Taranaki Ventures Limited
Copper Moki Production Station
Monitoring Programme
Biennial Report
2012-2014

Technical Report 2014 - 65

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Executive summary

Taranaki Ventures Limited holds consents for a petrochemical production station located on Cheal Road at Ngaere, in the Patea catchment. The Copper Moki Production Station processes oil and gas from the Company's adjacent wellsite. This report for the period July 2012-June 2014 describes the monitoring programme implemented by the Taranaki Regional Council to assess the Company's environmental performance during the period under review, and the results and environmental effects of the Company's activities.

In the 2013-2014 year Taranaki Ventures Limited achieved a high level of environmental performance in respect of this site.

The Company holds two resource consents in relation to the Copper Moki Production Station, which include a total of 23 conditions setting out the requirements that the Company must satisfy. The Company holds one consent to discharge treated stormwater, produced water and surplus drilling water from hydrocarbon exploration and production operations onto and into land, and one consent to discharge emissions related to production activities into the air at this site.

The Council's monitoring programme for the period under review included 13 inspections, nine water samples collected for physicochemical analysis, four biomonitoring surveys and ten ambient air quality analyses. Monitoring of the stormwater discharge from the site found that all applicable conditions in the consent were complied with. There were no adverse effects found in the adjacent unnamed tributary of the Ngaere Stream.

There were no adverse effects on the environment resulting from the exercise of the air discharge consent. The ambient air quality monitoring at the site showed that levels of carbon monoxide, combustible gases, PM_{10} 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 odours or smoke from the site.

In the 2012-2014 period, the Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with the Company's conditions in resource consents or provisions in Regional Plans. The Company demonstrated an overall high level of both environmental and administrative performance and compliance with the resource consents. The Copper Moki Production Station was well managed and maintained.

For reference, in the 2012-2013 year, 35% 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 59% demonstrated a good level of environmental performance and compliance with their consents. In the 2013-2014 year, 60% of consent holders achieved a high level of environmental performance and compliance with their consents, while another 29% demonstrated a good level of environmental performance and compliance.

This report includes a recommendation for the 2014-2015 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 Biennial Report for the period July 2012 – June 2014 by the Taranaki Regional Council on the monitoring programme associated with resource consents held by Taranaki Ventures Limited [TVL], which is a subsidiary of New Zealand Energy Corporation [NZEC]. The Company operates a petrochemical production station situated on Cheal Road at Ngaere, in the Patea catchment.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consent held by TVL that relates to discharges of water within the Patea catchment, and the air discharge permit held by TVL to cover emissions to air from the site.

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 Taranaki Regional Council generally implements integrated environmental monitoring programmes and reports the results of the programmes jointly. This report discusses the environmental effects of the Company's use of land and air, and is the first combined annual report by the Taranaki Regional Council for the Copper Moki Production Station.

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 though annual programmes, the resource consents held by TVL in the Patea catchment, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted at the Copper Moki Production Station.

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

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

Section 4 presents recommendations to be implemented in the 2014-2015 monitoring year.

A glossary of common abbreviations and scientific terms is 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 (eg, 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 Taranaki Regional Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each discharge source. 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 consent performance

Besides discussing the various details of the performance and extent of compliance by the consent holder/s during the period under review, this report also assigns a rating as to each Company'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 the Company's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

Events that were beyond the control of the consent holder and unforeseeable (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 2012-2013 year, 35% 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 59% demonstrated a good level of environmental performance and compliance with their consents. In the 2013-2014 year, 60% of consent holders achieved a high level of environmental performance and compliance with their consents, while another 29% demonstrated a good level of environmental performance and compliance.

1.2 Process description

The Copper Moki site is located on a property which borders Cheal and Skinner Roads approximately 3.3 km from State Highway 3, south-east of Stratford. The site is accessed from Cheal Road. Surrounding land use is predominantly agricultural. There are also a number of wellsites and pipelines associated with hydrocarbon exploration, production, and processing located within a 10 km radius of the site (including the Cheal and Waihapa Production Stations and wellsites). An unnamed tributary of the Ngaere Stream is located immediately to the east of the site and flows for approximately 1 km before entering the Ngaere Stream.

The Copper Moki wellsite was constructed in 2011. Four wells have been drilled from the site to date. The Copper Moki-1 well moved into full production in December 2011, followed by Copper Moki-2 in April 2012 and Copper Moki-3 in July 2012. Surface facilities were commissioned to accommodate well production of up to 1,000 barrels of oil per day. Oil was trucked to the New Plymouth tank farm and associated gas was flared. A pipeline tie-in from Copper Moki to Waihapa Production Station was completed in mid-2012. Artificial lift pump jacks were installed on the three producing wells in October 2012 and additional surface facilities were commissioned during June 2013 to improve production efficiency.

All chemical storage is contained within bunds and isolated from the stormwater system. The site's stormwater drain system consists of open culvert ring-drains which capture general surface water run-off. The drains direct stormwater into a skimmer pit system on site consisting of two settling ponds. Any hydrocarbons present in the stormwater float to the surface and can be removed. The ponds also provide an opportunity for suspended sediment to settle. Treated stormwater is then discharged from the site onto and into land.
A thermal oxidiser, or flare stack, was commissioned at the site in mid-2012 to safely dispose of surplus gas. This equipment significantly reduces the visible and audible impacts of gas combustion in comparison to the use of a flare pit.

Photo 1 Pump jacks at the Copper Moki site

In May 2012 NZEC finalised the purchase of the Waihapa Production Station and associated wellsite assets from Origin Energy NZ Ltd. Origin continued to operate the production station through the transition period until the 29th of October 2013 when NZEC began operating.

1.3 Resource consents

1.3.1 Discharge of wastes to land

Sections 15(1)(b) and (d) of the RMA stipulate that no person may discharge any contaminant onto land if it may then enter water, or from any industrial or trade premises onto land under any circumstances, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

TVL holds discharge permit **7761-1** to discharge treated stormwater, produced water and surplus drilling water from hydrocarbon exploration and production operations at the Copper Moki site onto and into land. This permit was issued by the Taranaki Regional Council on 19 January 2011 under Section 87(e) of the RMA. It is due to expire on 1 June 2028.

Conditions 1 and 2 require adoption of the best practicable option and place a limit on the maximum catchment area.

Conditions 3 and 4 require works notifications and provision of a contingency plan.

Conditions 5 and 6 relate to the stormwater system design and bunding of hazardous substance storage areas.

Conditions 7 to 9 relate to site reinstatement, lapse and review.

The permit is attached to this report in Appendix I.

1.3.2 Air discharge pemit

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.

TVL holds air discharge permit **7765-1** to discharge emissions to air associated with production activities at the Copper Moki site, including flaring from well workovers, and in emergency situations, and other miscellaneous activities. This permit was issued by the Taranaki Regional Council on 19 January 2011 under Section 87(e) of the RMA. It is due to expire on 1 June 2028.

Conditions 1 and 2 require notification of significant flaring events to the Council and neighbouring residents, and the maintenance of a record of all enquiries or complaints.

Conditions 3 and 4 exclude the flaring of liquid or solid hydrocarbons.

Condition 5 requires adoption of the best practicable option at all times.

Conditions 6 to 10 relate to the prevention and minimisation of emissions.

Conditions 11 and 12 require provision of an analysis of the well stream upon request and maintenance of a flaring log.

Conditions 13 and 14 are lapse and review provisions.

The permit is attached to this report in Appendix I.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets out obligations upon the Taranaki Regional 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 Taranaki Regional 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 Copper Moki Production Station consisted of four primary components.

1.4.2 Programme liaison and management

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

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

1.4.3 Site inspections

The Copper Moki Production Station and wellsite was visited 13 times during the monitoring period. With regards to the consent for discharges to land, the main points of interest were plant processes with potential or actual discharges, 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.

1.4.4 Chemical sampling

The Taranaki Regional Council undertook sampling of both the discharges from the site and the water quality upstream and downstream of the discharge point. The Copper Moki Production Station discharge was sampled on three occasions, and the samples analysed for chlorides, conductivity, hydrocarbons, pH and suspended solids. The adjacent unnamed tributary of the Ngaere Stream was sampled concurrently.

The Council also undertook sampling of the ambient air quality outside the boundary of the site. A multi-gas meter was deployed on four occasions 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). A 'DustTrak' PM_{10} particulate monitor was also deployed on four occasions, and nitrogen oxides (NO_x) passive absorption samplers were deployed on two occasions at three monitoring sites.

The full air monitoring reports are attached in Appendix II.

1.4.5 Biomonitoring surveys

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

The full survey reports are attached in Appendix III.

2. Results

2.1 Water

2.1.1 Inspections

Thirteen inspections were carried out at the Copper Moki Production Station and wellsite in the 2012-2014 period. The following was found during the inspections:

31 August 2012
A site inspection was undertaken with the site manager. The ring drains and bunds were all clear. The skimmer pits were discharging very clear spring water. Flaring was being undertaken through the new flare stack with no visible flame and much reduced noise levels. The Company was asked to position the bulk fuel supply within a bund to avoid any contamination of the stormwater ring drain nearby. The site was neat, tidy and well managed.

17 September 2012
The site was inspected after a weekend of heavy rainfall. The skimmer pits were functioning correctly. The ring drain bank on the south east side of the site near the emergency exit had been bolstered up, but more work was required to substantially strengthen this area. No flaring was occurring. The gas was being piped to the Waihapa Production Station. Large beam pumps were being installed onsite. Everything was satisfactory.

11 February 2013
Dave Simpson, the TVL site supervisor, was on site at the time of inspection. The site was neat and tidy. There was no stormwater discharge. The ring drains were secure and additional bunding was under construction. Everything was satisfactory.

29 April 2013
An inspection was undertaken with Pono Cooper from TVL. The site was neat and tidy. Ongoing works were occurring to improve visual and environmental aesthetics, including planting and noise reduction measures. The ring drains and bunds were secure. The skimmer pit was clear. There were no effects from flaring. Everything was satisfactory.

14 May 2013
The design and maintenance of the stormwater system was consistent with the Council-approved plans. The skimmer pits were clear and not discharging. Flaring was being undertaken. This did not give rise to any smoke or odour emissions and was being monitored by the staff. The site was neat and tidy. Everything was satisfactory.

22 May 2013
An inspection was undertaken following significant rainfall. The plant was temporarily shut down for commissioning of new equipment. The ring drains and stormwater discharge were inspected. There was no evidence of any contaminants or problems despite the heavy rainfall. The wells were shut in and no flaring was occurring. The site was neat and tidy. Everything was satisfactory.

23 July 2013
The plant was operating normally. Flaring was being undertaken through the stack with no smoke emissions noted. The stormwater drainage system was clear of all contaminants. Some iron oxide was present within the system, but this is natural and expected in this area. Bunds were situated as and where required. The site was neat and tidy.

14 August 2013
The site was inspected with Steve and Sera [NZEC]. Silt control and drainage issues were appraised. Silt control and sediment reduction measures were suggested for the site. The skimmer pits and ring drains were satisfactory. Some flaring was being undertaken which did not give rise to any odours, smoke or noise. Bunding at the site was assessed and found to be secure and well managed.

10 September 2013
Self notification was received of a very minor oil spill occurring on site during work over operations. The site was inspected with Sera Gibson and Pono Cooper. No contaminants were found beyond the immediate confines of the work area and all contingency measures were in place to prevent any discharge from the site. A clean up of the remaining residual oil was underway. No discharges to the environment occurred. The Company was advised to take any action necessary to prevent reoccurrence of such a spill.

23 September 2013
The site was unmanned and the gates were locked. A perimeter inspection was undertaken following torrential rain and high winds in the weekend. No effects from the stormwater discharge were noted in the adjacent stream. The site appeared neat and tidy. Everything was satisfactory.

5 November 2013
The site gates were shut. A perimeter inspection of the discharge drain and nearby tributary of the Ngaere Stream showed that no effects were evident from any stormwater discharges.

30 April 2014
No flaring was being undertaken at the time of inspection. The stormwater system was operating correctly. There was no discharge off site. Everything was satisfactory.

19 May 2014
The site was neat and tidy. No flaring or odours were noted. There was a westerly wind at the time of inspection. No discharge of stormwater was occurring. The ring drains were secure and clear of contaminants. Everything was satisfactory.

2.1.2 Results of discharge monitoring

Chemical water quality sampling of the discharge from the Copper Moki Production Station and wellsite was undertaken on three occasions during the 2012-2014 period. The samples were collected on 19 June 2013, 11 June 2014, and 26 June 2014. Table 1 presents the results. The location of the sampling site (IND002051) is shown in Figure 1.

Table 1 Results for discharge monitoring from Copper Moki Production Station (site IND002051)

Parameter	Units	19 June 2013	11 June 2014	26 June 2014	Consent limits
Chloride	g/m^3	40.6	7.4	14.6	50
Conductivity	mS/m	23.8	6.0	10.2	-
Hydrocarbons	g/m^3	< 0.5	< 0.5	< 0.5	-
Suspended solids	g/m^3	23	9	3	-
Temperature	Deg. C	12.2	10.3	12.4	-
pH		6.5	6.5	6.6	-

All results were in compliance with the applicable conditions of consent 7761-1 at the time of sampling.

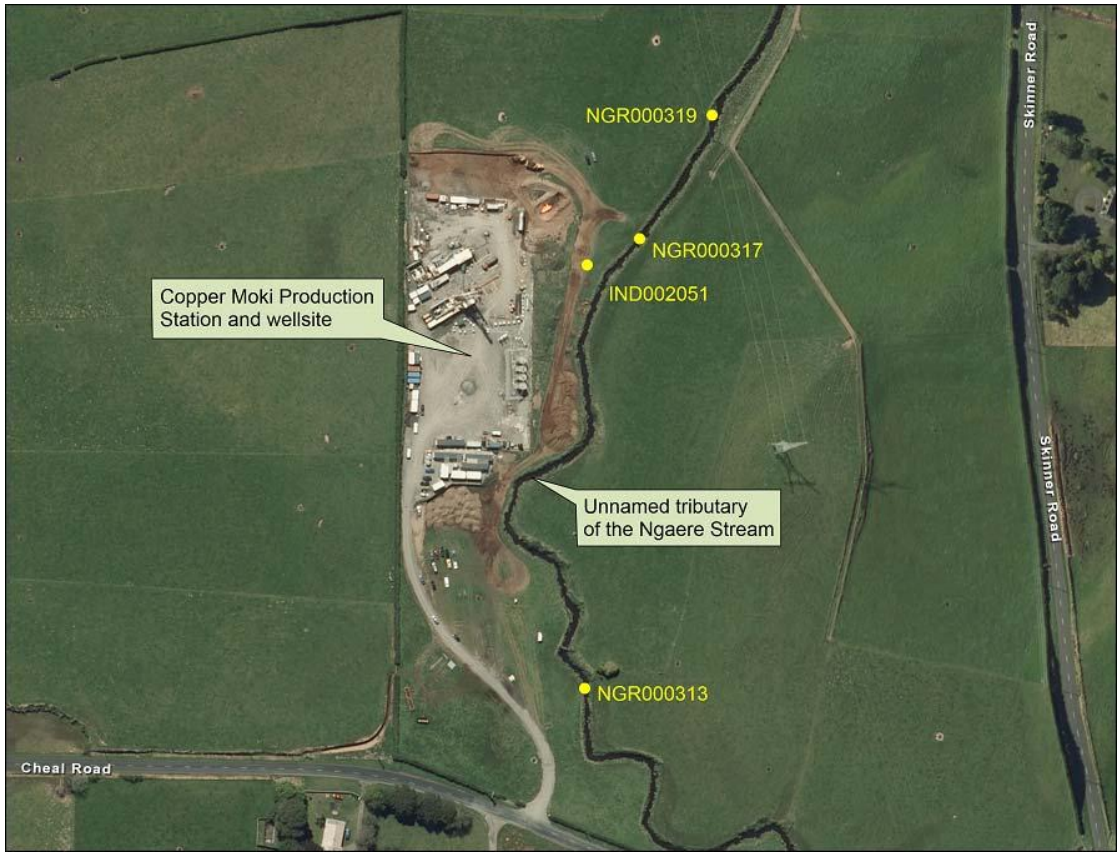

Figure 1 Copper Moki Production Station and associated water quality sampling sites

2.1.3 Results of receiving environment monitoring

Chemical

Receiving water quality sampling was undertaken in conjunction with discharge sampling at points upstream (NGR000313) and downstream (NGR000319) of the Copper Moki site. The results are presented in Table 2 and the sampling sites are shown in Figure 1 above.

Table 2 Results of receiving environment monitoring in relation to Copper Moki Production Station

Date	Parameter	Chloride	Conductivity	Hydrocarbons	Suspended solids	Temperature	pH
	Unit	g/m^3	mS/m	g/m^3	g/m^3	Deg. C	
19 Jun 2013	Upstream site NGR000313	18.9	27.9	< 0.5	15	12.6	6.2
	Downstream site NGR000319	19.3	27.7	< 0.5	16	12.6	6.2
11 Jun 2014	Upstream site NGR000313	20.9	25.5	< 0.5	38	11.8	6.4
	Downstream site NGR000319	20.5	25.4	< 0.5	39	11.8	6.4
26 Jun 2014	Upstream site NGR000313	21.0	27.3	< 0.5	54	12.5	6.1
	Downstream site NGR000319	21.4	27.2	< 0.5	50	12.5	6.1

The results indicate that the discharge was not affecting the water quality of the unnamed tributary of the Ngaere Stream at the time of sampling.

Biomonitoring

The Council's standard 'kick-sampling' technique was used at three established sites on four occasions to collect streambed macroinvertebrates from the unnamed tributary of the Ngaere Stream, to assess whether discharges from the Copper Moki Production Station had had any detrimental effects on the macroinvertebrate communities of this stream. The sites are shown in Figure 1. Site 1 (NGR000313) is upstream of the Copper Moki Production Station. Site 2 (NGR000317) is immediately downstream of the discharge area and site 3 (NGR000319) is a further 100 m downstream. Samples were sorted and identified to provide the number of taxa (richness) and MCI and SQMCI$_S$ scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects or 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 sites may indicate the degree of adverse effects (if any) of the discharges being monitored.

27 November 2012

This late spring macroinvertebrate survey indicated that any discharges of treated stormwater from the recently established Copper Moki Production Station site had not had any significant recent detrimental effects on the macroinvertebrate communities of the Ngaere Stream tributary. The MCI scores for each site were relatively similar although there was an insignificant decrease immediately downstream of the discharge area. The only significant changes in the macroinvertebrate communities related to abundances of a few individual taxa, mainly as a result of subtle habitat changes

between sites. $SQMCI_s$ scores were not significantly different between sites 1 and 2, but a significant decrease between sites 2 and 3 was due to an increased numerical abundance of one 'tolerant' taxon.

The macroinvertebrate communities of the stream contained relatively even proportions of 'tolerant' and 'moderately sensitive' taxa at all sites. In addition, communities at all sites had three common dominant taxa, although there was some variation as a result of subtle variations in habitat between sites. There were no significant changes in MCI values between sites, despite some differences in habitat although there was a downstream decrease in MCI score at sites adjacent to the discharge area. In addition, taxonomic richness (numbers of taxa) was relatively consistent across all three sites. The MCI scores indicated that the stream communities were of 'poor' to 'fair' health, but typical of conditions in comparison with median values recorded from previous surveys at similar sites. The absence of significant differences between the three sites indicated no recent significant impacts from the Copper Moki Production Station discharges authorised onto adjacent land.

26 March 2013
This late summer macroinvertebrate survey indicated that any discharges of treated stormwater from the recently established Copper Moki Production Station site had not had any significant recent detrimental effects on the macroinvertebrate communities of the Ngaere Stream tributary. The MCI scores for each site were very similar and there was minimal decrease through the surveyed reach downstream of the discharge area. The only significant changes in the macroinvertebrate communities related to abundances of a few individual taxa, mainly as a result of subtle habitat changes between sites. $SQMCI_s$ scores increased between sites 1 and 2, but there were no significant downstream decreases in relation to the upstream 'control' site 1.

The macroinvertebrate communities of the stream contained slightly higher proportions of 'tolerant' than 'moderately sensitive' taxa at all sites. In addition, communities at all sites had three common dominant taxa although there was some variation in a few other dominant taxa as a result of subtle variations in habitat between sites. There were no significant changes in MCI values between sites despite minor differences in habitat. In addition, taxonomic richness (numbers of taxa) increased in a downstream direction mainly due to the presence of additional taxa recorded only as rarities. The MCI scores indicated that the stream communities were of 'poor' to 'fair' health, but typical of conditions in comparison with median values recorded from previous surveys at similar sites. The absence of significant differences between the three sites indicated no recent significant impacts from the Copper Moki Production Station discharges authorised onto adjacent land.

13 November 2013
This late spring macroinvertebrate survey indicated that any discharges of treated stormwater from the recently established Copper Moki Production Station site had not had any significant recent detrimental effects on the macroinvertebrate communities of the Ngaere Stream tributary. The MCI scores for each site were very similar with no significant decreases downstream of the discharge area. The only changes in the macroinvertebrate communities related to minor variations in abundances of a few individual taxa, mainly as a result of very subtle habitat changes between sites. $SQMCI_s$ scores were not significantly different between sites 1, 2, or 3, ranging over only 0.3 $SQMCI_s$ unit.

The macroinvertebrate communities of the stream contained relatively even proportions of 'tolerant' and 'moderately sensitive' taxa at all sites. In addition, communities at all sites had seven common dominant taxa with minimal variation as a result of subtle variations in habitat between sites. There were no significant changes in MCI values between sites. In addition, taxonomic richness (numbers of taxa) was relatively consistent across all three sites. The MCI scores indicated that the stream communities were of 'poor' (bordering on 'fair') health, but typical of conditions in comparison with median values recorded from previous surveys at similar sites. The absence of significant differences between the three sites indicated no recent significant impacts from the Copper Moki Production Station discharges authorised onto adjacent land.

4 February 2014
This summer macroinvertebrate survey indicated that any discharges of treated stormwater from the Copper Moki Production Station site had not had any significant recent detrimental effects on the macroinvertebrate communities of the Ngaere Stream tributary. The MCI scores for each site were very similar with no significant decreases downstream of the discharge area. The only changes in the macroinvertebrate communities related to minor variations in abundances of a few individual taxa, mainly as a result of very subtle habitat changes between sites. The significant decrease in $SQMCI_s$ score recorded at site 2 in comparison to site 1 and site 2 can be attributed to several subtle changes in taxon abundances, rather than to any impacts caused by stormwater discharges from the Copper Moki Production Station.

The macroinvertebrate communities of the stream contained relatively even proportions of 'tolerant' and 'moderately sensitive' taxa at all sites. In addition, communities at all sites had three common dominant taxa with only slight variation as a result of subtle variations in habitat between sites. There were no significant changes in MCI values between sites. In addition, taxonomic richness (numbers of taxa) was relatively consistent across all three sites. The MCI scores indicated that the stream communities were of 'poor' (bordering on 'fair') health, but typical of conditions in comparison with median values recorded from previous surveys at similar sites (TRC, 1999 (updated 2013)). The absence of significant differences in MCI score or taxa richness between the three sites indicated no recent significant impacts from the Copper Moki Production Station discharges authorised onto adjacent land.

2.2 Air

2.2.1 Inspections

Air inspections were carried out in conjunction with site inspections as discussed in section 2.1.1 above. No issues regarding air quality were noted during the monitoring period.

2.2.2 Results of receiving environment monitoring

During the period under review, a multi-gas meter and a DustTrak PM_{10} particulate monitor were deployed concurrently on four occasions in the vicinity of the plant. Nitrogen oxides [NO_x] passive absorption samplers were deployed on two occasions at three monitoring sites. These sites are shown in Figure 2.

Carbon monoxide and combustible gases

A multi-gas meter was deployed on 14 December 2012, 1 February 2013, 15 August 2013 and 14 April 2014. The deployments lasted from 57 to 78 hours, with the instrument placed in a downwind position at the start of the deployment. Monitoring consisted of continual measurements of concentrations for carbon monoxide [CO] and combustible gases.

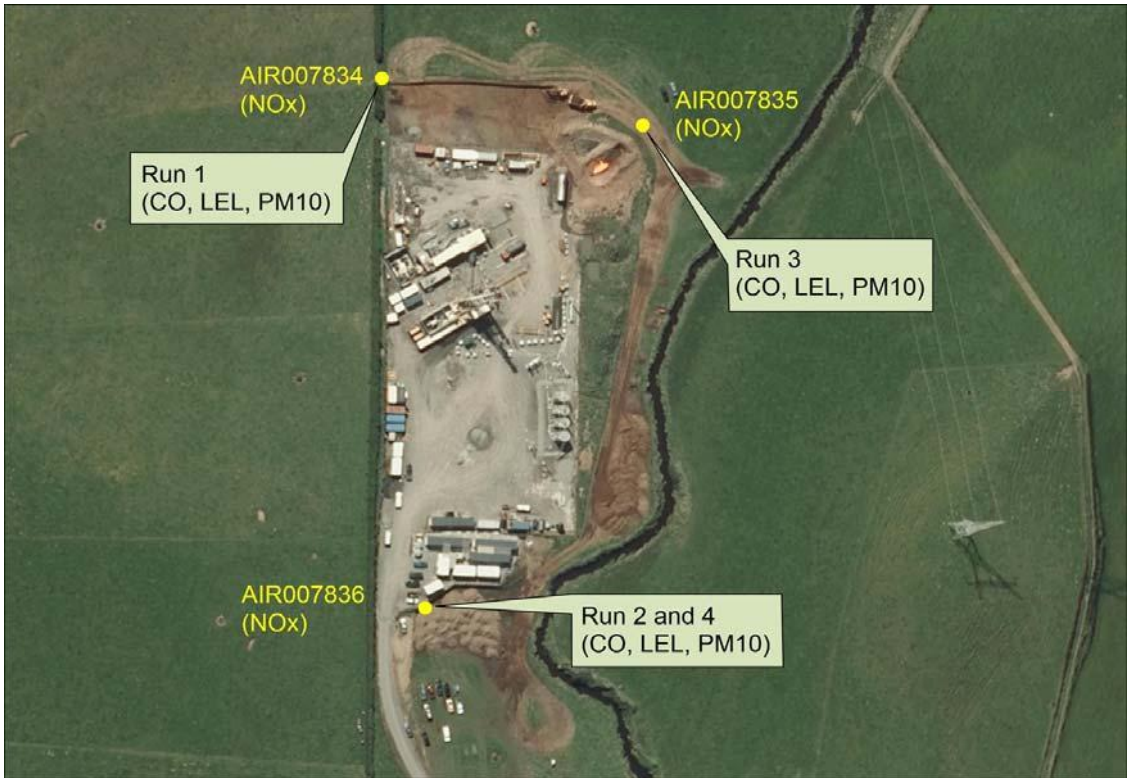

Figure 2 Air quality sampling sites in relation to the Copper Moki Production Station

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. A summary of the results is shown in Table 3.

The consents for air discharges from the Copper Moki Production Station and wellsite have specific limits for particular gases. Special condition 8 of consent 7765-1 sets a limit on the CO concentration at or beyond the production station site boundary at 10 mg/m^3 (eight-hour average exposure), or 30 mg/m^3 (one-hour average exposure). The maximum concentration of CO found during the monitoring period was 18.0 ppm, equivalent to 15.3 mg/m^3. The average concentration across all the monitoring runs was only 0.20 ppm, equivalent to 0.17 mg/m^3, which complies with the consent condition.

The concentration of combustible gases detected in the sampled air is expressed as a percentage of the lower explosive limit [LEL%] of methane. The sensor in 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 general requirement that no discharge shall result in a dangerous level of airborne contaminants, including risk of explosion. At no time did the level of explosive gases downwind of the Copper Moki Production Station reach any more than a trivial level.

Table 3 Summary of ambient gas monitoring results at Copper Moki Production Station

Run number		1	2	3	4	Average
Deployed	From	14 Dec 2012 10:33	1 Feb 2013 11:30	15 Aug 2013 11:01	14 April 2014 12:31	
	To	17 Dec 2012 06:16	4 Feb 2013 06:42	18 Aug 2013 17:39	16 April 2014 21:22	
Maximum	CO (ppm)	11.0	18.0	1.10	0.60	7.7
	LEL (%)	0.30	0.20	0.10	0.00	0.15
Mean	CO (ppm)	0.10	0.50	0.10	0.10	0.20
	LEL (%)	0.00	0.00	0.00	0.00	0.00
Minimum	CO (ppm)	0.00	0.00	0.00	0.00	0.00
	LEL (%)	0.00	0.00	0.00	0.00	0.00

PM_{10} particulates

Particulates can be derived from many sources, including motor vehicles (particularly diesel engines), solid and oil-burning processes for industry and power generation, incineration and waste burning, photochemical processes, and natural sources such as pollen and sea spray. PM_{10} particulates are linked to adverse health effects that arise primarily from the ability of particles of this size to penetrate deep into the lungs and inhibit their function. In 2004, the Ministry for the Environment introduced a National Environmental Standard [NES] for certain air pollutants. The NES for PM_{10} is 50 $\mu g/m^3$ (24-hour average). Background levels of PM_{10} in Taranaki have been found to be around 11 $\mu g/m^3$.

During the monitoring period, a DustTrak PM_{10} monitor was deployed on four occasions in the vicinity of the site, with the instrument placed in a downwind position at the start of the deployment. Monitoring consisted of continual measurement of PM_{10} concentrations. The sites are shown in Figure 2.

The average recorded PM_{10} concentration was 15 $\mu g/m^3$ for the first two runs, and 4.5 $\mu g/m^3$ for the last two runs. These equate to 30 and 9 percent, respectively, of the NES for a 24-hour average. The maximum recorded PM_{10} concentration over the monitoring period was 336 $\mu g/m^3$ during run 2. This short term spike may have been caused by local traffic movements on the adjacent unsealed road at the site entrance.

Nitrogen oxides

Nitrogen oxides [NO_x] are potential products of fossil fuel combustion. Exposure to elevated levels of NO_x in humans can affect breathing and impair immune system functioning. Nitrogen oxides are toxic to plants and can contribute to brown haze and petrochemical smog.

The Council has been monitoring NO_x in the region since 1993 using passive absorption discs which capture target gases from the air. The length of time the disc is exposed to the atmosphere and the amount of NO_x absorbed can be used to calculate theoretical maximum 1 and 24-hour average concentrations that may have occurred during the deployment period. The Council uses the most conservative corrective factor in this calculation to produce a 'worst case scenario' result.

Table 4 Summary of nitrogen oxides monitoring results at Copper Moki Production Station

Site	Date	NO_x laboratory result µg/m^3	NO_x 24-hour average (theoretical maximum) µg/m^3	NO_x 1-hour average (theoretical maximum) µg/m^3
AIR007834	Nov-Dec 2012	2.0	3.8	7.1
	Aug-Sep 2013	1.6	2.9	5.6
AIR007835	Nov-Dec 2012	2.3	4.3	8.2
	Aug-Sep 2013	1.7	3.1	5.8
AIR007836	Nov-Dec 2012	2.4	4.8	8.6
	Aug-Sep 2013	2.0	3.6	6.8
Consent limits			*100*	*200*

During the monitoring period, passive absorption discs were deployed at three sites around the boundary of the production station on two separate occasions, for periods of 24 and 19 days respectively. The sites are shown in Figure 2. The results and the calculated maxima are presented in Table 4, along with the limits imposed by condition 9 of consent 7765-1.

The results indicate that concentrations of nitrogen oxides in the vicinity of the Copper Moki Production Station were in compliance with all applicable consent conditions and far below levels of concern during the period under review.

2.3 Investigations, interventions, and incidents

The monitoring programme for the period was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the consent holder. During the period 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 Taranaki Regional 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 [UIR] 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 2012-2014 period, the Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with the Company's conditions in resource consents or provisions in Regional Plans relating to the Copper Moki Production Station.

3. Discussion

3.1 Discussion of site performance

Monitoring the Copper Moki Production Station during the 2012-2014 period found that the site was well managed. All consent conditions relating to site operations and management were complied with. Any issues identified during inspections were quickly resolved.

3.2 Environmental effects of exercise of consents

Monitoring of the stormwater discharge from the site found that all applicable conditions in the consent were complied with. There were no adverse effects found in the adjacent unnamed tributary of the Ngaere Stream.

There were no adverse effects on the environment resulting from the exercise of the air discharge consent. The ambient air quality monitoring at the site showed that levels of carbon monoxide, combustible gases, PM_{10} 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 odours or smoke from the site.

3.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the period under review is set out in Tables 5-6.

Table 5 Summary of performance for Consent 7761-1 to discharge treated stormwater, produced water and surplus drilling water from hydrocarbon exploration and production operations at the Copper Moki site onto and into land

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Adoption of the best practicable option	Inspection and liaison with consent holder	Yes
2. Maximum stormwater catchment area	Inspection and company records	Yes
3. Notification to Council seven days prior to site works and well drilling	Notifications received	Yes
4. Maintenance of a contingency plan	Latest update received 31 July 2014	Yes
5. Stormwater (with < 50 ppm chloride) to be directed for treatment prior to discharge	Inspection and sampling	Yes
6. Bunding and containment of hazardous substances	Inspection	Yes
7. 48 hrs notice prior to reinstatement	Site still active	N/A
8. Lapse provision	Consent exercised	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
9. Optional review provision	Next option for review in June 2016	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 6 Summary of performance for Consent 7765-1 to discharge emissions to air associated with production activities at the Copper Moki site, including flaring from well workovers, and in emergency situations, and other miscellaneous activities

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Notification prior to continuous flaring	Notifications received	Yes
2. Notification of neighbours prior to flaring	No complaints received	Yes
3. Effective liquid and solid separation prior to flaring	Inspection and notifications	Yes
4. Only gaseous hydrocarbons to be flared	Inspection and notifications	Yes
5. Adoption of best practicable option to minimise effects from the flare	Inspection and air monitoring	Yes
6. No offensive odour or smoke beyond boundary	Inspection and public notification	Yes
7. Hydrocarbon storage vessels to have vapour recovery systems	Inspection	Yes
8. Control of carbon monoxide emissions	Air monitoring	Yes
9. Control of nitrogen oxide emissions	Air monitoring	Yes
10. Control of emissions to meet WES limits for other contaminants	Explosive gases and PM10 levels also monitored	Yes
11. Analysis of typical gas and condensate stream	Analysis not requested	N/A
12. Keep and maintain a flaring log	Inspection and annual flaring report	Yes
13. Lapse provision	Consent exercised	N/A
14. Optional review provision	Next option for review in June 2016	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

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

consents as defined in Section 1.1.4. The Copper Moki Production Station was well managed and maintained.

3.4 Alterations to monitoring programmes for 2014-2015

In designing and implementing the monitoring programmes for air/water discharges in the region, the Taranaki Regional 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 2014-2015 the monitoring of the Copper Moki site is included within the NZEC Waihapa Production Station programme to reflect the changes to the Company's infrastructure in the Ngaere area. With the acquisition of the Waihapa facilities, Copper Moki is now an associated producing wellsite of the larger production station and there is a significantly reduced level of activity at the site. These changes, along with the high level of environmental performance demonstrated over the last two years, means that activities at the Copper Moki site no longer warrant a standalone monitoring programme. A recommendation to this effect is attached to this report.

4. Recommendation

1. THAT for 2014-2015 the monitoring of the Copper Moki site is included within the NZEC Waihapa Production Station programme to reflect the changes to the Company's infrastructure in the Ngaere area.

Glossary of common terms and abbreviations

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

Al*	Aluminium.
As*	Arsenic.
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.
BODF	Biochemical oxygen demand of a filtered sample.
Bund	A wall around a tank to contain its contents in the case of a leak.
CBOD	Carbonaceous biochemical oxygen demand. A measure of the presence of degradable organic matter, excluding the biological conversion of ammonia to nitrate.
cfu	Colony forming units. A measure of the concentration of bacteria usually expressed as per 100 millilitre sample.
COD	Chemical oxygen demand. A measure of the oxygen required to oxidise all matter in a sample by chemical reaction.
Condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
Cu*	copper.
Cumec	A volumetric measure of flow- 1 cubic metre per second (1 m^3s^{-1}).
DO	Dissolved oxygen.
DRP	Dissolved reactive phosphorus.
E.coli	Escherichia coli, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample.
F	Fluoride.
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
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.

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.
NH_4	Ammonium, normally expressed in terms of the mass of nitrogen (N).
NH_3	Unionised ammonia, normally expressed in terms of the mass of nitrogen (N).
NO_3	Nitrate, normally expressed in terms of the mass of nitrogen (N.)
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).
Pb*	Lead.
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	*Resource Management Act* 1991 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.
UIR	Unauthorised 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.
Zn*	Zinc.

*an abbreviation for a metal or other analyte may be followed by the letters 'As', to denote the amount of metal recoverable in acidic conditions. This is taken as indicating the total amount of metal that might be solubilised under extreme environmental conditions. The abbreviation may alternatively be followed by the letter 'D', denoting the amount of the metal present in dissolved form rather than in particulate or solid form. For further information on analytical methods, contact the Council's laboratory.

Appendix I

Resource consents held by Taranaki Ventures Limited

TARANAKI REGIONAL COUNCIL
CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz
Please quote our file number on all correspondence

Discharge Permit

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

Name of Consent Holder:	Taranaki Ventures Limited P O Box 24147 WELLINGTON 6142
	New Address: PO Box 8440 New Plymouth 4342
Decision Date:	19 January 2011
Commencement Date:	19 January 2011

Conditions of Consent

Consent Granted:	To discharge emissions to air associated with production activities at the Copper Moki-1 wellsite, including flaring from well workovers, and in emergency situations, and other miscellaneous activities at or about (NZTM) 1715290E-5638967N
Expiry Date:	1 June 2028
Review Date(s):	June 2016, June 2022
Site Location:	Copper Moki-1 wellsite, Cheal Road, Ngaere [Property owner: RC & DM Howells]
Legal Description:	Lot 2 DP 335676 [Discharge source & site]

For General, Standard and Special conditions pertaining to this consent please see reverse side of this document
www.trc.govt.nz

General condition

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

Special conditions

1. Other than in emergencies, 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.

2. At least 24 hours before any flaring, other than in emergencies, the consent holder shall provide notification to all residents within 300 metres of the wellsite 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. To the greatest extent possible, all gas that is flared must first be treated by effective liquid and solid separation and recovery.

4. Only gaseous hydrocarbons originating from the well stream shall be combusted within the flare pit.

5. 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, including, but not limited to, having 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 [other than for the maintenance of a pilot flare flame].

6. The discharge shall not cause any objectionable or offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.

7. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.

8. 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.

9. 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 [$\mu g/m^3$] [24-hour average exposure], or 200 $\mu g/m^3$ [1-hour average exposure] at or beyond the boundary of the of the property where the wellsite is located.

10. 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 $1/30^{th}$ 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].

11. 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 C_6 or higher number of compounds.

12. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council, a 'flaring log' that includes:

    a) the date, time and duration of all flaring episodes;

    b) the zone from which flaring occurred;

    c) the volume of substances flared;

    d) whether there was smoke at any time during the flaring episode and if there was, the time, duration and cause of each 'smoke event'.

13. This consent shall lapse on 31 March 2016, 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.

14. 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 2016 and/or June 2022, 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; and/or

    b) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or

    c) to alter, add or delete limits on mass discharge quantities or discharge or ambient concentrations of any contaminant.

Transferred at Stratford on 1 April 2011

For and on behalf of
Taranaki Regional Council

Director-Resource Management

TARANAKI REGIONAL COUNCIL
CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz
Please quote our file number on all correspondence

Discharge Permit

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

Name of Consent Holder:	Taranaki Ventures Limited P O Box 24147 WELLINGTON 6142
	New Address: PO Box 8440 New Plymouth 4342
Decision Date:	19 January 2011
Commencement Date:	19 January 2011

Conditions of Consent

Consent Granted:	To discharge treated stormwater, produced water and surplus drilling water from hydrocarbon exploration and production operations at the Copper Moki-1 wellsite onto and into land at or about (NZTM) 1715316E-5638937N
Expiry Date:	1 June 2028
Review Date(s):	June 2016, June 2022
Site Location:	Copper Moki-1 wellsite, Cheal Road, Ngaere [Property owner: RC & DM Howells]
Legal Description:	Lot 2 DP 335676 [Discharge source & site]
Catchment:	Patea
Tributary:	Ngaere

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 [the Council] all the administration, monitoring and supervision costs of this consent, fixed in accordance to section 36 of the Resource Management Act.

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 1 ha.

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. The contingency plan shall be provided to the Council prior to discharging from the site.

5. All stormwater and produced water [with a maximum chloride concentration of 50 ppm] shall be directed for treatment through the skimmer pit[s] before being discharged.

6. Any significant volumes of hazardous substances [e.g. bulk fuel, oil, drilling fluid] on site shall be:

   a) contained in a double skinned tank, or

   b) stored in a dedicated bunded area with drainage to sumps, or to other appropriate recovery systems, and not directly to the site stormwater system.

7. 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 adverse 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.

8. This consent shall lapse on 31 March 2016, 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.

9. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2016 and/or June 2022, 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.

Transferred at Stratford on 1 April 2011

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Appendix II

Air monitoring reports

Memorandum

To Job Manager, Callum MacKenzie
From Scientific Officer - Air Quality, Brian Cheyne
File Spordmon316, 7822-1, FRODO# 1344049
Date May 07, 2014

Ambient air quality monitoring at Copper Moki Production Well site

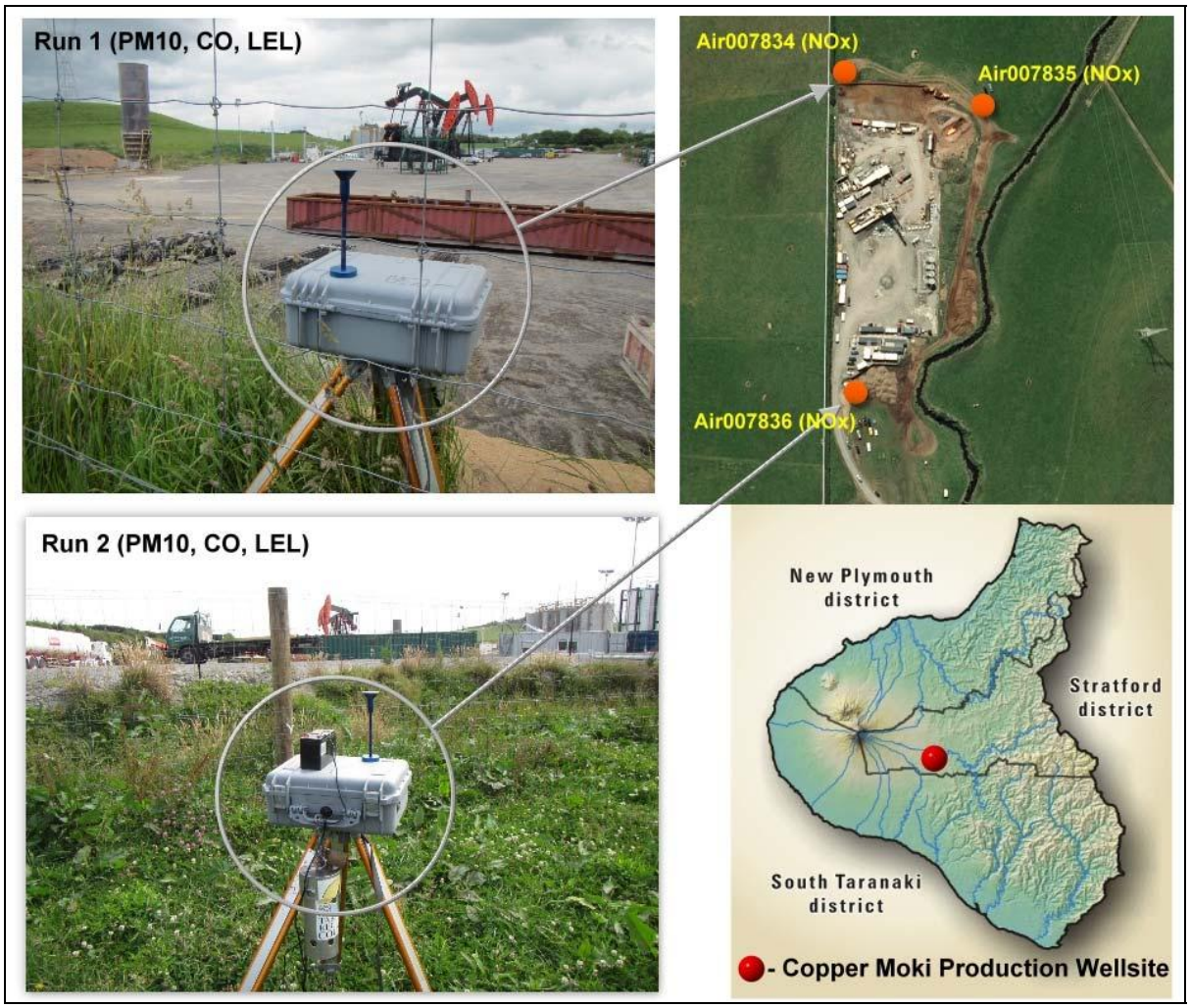

Figure 1 Air quality monitoring sites at Copper Moki Production Well site (2012 – 2013)

QRae -multi gas analyser:

During the July 2012 – 30 June 2013 monitoring period, a multi-gas meter was deployed on two occasions in the vicinity of the Copper Moki Production Well site. Both deployments lasted approximately seventy hours, with the instrument placed in a down-wind position. Monitoring consisted of continual measurements of gas concentration for carbon monoxide and combustible gases.

The location of the air quality monitoring sites is shown in Figure 1. The results of monitoring undertaken are summarized in Table 1 and the data presented graphically 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.

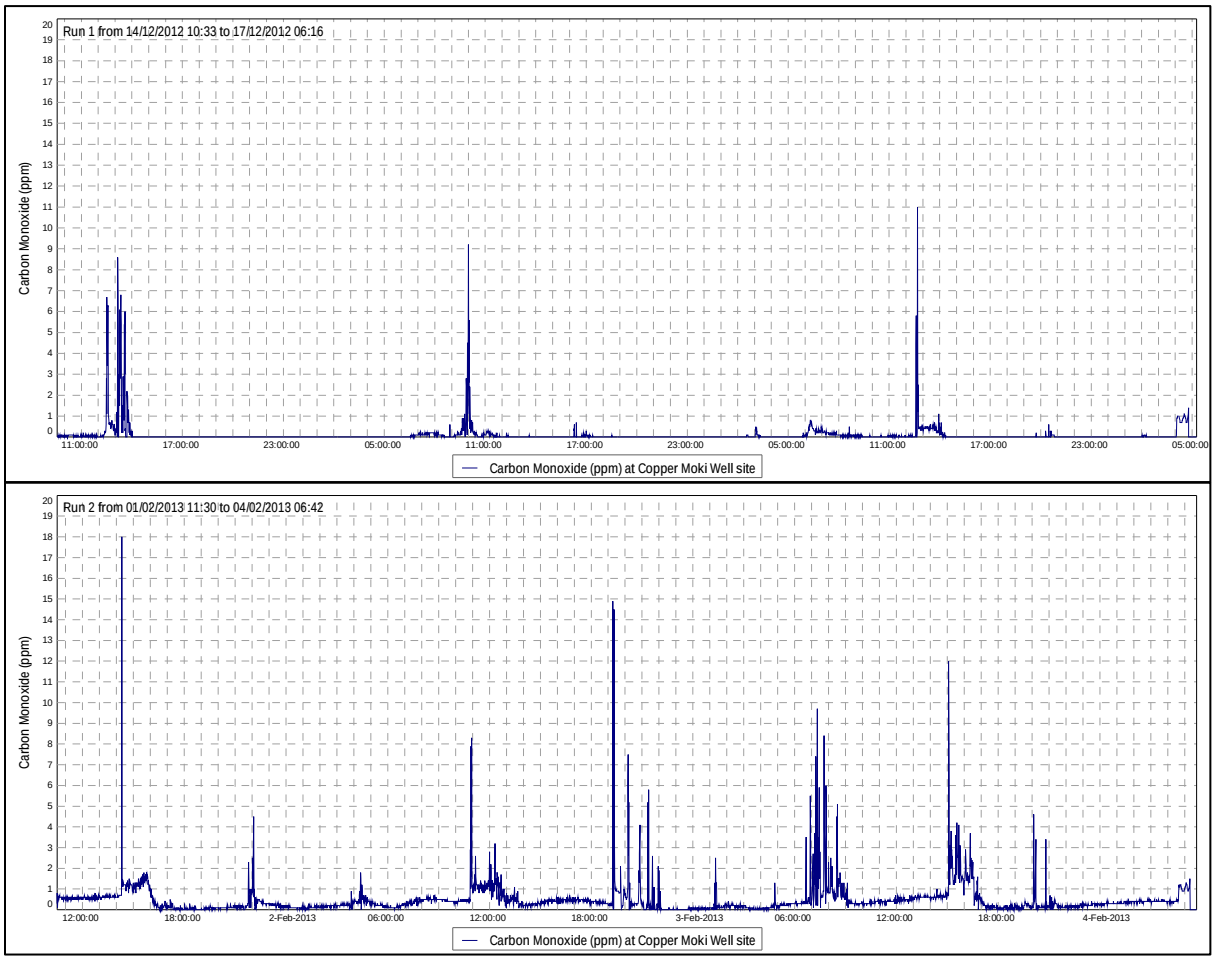

Figure 2 Graphs of ambient gas levels in the vicinity of the Copper Moki Production Well site

Table 1 Summary of ambient gas monitoring results at Copper Moki Production Well site

Run		1	2	Average
Period (from-to)		14.12.2012 10:33 17.12.2012 06:16	01.02.2013 11:30 04.02.2013 06:42	
Max	CO(ppm)	11.0	18.0	14.5
	LEL(%)	0.30	0.20	0.25
Mean	CO(ppm)	0.10	0.50	0.30
	LEL(%)	0.00	0.00	0.00
Min	CO(ppm)	0.00	0.00	0.00
	LEL(%)	0.00	0.00	0.00

Note: (1) the instrument records in units of ppm. At 15°C
1ppm CO = 0.85 mg/m^3

(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 % LEL by 20.

Carbon Monoxide (CO)

The consents covering air discharges from the Sidewinder Production Station have specific limits related to particular gases. Special condition 8 of consent 7765-1 set a limit on the carbon monoxide concentration at or beyond the production station's boundary.

> *"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."*

The maximum concentration of carbon monoxide found during the monitoring run was 18.0 ppm or 15.3 mg/m^3 and average concentration was only 0.30 ppm which complies with the consent condition

Lower Explosive Limit (LEL)

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 a dangerous level of airborne contaminants, including any risk of explosion.

At no time did the level of explosive gases downwind of the Copper Moki Production Well site reach any more than a trivial level.

PM-10 monitoring (DustTrak)

In September 2004 the Ministry for the Environment promulgated the National Environmental Standards (NES) relating to certain air pollutants. The (NES) for PM10 is 50 µg/m^3 (24-hour average).

Particulutes can be derived from many sources, including motor vehicles (particularly diesels), 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 two occasions in the vicinity of the plant. The deployments lasted approximately thirty hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continual measurements of PM 10 concentrations. The locations of the PM10 monitor during the sampling runs are shown in Figure 1.

The details of the sample runs are graphically presented in Figure 3.

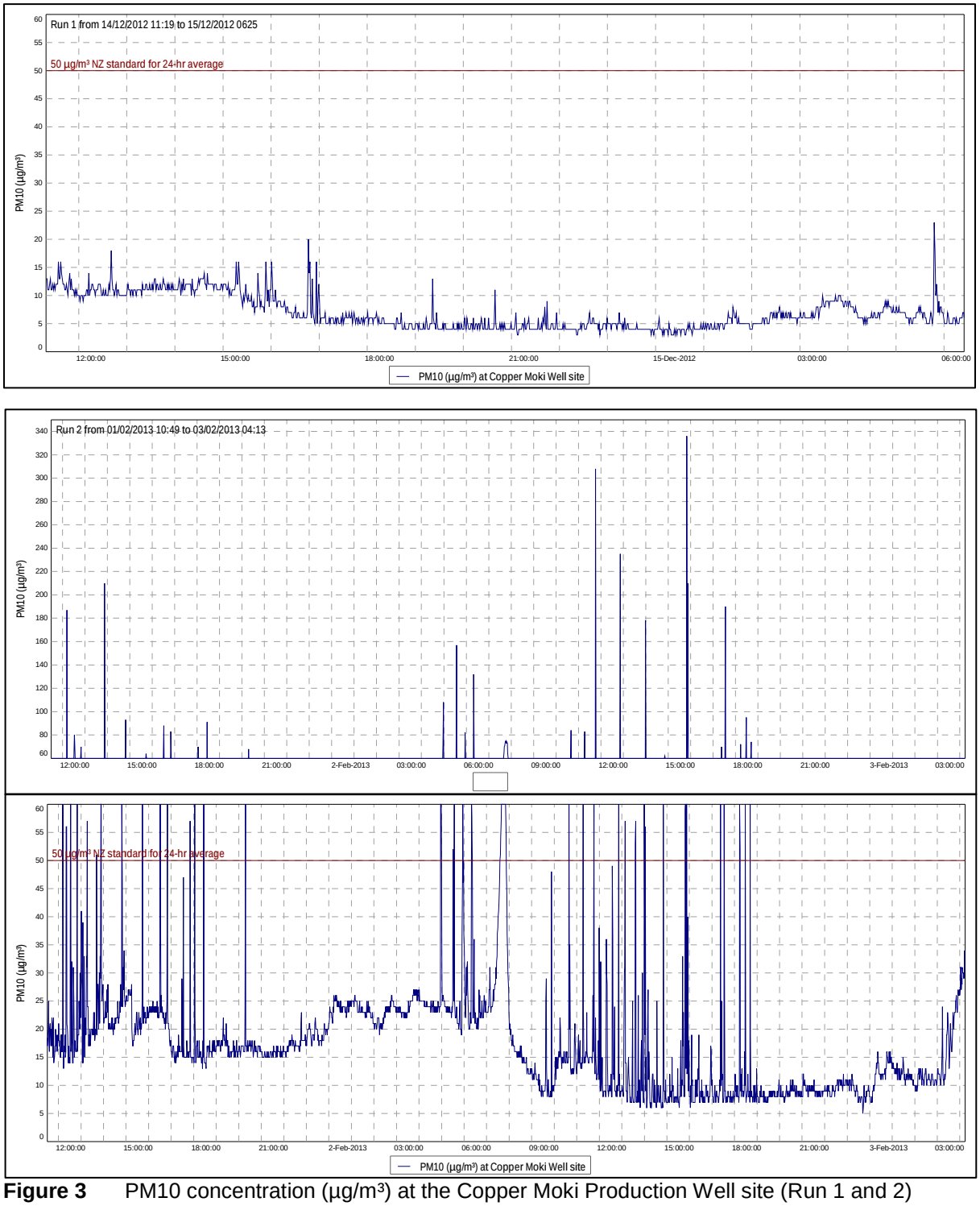

Figure 3 PM10 concentration (µg/m³) at the Copper Moki Production Well site (Run 1 and 2)

Findings

The average recorded PM10 concentration for the entire 77 hours dataset was 15 µg/m³. This equates to 30% of the National Environmental Standard for a 24-hour period of 50 µg/m³. The maximum recorded PM_{10} concentration over the entire monitoring period was 336 µg/m³. These short term spikes may be caused by traffic movement as the monitor was located adjacent to the site entrance.

Background levels of PM_{10} in the region have been found to be around 11 µg/m³.

Nitrogen (NOx) oxides monitoring

Nitrogen oxides are products of fossil fuel combustion. In humans they can reduce the body's resistance to infections and affect breathing. Nitrogen oxides are toxic to plants and can contribute to brown haze and petrochemical smog.

Special conditions 9 of air consent 7765-1 set limits for nitrogen dioxide at or beyond the boundary of the site.

> *"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 [µg/m³] [24-hour average exposure], or 200 µg/m³ [1-hour average exposure] at or beyond the boundary of the of the property where the wellsite is located."*

The Taranaki Regional Council has been monitoring nitrogen oxides (NOx) in the Taranaki region since 1993 using passive absorption discs. These discs are placed at the nominated sites, in the vicinity of the industry concerned. The gases diffuse into the discs and any target gases (nitrogen dioxide) are captured. Passive absorption discs were placed at three sites, staked about two metres off the ground for a period 24 days. The location of the monitoring sites is shown in Figure 1.

From the average concentration measured, it is possible to calculate a theoretical maximum daily concentration that may have occurred during the exposure period. Council data on NOx is gathered over a time period other than exactly 1-hour or 24-hours. 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 t_2 given a measured concentration for time period t_1). Using the 'worst case' factor of p = 0.20, the monitoring data reported above has been converted to equivalent 'maximum' 24-hour exposure levels.

Table 3 presents the actual levels found, theoretical maximum 1-hour and 24-hours concentration of NOx, and consent 7822-1 limits.

Table 3 Ambient NOx results from around the Copper Moki Well site (20/11/2012 to 14/12/2012)

Site	NOx µg/m³ Laboratory	NOx - 24 hour average µg/m³ (Theoretical maximum)	NOx - 1 hour average µg/m³ (Theoretical maximum)
Limits		***100 (Consent)***	***200 (Consent)***
AIR007834	2.0	3.8	7.1
AIR007835	2.3	4.3	8.2
AIR007836	2.4	4.5	8.6

Discussions

The calculated 24-hour and 1-hour average concentrations (using a power law exponent of 0.2) ranged from 3.8 mg/m³ to 4.5 mg/m³ and from 7.1 mg/m³ to 8.6 mg/m³ for nitrogen oxides respectively. These values were all within the consent limits of 100 and 200 mg/m³.

Conclusions

Levels of the emission of interest were all measured at levels well below NES or Taranaki Regional Council consent levels and provide a reference benchmark in an area where several other petrochemical processes plants discharge to air.

Memorandum

To Job Manager, Callum MacKenzie
From Scientific Officer - Air Quality, Brian Cheyne
File Spordmon316, 7822-1, FRODO# 1388480
Date August 14, 2014

Ambient air quality monitoring at Copper Moki Production Well site (2013-2014)

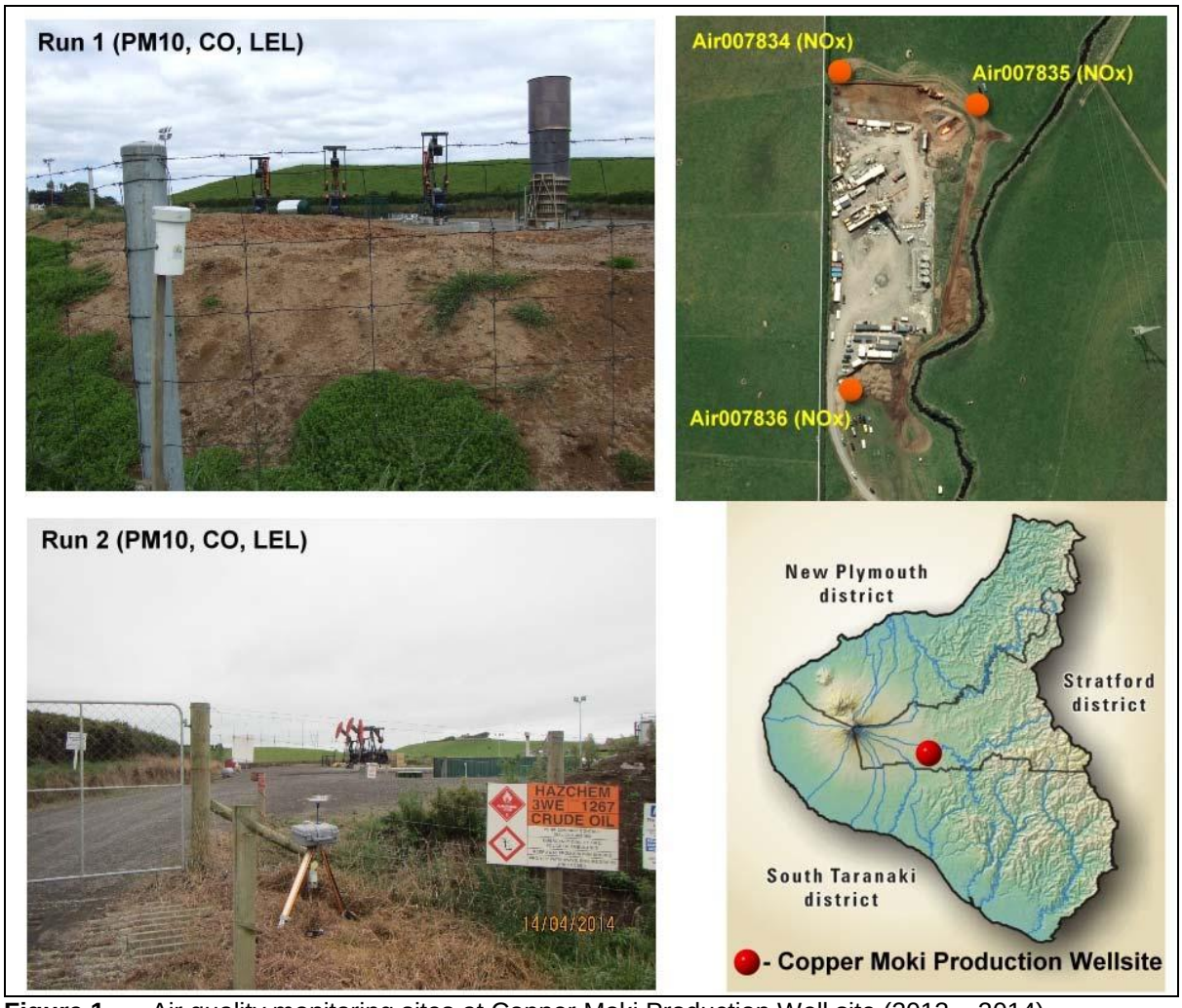

Figure 1 Air quality monitoring sites at Copper Moki Production Well site (2013 – 2014)

QRae -multi gas analyser:

During the July 2013 – 30 June 2014 monitoring period, a multi-gas meter was deployed on two occasions in the vicinity of the Copper Moki Production Well site. Both deployments lasted approximately seventy hours, with the instrument placed in a down-wind position. Monitoring consisted of continual measurements of gas concentration for carbon monoxide and combustible gases.

The location of the air quality monitoring sites is shown in Figure 1. The results of monitoring undertaken are summarized in Table 1 and the data presented graphically 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.

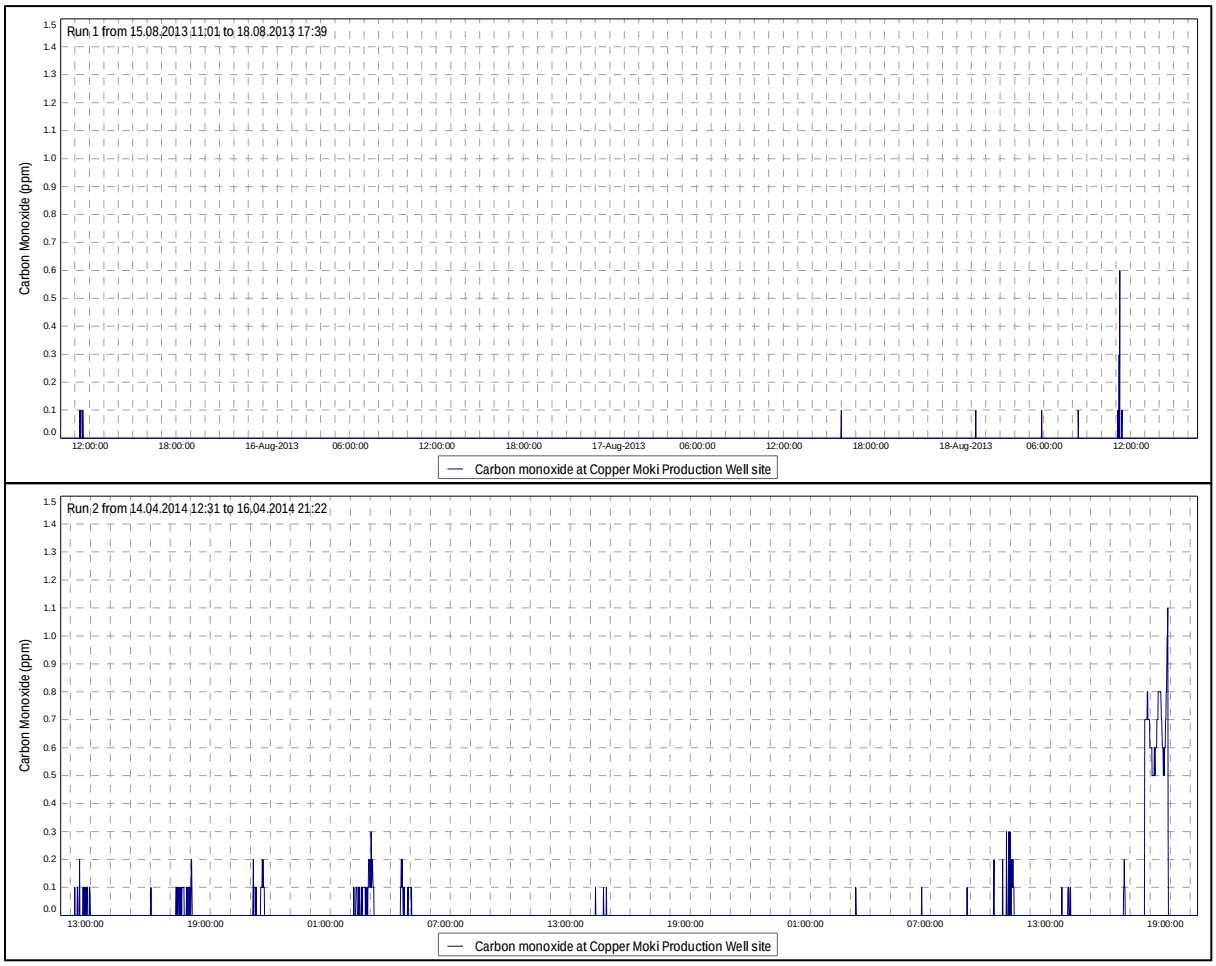

Figure 2 Graphs of ambient gas levels in the vicinity of the Copper Moki Production Well site

Table 1 Summary of ambient gas monitoring results at Copper Moki Production Well site

Run		1	2	Average
Period (from-to)		15.08.2013 11:01 18.08.2013 17:39	14.04.2014 12:31 16.04.2014 21:22	
Max	CO(ppm)	1.10	0.60	0.85
	LEL(%)	0.10	0.00	0.05
Mean	CO(ppm)	0.10	0.10	0.10
	LEL(%)	0.00	0.00	0.00
Min	CO(ppm)	0.00	0.00	0.00
	LEL(%)	0.00	0.00	0.00

Note: (1) the instrument records in units of ppm. At 15°C
1ppm CO = 0.85 mg/m^3

(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 % LEL by 20.

Carbon Monoxide (CO)

The consents covering air discharges from the Sidewinder Production Station have specific limits related to particular gases. Special condition 8 of consent 7765-1 set a limit on the carbon monoxide concentration at or beyond the production station's boundary.

> *"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."*

The maximum concentration of carbon monoxide found during the monitoring run was 1.10 ppm or 0.94 mg/m^3 and average concentration was only 0.10 ppm which complies with the consent condition

Lower Explosive Limit (LEL)

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 a dangerous level of airborne contaminants, including any risk of explosion.

At no time did the level of explosive gases downwind of the Copper Moki Production Well site reach any more than a trivial level.

PM-10 monitoring (DustTrak)

In September 2004 the Ministry for the Environment formally made public the National Environmental Standards (NES) relating to certain air pollutants. The (NES) for PM10 is 50 µg/m^3 (24-hour average).

Particulutes can be derived from many sources, including motor vehicles (particularly diesels), 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 two occasions in the vicinity of the production well site. The deployments lasted approximately fifty hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continual measurements of PM 10 concentrations. The locations of the PM10 monitor during the sampling runs are shown in Figure 1.

The details of the sample runs are graphically presented in Figure 3.

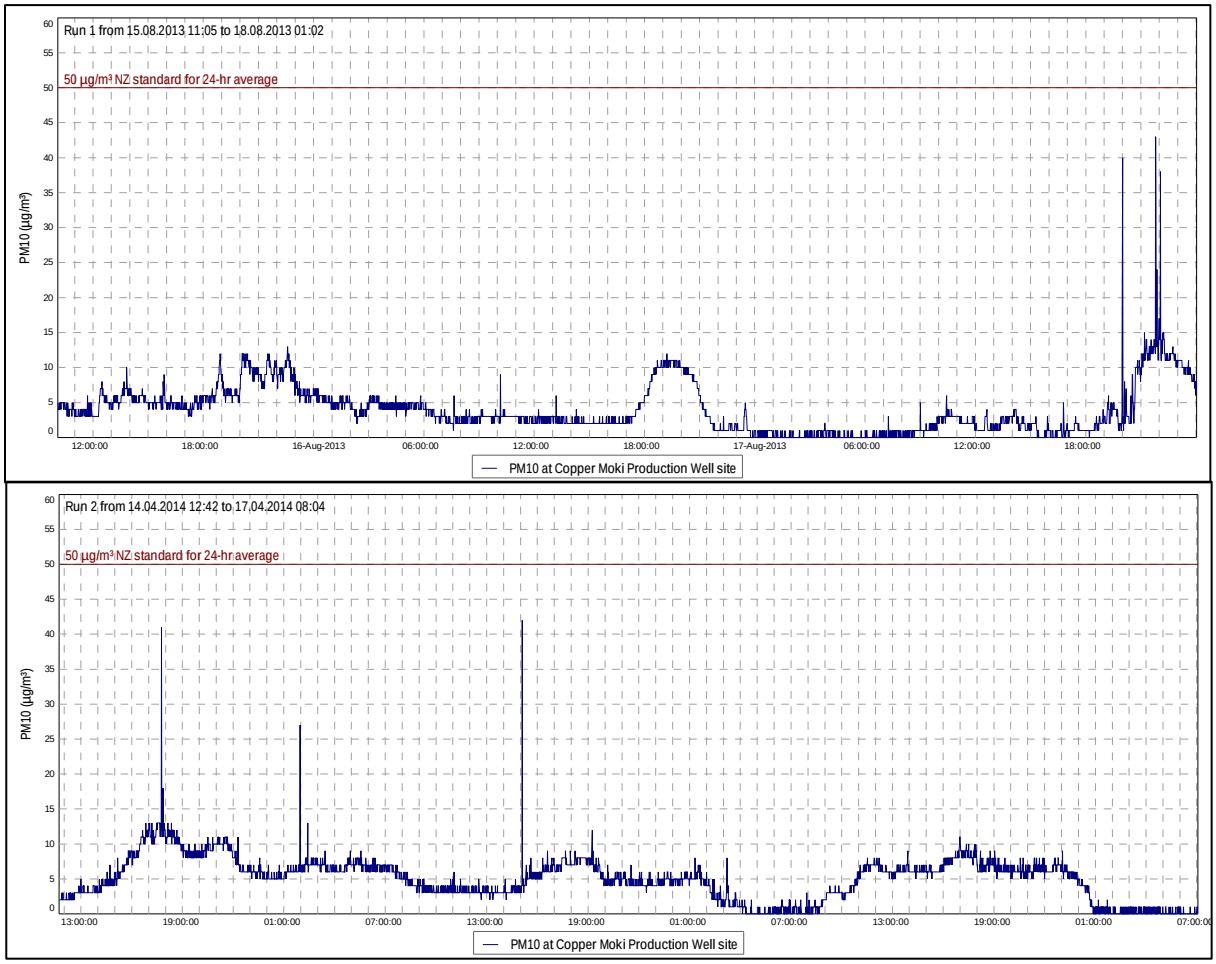

Figure 3 PM10 concentration (µg/m³) at the Copper Moki Production Well site (Run 1 and 2)

Findings

The average recorded PM10 concentration for the entire130 hours dataset was 4.5 µg/m³. This equates to 9% of the National Environmental Standard for a 24-hour period of 50 µg/m³. The maximum recorded PM_{10} concentration over the entire monitoring period was 43 µg/m³. These short term spikes may be caused by traffic movement as the monitor was located adjacent to the site entrance.

Background levels of PM_{10} in the region have been found to be around 11 µg/m³.

Nitrogen (NOx) oxides monitoring

Nitrogen oxides are products of fossil fuel combustion. In humans they can reduce the body's resistance to infections and affect breathing. Nitrogen oxides are toxic to plants and can contribute to brown haze and petrochemical smog.

Special conditions 9 of air consent 7765-1 set limits for nitrogen dioxide at or beyond the boundary of the site.

> *"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 [µg/m^3] [24-hour average exposure], or 200 µg/m^3 [1-hour average exposure] at or beyond the boundary of the of the property where the wellsite is located."*

The Taranaki Regional Council has been monitoring nitrogen oxides (NOx) in the Taranaki region since 1993 using passive absorption discs. These discs are placed at the nominated sites, in the vicinity of the industry concerned. The gases diffuse into the discs and any target gases (nitrogen dioxide) are captured. Passive absorption discs were placed at three sites, staked about two metres off the ground for a period 24 days. The location of the monitoring sites is shown in Figure 1.

From the average concentration measured, it is possible to calculate a theoretical maximum daily concentration that may have occurred during the exposure period. Council data on NOx is gathered over a time period other than exactly 1-hour or 24-hours. 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 t_2 given a measured concentration for time period t_1). Using the 'worst case' factor of p = 0.20, the monitoring data reported above has been converted to equivalent 'maximum' 24-hour exposure levels.

Table 3 presents the actual levels found, theoretical maximum 1-hour and 24-hours concentration of NOx, and consent 7822-1 limits.

Table 3 Ambient NOx results from around the Copper Moki Well site (15/08/2013 to 03/09/2013)

Site	NOx µg/m³ Laboratory	NOx - 24 hour average µg/m³ (Theoretical maximum)	NOx - 1 hour average µg/m³ (Theoretical maximum)
Limits		***100 (Consent)***	***200 (Consent)***
AIR007834	1.6	2.9	5.6
AIR007835	1.7	3.1	5.8
AIR007836	2.0	3.6	6.8

Discussions

The calculated 24-hour and 1-hour average concentrations (using a power law exponent of 0.2) ranged from 2.9 mg/m³ to 3.6 mg/m³ and from 5.6 mg/m³ to 6.8 mg/m³ for nitrogen oxides respectively. These values were all within the consent limits of 100 and 200 mg/m³.

Conclusions

Levels of the emission of interest were all measured at levels well below NES or Taranaki Regional Council consent levels.

Appendix III

Biomonitoring reports

To Job Manager, Callum McKenzie
From Scientific Officers, C R Fowles and B Jansma
Report No CF589
Doc No 1248268
Date September 2013

Biomonitoring of an unnamed tributary of the Ngaere Stream in relation to the Copper Moki Production Station, March 2013

Introduction

This was the second survey completed of the two scheduled biomonitoring surveys relating to the recently established Copper Moki Production Station of Taranaki Ventures Ltd for the 2012-2013 monitoring year, following the late spring survey of November, 2012.

The Production Station discharges treated stormwater, produced water, and surplus drilling water onto land in the vicinity of the tributary of the Ngaere Stream. Two stage skimmer pits on the eastern side of the site collect and treat water from the production and wellsite areas. The discharge from the second pit flows via a shallow drain to the paddock east of the site. Under high flow conditions, this discharge may traverse the paddock and enter the tributary. [Note: The discharge to land consent does not include conditions related to effects on stream biota nor provide an indication of a mixing zone within the adjacent stream environment].

The purpose of this survey was to determine whether discharges from the Production Station had resulted in any detrimental effects on the macroinvertebrate communities in the tributary of the Ngaere Stream downstream of the consented land discharge area.

In April 2012, an incident was reported to Council involving an unauthorised discharge of crude oil from the Copper Moki wellsite (owned and operated by New Zealand Energy Corporation) to an unnamed tributary of the Ngaere Stream. A biological survey was performed to investigate the effects of the unauthorised discharge on the macroinvertebrate communities of this unnamed tributary of the Ngaere Stream. The crude oil was apparently discharged to the unnamed tributary from a drainage pipe originating at the Copper Moki wellsite near Ngaere.

This April 2012 biological survey indicated that there had been minimal effects on the macroinvertebrate communities of the stream following the unauthorised discharge of crude oil. The results from this previous survey are discussed more fully in the report (KS004) listed in the references at the end of this report.

Methods

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from the three recently established sites in the Ngaere Stream (Table 1 and Figure 1) on 26 March 2013. The more recently established 'control' site (NGR000313) was situated further upstream than the 'control' site (NGR000315) used for the incident survey earlier in April 2012 as it was considered more representative of the reach of the stream unaffected by wellsite activities. The '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 an unnamed tributary of the Ngaere Stream surveyed in association with the Copper Moki Production Station

Site No.	Site code	GPS reference	Location
1	NGR 000313	E1715344 N5638713	270 m d/s of Cheal Road bridge (upstream of Production Station)
2	NGR 000317	E1715370 N5638950	630 m d/s of Cheal Road bridge (downstream of Production Station)
3	NGR 000319	E1715410 N5639016	740 m d/s of Cheal Road bridge (downstream of Production Station)

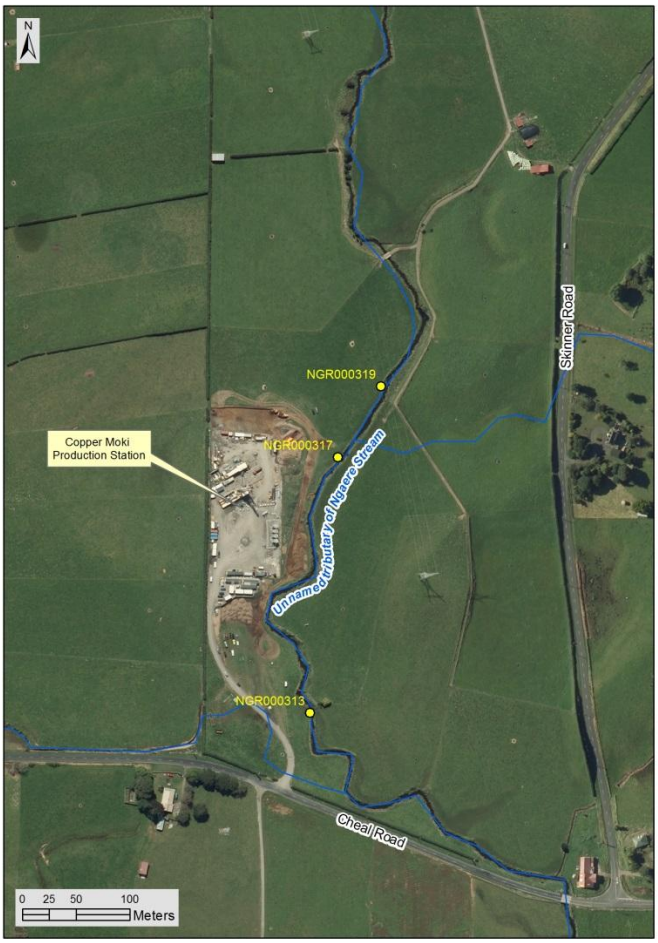

Figure 1 Biological sampling sites in an unnamed tributary of the Ngaere Stream related to the Copper Moki Production Station

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. By averaging the scores obtained from a list of taxa collected from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways.

The MCI was designed as a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. MCI results can also reflect the effects of warm temperatures, slow current speeds and low dissolved oxygen levels, because the taxa capable of tolerating these conditions generally have low sensitivity scores. Usually more 'sensitive' communities (with higher MCI values) inhabit less polluted waterways. The use of this index in non-stony streams is possible if results are related to physical habitat (e.g., good quality muddy/weedy sites tend to produce lower MCI values than good quality stony sites). Weedy stream macroinvertebrate communities tend to be dominated by more 'tolerant' taxa than is the case in stony stream communities. It may therefore require more severe organic pollution to cause a significant decline in MCI value in weedy streams.

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.

Results and discussion

At the time of this late morning survey there was a very low, steady, clear, uncoloured flow in the Ngaere Stream tributary at all three open, unshaded sites. Water temperature ranged from 15.0°C to 15.4°C during this survey. Substrate was similar at the three sites and comprised mainly silt, sand, and fine gravels with some wood amongst the substrate with slightly more wood at site 2. Periphyton mats were thin at sites 1 and 2, and filamentous algae were patchy at all sites. Moss was patchy at sites 2 and 3 and macrophyte beds were common on the stream bed at all sites. This survey was undertaken following a period of low flow recession, 49 days after the latest fresh in excess of 3x and 7x median flow.

Macroinvertebrate communities

A summary of results found by two survey occasions to date at four sites in the Ngaere Stream tributary is presented in Table 2 and the full results of the current survey in Table 3.

Table 2 Summary of previous numbers of taxa and MCI values, together with results of the March, 2013 survey in the Ngaere Stream tributary

Site	Number of previous surveys	Numbers of taxa			MCI values			$SQMCI_S$		
		Median	Range	Current Survey	Median	Range	Current Survey	Median	Range	Current Survey
NGR000313	1	-	15	13	-	85	80	-	5.9	3.6
NGR000315	1	-	16	-	-	85	-	-	2.5	-
NGR000317	2	16	15-17	17	78	74-81	81	4.5	3.5-5.4	4.5
NGR000319	2	18	17-18	22	79-82	81	78	5.3-5.0	4.2	3.6

Table 3 Macroinvertebrate fauna of the unnamed tributary of the Ngaere Stream in relation to Copper Moki Production Station sampled on 26 March 2013

Taxa List	Site Number	MCI score	1	2	3
	Site Code		NGR000313	NGR000317	NGR000319
	Sample Number		FWB13170	FWB13171	FWB13172
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	R	-	-
ANNELIDA (WORMS)	Oligochaeta	1	-	-	R
MOLLUSCA	*Physa*	3	-	-	R
	Potamopyrgus	4	VA	A	XA
CRUSTACEA	Ostracoda	1	R	R	C
	Paracalliope	5	XA	XA	XA
	Talitridae	5	-	-	R
	Paranephrops	5	-	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	C	A
	Zephlebia group	7	R	C	C
ODONATA (DRAGONFLIES)	*Xanthocnemis*	4	A	C	C
	Procordulia	5	-	-	R
HEMIPTERA (BUGS)	*Anisops*	5	-	-	C
	Microvelia	3	R	R	R
	Sigara	3	-	-	C
COLEOPTERA (BEETLES)	Elmidae	6	R	R	-
	Hydrophilidae	5	-	R	-
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	-	R	-
	Polyplectropus	6	-	-	R
	Oecetis	4	-	-	R
	Oxyethira	2	R	C	VA
	Paroxyethira	2	-	R	R
	Triplectides	5	C	R	C
DIPTERA (TRUE FLIES)	Orthocladiinae	2	XA	VA	XA
	Empididae	3	A	C	A
	Ephydridae	4	-	R	R
ACARINA (MITES)	Acarina	5	-	-	R
		No of taxa	13	17	22
		MCI	80	81	78
		SQMCIs	3.6	4.5	3.6
		EPT (taxa)	3	4	5
		%EPT (taxa)	23	24	23

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

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

Site 1: upstream of Production Station

A moderate community richness of 13 taxa was recorded at site 3 upstream of the Production Station discharges. This was slightly fewer than the taxa numbers found by the two earlier surveys at this and the nearby 'control' sites (Table 2). The community was characterised by four 'tolerant' taxa [(snail (*Potamopyrgus*), damselfly (*Xanthocnemis*), orthoclad midges (extremely abundant) and empidid flies]; and one 'moderately sensitive' taxon [extremely abundant amphipod (*Paracalliope*)] but no 'highly sensitive' taxa. Many of these taxa are associated with nutrient-enriched habitats in streams coincident with periphyton substrate cover and, in particular, widespread instream macrophyte growth.

The community was comprised of a relatively high proportion of 'tolerant' taxa (62% of richness) resulting in the MCI score of 80 units, five units lower than the scores recorded by the two previous surveys at this and the nearby 'control' sites (Table 2). This score was slightly higher than the median score (78 units) found by 167 previous surveys in similar streams at sites of equivalent altitude (TRC, 1999 (updated 2012)). A moderate $SQMCI_s$ score was recorded for this site (3.6 units), reflecting the numerical dominance by 'tolerant' taxa and, in particular, the predominance of one 'moderately sensitive' and one 'tolerant' taxa (Table 3). This score was slightly below the median of the range found by previous surveys at equivalent sites.

Site 2: 630 m downstream of Cheal Road bridge

A community richness of seventeen taxa was found at this site, nearly 350 m downstream of site 1 (and below various discharges from the Production Station). This was slightly higher than that found at the 'control' site 1 upstream but similar to the taxa numbers found by the two previous surveys at this site (Table 2). However, there were some differences in dominant taxa composition at this site. Reductions in abundance of the 'tolerant' damsel fly and empidid flies were recorded at site 2, although there were no significant differences in any individual taxon abundances between sites 1 and 2. This was coincident with subtle habitat variability between sites. Again, many of these taxa are associated with nutrient-enriched habitats and particularly macrophyte beds in mid to lower reaches of smaller streams in agricultural catchments.

More subtle reductions in abundances within four 'tolerant' taxa in particular at site 2, were illustrated by the difference in $SQMCI_s$ values which increased by 0.9 unit in a downstream direction.

'Tolerant' taxa comprised a similar proportion (59% of total taxa) of the community compared with site 1, which was reflected in the MCI score of 81 units. This was equal with the higher of the two previous survey scores and one unit above that recorded at site 1 upstream of all Production Station discharges, while the $SQMCI_s$ value increased by 0.9 unit (see above). Therefore these results indicate that it is unlikely that there had been any recent significant changes in physicochemical water quality caused by discharges from the Production Station between sites 1 and 2, impacting upon the macroinvertebrate community at site 2.

Site 3: 740 m downstream of Cheal Road bridge

A moderately high community richness of twenty two taxa was recorded at site 3, a further 100 m downstream of the various Production Station discharges. This was higher than the richnesses found by the two previous surveys at this site and that recorded at the nearest upstream site (Table 2). The number of characteristic taxa increased by three taxa compared to those at site 2, comprising two additional 'tolerant' taxa and one more 'moderately sensitive' taxon to those found at site 2 and one additional 'moderately sensitive' taxon compared to site 1.

There were four significant changes in individual taxon abundance between adjacent sites 2 and 3 but the numerical increases in 'tolerant' snail (*Potamopyrgus*), caddisfly (*Oxyethira*), and orthoclad midges were primarily responsible for the decrease in the $SQMCI_s$ value of 0.9 unit between sites 2 and 3, but the site 3 score was identical with that recorded at the 'control' site 1. The changes recorded between sites 2 and 3 are more likely to have been

attributable to variations in habitat characteristics at site 3, particularly the harder (wood0 substrate sampled.

The community was again comprised of a slightly higher proportion of 'tolerant' taxa which was reflected in the MCI score of 78 units. This score was within 4 units of the scores from the two previous surveys at this site (Table 2). It was not significantly different to the scores recorded at the two sites upstream and was indicative of no recent significant impacts of any Production Station discharges on the macroinvertebrate communities of the surveyed reach of the tributary of the Ngaere Stream.

Conclusions and summary

The Council's standard 'kick-sampling' technique was used at three established sites to collect streambed macroinvertebrates from an unnamed tributary of the Ngaere Stream, to assess whether any discharges from the Copper Moki Production Station had had any detrimental effects on the macroinvertebrate communities of this stream. This late summer survey was the second of two surveys programmed for the 2012-2013 monitoring period. Samples were sorted and identified to provide the number of taxa (richness) and MCI and $SQMCI_S$ scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects or 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 sites may indicate the degree of adverse effects (if any) of the discharges being monitored.

This late summer macroinvertebrate survey indicated that any discharges of treated stormwater and produced water from the recently established Copper Moki Production Station site had not had any significant recent detrimental effects on the macroinvertebrate communities of the Ngaere Stream tributary. The MCI scores for each site were very similar and there was minimal decrease through the surveyed reach downstream of the discharge area. The only significant changes in the macroinvertebrate communities related to abundances of a few individual taxa, mainly as a result of subtle habitat changes between sites. $SQMCI_s$ scores increased between sites 1 and 2, but there were no significant downstream decreases in relation to the upstream 'control' site 1.

The macroinvertebrate communities of the stream contained slightly higher proportions of 'tolerant' than 'moderately sensitive' taxa at all sites. In addition, communities at all sites had three common dominant taxa although there was some variation in a few other dominant taxa as a result of subtle variations in habitat between sites. There were no significant changes in MCI values between sites despite minor differences in habitat. In addition, taxonomic richness (numbers of taxa) increased in a downstream direction mainly due to the presence of additional taxa recorded only as rarities. The MCI scores indicated that the stream communities were of 'poor' to 'fair' health, but typical of conditions in comparison with median values recorded from previous surveys at similar sites (TRC, 1999 (updated 2012)). The absence of significant differences between the three sites indicated no recent significant impacts from the Copper Moki Production Station discharges authorised onto adjacent land.

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To Job Manager, Callum McKenzie
From Scientific Officers, C R Fowles and BR Thomas
Report No CF610
Doc No 1376967
Date July 2014

Biomonitoring of an unnamed tributary of the Ngaere Stream in relation to the Copper Moki Production Station, November 2013

Introduction

This was the first of the two scheduled biomonitoring surveys relating to the recently established Copper Moki Production Station of Taranaki Ventures Ltd for the 2013-2014 monitoring year.

The Production Station discharges treated stormwater, produced water, and surplus drilling water onto land in the vicinity of the tributary of the Ngaere Stream. Two stage skimmer pits on the eastern side of the site collect and treat water from the production and wellsite areas. The discharge from the second pit flows via a shallow drain to the paddock east of the site. Under high flow conditions, this discharge may traverse the paddock and enter the tributary. [Note: The discharge to land consent does not include conditions related to effects on stream biota nor provide an indication of a mixing zone within the adjacent stream environment].

The purpose of this survey was to determine whether discharges from the Production Station had resulted in any detrimental effects on the macroinvertebrate communities in the tributary of the Ngaere Stream downstream of the consented land discharge area.

In April 2012, an incident was reported to Council involving an unauthorised discharge of crude oil from the Copper Moki wellsite (owned and operated by New Zealand Energy Corporation) to an unnamed tributary of the Ngaere Stream. A biological survey was performed to investigate the effects of the unauthorised discharge on the macroinvertebrate communities of this unnamed tributary of the Ngaere Stream. The crude oil was apparently discharged to the unnamed tributary from a drainage pipe originating at the Copper Moki wellsite near Ngaere. This April 2012 biological survey indicated that there had been minimal effects on the macroinvertebrate communities of the stream following the unauthorised discharge of crude oil. Despite product observed floating on the surface of the water at all three downstream sampling sites and some minor accumulation of product on overhanging vegetation, no significant differences in taxa richness or MCI scores were recorded between upstream and downstream sites. However, statistically significant differences were recorded in the $SQMCI_s$ scores between sites. In general, this was attributed to variations in the amount of macrophyte habitat at these sites. A small number of dead mayflies and amphipods were found when live sampling was undertaken approximately 180 metres downstream of the discharge point on the day following the biological survey, which may have occurred as a result of the unauthorised discharge of product into the tributary. Therefore the effects of the discharge were considered to be minimal. Despite this, the tributary had some ecological values that are typical of lowland streams draining swamp land.

The results from this previous survey are discussed more fully in the report (KS004) listed in the references at the end of this report.

Subsequent surveys in the 2012-2013 period performed as components of the compliance monitoring programme are discussed in TRC reports referenced by this report.

Methods

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from three recently established sites in the Ngaere Stream (Table 1, Figure 1) on 13 November 2013. The 'control' site (NGR000313) was situated further upstream than the 'control' site (NGR000315) used for the incident survey as it was considered more representative of the reach of the stream unaffected by wellsite activities. The '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 an unnamed tributary of the Ngaere Stream surveyed in association with the Copper Moki Production Station

Site No.	Site code	GPS reference	Location
1	NGR 000313	E1715344 N5638713	270 m d/s of Cheal Road bridge (upstream of Production Station)
2	NGR 000317	E1715370 N5638950	630 m d/s of Cheal Road bridge (downstream of Production Station)
3	NGR 000319	E1715410 N5639016	740 m d/s of Cheal Road bridge (downstream of 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. By averaging the scores obtained from a list of taxa collected from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways.

The MCI was designed as a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. MCI results can also reflect the effects of warm temperatures, slow current speeds and low dissolved oxygen levels, because the taxa capable of tolerating these conditions generally have low sensitivity scores. Usually more 'sensitive' communities (with higher MCI values) inhabit less polluted waterways. The use of this index in non-stony streams is possible if results are related to physical habitat (e.g., good quality muddy/weedy sites tend to produce lower MCI values than good quality stony sites). Weedy stream macroinvertebrate communities tend to be dominated by more

'tolerant' taxa than is the case in stony stream communities. It may therefore require more severe organic pollution to cause a significant decline in MCI value in weedy streams.

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.

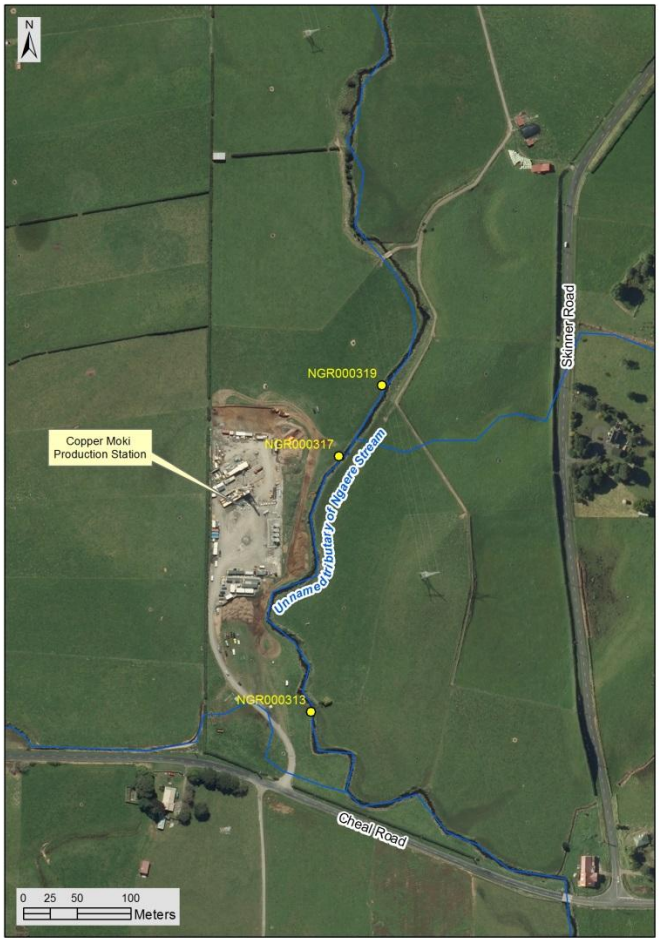

Figure 1 Biological sampling sites in an unnamed tributary of the Ngaere Stream related to the Copper Moki Production Station

Results and discussion

At the time of this mid-morning survey there was a moderate, steady, cloudy, brownish flow in the Ngaere Stream tributary at all three partially shaded sites. Water temperature ranged from 12.6°C to 13.2°C during this survey. Substrate was similar at the three sites and comprised mainly silt, sand and fine gravels with some wood also present although there was a softer substrate at site 1. There were no periphyton mats but patchy filamentous algae was present at all sites. Macrophyte beds were common on the stream bed at all sites. This survey was undertaken following a period of flow recession, 12 days after the latest fresh in excess of 3x and 7x median flow.

Macroinvertebrate communities

A summary of survey results performed on the three occasions to date at three sites in the Ngaere Stream tributary is presented in Table 2 and the full results of the current survey in Table 3.

Table 2 Summary of previous numbers of taxa and MCI values, together with results of the November, 2013 survey in the Ngaere Stream

Site	Number of previous surveys	Numbers of taxa			MCI values			SQMCIs		
		Median	Range	Current Survey	Median	Range	Current Survey	Median	Range	Current Survey
NGR000313	2	14	13-15	21	83	80-85	79	4.8	3.6-5.9	4.5
NGR000315	1	-	16	-	-	85	-	-	2.5	-
NGR000317	3	17	15-17	19	81	74-81	80	4.5	3.5-5.4	4.2
NGR000319	3	18	17-22	20	79	78-82	78	3.6	3.3-5.0	4.3

Table 3 Macroinvertebrate fauna of the unnamed tributary of the Ngaere Stream in relation to Copper Moki Production Station sampled on 13 November 2013

Taxa List	Site Number	MCI score	1	2	3
	Site Code		NGR000313	NGR000317	NGR000319
	Sample Number		FWB13300	FWB13299	FWB13298
ANNELIDA (WORMS)	Oligochaeta	1	A	VA	VA
	Lumbricidae	5	R	-	-
HIRUDINEA (LEECHES)	Hirudinea	3	-	R	-
MOLLUSCA	*Potamopyrgus*	4	A	VA	XA
CRUSTACEA	Copepoda	5	R	-	-
	Ostracoda	1	C	R	R
	Paracalliope	5	XA	XA	XA
	Paraleptamphopidae	5	-	-	R
	Paranephrops	5	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	VA	VA
	Zephlebia group	7	C	C	C
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	C	C
ODONATA (DRAGONFLIES)	*Austrolestes*	4	R	-	-
	Xanthocnemis	4	C	C	VA
HEMIPTERA (BUGS)	*Microvelia*	3	R	R	R
COLEOPTERA (BEETLES)	Dytiscidae	5	-	R	-
	Hydrophilidae	5	R	-	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	R	R	R
	Polyplectropus	6	R	R	-
	Oxyethira	2	VA	VA	A
	Pycnocentria	7	-	-	R
	Triplectides	5	-	R	R
DIPTERA (TRUE FLIES)	*Chironomus*	1	R	-	R
	Corynoneura	3	R	-	R
	Orthocladiinae	2	A	A	A
	Empididae	3	-	R	R
	Austrosimulium	3	VA	VA	A
ACARINA (MITES)	Acarina	5	R	R	-
		No of taxa	21	19	20
		MCI	79	80	78
		SQMCIs	4.5	4.2	4.3
		EPT (taxa)	5	6	6
		%EPT (taxa)	24	32	30

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

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

Site 1: Upstream of Production Station

A moderate community richness of 21 taxa was recorded at site 1 upstream of the Production Station discharges. This was six taxa more than found by the two earlier surveys at this site (Table 2). The community was characterised by five 'tolerant' taxa [(oligochaete worms, snail (*Potamopyrgus*), algal-piercing caddisfly (*Oxyethira*), orthoclad midges, and sandfly (*Austrosimulium*)] and two 'moderately sensitive' taxa [extremely abundant amphipod (*Paracalliope*) and mayfly (*Austroclima*)]; but no 'highly sensitive' taxa. Many of these taxa are associated with nutrient-enriched habitats in streams coincident with periphyton substrate cover and, in particular, widespread instream macrophyte growth. The community was comprised of relatively even proportions of 'tolerant' and 'moderately sensitive' taxa resulting in the MCI score of 79 units, slightly lower, but within 6 units of scores recorded by the previous surveys at this site (Table 2). This score was equal with the median score (79 units) found by 169 previous surveys in similar streams at sites of equivalent altitude (TRC, 1999 (updated 2013)). A moderate $SQMCI_s$ score was recorded for this site (4.5 units), reflecting the shared numerical dominance between 'moderately sensitive' and 'tolerant' taxa and, in particular, the predominance of one 'moderately sensitive' taxon (Table 3). This score was within 0.5 unit of the median of the range found by previous surveys at equivalent sites.

Site 2: 630 m downstream of Cheal Road bridge

A community richness of nineteen taxa was found at this site, nearly 350 m downstream of site 1 (and below various discharges from the Production Station). This was slightly lower than that found at the 'control' site 1 upstream but two taxa higher than found by the three previous surveys at this site (Table 2). However, there were no differences in dominant taxa composition at this site compared to that at site 1. Again, many of these taxa are associated with nutrient-enriched habitats and particularly macrophyte beds in mid to lower reaches of smaller streams in agricultural catchments.

However, there were no significant changes in individual taxon abundances between sites 1 and 2, and the subtle changes within the predominant taxa (increased snail and worm numbers) at site 2 were illustrated by the relative similarity between $SQMCI_s$ values which dropped by only 0.3 unit.

'Tolerant' taxa comprised very similar proportion (53% of total taxa) of the community compared with site 1, which was reflected in the MCI score of 80 units. This was one unit lower than the range of previous scores and an insignificant (Stark, 1998) one unit above that recorded at site 1 upstream of all Production Station discharges, while the $SQMCI_s$ values also were relatively similar (see above). Therefore, these results indicate that there had been no recent significant changes in physicochemical water quality caused by discharges from the Production Station between sites 1 and 2, impacting upon the macroinvertebrate community at site 2.

Site 3: 740 m downstream of Cheal Road bridge

A moderate community richness of twenty taxa was recorded at site 3, a further 100 m downstream of the various Production Station discharges. This was within the range of richnesses found by three previous surveys at this site and very similar to those recorded at the two upstream sites (Table 2). The number of characteristic taxa increased by one taxon compared to those at site 2, and comprised one additional 'tolerant' taxon and the same number of 'moderately sensitive' taxa as found at site 2 (and site 1).

However, there was only one significant change in individual taxon abundance between adjacent sites 2 and 3 but the numerical increases in 'tolerant' snail (*Potamopyrgus*) and damselfly (*Xanthocnemis*) in particular, resulted in a very small increase in the $SQMCI_s$ value (of 0.1 unit) which was only 0.2 unit lower than recorded at the 'control' site 1. These minor changes recorded between sites were reflective of minimal variability in habitat characteristics between the three sites.

The community was again comprised of relatively even proportions of 'tolerant' and 'moderately sensitive' taxa which was reflected in the MCI score of 78 units. This score was within the range of scores from the previous surveys at this site (Table 2). It was not significantly different to the scores recorded at the two sites upstream, and was also indicative of no recent significant impacts of any Production Station discharges on the macroinvertebrate communities of the tributary of the Ngaere Stream.

Conclusions and summary

The Council's standard 'kick-sampling' technique was used at three established sites to collect streambed macroinvertebrates from an unnamed tributary of the Ngaere Stream, to assess whether any discharges from the Copper Moki Production Station had had any detrimental effects on the macroinvertebrate communities of this stream. This late spring survey was the first of two surveys programmed for the 2013-2014 monitoring period. Samples were sorted and identified to provide the number of taxa (richness) and MCI and $SQMCI_S$ scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects or 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 sites may indicate the degree of adverse effects (if any) of the discharges being monitored.

This late spring macroinvertebrate survey indicated that any discharges of treated stormwater and produced water from the recently established Copper Moki Production Station site had not had any significant recent detrimental effects on the macroinvertebrate communities of the Ngaere Stream tributary. The MCI scores for each site were very similar with no significant decreases downstream of the discharge area. The only changes in the macroinvertebrate communities related to minor variations in abundances of a few individual taxa, mainly as a result of very subtle habitat changes between sites. $SQMCI_s$ scores were not significantly different between sites 1, 2, or 3, ranging over only 0.3 $SQMCI_s$ unit.

The macroinvertebrate communities of the stream contained relatively even proportions of 'tolerant' and 'moderately sensitive' taxa at all sites. In addition, communities at all sites had seven common dominant taxa with minimal variation as a result of subtle variations in habitat between sites. There were no significant changes in MCI values between sites. In addition, taxonomic richness (numbers of taxa) was relatively consistent across all three sites. The MCI scores indicated that the stream communities were of 'poor' (bordering on 'fair') health, but typical of conditions in comparison with median values recorded from previous surveys at similar sites (TRC, 1999 (updated 2013)). The absence of significant

differences between the three sites indicated no recent significant impacts from the Copper Moki Production Station discharges authorised onto adjacent land.

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To	Job Manager, Callum McKenzie
From	Scientific Officer, BR Thomas
Report No	BT034
Doc No	1418334
Date	October 2014

Biomonitoring of an unnamed tributary of the Ngaere Stream in relation to the Copper Moki Production Station, February 2014

Introduction

This was the second of the two scheduled biomonitoring surveys relating to the Copper Moki Production Station of Taranaki Ventures Ltd for the 2013-2014 monitoring year.

The Production Station discharges treated stormwater, produced water, and surplus drilling water onto land in the vicinity of the tributary of the Ngaere Stream. Two stage skimmer pits on the eastern side of the site collect and treat water from the production and wellsite areas. The discharge from the second pit flows via a shallow drain to the paddock east of the site. Under high flow conditions, this discharge may traverse the paddock and enter the tributary. [Note: The discharge to land consent does not include conditions related to effects on stream biota nor provide an indication of a mixing zone within the adjacent stream environment].

The purpose of this survey was to determine whether discharges from the Production Station had resulted in any detrimental effects on the macroinvertebrate communities in the tributary of the Ngaere Stream downstream of the consented land discharge area.

In April 2012, an incident was reported to Council involving an unauthorised discharge of crude oil from the Copper Moki wellsite (owned and operated by New Zealand Energy Corporation) to an unnamed tributary of the Ngaere Stream. A biological survey was performed to investigate the effects of the unauthorised discharge on the macroinvertebrate communities of this unnamed tributary of the Ngaere Stream. The crude oil was apparently discharged to the unnamed tributary from a drainage pipe originating at the Copper Moki wellsite near Ngaere. This April 2012 biological survey indicated that there had been minimal effects on the macroinvertebrate communities of the stream following the unauthorised discharge of crude oil. Despite product observed floating on the surface of the water at all three downstream sampling sites and some minor accumulation of product on overhanging vegetation, no significant differences in taxa richness or MCI scores were recorded between upstream and downstream sites. However, statistically significant differences were recorded in the $SQMCI_s$ scores between sites. In general, this was attributed to variations in the amount of macrophyte habitat at these sites. A small number of dead mayflies and amphipods were found when live sampling was undertaken approximately 180 metres downstream of the discharge point on the day following the biological survey, which may have occurred as a result of the unauthorised discharge of product into the tributary. Therefore the effects of the discharge were considered to be minimal. Despite this, the tributary had some ecological values that are typical of lowland streams draining swamp land.

The results from this previous survey are discussed more fully in the report (KS004) listed in the references at the end of this report.

Subsequent surveys in the 2012-2013 period performed as components of the compliance monitoring programme are discussed in TRC reports referenced by this report.

Methods

A combination of the standard '400 ml kick-sampling' and 'vegetation-sweep' sampling techniques was used to collect streambed macroinvertebrates from three established sites in the Ngaere Stream (Table 1, Figure 1) on 04 February 2014. The 'control' site (NGR000313) was situated further upstream than the 'control' site (NGR000315) used for the incident survey as it was considered more representative of the reach of the stream unaffected by wellsite activities. The '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). The 'vegetation sweep' technique is very similar to Protocol 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 an unnamed tributary of the Ngaere Stream surveyed in association with the Copper Moki Production Station

Site No.	Site code	GPS reference	Location
1	NGR 000313	E1715344 N5638713	270 m d/s of Cheal Road bridge (upstream of Production Station)
2	NGR 000317	E1715370 N5638950	630 m d/s of Cheal Road bridge (downstream of Production Station)
3	NGR 000319	E1715410 N5639016	740 m d/s of Cheal Road bridge (downstream of 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. By averaging the scores obtained from a list of taxa collected from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways.

The MCI was designed as a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. MCI results can also reflect the effects of warm temperatures, slow current speeds and low dissolved oxygen levels, because the taxa capable of tolerating these conditions generally have low sensitivity scores. Usually more 'sensitive' communities (with higher MCI values) inhabit less polluted waterways. The use of this index in non-stony streams is possible if results are related to physical habitat (e.g.,

good quality muddy/weedy sites tend to produce lower MCI values than good quality stony sites). Weedy stream macroinvertebrate communities tend to be dominated by more 'tolerant' taxa than is the case in stony stream communities. It may therefore require more severe organic pollution to cause a significant decline in MCI value in weedy streams.

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.

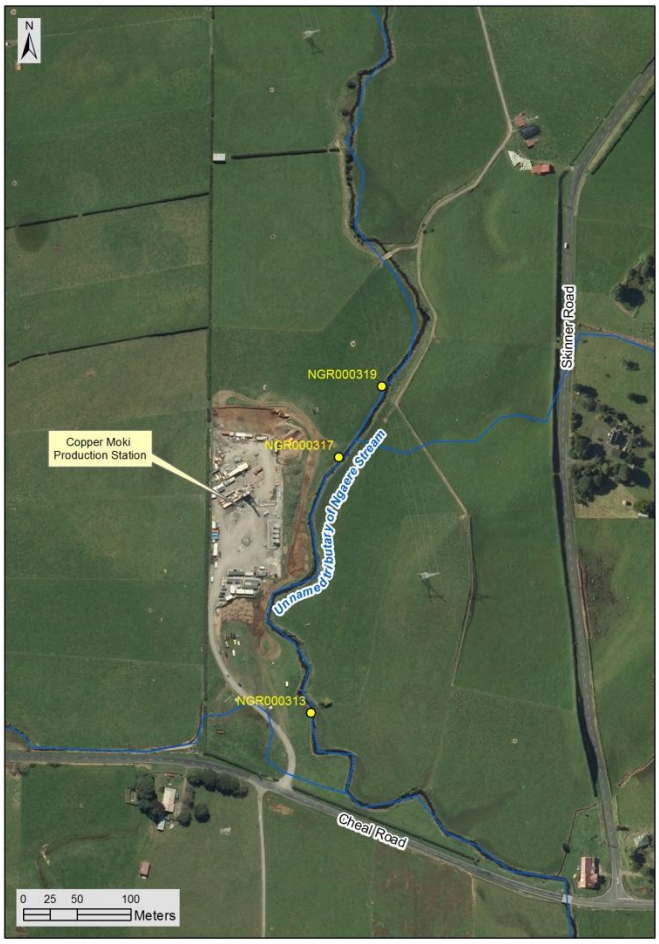

Figure 1 Biological sampling sites in an unnamed tributary of the Ngaere Stream related to the Copper Moki Production Station

Results and discussion

At the time of this mid-afternoon survey there was a low, slow, cloudy, brownish flow in the Ngaere Stream tributary at all three unshaded sites. Water temperature ranged from 18.0°C to 18.1°C during this survey. Substrate was similar at sites 1 and 2 and comprised mainly silt, with sand, cobbles and fine and coarse gravels. Substrate at site 3 was comprised predominantly of silt with some wood also present. There were no filaments of periphyton although slippery mats of periphyton were recorded at site 1. Macrophyte beds were common on the stream bed at all sites. This survey was undertaken following a period of flow recession, 14 days after the latest fresh in excess of 3x median flow.

Macroinvertebrate communities

A summary of survey results performed on the four occasions to date at three sites in the Ngaere Stream tributary is presented in Table 2 and the full results of the current survey in Table 3.

Table 2 Summary of previous numbers of taxa and MCI values, together with results of the February, 2014 survey in the Ngaere Stream

Site	Number of previous surveys	Numbers of taxa			MCI values			$SQMCI_S$		
		Median	Range	Current Survey	Median	Range	Current Survey	Median	Range	Current Survey
NGR000313	3	15	13-21	17	80	79-85	79	4.5	3.6-5.9	3.4
NGR000315	1	-	16	-	-	85	-	-	2.5	-
NGR000317	4	17	15-19	14	81	74-81	77	4.4	3.5-5.4	2.5
NGR000319	4	19	17-22	19	79	78-82	77	4.0	3.3-5.0	3.9

Table 3 Macroinvertebrate fauna of the unnamed tributary of the Ngaere Stream in relation to Copper Moki Production Station sampled on 04 February 2014

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3
	Site Code		NGR000313	NGR000317	NGR000319
	Sample Number		FWB14057	FWB14058	FWB14059
PLATYHELMINTHES (FLATWORMS)	*Cura*	3	R	R	R
ANNELIDA (WORMS)	Oligochaeta	1	XA	VA	VA
HIRUDINEA (LEECHES)	Hirudinea	3	R	R	-
MOLLUSCA	*Potamopyrgus*	4	A	C	VA
	Sphaeriidae	3	-	R	-
CRUSTACEA	Ostracoda	1	C	A	VA
	Paracalliope	5	XA	A	XA
	Paraleptamphopidae	5	-	R	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	VA	A	A
	Zephlebia group	7	A	C	C
ODONATA (DRAGONFLIES)	*Xanthocnemis*	4	R	R	A
HEMIPTERA (BUGS)	*Microvelia*	3	-	-	R
COLEOPTERA (BEETLES)	Elmidae	6	R	-	-
	Dytiscidae	5	-	-	R
	Hydrophilidae	5	R	-	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	-	-	R
	Triplectides	5	C	C	C
DIPTERA (TRUE FLIES)	*Chironomus*	1	-	-	C
	Orthocladiinae	2	R	-	C
	Paradixa	4	R	-	R
	Empididae	3	R	R	R
	Austrosimulium	3	R	R	R
	Tanyderidae	4	R	-	-
ACARINA (MITES)	Acarina	5	-	-	R
		No of taxa	17	14	19
		MCI	79	77	77
		SQMCIs	3.4	2.5	3.9
		EPT (taxa)	3	3	4
		%EPT (taxa)	18	21	21

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

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

Site 1: Upstream of Production Station

A moderate community richness of 17 taxa was recorded at site 1 upstream of the Production Station discharges. This was four taxa less than found by the three earlier surveys at this site (Table 2). The community was characterised by two 'tolerant' taxa (oligochaete worms and snail (*Potamopyrgus*)) and three 'moderately sensitive' taxa (extremely abundant amphipod (*Paracalliope*) and mayflies (*Austroclima*) and (*Zephlebia* group)); but no 'highly sensitive' taxa. Many of these taxa are associated with nutrient-enriched habitats in streams coincident with periphyton substrate cover and, in particular, widespread instream macrophyte growth.

The community was comprised of a moderately high proportion of 'tolerant' taxa resulting in the MCI score of 79 units, the same as what was recorded by the previous survey and similar to the median for this site (Table 2). This score was also equal with the median score (79 units) found by 169 previous surveys in similar streams at sites of equivalent altitude (TRC, 1999 (updated 2013)).

A moderate $SQMCI_s$ score was recorded for this site (3.4 units), reflecting the almost shared numerical dominance between 'moderately sensitive' and 'tolerant' taxa and, in particular the predominance of one 'moderately sensitive' taxon (Table 3).

Site 2: 630 m downstream of Cheal Road bridge

A community richness of 14 taxa was found at this site, nearly 350 m downstream of site 1 (and below various discharges from the Production Station). This was slightly lower than that found at the 'control' site 1 upstream and one taxon lower than found by the four previous surveys at this site (Table 2). There were three differences in dominant taxa composition at this site compared to that at site 1; dominant taxa included: two 'tolerant' taxa (ostracod seed shrimp and oligochaete worms) and two 'moderately sensitive' taxa (amphipod (*Paracalliope*) and mayfly (*Austroclima*)). Again, many of these taxa are associated with nutrient-enriched habitats and particularly macrophyte beds in mid to lower reaches of smaller streams in agricultural catchments.

Despite only one significant change in individual taxon abundance between sites 1 and 2, subtle changes, including the drop in abundance of five 'moderately sensitive' taxa and increase in abundance of three 'tolerant' taxa at site 2, were illustrated by the drop in $SQMCI_s$ value (2.5 units) by a significant 0.9 unit (Stark, 1998).

'Tolerant' taxa comprised a very similar proportion (64% of total taxa) of the community compared with site 1, which was reflected in the MCI score of 77 units. This was three units higher than the lowest score previously recorded and an insignificant (Stark, 1998) two units below that recorded at site 1 upstream of all Production Station discharges.

These results indicate that there had been no recent significant changes in physicochemical water quality caused by discharges from the Production Station between sites 1 and 2, impacting upon the macroinvertebrate community at site 2.

Site 3: 740 m downstream of Cheal Road bridge

A moderate community richness of 19 taxa was recorded at site 3, a further 100 m downstream of the various Production Station discharges. This was within the range of richnesses found by four previous surveys at this site and slightly higher to those recorded

at the two upstream sites (Table 2). The number of characteristic taxa increased by two taxa compared to those at site 2, and comprised two additional 'tolerant' taxa (*Potamopygryus* snails and dragonfly larvae *Xanthocnemis*).

There were five significant changes in individual taxon abundance between adjacent sites 2 and 3 including the increase of four 'tolerant' taxa and one 'moderately sensitive' taxon. These significant changes in abundance, together with more subtle differences, including the increase of four other 'sensitive' taxa resulted in a significant (Stark, 1998) increase in the $SQMCI_s$ value (by 1.4 units). This $SQMCI_s$ value was however an insignificant (Stark, 1998) 0.5 unit higher than at the upstream 'control' site 1. These changes in $SQMCI_s$ value recorded between sites were reflective of only slight variability in habitat characteristics between the three sites.

The community was again comprised of relatively even proportions of 'tolerant' and 'moderately sensitive' taxa which was reflected in the MCI score of 77 units. This score was the lowest recorded at this site to date but only by 1 unit (Table 2). It was the same as that recorded by site 2 and similar to that recorded by site 1, and was also indicative of no recent significant impacts of any Production Station discharges on the macroinvertebrate communities of the tributary of the Ngaere Stream.

Conclusions and summary

A combination of the standard '400 ml kick-sampling' and 'vegetation-sweep' sampling techniques was used at three established sites to collect streambed macroinvertebrates from an unnamed tributary of the Ngaere Stream, to assess whether any discharges from the Copper Moki Production Station had had any detrimental effects on the macroinvertebrate communities of this stream. This summer survey was the second of two surveys programmed for the 2013-2014 monitoring period. Samples were sorted and identified to provide the number of taxa (richness) and MCI and $SQMCI_S$ scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects or 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 sites may indicate the degree of adverse effects (if any) of the discharges being monitored.

This summer macroinvertebrate survey indicated that any discharges of treated stormwater and produced water from the Copper Moki Production Station site had not had any significant recent detrimental effects on the macroinvertebrate communities of the Ngaere Stream tributary. The MCI scores for each site were very similar with no significant decreases downstream of the discharge area. The only changes in the macroinvertebrate communities related to minor variations in abundances of a few individual taxa, mainly as a result of very subtle habitat changes between sites. The significant decrease in $SQMCI_s$ score recorded at site 2 in comparison to site 1 and site 2 can be attributed to several subtle changes in taxon abundances, rather than to any impacts caused by stormwater or produced water discharges from the Copper Moki Production Station.

The macroinvertebrate communities of the stream contained relatively even proportions of 'tolerant' and 'moderately sensitive' taxa at all sites. In addition, communities at all sites had three common dominant taxa with only slight variation as a result of subtle variations in habitat between sites. There were no significant changes in MCI values between sites. In addition, taxonomic richness (numbers of taxa) was relatively consistent across all three sites. The MCI scores indicated that the stream communities were of 'poor' (bordering on 'fair') health, but typical of conditions in comparison with median values recorded from previous surveys at similar sites (TRC, 1999 (updated 2013)). The absence of significant differences in MCI score or taxa richness between the three sites indicated no recent significant impacts from the Copper Moki Production Station discharges authorised onto adjacent land.

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To Job Manager, Callum McKenzie
From Scientific Officers, C R Fowles and K L Smith
Report No CF588
Doc No 1245420
Date September 2013

Biomonitoring of an unnamed tributary of the Ngaere Stream in relation to the Copper Moki Production Station, November 2012

Introduction

This was the first survey completed of the two scheduled biomonitoring surveys relating to the recently established Copper Moki Production Station of Taranaki Ventures Ltd for the 2012-2013 monitoring year.

The Production Station discharges treated stormwater, produced water, and surplus drilling water onto land in the vicinity of the tributary of the Ngaere Stream. Two stage skimmer pits on the eastern side of the site collect and treat water from the production and wellsite areas. The discharge from the second pit flows via a shallow drain to the paddock east of the site. Under high flow conditions, this discharge may traverse the paddock and enter the tributary. [Note: The discharge to land consent does not include conditions related to effects on stream biota nor provide an indication of a mixing zone within the adjacent stream environment].

The purpose of this survey was to determine whether discharges from the Production Station had resulted in any detrimental effects on the macroinvertebrate communities in the tributary of the Ngaere Stream downstream of the consented land discharge area.

In April 2012, an incident was reported to Council involving an unauthorised discharge of crude oil from the Copper Moki wellsite (owned and operated by New Zealand Energy Corporation) to an unnamed tributary of the Ngaere Stream. A biological survey was performed to investigate the effects of the unauthorised discharge on the macroinvertebrate communities of this unnamed tributary of the Ngaere Stream. The crude oil was apparently discharged to the unnamed tributary from a drainage pipe originating at the Copper Moki wellsite near Ngaere.

This April 2012 biological survey indicated that there had been minimal effects on the macroinvertebrate communities of the stream following the unauthorised discharge of crude oil.

Despite product observed floating on the surface of the water at all three downstream sampling sites and some minor accumulation of product on overhanging vegetation, no significant differences in taxa richness or MCI scores were recorded between upstream and downstream sites. However, statistically significant differences were recorded in the $SQMCI_s$ scores between sites. In general, this was attributed to variations in the amount of macrophyte habitat at these sites.

A small number of dead mayflies and amphipods were found when live sampling was undertaken approximately 180 metres downstream of the discharge point on the day

following the biological survey, which may have occurred as a result of the unauthorised discharge of product into the tributary. Therefore the effects of the discharge were considered to be minimal. Despite this, the tributary had some ecological values that are typical of lowland streams draining swamp land.

The results from this previous survey are discussed more fully in the report (KS004) listed in the references at the end of this report.

Methods

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from two recently and one newly established sites in the Ngaere Stream (Table 1, Figure 1) on 27 November 2012. The newly established 'control' site (NGR000313) was situated further upstream than the 'control' site (NGR000315) used for the incident survey as it was considered more representative of the reach of the stream unaffected by wellsite activities. The '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 an unnamed tributary of the Ngaere Stream surveyed in association with the Copper Moki Production Station

Site No.	Site code	GPS reference	Location
1	NGR 000313	E1715344 N5638713	270 m d/s of Cheal Road bridge (upstream of Production Station)
2	NGR 000317	E1715370 N5638950	630 m d/s of Cheal Road bridge (downstream of Production Station)
3	NGR 000319	E1715410 N5639016	740 m d/s of Cheal Road bridge (downstream of 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. By averaging the scores obtained from a list of taxa collected from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways.

The MCI was designed as a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. MCI results can also reflect the effects of warm temperatures, slow current speeds and low dissolved oxygen levels, because the taxa capable of tolerating these conditions generally have low sensitivity scores. Usually more 'sensitive' communities (with higher MCI values) inhabit less polluted waterways. The use of this index in non-stony streams is possible if results are related to physical habitat (e.g.,

good quality muddy/weedy sites tend to produce lower MCI values than good quality stony sites). Weedy stream macroinvertebrate communities tend to be dominated by more 'tolerant' taxa than is the case in stony stream communities. It may therefore require more severe organic pollution to cause a significant decline in MCI value in weedy streams.

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.

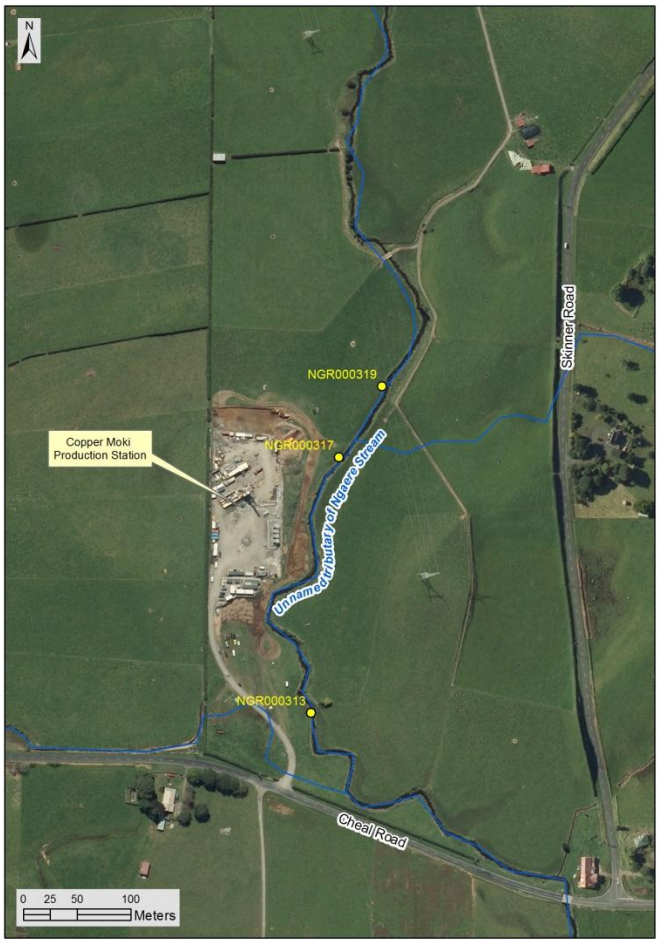

Figure 1 Biological sampling sites in an unnamed tributary of the Ngaere Stream related to the Copper Moki Production Station

Results and discussion

At the time of this early afternoon survey there was a low, steady, cloudy, uncoloured flow in the Ngaere Stream tributary at all three open, unshaded sites. Water temperature ranged from 18.6°C to 19.2°C during this survey. Substrate was similar at the three sites and comprised mainly sand and fine gravels with some wood and silt substrate also present although there was less wood at site 1. Periphyton mats were thin and filaments and moss were patchy at all sites. Macrophyte beds were common on the stream bed at all sites. This survey was undertaken following a period of flow recession, 24 days after the latest fresh in excess of 3x and 7x median flow.

Macroinvertebrate communities

A summary of survey results performed on the one occasion to date at three sites in the Ngaere Stream tributary is presented in Table 2 and the full results of the current survey in Table 3.

Table 2 Summary of previous numbers of taxa and MCI values, together with results of the November, 2012 survey in the Ngaere Stream

Site	Number of previous surveys	Numbers of taxa			MCI values			$SQMCI_S$		
		Median	Range	Current Survey	Median	Range	Current Survey	Median	Range	Current Survey
NGR000313	-	-	-	15	-	-	85	-	-	5.9
NGR000315	1	-	16	-	-	85	-	-	2.5	-
NGR000317	1	-	15	17	-	81	74	-	3.5	5.4
NGR000319	1	-	18	17	-	79	82	-	5.0	3.3

Table 3 Macroinvertebrate fauna of the unnamed tributary of the Ngaere Stream in relation to Copper Moki Production Station sampled on 27 November 2012

Taxa List	Site Number	MCI score	1	2	3
	Site Code		NGR000313	NGR000317	NGR000319
	Sample Number		FWB12446	FWB12447	FWB12448
NEMERTEA	Nemertea	3	-	R	-
ANNELIDA (WORMS)	Oligochaeta	1	A	VA	XA
MOLLUSCA	*Potamopyrgus*	4	A	C	C
CRUSTACEA	Ostracoda	1	-	R	R
	Isopoda	5	R	-	-
	Paracalliope	5	XA	XA	XA
	Paraleptamphopidae	5	-	-	A
	Paranephrops	5	R	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	XA	XA	VA
	Zephlebia group	7	VA	C	C
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	R	-
COLEOPTERA (BEETLES)	Elmidae	6	R	R	R
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	R	R	-
	Hydrobiosis	5	C	A	C
	Psilochorema	6	-	-	R
	Oecetis	4	-	-	R
	Oxyethira	2	R	A	VA
	Triplectides	5	-	-	R
DIPTERA (TRUE FLIES)	*Chironomus*	1	-	R	C
	Harrisius	6	-	-	R
	Orthocladiinae	2	C	C	C
	Polypedilum	3	R	-	-
	Empididae	3	-	R	-
	Austrosimulium	3	C	A	C
	Tanyderidae	4	-	R	-
		No of taxa	15	17	17
		MCI	85	74	82
		SQMCIs	5.9	5.4	3.3
		EPT (taxa)	5	5	6
		%EPT (taxa)	33	29	35
'Tolerant' taxa	'Moderately sensitive' taxa		'Highly sensitive' taxa		

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

Site 1: Upstream of Production Station

A moderate community richness of 15 taxa was recorded at site 3 upstream of the Production Station discharges. This was very similar to the taxa number found by the one earlier survey at the nearby 'control' site (Table 2). The community was characterised by two 'tolerant' taxa [(oligochaete worms and snail (*Potamopyrgus*)] and three 'moderately sensitive' taxa [extremely abundant amphipod (*Paracalliope*), mayfly (*Austroclima*); and another mayfly (*Zephlebia* group)] but no 'highly sensitive' taxa. Many of these taxa are associated with nutrient-enriched habitats in streams coincident with periphyton substrate cover and, in particular, widespread instream macrophyte growth.

The community was comprised of relatively even proportions of 'tolerant' and 'moderately sensitive' taxa resulting in the MCI score of 85 units, identical with the score recorded by the single previous survey at the nearby 'control' site (Table 2). This score was slightly higher than the median score (78 units) found by 167 previous surveys in similar streams at sites of equivalent altitude (TRC, 1999 (updated 2012)). A moderately high $SQMCI_s$ score was recorded for this site (5.9 units), reflecting the numerical dominance by 'moderately sensitive' taxa and, in particular, the predominance of two 'moderately sensitive' taxa (Table 3). This score was toward the maximum of the range found by the previous surveys at equivalent sites.

Site 2: 630 m downstream of Cheal Road bridge

A community richness of seventeen taxa was found at this site, nearly 350 m downstream of site 1 (and below various discharges from the Production Station). This was slightly higher than that found at the 'control' site 1 upstream and similar to the taxa number found by the only previous survey at this site (Table 2). However, there were several differences in dominant taxa composition at this site. Reductions in abundance of the 'moderately sensitive' mayfly (*Zephlebia* group) and 'tolerant' snail (*Potamopyrgus*) were recorded at site 2, while the 'moderately sensitive' caddisfly (*Hydrobiosis*) and 'tolerant' caddisfly (*Oxyethira*) and sandfly (*Austrosimulium*) were all abundant at site 2. This was probably coincident with subtle habitat variability between sites. Again, many of these taxa are associated with nutrient-enriched habitats and particularly macrophyte beds in mid to lower reaches of smaller streams in agricultural catchments.

However, there were relatively few significant changes in individual taxon abundances between sites 1 and 2, and the predominant taxa altered by the addition of only one 'tolerant' taxon at site 2, which was illustrated by the relative similarity between $SQMCI_s$ values which dropped by only 0.5 unit.

'Tolerant' taxa comprised an increased proportion (65% of total taxa) of the community compared with site 1, which was reflected in the MCI score of 74 units. This was 7 units lower than the single previous survey score and a significant (Stark, 1998) eleven units below that recorded at site 1 upstream of all Production Station discharges, while the $SQMCI_s$ values were relatively similar (see above). However, the MCI decrease was related mainly to the presence of four additional 'tolerant' taxa as rarities (i.e. less than 5 individuals per taxon) at site 2 rather than any significant changes in community structure. (These four taxa reduced the MCI score for this site by 6 units). Therefore these results indicate that it is unlikely that there had been any recent significant changes in physicochemical water quality caused by discharges from the Production Station between sites 1 and 2, impacting upon the macroinvertebrate community at site 2.

Site 3: 740 m downstream of Cheal Road bridge

A community richness of seventeen taxa was recorded at site 3, a further 100 m downstream of the various Production Station discharges. This was very similar to the richness found by the earlier previous survey at this site and identical with that recorded at the nearest upstream site (Table 2). The number of characteristic taxa decreased by one taxon compared to those at site 2, and comprised one fewer 'tolerant' taxon and the same number of 'moderately sensitive' taxa as found at site 2.

However, there was only one significant change in individual taxon abundance between adjacent sites 2 and 3 but the numerical increases in 'tolerant' oligochaete worms and caddisfly (*Oxyethira*) and decrease in 'sensitive' mayfly (*Austroclima*) resulted in a decrease in the $SQMCI_s$ value of 2.1 units which was 2.6 units lower than recorded at the 'control' site 1. These changes recorded between sites 1 and 3 and sites 2 and 3 are more likely to have been attributable to variations in habitat characteristics at site 3.

The community was again comprised of relatively even proportions of 'tolerant' and 'moderately sensitive' taxa which was reflected in the MCI score of 82 units. This score was similar to the score from the single previous survey at this site (Table 2). It was not significantly different to the scores recorded at the two sites upstream, and showed an improvement of 8 units between sites 2 and 3 indicative of no recent significant impacts of any Production Station discharges on the macroinvertebrate communities of the tributary of the Ngaere Stream.

Conclusions and summary

The Council's standard 'kick-sampling' technique was used at three established sites to collect streambed macroinvertebrates from an unnamed tributary of the Ngaere Stream, to assess whether any discharges from the Copper Moki Production Station had had any detrimental effects on the macroinvertebrate communities of this stream. This late spring survey was the first of two surveys programmed for the 2012-2013 monitoring period. Samples were sorted and identified to provide the number of taxa (richness) and MCI and $SQMCI_S$ scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects or 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 sites may indicate the degree of adverse effects (if any) of the discharges being monitored.

This late spring macroinvertebrate survey indicated that any discharges of treated stormwater and produced water from the recently established Copper Moki Production Station site had not had any significant recent detrimental effects on the macroinvertebrate communities of the Ngaere Stream tributary. The MCI scores for each site were relatively similar although there was an insignificant decrease immediately downstream of the discharge area. The only significant changes in the macroinvertebrate communities related to abundances of a few individual taxa, mainly as a result of subtle habitat changes between sites. $SQMCI_s$ scores were not significantly different between sites 1 and 2, but a significant decrease between sites 2 and 3 was due to an increased numerical abundance of one 'tolerant' taxon.

The macroinvertebrate communities of the stream contained relatively even proportions of 'tolerant' and 'moderately sensitive' taxa at all sites. In addition, communities at all sites had three common dominant taxa although there was some variation as a result of subtle variations in habitat between sites. There were no significant changes in MCI values between sites, despite some differences in habitat although there was a downstream decrease in MCI score at sites adjacent to the discharge area. In addition, taxonomic richness

(numbers of taxa) was relatively consistent across all three sites. The MCI scores indicated that the stream communities were of 'poor' to 'fair' health, but typical of conditions in comparison with median values recorded from previous surveys at similar sites (TRC, 1999 (updated 2012)). The absence of significant differences between the three sites indicated no recent significant impacts from the Copper Moki Production Station discharges authorised onto adjacent land.

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