details of the entire NO_x results are set out in Table 3.

Table 2 Environmental Performance Indicator air quality categories

| Measured value | Less than 10% of NES | 10-33% of NES | 33-66% of NES | 66-100% of NES | More than 100% of NES |
|----------------|----------------------|---------------|-------------------|----------------|-----------------------|
| Category | <i>excellent</i> | <i>good</i> | <i>acceptable</i> | <i>alert</i> | <i>action</i> |

Table 3 Categorisation of results

| National Environmental Standard for NO ₂ = 200 µg/m ³ - 1 hour average. | | |
|--|--|------------------|
| Category | Measured values | |
| Excellent | <10% of the NES, (0-20µg/m ³) | 18 (67%) |
| Good | 10-33% of the NES, (20-66µg/m ³) | 9 (33 %) |
| Acceptable | 33-66% of the NES, (66-132 µg/m ³) | 0 (0%) |
| Alert | 66-100% of the NES, (132-200 µg/m ³) | 0 (0%) |
| Total number of samples | | 27 (100%) |

Conclusion

The monitoring showed that 67% of the 1-hour average results fell into Ministry's 'excellent' categories and 33% of the results lay within Ministry's 'good' category. No results ever entered the 'acceptable' or 'alert' categories, i.e., no results ever exceeded the National Environmental Standard of 200µg/m³.

These results, and all regional monitoring to date, have shown that Taranaki has very clean air, and on a regional basis there are no significant pressures upon the quality of the air resource.