TWN Limited Partnership
Waihapa Production Station
Monitoring Programme
Annual Report
2016-2017

Technical Report 2017-53

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Executive summary

TWN Limited Partnership (the Company) operates a petrochemical production station located on Bird Road at Stratford, in the Patea catchment. The Waihapa Production Station processes oil and gas from numerous associated wellsites. This report for the period July 2016 to June 2017 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the Company's environmental and consent compliance performance during the period under review. The report also details the results of the monitoring undertaken and assesses the environmental effects of the Company's activities.

The Company holds three resource consents in relation to the Waihapa Production Station, which include a total of 41 conditions setting out the requirements that the Company must satisfy. The Company holds one consent to discharge treated impounded stormwater from the Waihapa Production Station into the Ngaere Stream and to discharge treated stormwater from perimeter drains to land where it may enter the Ngaere Stream, one consent to abstract water from the Ngaere Stream, and one consent to discharge emissions related to production activities into the air at the site.

During the monitoring period, TWN Limited demonstrated an overall high level of environmental performance.

The Council's monitoring programme for the year under review included five inspections, six water samples collected for physicochemical analysis, two biomonitoring surveys of receiving waters, and two ambient air quality surveys.

Stormwater system inspections showed that discharges from the site at the time complied with consent conditions. Receiving water inspections and sampling showed that the discharges were not causing any adverse effects on the Ngaere Stream at the time of monitoring.

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, PM10 particulates and nitrogen oxides were all below levels of concern at the time of sampling. No offensive or objectionable odours were detected beyond the boundary during inspections and there were no complaints in relation to air emissions from the site.

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

For reference, in the 2016-2017 year, consent holders were found to achieve a high level of environmental performance and compliance for 74% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 21% of the consents, a good level of environmental performance and compliance was achieved.

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

This report includes a recommendation for the 2017-2018 year.

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1 Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period July 2016 to June 2017 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by TWN Limited Partnership (TWNLP). The Company operates the Waihapa Production Station situated on Bird Road at Stratford, in the Patea catchment.

The report includes the results and findings of the monitoring programme implemented by the Council in respect of the consents held by the Company that relate to abstractions and discharges of water within the Patea catchment, and the air discharge permit 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 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 water, land and air, and is the fourth combined annual report by the Council for the Company.

1.1.2 Structure of this report

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

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites though annual programmes;
- the resource consents held by the Company 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 Waihapa 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 2017-2018 monitoring year.

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

1.1.3 The Resource Management Act 1991 and monitoring

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

a. the neighbourhood or the wider community around an activity, and may include cultural and social-economic effects;

b. physical effects on the locality, including landscape, amenity and visual effects;

c. ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;

d. natural and physical resources having special significance (for example recreational, cultural, or aesthetic); and

e. risks to the neighbourhood or environment.

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

1.1.4 Evaluation of environmental and administrative performance

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

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

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

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

Environmental Performance

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

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

For example:

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

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

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

Administrative performance

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

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

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

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

For reference, in the 2016-2017 year, consent holders were found to achieve a high level of environmental performance and compliance for 74% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 21% of the consents, a good level of environmental performance and compliance was achieved.

1.2 Process description

The Waihapa Production Station is located on Bird Road approximately 7.5 km east of Stratford in a rural area which is predominantly used for dairying. The production station processes oil and gas from wells in the surrounding Tariki, Waihapa, and Ngaere (TWN) fields by separating the oil, gas, condensate and water components of each wellsite's production. The produced oil is temporarily stored on site prior to being piped to the Omata tank farm in New Plymouth. The gas is processed, compressed and piped to end users. The produced water is disposed of by deep well injection.

Stormwater from the production station is collected and discharged at three separate points. The water level in the firewater pond in the north western corner of the site is maintained by an abstraction from the Ngaere Stream. Overflow due to rainfall entering this pond is discharged to land and to the Ngaere Stream to the north of the pond. Stormwater from the process areas is directed to a large separator system to the north east of the site. The effluent from this separator is discharged to a small unnamed tributary to the east which joins the Ngaere Stream approximately 40 metres above its confluence with the Patea River. Stormwater from other areas is directed to retention ponds at the northern perimeter. Overflow from these ponds is discharged to the Ngaere Stream to the north. Figure 1 in Section 2.1.2 shows the location of these systems and the related sampling sites.

Photo 1 Waihapa Production Station

1.3 Resource consents

1.3.1 Water abstraction permit

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

TWNLP holds water permit **3767-3**, to take water from the Ngaere Stream for utility and firewater purposes at the Waihapa Production Station. This permit was originally issued by the Council to Swift Energy NZ Ltd on 25 November 1999 under Section 87(d) of the RMA. It was transferred to Origin Energy on 11 April 2008 and then to TWNLP on 13 December 2013. The consent was renewed on 17 March 2016, with an additional eight conditions. The consent is due to expire on 1 June 2034.

There are 11 special conditions attached to the consent.

Condition 1 imposes limits upon the volume of water to be abstracted.

Conditions 2 to 6 deal with the installation and maintenance of a water meter, and the supply of the abstraction data to the Council.

Condition 7 limits the take during low flow.

Condition 8 requires the intake to be screened to avoid fish entering.

Condition 9 requires the installation of a staff gauge and establishment of a low flow rating curve.

Conditions 10 and 11 deal with lapse and review of the consent.

The permit is attached to this report in Appendix I.

1.3.2 Water discharge permit

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

TWNLP holds water discharge permit **3457-2** to discharge treated impounded stormwater [including washdown water and minor quantities of process water subject to potential contamination by hydrocarbons] from the Waihapa Production Station into the Ngaere Stream and to discharge treated stormwater from perimeter drains to land where it may enter the Ngaere Stream. This permit was issued by the Council to Origin Energy on 27 September 2009 as a resource consent under Section 87(e) of the RMA. It was transferred to TWNLP on 13 December 2013, and is due to expire on 1 June 2028.

There are 12 special conditions attached to this consent.

Condition 1 requires the adoption of the best practicable option.

Condition 2 limits the stormwater catchment area to 5 hectares.

Condition 3 requires maintenance of a contingency plan.

Condition 4 relates to management and maintenance of the stormwater treatment system.

Condition 5 requires all stormwater and produced water to be treated.

Condition 6 requires hazardous substance storage areas to be bunded.

Conditions 7, 8 and 9 impose limits upon contaminants in the discharge and adverse effects on the receiving waters.

Condition 10 concerns the provision of sampling results.

Condition 11 requires the consent holder to remedy any erosion.

Condition 12 is a review provision.

The permit is attached to this report in Appendix I.

1.3.3 Air discharge permit

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

TWNLP holds air discharge permit **4049-3** to discharge emissions into the air from the flaring of hydrocarbons at the Waihapa Production Station in association with production, processing and maintenance activities and in emergency situations, together with miscellaneous emissions. This permit was issued by the Council to Origin Energy on 6 October 2009 as a resource consent under Section 87(e) of the RMA. It was transferred to TWNLP on 13 December 2013, and is due to expire on 1 June 2028.

There are 18 special conditions attached to this consent.

Condition 1 requires the adoption of the best practicable option.

Conditions 2 to 5 concern record keeping and reporting.

Conditions 6 to 9 concern information and notifications.

Conditions 10 to 12 require the consent holder to take steps to minimise the effects of emissions and flaring.

Conditions 13 to 17 relate to levels of contaminants at or beyond the boundary.

Condition 18 is a review provision.

The permit is attached to this report in Appendix I.

This summary of consent conditions may not reflect the full requirements of each condition. The consent conditions in full can be found in the resource consent(s) which is/are appended to this report.

1.3.4 Wellsite consents

TWNLP, in conjunction with a number of related companies, also holds consents for production activities at wellsites associated with the Waihapa Production Station. A summary of these consents is provided in Table 1.

Table 1 Consents for production activities at wellsites associated with the Waihapa Production Station

Wellsite	Consent number	Purpose	Issue date	Expiry
Goss-A	6561-1	To discharge emissions to air during flaring from well workovers and in emergency situations and miscellaneous emissions associated with production activities at the Goss-A wellsite	31/03/2005	2022
	6562-1	To discharge treated stormwater and treated produced water from hydrocarbon exploration and production operations at the Goss-A wellsite onto and into land in the vicinity of an unnamed tributary of the Ngaere Stream in the Patea catchment	31/03/2005	2022
Ngaere-F	4162-2	To discharge treated stormwater and produced water from hydrocarbon exploration and production operations onto and into land in the vicinity of the Patea River	9/09/2010	2028
Tariki-A	3679-2	To discharge treated stormwater, uncontaminated treated site water and uncontaminated treated production water from hydrocarbon exploration and production operations at the Tariki-A wellsite onto and into land and into and unnamed tributary of the Mako Stream in the Waitara catchment	09/06/2003	2033
Tariki-B	3680-2	To discharge treated stormwater, uncontaminated treated site water and uncontaminated treated production water from hydrocarbon exploration and production operations at the Tariki-B wellsite onto and into land and into and unnamed tributary of the Mako Stream in the Waitara catchment	09/06/2003	2033
Kupara North (Tariki-C)	5273-2	To discharge treated stormwater from hydrocarbon exploration and production operations at the Kurapa North wellsite onto land and into an unnamed tributary of Lake Ratapiko	04/02/1998	2033
	5456-3	To discharge emissions into the air from the flaring of gas together with miscellaneous emissions arising from hydrocarbon production operations from the Tariki-2C well on the Kupara North wellsite	27/08/2007	2021
Tariki-D	6202-1	To discharge emissions to air during flaring from well workovers and in emergency situations associated with production activities from the Tariki-D wellsite	10/09/2003	2021

Wellsite	Consent number	Purpose	Issue date	Expiry
Tariki-D	6203-1	To discharge treated stormwater and treated produced water from hydrocarbon exploration and production operations at the Tariki-D wellsite onto and into land and into an unnamed tributary of Lake Ratapiko in the Waitara catchment	10/09/2003	2021
Toko-B	4201-2	To discharge treated stormwater and produced water from hydrocarbon exploration and production operations into an unnamed tributary of the Patea River	16/09/2010	2028
Toko-D	4470-2	To discharge treated stormwater and produced water from hydrocarbon exploration and production operations onto and into land in the vicinity of an unnamed tributary of the Patea River	15/09/2010	2028
Toko-E	4474-2	To discharge treated stormwater and produced water from hydrocarbon exploration and production operations into an unnamed tributary of the Manawawiri Stream in the Patea catchment	17/09/2010	2028
Waihapa-A	3683-2	To discharge treated stormwater, uncontaminated treated site water and uncontaminated treated production water from hydrocarbon exploration and production operations at the Waihapa-A wellsite onto and into land and into an unnamed tributary of the Waihapa Stream in the Patea catchment	09/06/2003	2034
Waihapa-B	3684-2	To discharge treated stormwater, uncontaminated treated site water and uncontaminated treated production water from hydrocarbon exploration and production operations at the Waihapa-B wellsite onto and into land and into an unnamed tributary of the Ngaere Stream in the Patea catchment	09/06/2003	2034
Waihapa-C	3685-2	To discharge treated stormwater, uncontaminated treated site water and uncontaminated treated production water from hydrocarbon exploration and production operations at the Waihapa-C wellsite onto and into land and into an unnamed tributary in the Patea catchment	09/06/2003	2034
Waihapa-D	3686-2	To discharge treated stormwater, uncontaminated treated site water and uncontaminated treated production water form hydrocarbon exploration and production operations at the Waihapa-D wellsite onto and into land and into an unnamed tributary of the Ngaere Stream in the Patea catchment	09/06/2003	2034
Waihapa-E	3687-2	To discharge treated stormwater, uncontaminated treated site water and uncontaminated treated production water from hydrocarbon exploration and production operations at the Waihapa-E wellsite onto and into land and into an unnamed tributary of the Ngaere Stream in the Patea catchment	09/06/2003	2034
Waihapa-F	4093-2	To discharge treated stormwater and produced water from hydrocarbon exploration and production operations onto and into land in the vicinity of the Ngaere Stream	10/09/2010	2028

Wellsite	Consent number	Purpose	Issue date	Expiry
Waihapa-G	6848-1	To discharge emissions to air during flaring from well workovers and in emergency situations and miscellaneous emissions associated with production activities at the Waihapa-G wellsite	06/04/2006	2022
	7846-1	To discharge treated stormwater and production water from hydrocarbon exploration and production operations at the Waihapa-G wellsite onto and into land in the vicinity of an unnamed tributary of the Ngaere Stream	22/06/2011	2028
	7850-1	To take water from the Ngaere Stream for wellsite and well drilling activities during hydrocarbon exploration and production activities at the Waihapa-G wellsite	22/06/2011	2022
Waihapa-H	6854-1	To discharge emissions to air during flaring from well workovers and in emergency situations and miscellaneous emissions associated with production activities at the Waihapa-H wellsite	03/04/2006	2022
	6855-1	To discharge treated stormwater and treated produced water from hydrocarbon exploration and production operations at the Waihapa-H wellsite onto and into land	03/04/2006	2022
	6859-1	To take water from from the Ngaere Stream in the Patea catchment for hydrocarbon exploration purposes associated with the Waihapa-H wellsite	03/04/2006	2022
Various	7518-1	To discharge emissions to air during flaring from well workovers and in emergency situations associated with production activities at established wellsites [Waihapa-A, B, C, D, E and F; Toko-B, D and E, Tariki-A and Ahuroa-B], together with miscellaneous emissions	06/10/2009	2028

1.4 Monitoring programme

1.4.1 Introduction

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

The Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations and seek information from consent holders.

The monitoring programme for the Waihapa Production Station site consisted of four primary components.

1.4.2 Programme liaison and management

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

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- in discussion over monitoring requirements;
- preparation for any consent reviews, renewals or new consent applications;

- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

1.4.3 Site inspections

The Waihapa Production Station was visited five times during the monitoring period. With regard to consents for the abstraction of or discharge to water, the main points of interest were plant processes with potential or actual discharges to receiving watercourses, including contaminated stormwater and process wastewaters. Air inspections focused on plant processes with associated actual and potential emission sources and characteristics, including potential odour, dust, noxious or offensive emissions. Sources of data being collected by the Company 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 Council undertook sampling of both the discharges from the site and the water quality upstream and downstream of the discharge point and mixing zone.

The three production station discharges were sampled on one occasion, and the samples analysed for chlorides, conductivity, hydrocarbons, pH, suspended solids and turbidity. The Ngaere Stream was sampled concurrently, and the samples analysed for the same constituents.

The Council also undertook sampling of the ambient air quality outside the boundary of the site. A multi-gas meter was deployed on one occasion in the vicinity of the plant, with monitoring consisting of continuous measurements of gas concentrations for the gases of interest (carbon monoxide and combustible gases). A PM10 particulate monitor was deployed concurrently with the multi-gas meter. Two nitrogen oxide measuring devices were also deployed in the vicinity of the plant on one occasion during the year under review. The Company supplied data on flaring causes and flare volumes throughout the period.

1.4.5 Biomonitoring surveys

A biological survey was performed on two occasions in the Ngaere Stream to determine whether or not the discharge of stormwater from the Waihapa Production Station was having a detrimental effect upon the communities of the stream.

2 Results

2.1 Water

2.1.1 Inspections

Five inspections were undertaken at the Waihapa Production Station during the period under review, along with an annual inspection at the associated wellsites. The following was found during the inspections:

22 August 2016

The site was inspected after recent spell of good weather. The fire water pond was clear of any contaminants, and separators and bunds were clear. The truck load out area was secure. The DWI site was clean and tidy.

Minimal flaring was being undertaken at the time of the inspection with no smoke or odours noted.

21 October 2016

The site was found to be neat and tidy. A large population of frogs was noted in the various separators, indicating good water quality. The deepwell injection well was being utilised with no above ground effects observed.

Minimal flaring was being undertaken at the time of the inspection and this was not resulting in any smoke or odours off site.

16 January 2017

The site was neat and tidy. Bunds and ring drains were clear of contaminants and frogs were present in the stormwater system, giving an indication of good water quality.

Minimal flaring was observed with no smoke or odours noted.

28 February 2017

The site was neat and tidy. The stormwater system was satisfactory with frogs and other aquatic species evident in the skimmer pit. There was no off site discharge occurring.

Minimal flaring was occurring at the time of the inspection with no effects or odours noted.

2 May 2017

The site was neat and tidy. The fire water pond level appeared to be a bit lower than normal but the water was clear. The separator was clear of contaminants, with a healthy population of frogs in residence. The area around the deep well reinjection site was clear of any contaminants.

A pilot flare was in operation at the time of the inspection with no odours or smoke observed.

2.1.2 Results of discharge monitoring

Water quality sampling of the discharges to the Ngaere Stream was undertaken on one occasion during the 2016-2017 period. The sampling sites are shown in Figure 1 while Table 2 presents the results of this sampling.

Table 2 Monitoring results for discharges from the Waihapa Production Station on 12 May 2017

Parameter	Units	Firewater pond STW001058	Stormwater IND002019	API separator IND001026	Consent 3457-2 limits
Chloride	g/m^3	29.2	<0.2	7.6	50
Conductivity	mS/m	15.2	0.6	8.6	-
Hydrocarbons	g/m^3	<0.5	<0.5	<0.5	15
pH		6.8	6.5	6.8	6.0 – 9.0
Suspended solids	g/m^3	4	<2	<2	100
Turbidity	NTU	4.6	1.4	0.66	-
Temperature	Deg.C	13.8	11.9	13.7	-

The results are indicative of very clean discharges at the time of sampling, with parameters compliant with the limits imposed by consent 3457-2.

The Company undertook sampling of impounded stormwater prior to release into the Ngaere Stream to ensure compliance with consent conditions. There were 12 samples collected during the 2016-2017 year. Results of this monitoring are summarized in Table 3.

The Company's results show consistently clean stormwater with results for all parameters well within the consent limits. The Company does not discharge impounded water to the Ngaere Stream unless it is within the limits imposed by consent 3457-2.

Table 3 Monitoring results for impounded stormwater tested by TWNLP in 2016-2017 (n=12)

Parameter	Units	Min	Max	Median	Consent 3457-1 limits	Number of exceedances
Chloride	g/m^3	13.8	48.4	23.1	50	0
Hydrocarbons	g/m^3	<1	1.8	<1	15	0
pH		6.0	7.8	6.7	6.0 – 9.0	0
Suspended solids	g/m^3	2	26	12	100	0

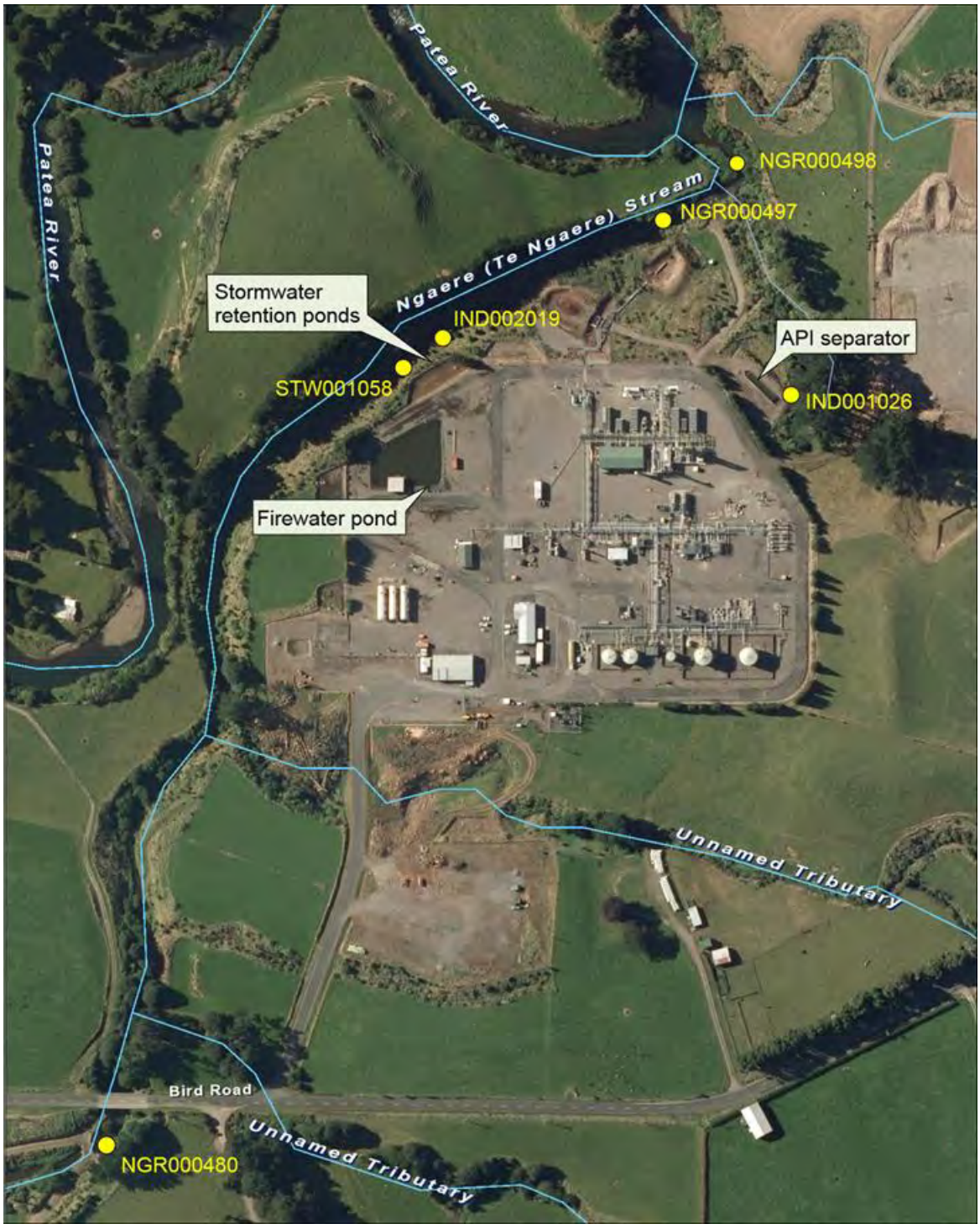

Figure 1 Waihapa Production Station stormwater systems and monitoring sites

2.1.3 Results of receiving environment monitoring

2.1.3.1 Chemical

Water quality sampling of the Ngaere Stream was undertaken in conjunction with stormwater discharge sampling. The results are presented in Table 4. The sampling sites are shown in Figure 1 and include upstream, intermediate and downstream points. The intermediate site is situated below the firewater and general site discharges and above the confluence with the tributary carrying the API separator discharge.

Table 4 Receiving environment results for Ngaere Stream on 12 May 2017

Parameter	Units	Upstream NGR000480	Intermediate NGR000497	Downstream NGR000498	Consent 3457-2 conditions
Chloride	g/m^3	16.9	16.9	16.5	-
Conductivity	mS/m	16.5	16.5	16.3	-
Hydrocarbons	g/m^3	<0.5	<0.5	<0.5	No conspicuous oil films or foams
pH		6.5	6.5	6.5	-
Suspended solids	g/m^3	100	19	19	No conspicuous change
Turbidity	NTU	48	16	16	No conspicuous change
Temperature	deg. C	13.9	13.9	13.9	<2 deg. C increase

The results indicate that the discharges from the Waihapa Production Station were not having a negative impact on the water quality of the Ngaere Stream and were in compliance with the conditions of consent 3457-2 at the time of sampling.

2.1.3.2 Biomonitoring

The Council's standard 'kick-sampling' technique was used at three established sites to collect streambed macroinvertebrates from the Ngaere Stream on 19 December 2016 and 6 March 2017. Samples were processed to provide number of taxa (richness), MCI and $SQMCI_S$ scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_S$ takes into account taxa abundance as well as sensitivity to pollution, and may reveal more subtle changes in communities. It may be the more appropriate index if non-organic impacts are occurring.

Significant differences in either the MCI or the $SQMCI_S$ between sites indicate the degree of adverse effects (if any) of the discharges being monitored.

Both surveys recorded taxa richnesses and MCI scores that were not significantly different between sites. These scores were also not significantly different from the previous survey or from median scores for each site. In the spring survey $SQMCI_s$ scores at sites 3 and 5 were similar to each other, while the score recorded at site 4 was significantly lower than at either site 3 or site 5. While in the Autumn survey MCI scores were similar to those recorded in the preceding survey at sites 3 and 4, but significantly lower than the preceding score at site 5. $SQMCI_s$ scores at sites 3 and 5 were significantly different from each other, while no other significant differences between sites were recorded. $SQMCI_s$ scores were similar to median scores at all sites.

However, $SQMCI_s$ scores have the potential to be strongly influenced by the patchy spatial nature of macroinvertebrate distributions within the community, and must therefore be considered together with other macroinvertebrate community metrics. When MCI, taxa richnesses and $SQMCI_s$ scores are considered together, there was no evidence that discharges from the Waihapa Production Station had caused any recent detrimental impacts on the macroinvertebrate communities of the Ngaere Stream.

The full biomonitoring reports are attached to this report in Appendix II.

2.1.4 Summary of water abstractions reported by TWNLP

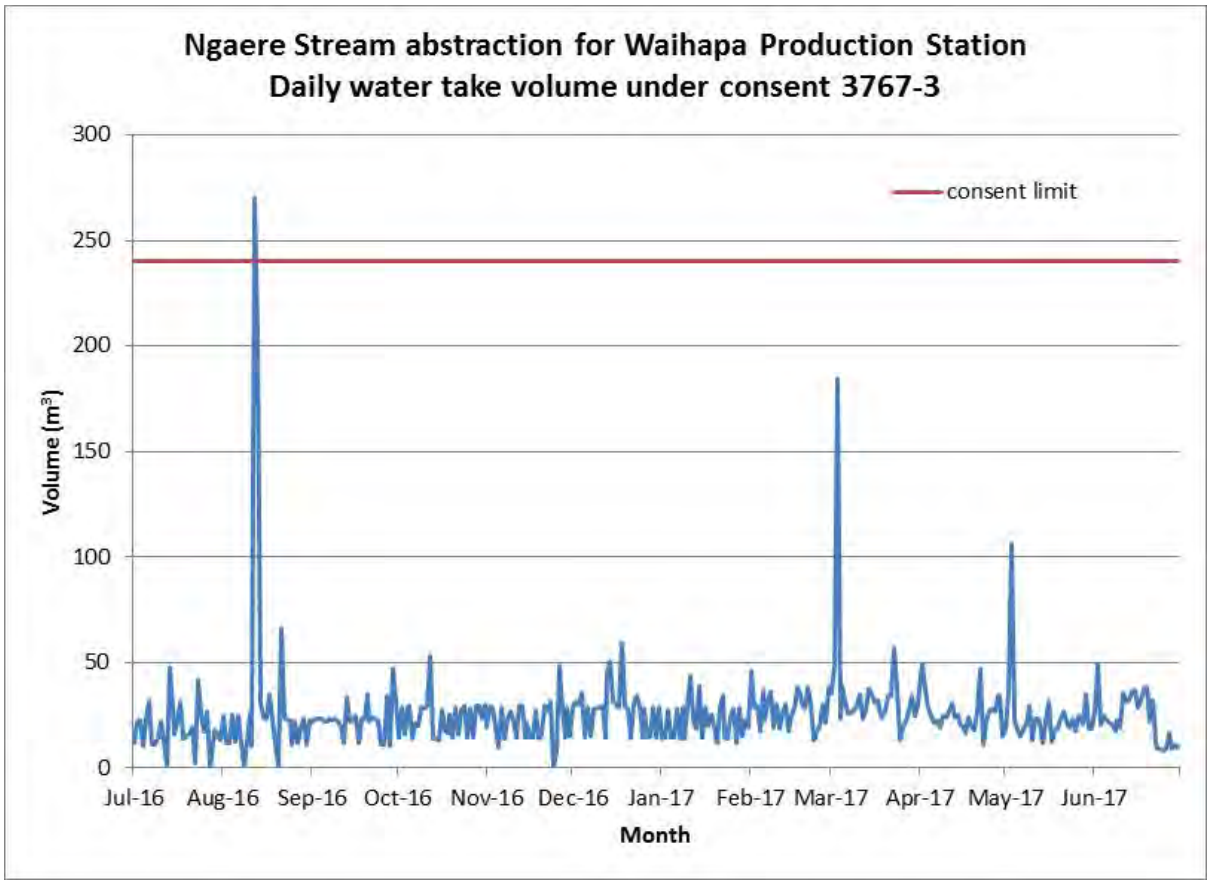

Figure 2 Daily water abstraction volumes for Waihapa Production Station under consent 3767-3

Figure 2 provides a summary of the abstraction volumes for the consented water take from the Ngaere Stream for utility and firewater purposes at the Waihapa Production Station. The majority of the abstraction volumes and rates were within the limits stipulated by consent 3767-3. The minor exceedances recorded on 12 and 13 August 2016 were due to the pump being left running to prevent the pipes from freezing in extremely cold weather.

No water was abstracted under the water take consents for the Waihapa-H (consent 6859-1) or Waihapa-G (7850-1) sites during the period under review.

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 year.

2.2.2 Results of receiving environment monitoring

2.2.2.1 Carbon monoxide and combustible gases

During the monitoring year, a multi-gas meter was deployed on one occasion in the vicinity of the plant. The deployment lasted approximately 44 hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continuous measurements of gas concentrations for the

gases of interest (carbon monoxide and combustible gases). The monitoring sites used in the year under review are shown in Figure 3.

Figure 3 Air monitoring sites at Waihapa Production Station for 2016-2017

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.

The details of the sample run are summarised in Table 5 and the data from the sample run are presented graphically in Figure 4.

The consent covering air discharges from the Waihapa Production Station has specific limits related to particular gases. Special condition 15 of consent 4049-3 sets a limit on the carbon monoxide concentration at or beyond the production station's boundary. The limit is expressed as 10 mg/m^3 for an eight hour average or 30 mg/m^3 for a one hour average exposure. The maximum concentration of carbon monoxide found during the monitoring run was 5.8 mg/m^3 while the average concentration for the entire dataset was 0.23 mg/m^3 which comply with consent conditions. This is in line with the pattern found in previous years.

Table 5 Results of carbon monoxide and LEL monitoring at Waihapa Production Station

Parameter		8 to 10 May 2017
Max	CO (mg/m^3)	5.84
	LEL(%)	0.20
Mean	CO (mg/m^3)	0.23
	LEL(%)	0.00
Min	CO (mg/m^3)	0.00
	LEL(%)	0.00

Notes: (1) the instrument records in units of ppm. At 25°C and 1 atm, 1ppm CO = 1.145 mg/m^3
(2) because the LEL of methane is equivalent to a mixture of approximately 5% methane in air, then the actual concentration of methane in air can be obtained by dividing the percentage LEL by 20.

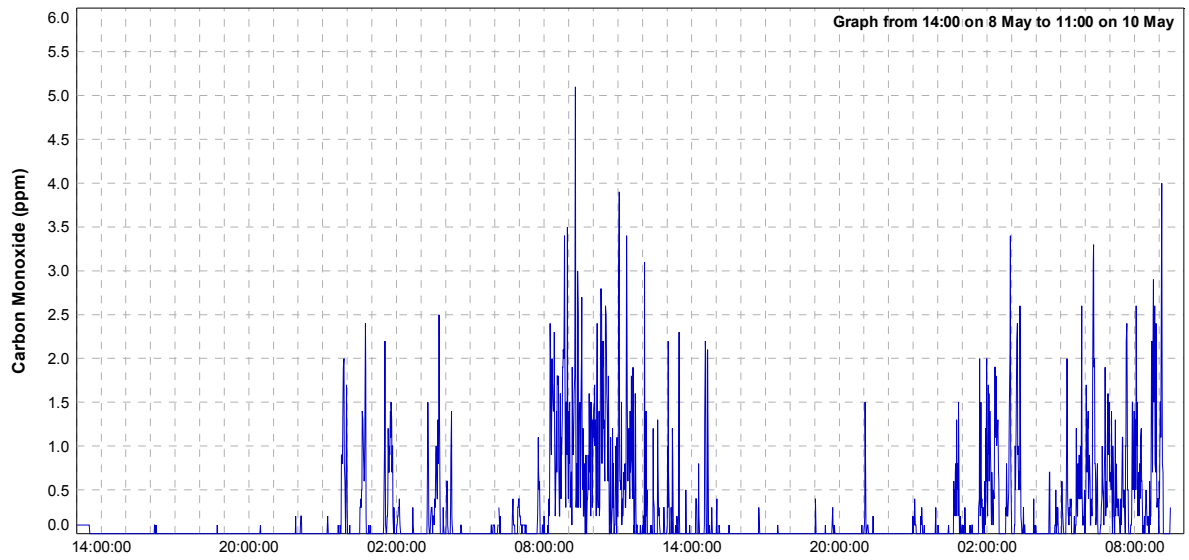

Figure 4 Ambient CO levels in the vicinity of Waihapa Production Station

For comparison, environmental monitoring of ambient carbon monoxide levels in Stratford township has shown average levels of less than 1 mg/m^3, while the peak eight hour average carbon monoxide concentration recorded at the Northgate-Mangorei Rd intersection in New Plymouth during a 2015 survey was 2.7 mg/m^3.

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

2.2.2.2 PM10 particulates

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

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

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

During the reporting period a DustTrak PM10 monitor was deployed on one occasion in the vicinity of Waihapa Production Station. The deployment lasted approximately 21 hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continual measurements of PM10 concentrations. The location of the DustTrak monitor during the sampling run is shown in Figure 3. The results of the sample run are presented in Figure 5 and Table 6.

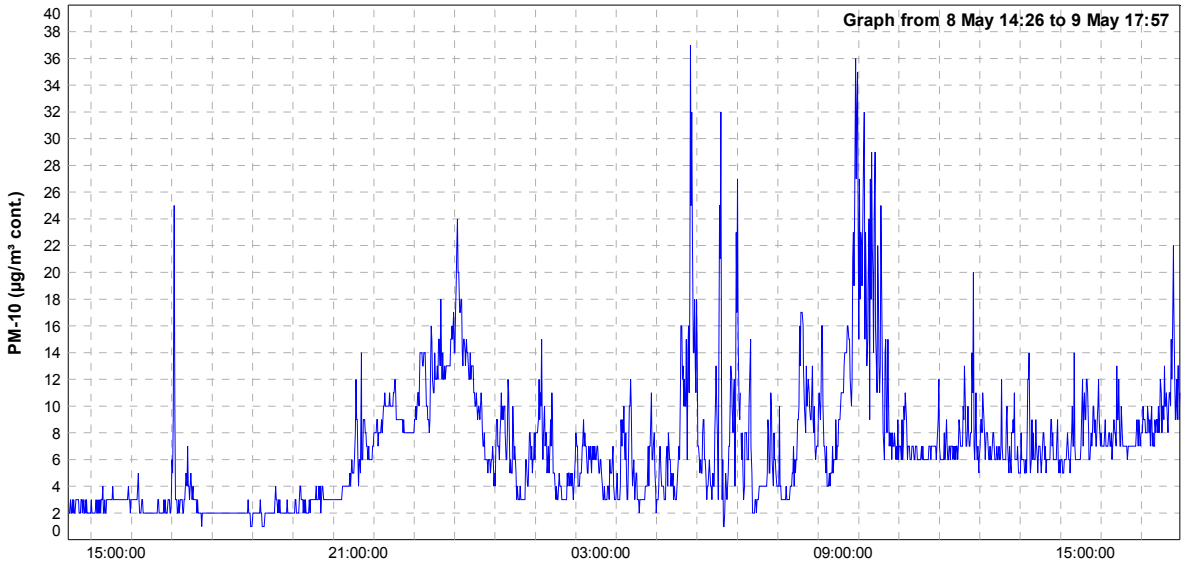

Figure 5 PM10 concentrations (µg/m³) at the Waihapa production station 2016-17

Table 6 Daily averages of PM10 results from monitoring at Waihapa Production Station

	(21 hours) (08-09/05/2017)	
24 hr. set	Day 1	Day 2
Daily average	6.9 µg/m³	N/A
NES	50µg/m³	

During the 21-hour run, from 8 to 9 of May 2017, the average recorded PM10 concentration for the 21 hour period was 6.9 µg/m³. This daily mean equates to 14% of the 50 µg/m³ value that is set by the National Environmental Standard. Background levels of PM10 in the region have been found to be typically around 11 µg/m³.

2.2.2.3 Nitrogen oxides

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

The consent covering air discharges from the Waihapa Production Station has specific limits related to particular gases. Special condition 16 of consent 4049-3 sets a limit on the nitrogen dioxide concentration at or beyond the production station's boundary. The limit is expressed as 200 µg/m³ for a 1-hour average or 100 µg/m³ for a 24-hour average exposure.

NOx passive adsorption discs were place at two locations in the vicinity of the Waihapa Production Station on one occasion during the year under review. The discs were left in place for a period of 21 days. The calculated 1-hour and 24-hour theoretical maximum NOx concentrations found at Waihapa Production Station during the year under review equate to 6.8 µg/m³ and 3.6 µg/m³, respectively. The results show that the ambient ground level concentration of NOx is well below the limits set out by consent 4049-3.

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

2.2.3 Summary of flaring volumes reported by TWNLP

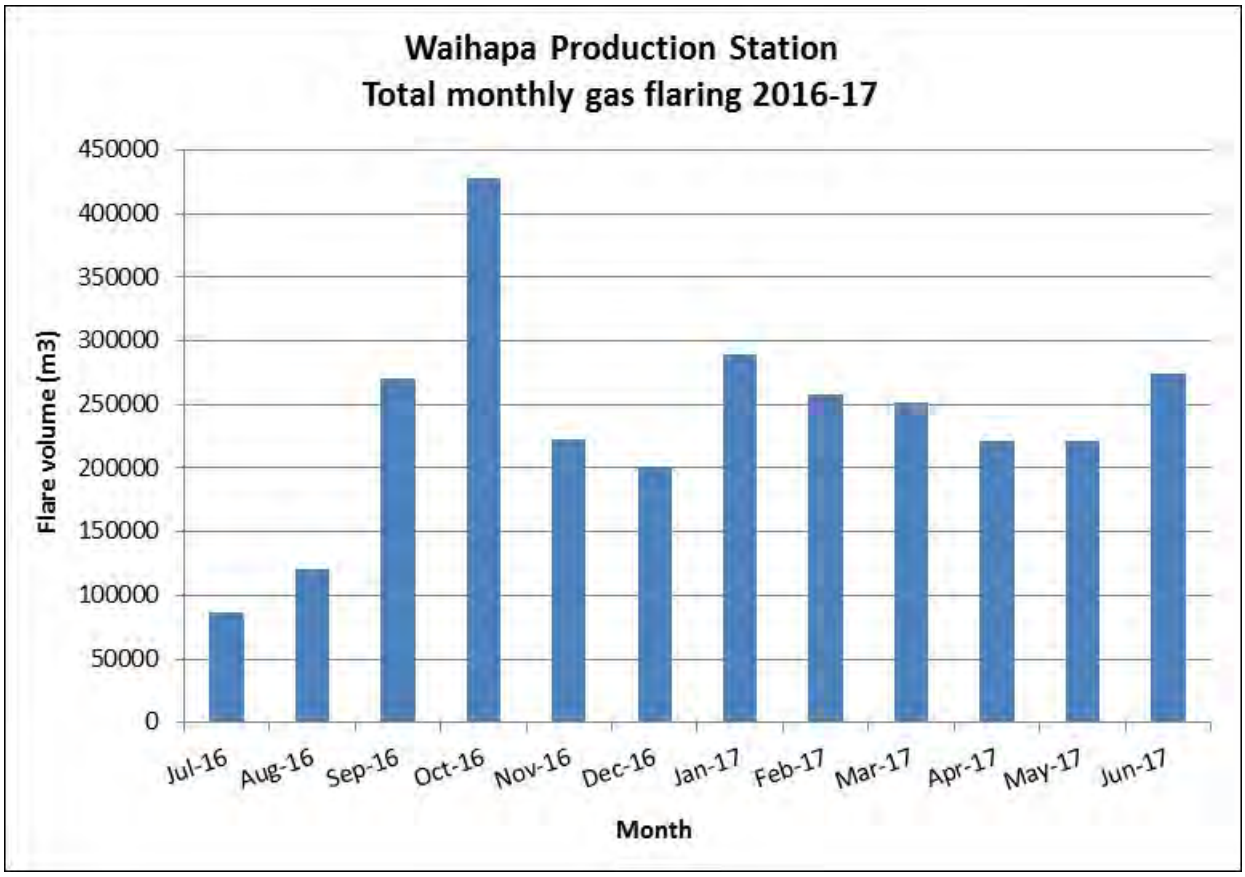

Figure 6 Monthly gas flaring for Waihapa Production Station under consent 4049-3

A summary of flaring volumes at Waihapa Production Station is provided in Figure 6. Routine operational flaring of process gas at Waihapa Production Station is continuous and occurs under normal conditions in a low pressure flare. No visible smoke events were recorded and no complaints were received by the Company or the Council during the 2016-2017 period.

2.3 Investigations, interventions, and incidents

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

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

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

In the 2016-2017 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.

3 Discussion

3.1 Discussion of site performance

Monitoring of the Waihapa Production Station during the 2016-2017 year found that the site was well managed. All consent conditions relating to site operations and management were complied with.

3.2 Environmental effects of exercise of consents

Stormwater system inspections showed that discharges from the site at the time complied with consent conditions. Receiving water inspections and sampling showed that the discharges were not causing any adverse effects on the Ngaere Stream at the time of monitoring.

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, PM10 particulates and nitrogen oxides were all below levels of concern at the time of sampling. No offensive or objectionable odours were detected beyond the boundary during inspections and there were no complaints in relation to air emissions from the site.

3.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Tables 7-9.

Table 7 Summary of performance for consent 3457-2

Purpose: ***To discharge treated impounded stormwater [including washdown water and minor quantities of process water subject to potential contamination by hydrocarbons] from the Waihapa Production Station into the Ngaere Stream and to discharge treated stormwater from perimeter drains to land where it may enter the Ngaere Stream***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Adoption of best practicable option	Site inspection	Yes
2. Catchment area not to exceed 5 ha	Site inspection and liaison with consent holder	Yes
3. Maintenance of a contingency plan	Plan up to date as of May 2016	Yes
4. Maintenance and management of the stormwater system in accordance with application documentation	Site inspection and liaison with consent holder	Yes
5. All stormwater and produced water to be treated	Site inspection	Yes
6. Bunding of hazardous substances	Site inspection	Yes
7. Limits on contaminants in the discharge	Sampling	Yes

Purpose: *To discharge treated impounded stormwater [including washdown water and minor quantities of process water subject to potential contamination by hydrocarbons] from the Waihapa Production Station into the Ngaere Stream and to discharge treated stormwater from perimeter drains to land where it may enter the Ngaere Stream*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
8. Limit on temperature increase in receiving water	Sampling	Yes
9. Discharge shall not have certain effects on the receiving water	Sampling and inspection	Yes
10. Monitoring data to be made available upon request	Data received	Yes
11. Consent holder to remedy any erosion	Site inspections - no erosion noted	Yes
12. Optional review provision re environmental effects	Not scheduled for consideration during year under review. Next consideration June 2022	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent Overall assessment of administrative performance in respect of this consent		**High** **High**

N/A = not applicable

Table 8 Summary of performance for consent 3767-3

Purpose: *To take water from the Ngaere Stream for utility and firewater purposes at the Waihapa Production Station*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Limit on abstraction rate and volume	Review of abstraction data	Yes. Two minor exceedances were justified and not significant
2. Water meter to be installed and maintained	Inspections and liaison with consent holder	Yes
3. Provision of water meter certification within 30 days and then every 5 years	Documentation obtained in April 2015, next due before April 2020	Yes
4. Notify Council of recording equipment failure	Liaison with consent holder, no issues during monitoring period	Yes
5. Consent holder to provide access to water meter	Site inspections	Yes
6. Abstraction records to be provided to Council by 31 July annually	Records received	Yes
7. Take to cease when Ngaere Stream flow is below 20 l/s	Ratings curve to be established during 2017-2018	N/A

Purpose: *To take water from the Ngaere Stream for utility and firewater purposes at the Waihapa Production Station*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
8. Intake to be screened	Site inspections	Yes
9. Installation of staff gauge to determine flow	Installed in November 2016	Yes
10. Lapse of consent	Consent exercised	N/A
11. Review of consent	Not scheduled for consideration during year under review. Next consideration June 2019	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent Overall assessment of administrative performance in respect of this consent		**High** **High**

Table 9 Summary of performance for consent 4049-3

Purpose: *To discharge emissions into the air from the flaring of hydrocarbons at the Waihapa Production Station in association with production, processing and maintenance activities and in emergency situations, together with miscellaneous emissions*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Adoption of best practicable option	Site inspection	Yes
2. Provision of monthly flaring information	Information received	Yes
3. Annual report on flaring and emissions	Report received	Yes
4. Maintenance of a flaring log	Site inspection	Yes
5. Record of smoke emitting incidents and complaints	Site inspection and liaison with consent holder	Yes
6. Analysis of typical gas/condensate stream to be made available	Not requested	N/A
7. Consultation prior to plant alterations	Liaison with consent holder	Yes
8. Notification of hazardous situations beyond the site boundary	Liaison with consent holder	Yes
9. Notification prior to flaring	Notifications received	Yes
10. Minimise emissions	Site inspection and liaison with consent holder	Yes
11. Minimise flaring	Site inspection and liaison with consent holder	Yes
12. Control of plant depressurisation rate	Site inspection and liaison with consent holder	Yes

Purpose: *To discharge emissions into the air from the flaring of hydrocarbons at the Waihapa Production Station in association with production, processing and maintenance activities and in emergency situations, together with miscellaneous emissions*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
13. No offensive/ objectionable/obnoxious odour/dust/smoke at or beyond the site boundary	Site inspection and air monitoring	Yes
14. Discharged contaminants shall not be hazardous/ toxic/noxious at or beyond the site boundary	Site inspections and air monitoring	Yes
15. Limit on carbon monoxide at or beyond the site boundary	Air monitoring	Yes
16. Limit on nitrogen dioxide at or beyond the site boundary	Air monitoring	Yes
17. Limit on contaminants at or beyond the site boundary	Air monitoring	Yes
18. Optional review of consent	Not scheduled for consideration during year under review. Next consideration June 2022	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent Overall assessment of administrative performance in respect of this consent		**High** **High**

Table 10 Evaluation of environmental performance over time

Year	Consent no	High	Good	Improvement req	Poor
2013-14	3457-2	1			
	3767-2	1			
	4049-3	1			
2014-15	3457-2	1			
	3767-2	1			
	4049-3	1			
2015-16	3457-2	1			
	3767-2, 3767-3	1			
	4049-3	1			
Totals		9	0	0	0

During the year, 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. There were no unauthorised incidents recorded by the Council in relation to the Company's activities. The Waihapa Production Station and associated wellsites were well managed and maintained.

3.4 Recommendations from the 2015-2016 Annual Report

In the 2015-2016 Annual Report, it was recommended:

1. THAT monitoring of consented activities at the Waihapa Production Station and associated facilities in the 2016-2017 year continue at the same level as in 2015-2016.

This recommendation was implemented.

3.5 Alterations to monitoring programmes for 2017-2018

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

- the extent of information made available by previous authorities;
- its relevance under the RMA;
- its obligations to monitor emissions/discharges and effects under the RMA; and
- to report to the regional community.

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

It is proposed that for 2017-2018 the monitoring programme remains unchanged from that of 2016-2017.

4 Recommendation

1. THAT monitoring of consented activities at the Waihapa Production Station and associated facilities in the 2017-2018 year continue at the same level as in 2016-2017.

Glossary of common terms and abbreviations

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

Biomonitoring	Assessing the health of the environment using aquatic organisms.
Bund	A wall around a tank to contain its contents in the case of a leak.
Conductivity	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
DWI	Deep well injection.
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.
Incident Register	The Incident Register contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
L/s	Litres per second.
LEL	Lower Explosive Limit. The percentage of the lower explosive limit, expressed as methane, that is detected in the air sampled
m^2	Square Metres.
mg/m3	Milligrams per cubic metre
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.
NES	National Environmental Standards
NOx	Nitrogen oxides
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
O&G	Oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons).
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.

Physicochemical	Measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment.
$PM_{10,}$	Relatively fine airborne particles (less than 10 micrometre diameter).
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).
RMA	*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.

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

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Appendix I

Resource consents held by TWN Limited Partnership

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

Discharge Permit

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

Name of Consent Holder:	TWN Limited Partnership P O Box 8440 NEW PLYMOUTH 4342
Decision Date:	27 July 2009
Commencement Date:	27 July 2009

Conditions of Consent

Consent Granted:	To discharge treated impounded stormwater [including washdown water and minor quantities of process water subject to potential contamination by hydrocarbons] from the Waihapa Production Station into the Ngaere Stream and to discharge treated stormwater from perimeter drains to land where it may enter the Ngaere Stream at or about (NZTM) 1717334E-5642168N
Expiry Date:	1 June 2028
Review Date(s):	June 2016, June 2022
Site Location:	Waihapa Production Station, Bird Road, Stratford
Legal Description:	Sec 10 Blk III Ngaere SD
Catchment:	Patea
Tributary:	Ngaere

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

General conditions

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

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

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

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

Special conditions

1. Notwithstanding any other condition of this consent, 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 5 hectares.

3. The consent holder shall maintain a contingency plan outlining measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not licensed by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge. No changes shall be made to the contingency plan without the prior approval of the Chief Executive, Taranaki Regional Council.

4. The management and maintenance of the stormwater treatment system shall be undertaken in general accordance with the information submitted in support of consent application 5217.

5. All stormwater and produced water shall be directed for treatment through the stormwater treatment system, identified under condition 4 of this consent, before being discharged.

6. Any above ground hazardous substances storage areas shall be bunded with drainage to an appropriate treatment system.

7. Constituents of the discharge shall meet the standards shown in the following table.

Constituent	Standard
pH	Within the range 6.0 to 9.0
suspended solids	Concentration not greater than 100 gm^{-3}
total recoverable hydrocarbons	Concentration not greater than 15 gm^{-3}
chloride	Concentration not greater than 50 gm^{-3}

This condition shall apply before entry of the treated stormwater into the receiving waters of the Ngaere Stream, or onto/into land, at a designated sampling point(s) approved by the Chief Executive, Taranaki Regional Council.

8. After allowing for a mixing zone of 25 metres, the discharge shall not give rise to an increase in temperature of more than 2 degrees Celsius within the Ngaere Stream.

9. After allowing for a mixing zone of 25 metres, the discharge shall not give rise to any of the following effects in the Ngaere Stream:

a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
b) any conspicuous change in the colour or visual clarity;
c) any emission of objectionable odour;
d) the rendering of fresh water unsuitable for consumption by farm animals;
e) any significant adverse effects on aquatic life.

10. Results of the water samples taken from the firewater pond [undertaken prior to the release of stormwater from the facility] shall be made available to the Chief Executive, Taranaki Regional Council, on request.

11. Any erosion, scour or instability of the bed or banks of the Ngaere Stream that is attributable to the discharges authorised by this consent shall be remedied by the consent holder.

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

Signed at Stratford on 1 November 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Water Permit

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

Name of Consent Holder:	TWN Limited Partnership PO Box 8440 New Plymouth 4342
Decision Date:	17 March 2016
Commencement Date:	17 March 2016

Conditions of Consent

Consent Granted:	To take water from the Ngaere Stream for utility and firewater purposes at the Waihapa Production Station
Expiry Date:	1 June 2034
Review Date(s):	June 2019 and 3 yearly thereafter
Site Location:	Waihapa Production Station, 593 Bird Road, Stratford
Grid Reference (NZTM)	1717395E-5642260N
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 all the administration, monitoring and supervision costs of this consent, fixed in accordance with section 36 of the Resource Management Act 1991.

Special conditions

1. The rate of taking shall not exceed 2.8 litres per second, and the volume taken in any 24 hour period ending at midnight (New Zealand Standard Time) shall not exceed 240 cubic metres.

2. Before exercising this consent the consent holder shall install, and thereafter maintain a water meter at the site of taking (or a nearby site in accordance with Regulation 10 of the *Resource Management (Measurement and Reporting of Water Takes) Regulations 2010*. The water meter shall be tamper-proof and shall measure and record the rate and volume of water taken to an accuracy of ± 5%.

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

3. The consent holder shall provide the Chief Executive, Taranaki Regional Council with a document from a suitably qualified person certifying that water measuring and recording equipment required by the conditions of this consent ('the equipment'):

   (a) has been installed and/or maintained in accordance with the manufacturer's specifications; and/or

   (b) has been tested and shown to be operating to an accuracy of ± 5%.

   The documentation shall be provided:

   (i) within 30 days of the installation of a water meter;

   (ii) at other times when reasonable notice is given and the Chief Executive, Taranaki Regional Council has reasonable evidence that the equipment may not be functioning as required by this consent; and

   (iii) no less frequently than once every five years.

4. If any measuring or recording equipment breaks down, or for any reason is not operational, the consent holder shall advise the Chief Executive, Taranaki Regional Council immediately. Any repairs or maintenance to this equipment must be undertaken by a suitably qualified person and a maintenance report provided to the Chief Executive, Taranaki Regional Council within 30 days of the work occurring.

5. Any water meter shall be accessible to Taranaki Regional Council officers at all reasonable times for inspection and/or data retrieval.

6. The records of water taken shall:

   (a) be in a format that, in the opinion of the Chief Executive, Taranaki Regional Council, is suitable for auditing;

   (b) be maintained by the consent holder by recording the meter reading and the date of the reading at daily intervals.

   (c) specifically record the water taken as 'zero' when no water is taken; and

   (d) for each 12-month period ending on 30 June, be provided to the Chief Executive, Taranaki Regional Council within one month after end of that period.

7. No taking shall occur when the flow in the Ngaere Stream/River immediately downstream of the intake point is less than 20 litres per second.

   Note: Taking water required for fire fighting purposes is not restricted by this condition.

8. The consent holder shall ensure that the intake is screened to avoid fish (in all stages of their life-cycle) entering the intake or being trapped against the screen.

9. A staff gauge shall be installed and a low flow rating curve established and maintained that determines the flow in the Ngaere Stream immediately downstream of the take site. The cost of the installation, and the establishment and maintenance of the rating shall be met by the consent holder.

   Note: The installation of the staff gauge and establishment of the rating will be undertaken by the Council and included in the monitoring programme.

10. This consent shall lapse on 31 March 2021, 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.

11. 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 2019 and at 3 yearly intervals thereafter for the purposes of:

    (a) 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; and/or

    (b) requiring continuous measuring and recording of the flow immediately downstream of the take site; and/or

    (c) requiring any data collected in accordance with the conditions of this consent to be transmitted directly to the Taranaki Regional Council's computer system, in a format suitable for providing a 'real time' record over the internet.

Signed at Stratford on 17 March 2016

For and on behalf of
Taranaki Regional Council

_____

A D McLay
Director - Resource Management

Discharge Permit

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

Name of Consent Holder:	TWN Limited Partnership P O Box 8440 NEW PLYMOUTH 4342
Decision Date:	6 October 2009
Commencement Date:	6 October 2009

Conditions of Consent

Consent Granted:	To discharge emissions into the air from the flaring of hydrocarbons at the Waihapa Production Station in association with production, processing and maintenance activities and in emergency situations, together with miscellaneous emissions at or about (NZTM) 1717334E-5642168N
Expiry Date:	1 June 2028
Review Date(s):	June 2011, June 2016, June 2022
Site Location:	Waihapa Production Station, Bird Road, Stratford
Legal Description:	Sec 10 Blk III Ngaere SD

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

General conditions

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

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

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

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

Special conditions

Exercise of consent

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 effects on the environment associated with the discharge of contaminants into the environment arising from the emissions to air from the flare.

Recording and submitting information

2. The consent holder shall supply to the Taranaki Regional Council each month a copy of flaring information comprising: the type and amount of material flared [including any gas used to maintain a pilot flame], the date this was flared, the reason why flaring was undertaken, and an indication of whether smoke was produced from such flaring events.

3. The consent holder shall provide to the Taranaki Regional Council during May of each year, for the duration of this consent, a report:

a) detailing gas combustion at the production station flare, including but not restricted to routine operational flaring and flaring logged in accordance with condition 4;
b) detailing any measures that have been undertaken by the consent holder to improve the energy efficiency of the production station;
c) detailing any measures to reduce smoke emissions;
d) detailing any measures to reduce flaring,
e) addressing any other issue relevant to the minimisation or mitigation of emissions from the production station flare; and
f) detailing any complaints received and any measures undertaken to address complaints.

4. The consent holder shall keep and maintain a log of all continuous flaring incidents lasting longer than 5 minutes and any intermittent flaring lasting for an aggregate of 10 minutes or longer in any 60-minute period. The log shall contain the date, the start and finish times, the quantity and type of material flared, and the reason for flaring. The log shall be made available to the Chief Executive, Taranaki Regional Council, upon request, and summarised annually in the report required under condition 3. Flaring, under normal operation in the low pressure flare, of rich mono-ethylene glycol degasser vapour, condensate tank vapours, non-condensibles from tri-ethylene glycol/mono-ethylene glycol regeneration and purge gas shall be excluded from this requirement.

5. The consent holder shall keep and make available to the Chief Executive, Taranaki Regional Council, upon request, a record of all smoke emitting incidents, noting time, duration and cause. The consent holder shall also keep, and make available to the Chief Executive, upon request, a record of all complaints received as a result of the exercise of this consent.

Information and notification

6. The consent holder shall make available to the Chief Executive, Taranaki Regional Council upon request, an analysis of a typical gas and/or condensate stream from the Waihapa field, covering sulphur compound content and the content of compounds containing six or more carbon atoms in their molecular structure.

7. Prior to undertaking any alterations to the plant equipment, processes or operations, which may substantially alter the nature or quantity of flare emissions other than as described in the consent application, the consent holder shall first consult with the Chief Executive, Taranaki Regional Council, and shall obtain any necessary approvals under the Resource Management Act 1991.

8. Any incident whereby the discharge of emissions to air has potential or actual adverse environmental effects which has caused or is liable to cause a substantiated complaint, or a hazardous situation beyond the boundary of the property on which the production station flare is located, shall be notified to the Taranaki Regional Council, as soon as possible, followed by a written report to the Chief Executive, Taranaki Regional Council, within one week of the incident, with comment about the measures taken to minimise the impact of the incident and to prevent re-occurrence.

9. The consent holder shall notify the Chief Executive, Taranaki Regional Council, as soon as practicable, whenever the continuous flaring of hydrocarbons [other than the flaring of rich mono-ethylene glycol degasser vapour, condensate tank vapours, non-condensibles from tri-ethylene glycol/mono-ethylene glycol regeneration and purge gas] is expected to occur for more than five minutes in duration.

Preventing and minimising emissions

10. The consent holder shall minimise the emissions and impacts of air contaminants discharged from the flare by the selection of the most appropriate process equipment, process control equipment, emission control equipment, methods of control, supervision and operation, and the proper and effective operation, supervision, control and maintenance of all equipment and processes.

11. All practicable steps shall be taken to minimise flaring.

12. Other than in emergencies, the rate of depressurisation of the plant, or sections of the plant, shall be managed to prevent dense black smoke from being discharged from the flare.

13. The discharges authorised by this consent shall not, whether alone or in conjunction with any other emissions from the site arising through the exercise of any other consent, give rise to any levels of odour or dust or smoke that are offensive or obnoxious or objectionable at or beyond the property boundary.

14. The consent holder shall not discharge any contaminant to air from the site at a rate or a quantity such that the contaminant, whether alone or in combination with other contaminants, is or is liable to be hazardous or toxic or noxious at or beyond the boundary of the property where the production station is located.

15. The consent holder shall control all discharges of carbon monoxide to the atmosphere from the flare, whether alone or in conjunction with any other emissions from the site arising through the exercise of any other consent, in order that 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 [eight-hour average exposure], or 30 milligrams per cubic metre [one-hour average exposure] at or beyond the boundary of the property on which the production station flare is located.

16. The consent holder shall control all discharges of nitrogen dioxide or its precursors to the atmosphere from the flare, whether alone or in conjunction with any other discharges to the atmosphere from the site arising through the exercise of any other consent, in order that the maximum ground level concentration of nitrogen dioxide arising from the exercise of this consent measured under ambient conditions does not exceed 200 micrograms per cubic metre [one hour average exposure], or 100 micrograms per cubic metre [twenty-four hour average exposure], at or beyond the boundary of the property on which the production station flare is located.

17. The consent holder shall control discharges to the atmosphere from the flare of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides, whether alone or in conjunction with any other emissions from the site arising through the exercise of any other consent, in order that 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 on which the production station flare is located, is not increased above background levels:

    a) by more than 1/30th of the relevant Workplace Exposure Standard-Time Weighted Average [exposure averaged over a duration as specified for the Workplace Exposure Standard-Time Weighted Average], or by more than 1/10th of the Workplace Exposure Standard-Short Term Exposure Limit over any short period of 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 the General Excursion Limit at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour].

Review

18. 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 2011 and/or June 2016 and/or June 2022, for the purposes of:

    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 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 or contaminants.

Signed at Stratford on 1 November 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Appendix II

Biomonitoring reports

To	Job Manager, Callum MacKenzie
From	Technical Officer, Katie Blakemore
Report No	KB014
Document	1808967
Date	24 January 2017

Biomonitoring of the Ngaere Stream in relation to the Waihapa Production Station, December 2016

Introduction

This was the first survey of two biomonitoring surveys relating to the Waihapa Production Station, owned by TWN Limited Partnership, for the 2016-2017 monitoring year. The Production Station discharges stormwater, wastewater and firewater to the Ngaere Stream. An API separator of the production station discharges to a small tributary of the Ngaere Stream, a short distance upstream of the Ngaere Stream confluence with the Patea River.

The purpose of this survey was to determine whether these discharges from the Production Station had resulted in any detrimental effects on the macroinvertebrate communities in the Ngaere Stream downstream of the discharge. The results from surveys performed since the 2002-2003 monitoring years are discussed in the reports listed in the references at the end of this report.

Methods

The standard '400ml kick-sampling' technique was used to collect streambed macroinvertebrates from sites 3, 4 and 5 in the Ngaere Stream on 19 December 2016 (Table 1, Figure 1).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 the Ngaere Stream surveyed in association with the Waihapa Production Station

Site No.	Site code	GPS reference	Location
3	NGR 000480	E1717076 N5641732	Ngaere Stream, Bird Road Bridge
4	NGR 000497	E1717385 N5642263	Ngaere Stream, 35 m above confluence with Patea R
5	NGR 000498	E1717431 N5642297	Ngaere Stream, 10 m upstream confluence with Patea R

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

Macroinvertebrate taxa abundances found in each sample were recorded based on the categories in Table 2.

Table 2 Macroinvertebrate abundance categories

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

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. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998). A gradation of biological water quality conditions based upon MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985; Boothroyd and Stark, 2000) (Table 3).

Table 3 Macroinvertebrate community health based on MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985 and Boothroyd and Stark, 2000)

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

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. A difference of 0.9 units or more in $SQMCI_s$ is considered significantly different (Stark, 1998).

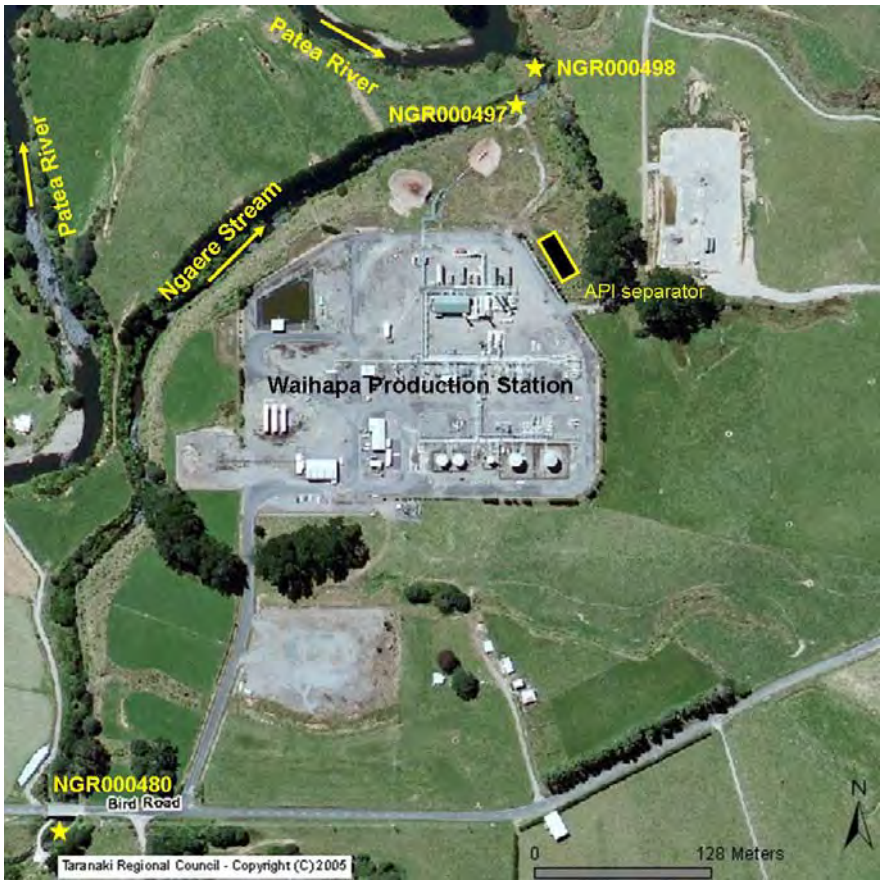

Figure 1 Biological sampling sites in the Ngaere Stream related to the Waihapa Production Station

Results

This survey followed a period of eight days since a fresh in excess of 3x median flow and 24 days since a fresh of 7x median flow (based on the flow gauging site on the Patea River at Skinner Road). In the month prior to this survey there were two freshes in excess of three times median flow.

The water temperatures during the survey were in the range 15.7-15.9 °C. Water levels were moderate and water velocity was steady at all sites. Water was cloudy brown at all sites. Substrate at all sites was predominantly cobble, with boulder, coarse gravel, fine gravel and silt also present in varying amounts. Sand was also present at sites 3 and 5. There was a coating of deposited silt on the streambed at sites 3 and 4.

Periphyton mats were patchy at sites 3 and 4, and widespread at site 5, while filamentous periphyton was widespread at all sites. All sites had patchy leaves present on the streambed, while macrophytes were absent at all sites. Moss was patchy at sites 3 and 4 but absent at site 5, while wood was absent at sites 3 and 4 but absent at site 5. All sites had some overhanging vegetation and partial shading.

Macroinvertebrate communities

A summary of the survey results performed to date at the three sites in the Ngaere Stream are presented in Table 4 and the full results of the current survey in Table 5.

Table 4 Summary of previous numbers of taxa, MCI values and SQMCIS scores together with results of the December 2016 survey of the Ngaere Stream

Site	Number of previous surveys	Numbers of taxa			MCI values			$SQMCI_S$			
		Median	Range	Current Survey	Median	Range	Current Survey	Number of previous surveys	Median	Range	Current Survey
3	45	20	11-26	16	85	65-107	90	33	4.4	2.3-6.1	4.4
4	33	21	12-27	16	85	67-105	91	24	3.9	2.9-5.8	2.2
5	37	22	12-28	19	85	62-104	97	33	3.6	2.2-5.2	4.1

Table 5 Macroinvertebrate fauna of the Ngaere Stream in relation to Waihapa Production Station sampled on 19 December 2016

Taxa List	Site Number	MCI score	3	4	5
	Site Code		NGR000480	NGR000497	NGR000498
	Sample Number		FWB16311	FWB16312	FWB16313
ANNELIDA (WORMS)	Oligochaeta	1	A	VA	A
	Lumbricidae	5	-	R	-
MOLLUSCA	*Potamopyrgus*	4	A	R	C
CRUSTACEA	*Paracalliope*	5	C	C	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	C	A
	Deleatidium	8	-	-	C
	Zephlebia group	7	R	R	C
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	C	-	C
COLEOPTERA (BEETLES)	Elmidae	6	A	C	C
	Hydraenidae	8	-	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	-	-
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	C	A
	Costachorema	7	-	-	R
	Hydrobiosis	5	C	C	C
	Olinga	9	-	-	R
	Pycnocentrodes	5	R	R	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C	C
	Maoridiamesa	3	R	C	A
	Orthocladiinae	2	C	C	C
	Polypedilum	3	C	C	A
	Tanytarsini	3	-	-	C
	Empididae	3	R	R	-
	Muscidae	3	-	-	R
No of taxa			16	16	19
MCI			90	91	97
SQMCIs			4.4	2.2	4.1
EPT (taxa)			6	5	9
%EPT (taxa)			38	31	47
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

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

Site 3: Bird Road, upstream of Production Station

A moderately low taxa richness of 16 taxa was recorded at site 3 ('control' site) at the time of this survey, which was four taxa less than the median number recorded for this site (median richness 20 taxa; Table 4, Figure 2) and seven taxa less than the previous sample (Figure 2).

The MCI score of 90 units indicated 'fair' community health which was not significanlty different from either the median MCI score for this site (median MCI score 85 units; Table 4, Figure 2) or the previous survey result of 85 units (Figure 2). The $SQMCI_s$ score recorded in this survey was 4.4 units, which was equal to the median score for this site (median $SQMCI_s$ score 4.4 units; Table 4) but was insignificantly lower (Stark 1998) than the previous survey score of 4.9.

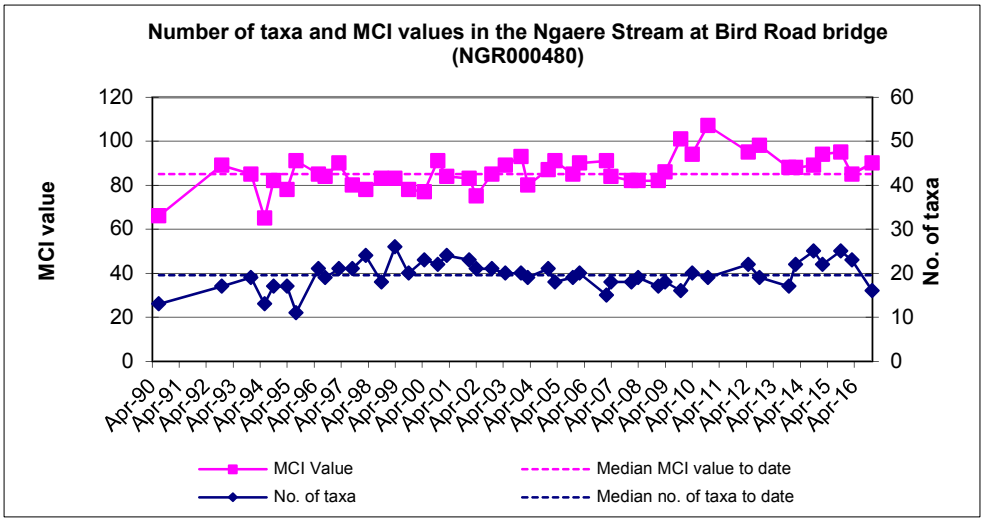

Figure 2 Number of taxa and MCI scores recorded to date at site 3, Bird Road.

The macroinvertebrate community was characterised by five taxa, two classed as 'moderately sensitive' [mayfly (*Austroclima*), beetle (Elmidae)] and three as 'tolerant' [oligochaete worms, snail (*Potamopyrgus*), caddisfly (*Hydropsyche/Aoteapsyche*)] (Table 5).

Site 4: 35m upstream of Patea River confluence

A moderately low taxa richness of 16 taxa was recorded at site 4 (the 'primary impact' site). This is five taxa less than the median for this site (median richness 21 taxa; Figure 3, Table 4) and is six taxa less than the previous sample (Figure 3).

The MCI score of 91 units recorded at this site indicated 'fair' macroinvertebrate community health which was not significantly different (Stark 1998) to either the median score calculated for this site (median MCI score 85 units; Table 4, Figure 3) or the previously recorded survey result of 90 units (Figure 3). The $SQMCI_s$ score of 2.2 units was significantly lower (Stark 1998) than the median score (median $SQMCI_s$ score 3.9 units; Table 4) and the previous survey result of 4.3. It is the lowest $SQMCI_s$ score recorded at this site to date (Table 4).

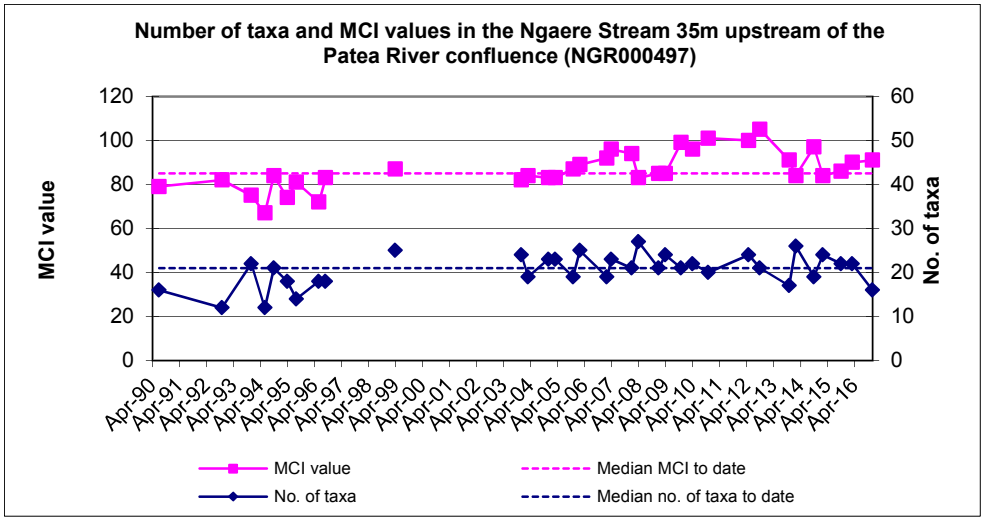

Figure 3 Number of taxa and MCI scores recorded to date at site 4, 35m upstream of the Patea River confluence.

The macroinvertebrate community was characterised by only one taxon, the 'tolerant' oligochaete worms which were very abundant in this survey (Table 5).

Site 5: 10m upstream of Patea River confluence

A moderate taxa richness of 19 taxa was recorded at this site (the 'secondary impact' site). This is three taxa less than the median value for this site (median richness 22 taxa; Table 4, Figure 4) and two taxa less than the previous sample result of 21 taxa (Figure 4).

A MCI score of 97 units was recorded. This classes the site as having 'fair' macroinvertebrate community health and is significantly higher (Stark 1998) than the median score of 85 units for this site (median MCI score 85 units; Table 4, Figure 4) and the previous result of 86 units (Figure 4). A $SQMCI_s$ score of 4.1units was recorded at this site. This is similar to the median score for this site (median $SQMCI_s$ score3.6 units; Table 4), but is significantly higher (Stark 1998) than the previous survey result of 3.2.

The macroinvertebrate community at this site was characterised by five taxa. One taxon is classed as 'moderately sensitive' [mayfly (*Austroclima*)], with the remaining four classed as 'tolerant' [oligochaete worms, caddisfly (*Hydropsyche/Aoteapsyche*) and midge larvae (*Maoridiamesa* and *Polypedilum*)].

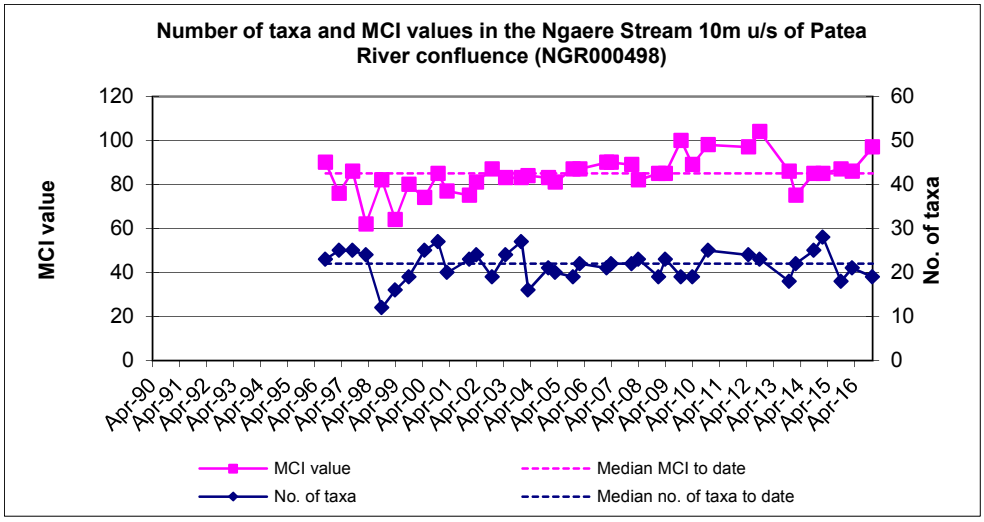

Figure 4 Number of taxa and MCI scores recorded to date at site 5, 10m upstream of the Patea River confluence

Discussion and conclusions

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

Taxa richness is the most robust metric when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges. When exposed to toxic discharges, macroinvertebrates may die and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with differing sensitivity to organic pollution. The $SQMCI_s$ is similar to the MCI, but accounts for relative abundances of the taxa found as well as sensitivity to pollution. As such, it provides additional insight to that provided by the MCI score but is also easily influenced by the 'patchiness' of invertebrates on the stream bed, and therefore must be considered in the context of all three metrics. Significant differences in taxa richness, MCI or $SQMCI_s$ between sites may indicate the degree of adverse effects (if any) of the discharges being monitored.

At the time of the current survey, taxa richnesses did not change significantly between the three sites. Taxa richness was slightly lower than the previous result for all three sites. The lower than usual taxa richnesses may be a result of a particularly wet spring, with 12 freshes in excess of 3x median flow and 8 freshes in excess of 7x median flow occurring between 1 October 2016 and the time the survey was carried out. There were no significant differences in MCI scores between the three sites, and sites 3 and 4 recorded an MCI score that was similar to both the median and previous scores for each site respectively. In contrast, site 5 recorded an MCI score significantly higher than both the median and previous scores for this site.

The $SQMCI_s$ score was similar at sites 3 and 5, while site 4 recorded a significantly lower $SQMCI_s$ score. This score was the lowest score recorded to date for this site and was significantly lower than the previously recorded score for this site. The low score at site 4 was primarily due to the numerical dominance of the low-scoring oligochaete worm (MCI score 1) in the macroinvertebrate community composition. This taxon was recorded as 'very abundant', while all other taxa recorded on this occasion were either 'rare' or 'common' (less than 20 individuals present in the sample) (Table 5). To demonstrate the influence of this

one particularly dominant taxon on the $SQMCI_s$ score, a decrease in abundance of oligochaete worms from 'very abundant' to 'abundant', would result in an $SQMCI_s$ score of 3.5 units, which is a statistically significant increase (Stark 1998). Deposited sediment, which is often associated with oligochaete worms, was present on the streambed at this site, as well as at site 3.

These changes in the macroinvertebrate communities between sites demonstrate the influence that the patchy spatial macroinvertebrate distributions can cause on $SQMCI_s$ scores. Minor habitat differences between sites may also have contributed to the observed results. When the results are considered in the context of all three invertebrate community metrics, with MCI scores and taxa richnesses that were similar for all three sites, as well as being similar to respective median scores for all three sites, there is no evidence that the decreased $SQMCI_s$ score at site 4 is reflective of a detrimental effect caused by discharges from the Waihapa Production Station.

The taxa richnesses and MCI scores for all sites were not significantly different from each other or from the median scores calculated from previous surveys. $SQMCI_s$ scores were similar to median scores and the previous result at sites 3 and 5, but significantly lower than the median and the previous result at site 4. When considered in the context of all three metrics, this demonstrates the influence that a single abundant taxon can have the $SQMCI_s$ score. Overall the results of this survey indicate that the discharge of treated stormwater, firewater and wastewater have not caused any recent detrimental impacts on the macroinvertebrate communities of the Ngaere Stream.

Summary

A macroinvertebrate survey was carried out at three sites in the Ngaere Stream near the Waihapa Production Station on 19 December 2016 to determine whether discharges of treated stormwater, wastewater and firewater caused detrimental impacts on the stream macroinvertebrate communities.

The survey recorded taxa richnesses and MCI scores that were not significantly different between sites. These scores were also not significantly different from the previous survey or from median scores for each site. $SQMCI_s$ scores at sites 3 and 5 were similar to each other, while the recorded score at site 4 was significantly lower than at either site 3 or site 5. However, $SQMCI_s$ scores have the potential to be strongly influenced by the patchy spatial nature of macroinvertebrate distributions within the community, and must therefore be considered together with other macroinvertebrate community metrics. When MCI, taxa richnesses and $SQMCI_s$ scores are considered together, there was no evidence that discharges from the Waihapa Production Station had caused any recent detrimental impacts on the macroinvertebrate communities of the Ngaere Stream.

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To	Job Manager, Callum MacKenzie
From	Technical Officer, Katie Blakemore
Report No	KB020
Document	1895090
Date	7 July 2017

Biomonitoring of the Ngaere Stream in relation to the Waihapa Production Station, March 2017

Introduction

This was the second survey of two biomonitoring surveys relating to the Waihapa Production Station, owned by TWN Limited Partnership, for the 2016-2017 monitoring year. The Production Station discharges stormwater, wastewater and firewater to the Ngaere Stream. An API separator of the production station discharges to a small tributary of the Ngaere Stream, a short distance upstream of the Ngaere Stream confluence with the Patea River.

The purpose of this survey was to determine whether these discharges from the Production Station had resulted in any detrimental effects on the macroinvertebrate communities in the Ngaere Stream downstream of the discharge. The results from surveys performed since the 2002-2003 monitoring years are discussed in the reports listed in the references at the end of this report.

Methods

The standard '400ml kick-sampling' technique was used to collect streambed macroinvertebrates from sites 3, 4 and 5 in the Ngaere Stream on 6 March 2017 (Table 1, Figure 1).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 the Ngaere Stream surveyed in association with the Waihapa Production Station

Site No.	Site code	GPS reference	Location
3	NGR 000480	E1717076 N5641732	Ngaere Stream, Bird Road Bridge
4	NGR 000497	E1717385 N5642263	Ngaere Stream, 35 m above confluence with Patea R
5	NGR 000498	E1717431 N5642297	Ngaere Stream, 10 m upstream confluence with Patea R

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

Macroinvertebrate taxa abundances found in each sample were recorded based on the categories in Table 2.

Table 2 Macroinvertebrate abundance categories

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

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. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998). A gradation of biological water quality conditions based upon MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985; Boothroyd and Stark, 2000) (Table 3).

Table 3 Macroinvertebrate community health based on MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985 and Boothroyd and Stark, 2000)

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

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. A difference of 0.9 units or more in $SQMCI_s$ is considered significantly different (Stark, 1998).

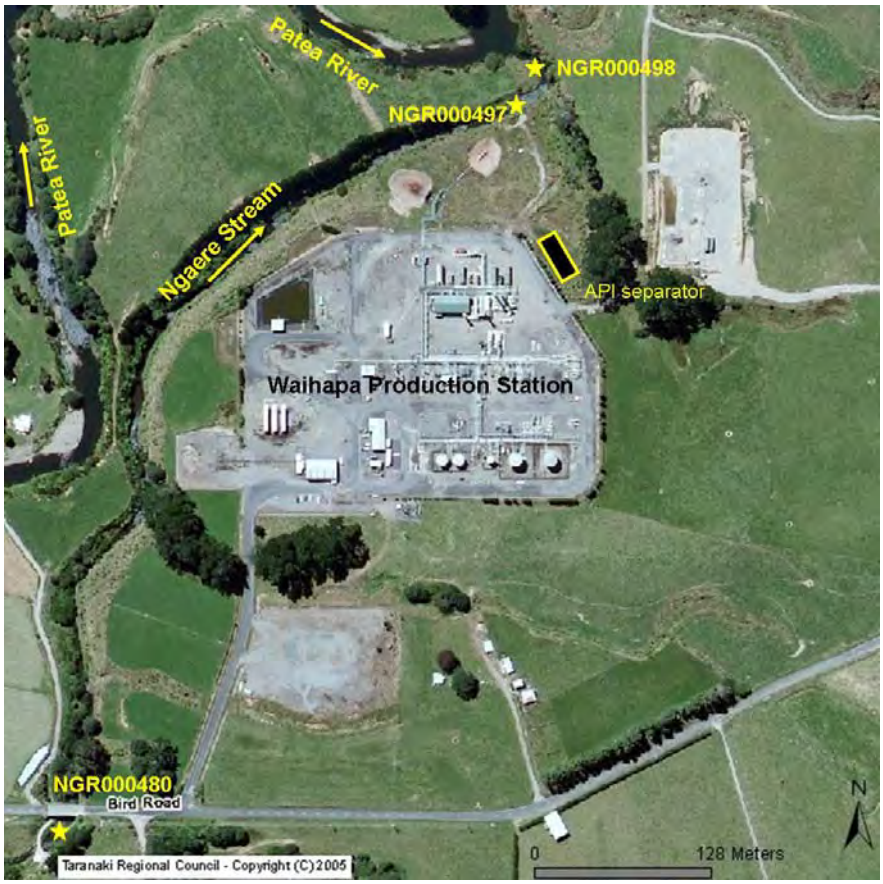

Figure 1 Biological sampling sites in the Ngaere Stream related to the Waihapa Production Station

Results

This survey followed a period of 31 days since a fresh in excess of 3x median flow and 43 days since a fresh of 7x median flow (based on the flow gauging site on the Patea River at Skinner Road). In the period since the preceding survey, there were four freshes greater than 3x median flow and three freshes greater than 7x median flow.

The water temperatures during the survey were in the range 17.1-17.7 °C. Water levels were low and water velocity was swift at all sites. Water was clear with a slight grey tinge at all sites. Substrate at all sites was predominantly cobble, with boulder, coarse gravel, fine gravel, silt and silt also present in varying amounts. There was a coating of deposited silt on the streambed at sites 4 and 5. The presence of iron oxide was also noted at site 4.

Periphyton mats were absent at all three sites, while filamentous periphyton was widespread at all sites. All sites had patches of leaves and moss present on the streambed, while macrophytes and woody debris were absent at all sites. All sites had partial shading, caused by overhanging vegetation and the streambanks.

Macroinvertebrate communities

A summary of the survey results performed to date at the three sites in the Ngaere Stream are presented in Table 4 and the full results of the current survey in Table 5.

Table 4 Summary of previous numbers of taxa, MCI values and SQMCIS scores together with results of the March 2017 survey of the Ngaere Stream

Site	Number of previous surveys	Numbers of taxa			MCI values			$SQMCI_S$			
		Median	Range	Current Survey	Median	Range	Current Survey	Number of previous surveys	Median	Range	Current Survey
3	46	20	11-26	17	85	65-107	93	34	4.4	2.3-6.1	4.9
4	34	21	12-27	22	85	67-105	85	25	3.9	2.2-5.8	4.3
5	38	22	12-28	18	85	62-104	84	34	3.7	2.2-5.2	3.5

Table 5 Macroinvertebrate fauna of the Ngaere Stream in relation to Waihapa Production Station sampled on 6 March 2017

Taxa List	Site Number	MCI score	3	4	5
	Site Code		NGR000480	NGR000497	NGR000498
	Sample Number		FWB17183	FWB17184	FWB17185
NEMERTEA	Nemertea	3	-	R	R
ANNELIDA (WORMS)	Oligochaeta	1	C	C	C
	Lumbricidae	5	-	-	R
MOLLUSCA	*Physa*	3	-	R	-
	Potamopyrgus	4	A	VA	C
CRUSTACEA	*Paracalliope*	5	VA	A	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	A	R
	Deleatidium	8	R	R	-
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	-	R	-
HEMIPTERA (BUGS)	*Microvelia*	3	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	C	R	C
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	R	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	C	A	A
	Hydrobiosis	5	R	C	C
	Oxyethira	2	C	R	-
	Pycnocentria	7	C	C	R
	Pycnocentrodes	5	A	A	C
	Triplectides	5	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	R	R
	Maoridiamesa	3	-	-	C
	Orthocladiinae	2	C	A	A
	Polypedilum	3	-	R	-
	Tanytarsini	3	-	C	C
	Empididae	3	-	R	R
	Muscidae	3	-	R	R
	Austrosimulium	3	R	R	R
ACARINA (MITES)	Acarina	5	R	-	-
		No of taxa	17	22	18
		MCI	93	85	84
		SQMCIs	4.9	4.3	3.5
		EPT (taxa)	7	7	5
		%EPT (taxa)	41	32	28

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

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

Site 3: Bird Road, upstream of Production Station

A moderate taxa richness of 17 taxa was recorded at site 3 ('control' site) at the time of this survey, which was three taxa less than the median number recorded for this site (median richness 20 taxa; Table 4, Figure 2) and one taxon more than the previous sample (Figure 2).

The MCI score of 93 units indicated 'fair' community health which was not significanlty different from either the median MCI score for this site (median MCI score 85 units; Table 4, Figure 2) or the previous survey result of 90 units (Figure 2). The $SQMCI_s$ score recorded in this survey was 4.9 units, which was insignificantly higher (Stark 1998) than both the median score for this site (median $SQMCI_s$ score 4.4 units; Table 4) and the than the previous survey score of 4.4 units.

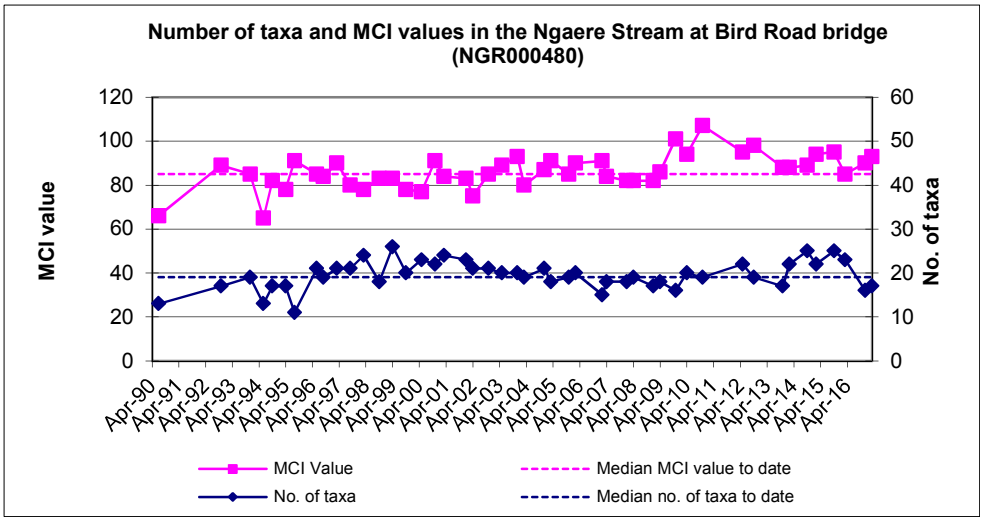

Figure 2 Number of taxa and MCI scores recorded to date at site 3, Bird Road.

The macroinvertebrate community was characterised by four taxa, three classed as 'moderately sensitive' [amphipod (*Paracalliope*), mayfly (*Austroclima*), caddisfly (*Pyncnocentrodes*)] and one as 'tolerant' [snail (*Potamopyrgus*)] (Table 5).

Site 4: 35m upstream of Patea River confluence

A moderate taxa richness of 22 taxa was recorded at site 4 (the 'primary impact' site). This is one taxon more than the median for this site (median richness 21 taxa; Table 4, Figure 3) and is six taxa more than the previous sample (Figure 3).

The MCI score of 85 units recorded at this site indicated 'fair' macroinvertebrate community health which was equal to not significantly different (Stark 1998) to either the median score calculated for this site (median MCI score 85 units; Table 4, Figure 3) and was not significantly lower (Stark 1998) than the previously recorded survey result of 91 units (Figure 3). The $SQMCI_s$ score 4.3 units was not significantly different (Stark 1998) from the median score (median $SQMCI_s$ score 3.9 units; Table 4) and significantly higher (Stark 1998) than the previous survey result of 2.2 (Table 4).

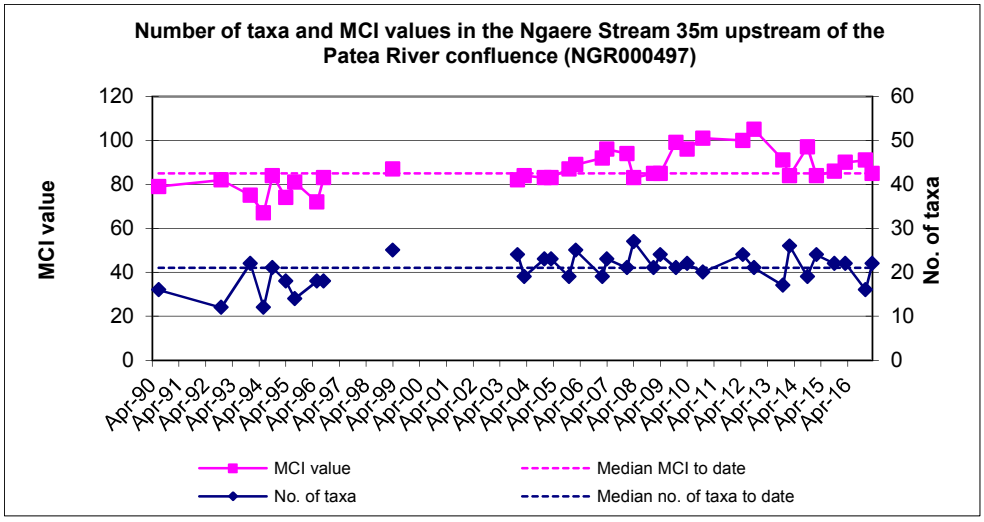

Figure 3 Number of taxa and MCI scores recorded to date at site 4, 35m upstream of the Patea River confluence.

The macroinvertebrate community was characterised by six taxa, three 'moderately sensitive' taxa [amphipod (*Paracalliope*), mayfly (*Austroclima*), caddisfly (*Pyncnocentrodes*)] and three 'tolerant' taxa [snail (*Potamopyrgus*), caddisfly (*Hydropsyche* – formerly *Aoteapsyche*) and midge larvae (Orthocladiinae)] (Table 5).

Site 5: 10m upstream of Patea River confluence

A moderate taxa richness of 18 taxa was recorded at this site (the 'secondary impact' site). This is four taxa less than the median value for this site (median richness 22 taxa; Table 4, Figure 4) and one taxon less than the previous sample result of 19 taxa (Figure 4).

A MCI score of 84 units was recorded. This classes the site as having 'fair' macroinvertebrate community health and is not significantly different (Stark 1998) to the median score (median MCI score 85 units; Table 4, Figure 4) but is significantly lower (Stark 1998) than previous result of 97 units (Figure 4). A $SQMCI_s$ score of 3.5 units was recorded at this site. This is not significantly different (Stark 1998) from to the median score for this site (median $SQMCI_s$ score 3.7 units; Table 4) or the previous survey result of 4.1.

The macroinvertebrate community at this site was characterised by two taxa, both classed as 'tolerant' [caddisfly (*Hydropsyche*- formerly *Aoteapsyche*) and midge larvae (Orthocladiinae)].

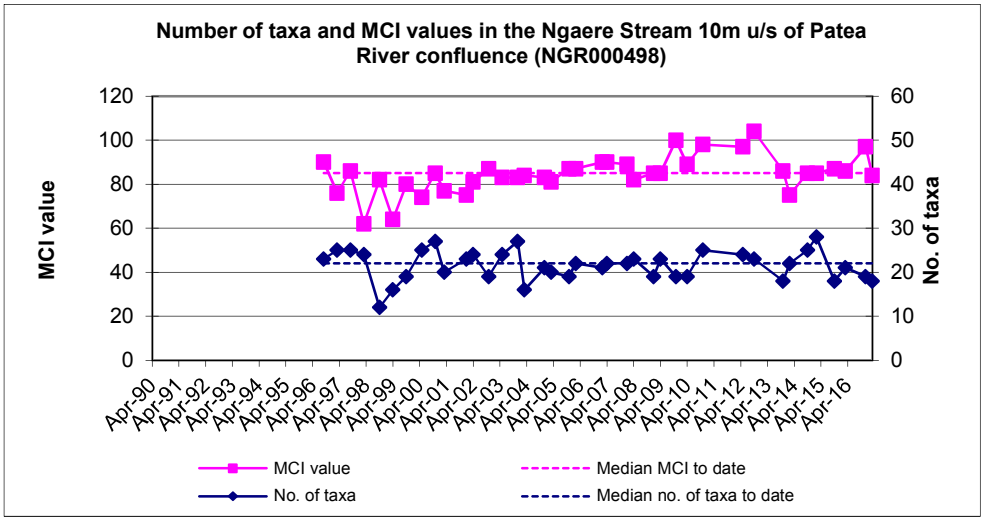

Figure 4 Number of taxa and MCI scores recorded to date at site 5, 10m upstream of the Patea River confluence

Discussion and conclusions

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

Taxa richness is the most robust metric when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges. When exposed to toxic discharges, macroinvertebrates may die and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with differing sensitivity to organic pollution. The $SQMCI_s$ is similar to the MCI, but accounts for relative abundances of the taxa found as well as sensitivity to pollution. As such, it provides additional insight to that provided by the MCI score but is also easily influenced by the 'patchiness' of invertebrates on the stream bed, and therefore must be considered in the context of all three metrics. Significant differences in taxa richness, MCI or $SQMCI_s$ between sites may indicate the degree of adverse effects (if any) of the discharges being monitored.

At the time of the current survey, taxa richnesses did not change significantly between the three sites, and was similar to both the median richness and the richness recorded in the previous survey at all sites. There were no significant differences in MCI scores between the three sites, and sites 3 and 4 recorded an MCI score that was similar to both the median and previous scores for each site respectively. In contrast, site 5 recorded a MCI score which was similar to the median score, but significantly lower than the previously recorded score for this site.

The $SQMCI_s$ score was similar the median at all sites. No significant difference in $SQMCI_s$ scores was recorded between sites 3 and 4, or between sites 4 and 5, however there as a significant difference between the scores recorded at sites 3 and 5. The $SQMCI_s$ score at site 4 was significantly higher than the previously recorded score at this site, while the scores at sites 3 and 5 were not significantly different from the previously recorded scores for the respective sites. This difference was caused by the dominance of 'tolerant' taxa in the macroinvertebrate community at site 5, which is likely to result from minor habitat differences between the sites.

The taxa richnesses and MCI scores for all sites were not significantly different from each other or from the median scores calculated from previous surveys. $SQMCI_s$ scores were similar to median scores at all sites, and no significant differences were observed between sites, with the exception of the scores recorded at sites 3 and 5. When considered in the context of all three metrics, and given that there were no significant differences from median scores for any macroinvertebrate community metric at any site, the results of this survey indicate that the discharge of treated stormwater, firewater and wastewater have not caused any recent detrimental impacts on the macroinvertebrate communities of the Ngaere Stream.

Summary

A macroinvertebrate survey was carried out at three sites in the Ngaere Stream near the Waihapa Production Station on 6 March 2017 to determine whether discharges of treated stormwater, wastewater and firewater caused detrimental impacts on the stream macroinvertebrate communities.

The survey recorded taxa richnesses and MCI scores that were not significantly different between sites. These scores were also not significantly different from the median scores for each site. MCI scores were similar to those recorded in the preceding survey at sites 3 and 4, but significantly lower than the preceding score at site 5. $SQMCI_s$ scores at sites 3 and 5 were significantly different from each other, while no other significant differences between sites were recorded. $SQMCI_s$ scores were similar to median scores at all sites. However, $SQMCI_s$ scores have the potential to be strongly influenced by the patchy spatial nature of macroinvertebrate distributions within the community, and must therefore be considered together with other macroinvertebrate community metrics. When MCI, taxa richnesses and $SQMCI_s$ scores are considered together, there was no evidence that discharges from the Waihapa Production Station had caused any recent detrimental impacts on the macroinvertebrate communities of the Ngaere Stream.

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Appendix III

Air reports

Memorandum

To	Alex Connolly, Scientific Officer – State of the Environment
	Job Managers - Callum MacKenzie, Emily Roberts, Nathan Crook
From	Brian Cheyne, Scientific Officer – Air Quality
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Monitoring of nitrogen oxides (NOx) levels in Taranaki near the NOx emitting sites, year 2016-2017

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

Nitrogen oxides

Nitrogen oxides (NOx), a mixture of nitrous oxide (N_2O), nitric oxide (NO) and nitrogen dioxide (NO_2), are produced from natural sources, motor vehicles and other fuel combustion processes. Indoor domestic appliances (gas stoves, gas or wood heaters) can also be significant sources of nitrogen oxides, particularly in areas that are poorly ventilated. NO and NO_2 are of interest because of potential effects on human health.

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

Environmental and health effects of nitrogen oxides

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

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

National environmental standards and guidelines

In 2004, national environmental standards (NES) for ambient (outdoor) air quality were introduced in New Zealand to provide a guaranteed level of protection for the health of New Zealanders. The national standard for nitrogen dioxide (NO_2) is set out below.

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

Before the introduction of the national environmental standards, air quality was measured against the national air quality guidelines. The national guidelines were developed in 1994 and revised in 2002 following a comprehensive review of international and national research and remain relevant. The national guideline for nitrogen dioxide (NO_2) is set out below.

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

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

Measurement of nitrogen oxides

The Taranaki Regional Council has been monitoring nitrogen oxides (NOx) in the Taranaki region since 1993 using passive absorption discs. Research to date indicates that this is an accurate method, with benefits of simplicity of use and relatively low cost. To date more then 690 samplers of nitrogen oxides have been collected in Taranaki region. Discs are sent to EUROFINS ELS Ltd. Lower Hutt for analysis. Passive absorption discs are placed at the nominated sites. The gases diffuse into the discs and any target gases (nitrogen dioxide or others) are captured.

In the 2016-17 year, passive absorption discs were placed on one occasion at twenty four sites, staked about two metres off the ground for a period of 21 days, for the purpose of Compliance Monitoring.

Conversion of exposure result to standardised exposure time period

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

One formula in general use is of the form:

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

where C(t) = the average concentration during the time interval t, and p = a factor lying between 0.17 and 0.20. When converting from longer time periods to shorter time periods, using p = 0.20 gives the most conservative estimate (i.e. the highest calculated result for time period 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' 1-hour and 'maximum'24-hour exposure levels.

Results

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

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

	Survey at	Site code	NOx(µg/m^3) Lab. results	NOx 1/hr (µg/m^3) Theoretical max.	NOx 24/hr (µg/m^3) Theoretical max.
Petrochemical	McKee PS	AIR007901	1.2	4.2	2.2
		AIR007902	6.8	23.6	12.5
	Turangi PS	AIR007822	3.2	11.1	5.9
		AIR007824	1.5	5.2	2.8
	Kaimiro PS	AIR007817	0.6	2.1	1.1
		AIR007818	2.4	8.3	4.4
	Sidewinder PS	AIR007831	0.5	1.7	0.9
		AIR007832	1.1	3.8	2.0
	Maui PS	AIR008201	0.4	1.4	0.7
		AIR008214	0.1	0.4	0.2
	Kupe PS	AIR007827	0.4	1.4	0.7
		AIR007830	1.3	4.5	2.4
	Kapuni PS	AIR003410	2.7	9.7	4.5
		AIR003411	8.4	29.2	15.4
	Cheal PS	AIR007841	0.5	1.7	0.9
		AIR007842	7.2	25.0	13.2
	Waihapa PS	AIR007815	1.5	3.1	1.6
		AIR007816	3.0	10.4	5.5
	Ballance AUP	AIR003401	0.5	1.7	0.9
		AIR003404	4.7	16.3	8.6
Dairy factory	Fonterra	AIR002410	7.1	24.6	13.0
		AIR002711	7.0	24.3	12.9
		AIR002412	2.2	7.6	4.0
		AIR002413	2.1	7.3	3.9
National Environmental Standard (NES) and MfE guideline			**200 (NES)**	**100 (guideline)**	

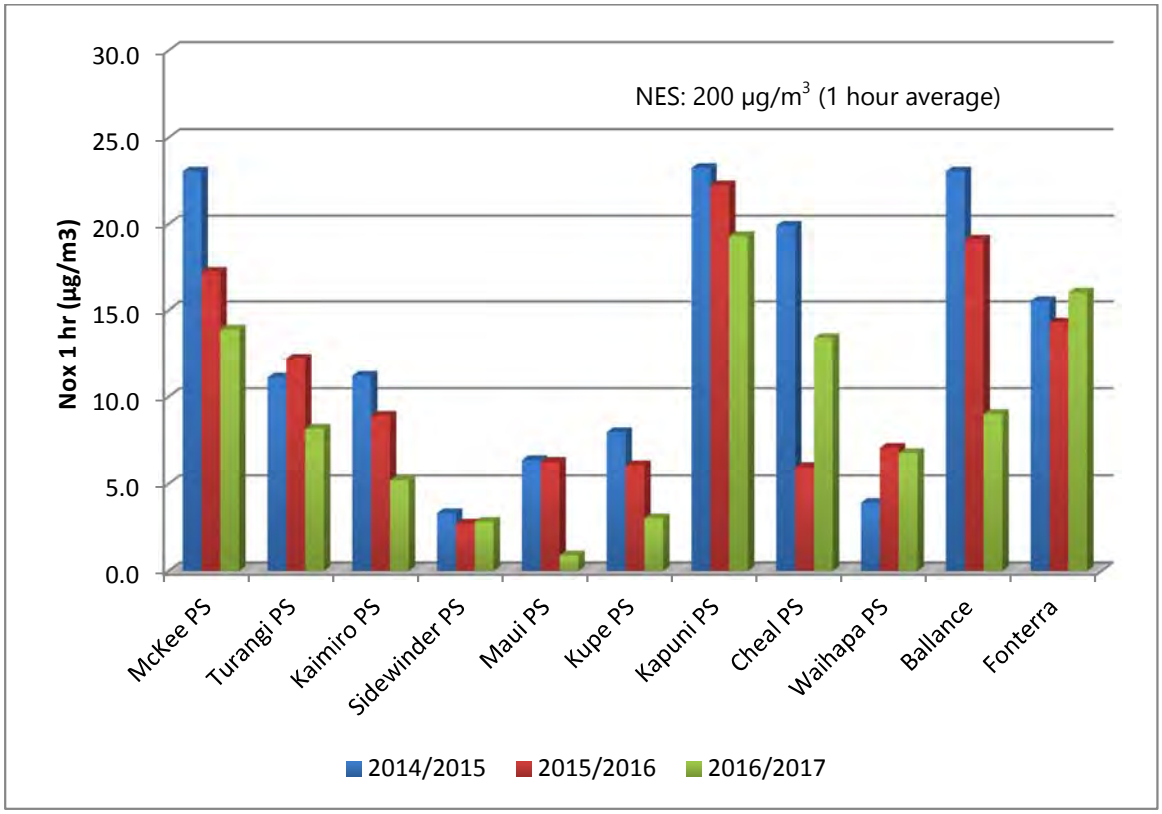

Figure 2 Average NOx levels at 11 surveyed locations throughout the region (year 2016-2017).

Discussion

The calculated 1-hour and 24-hour theoretical maximum concentrations (using a power law exponent of 0.2) ranged from 0.4 µg/m³ to 29.2 µg/m³ and 0.2 µg/m³ to 15.4 µg/m³ respectively. The highest results in 2016-17 monitoring year were obtained from the NOx emitting sites at four different locations:

1. In Kapuni heavy industrial area around the STOS production station.
2. Around the Fonterra's Whareroa co-generation plant.
3. From the sites at McKee production station.
4. And around the Cheal production station.

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

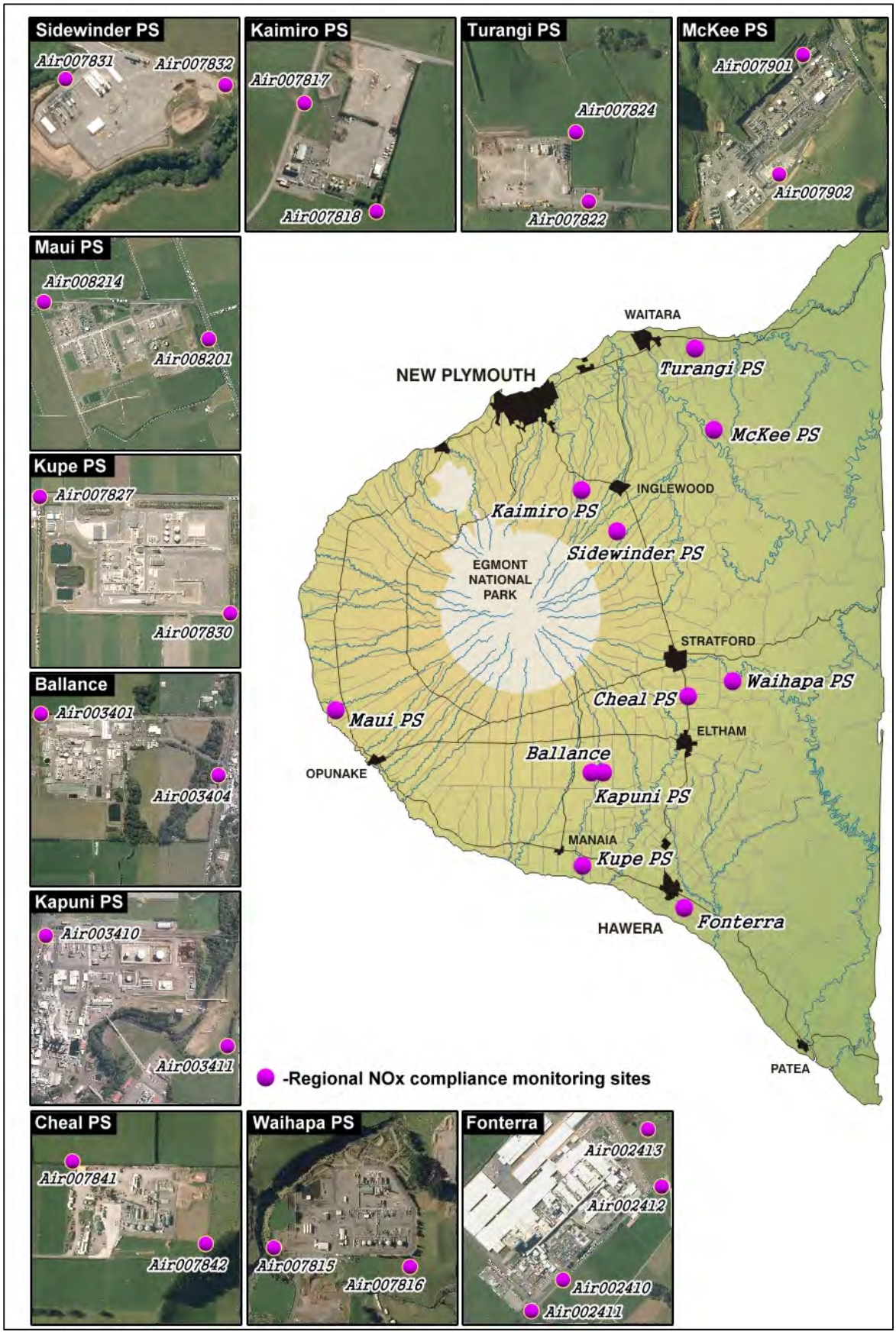

Figure 1 NOx monitoring sites in Taranaki Region, 2016-2017

Ministry for the Environment environmental performance indicator

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

Table 2 Environmental Performance Indicator air quality categories

Measured value	Less than 10% of NES	10-33% of NES	33-66% of NES	66-100% of NES	More than 100% of NES
Category	*excellent*	*good*	*acceptable*	*alert*	*action*

Table 3 Categorisation of results (2016-2017 monitoring year)

National Environmental Standard for NO_2 = 200 µg/m^3- 1 hour average.		
Category	**Measured values**	
Excellent	<10% of the NES, (0-20µg/m^3)	**19** (79%)
Good	10-33% of the NES, (20-66µg/m^3)	**5** (21 %)
Acceptable	33-66% of the NES, (66-132 µg/m^3)	**0** (0%)
Alert	66-100% of the NES, (132-200 µg/m^3)	**0** (0%)
Total number of samples		**24** (100%)

Conclusion

The monitoring showed that 79% of the 1-hour average results fell into Ministry's 'excellent' categories and 21% of the results lay within Ministry's 'good' category. No results ever entered the 'acceptable' or 'alert' categories, i.e., no results ever exceeded the National Environmental Standard of 200µg/m^3.

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

To	Job Manager, Callum MacKenzie
From	Scientific Officer - Air Quality, Brian Cheyne
File	1870991
Date	May 25, 2017

Ambient Gas (PM10, NOx, CO and LEL) Monitoring at Waihapa Production Stations during 2016-2017 monitoring year

Introduction

In January and May 2017 as part of the compliance monitoring programme for the Waihapa production station, a survey of ambient air quality sampling was carried out by the Taranaki Regional Council (the Council) in the vicinity of the plant. The main objectives were to measure:

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

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

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

During the monitoring year, a multi-gas meter was deployed on one occasion in the vicinity of the plant. The recording lasted approximately 44 hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continuous measurements of gas concentrations for the gases of interest (carbon monoxide and combustible gases).

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

Figure 1 Air monitoring sites at Waihapa production station (2016-2017)

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

The consents covering air discharges from the Waihapa production station have specific limits related to particular gases. Special condition 15 of consent 4049-3 set a limit on the carbon monoxide concentration at or beyond the production station's boundary. The limit is expressed as 10 mg/m^3 for an eight hour average or 30 mg/m^3 for a one hour average exposure. The maximum concentration of carbon monoxide found during the monitoring run was 5.8 mg/m^3 with average concentration for the entire dataset was only 0.23 mg/m^3 which comply with consent conditions. This is in line with the pattern found in previous years.

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

Period (from-to)		**08/05/2017 14:31 to 10/05/2017 10:27**
Max	CO(ppm)	5.10
	LEL(%)	0.20
Mean	CO(ppm)	0.20
	LEL(%)	0.00
Min	CO(ppm)	0.00
	LEL(%)	0.00

Note: (1) the instrument records in units of ppm. At 25°C, 1 atm.

1ppm CO = 1.145 mg/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 percentage LEL by 20.

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

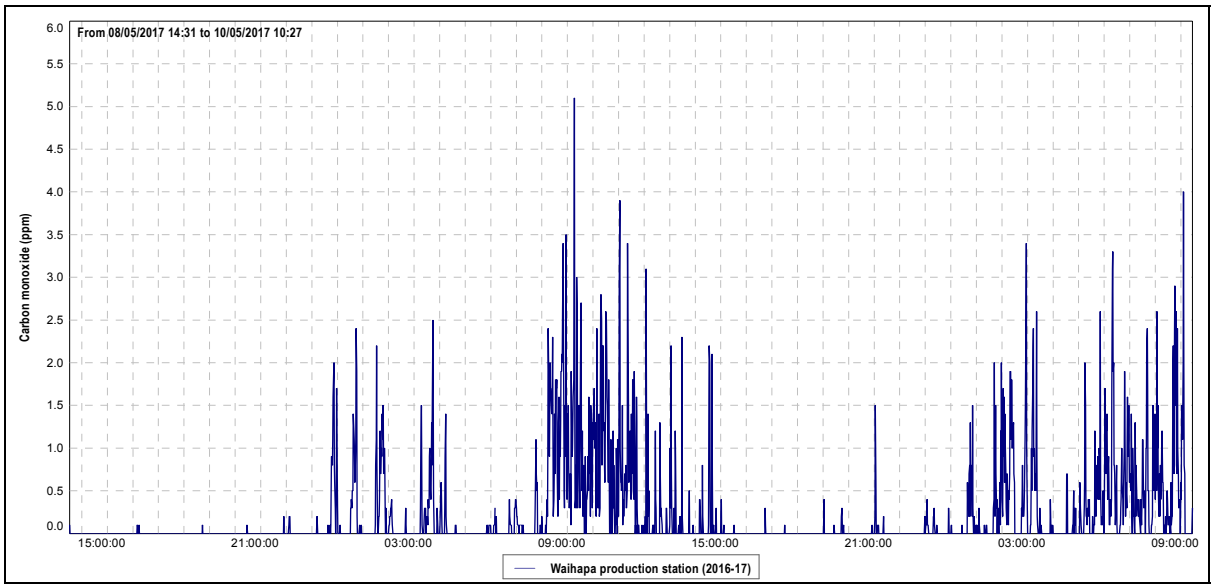

Figure 2 Graph of ambient CO levels in the vicinity of the Waihapa Production Station (2016-2017)

PM10

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

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

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

During the reporting 2016-17 period, a "DustTrak" PM10 monitor was deployed on one occasion in the vicinity of the Waihapa production station. The deployment lasted approximately 21 hours, with the instrument placed in a down-wind position at the start of the deployment. Monitoring consisted of continual measurements of PM10 concentrations. The location of the "DustTrak" monitor during the sampling run is shown in Figure 1.

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

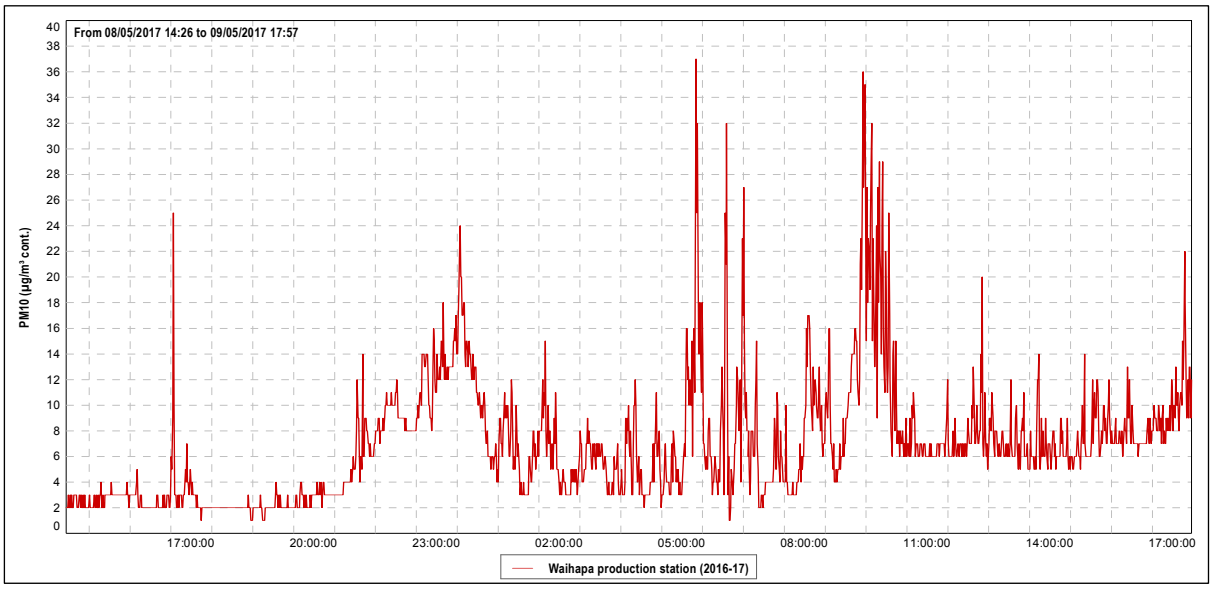

Figure 3 PM10 concentrations (µg/m^3) at the Waihapa production station (2016-17)

Table 2 Daily mean of PM10 result during one days monitoring at Waihapa production station

	(21 hours) **(08-09/05/2017)**	
24 hr. set	Day 1	Day 2
Daily average	6.9 µg/m^3	N/A
NES	50µg/m^3	

During the 21-hour run, from 8th of May to 9th of May 2017, the average recorded PM_{10} concentration for the 21 hour period was 6.9µg/m^3. This daily mean equate to 14% of the 50 µg/m^3 value that is set by the National Environmental Standard.

Background levels of PM_{10} in the region have been found to be typically around 11µg/m^3.

Nitrogen oxides (NOx)

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

The complete report covering region-wide NOx monitoring is attached in the Appendix to this memorandum (TRC # 1841084).

The consents covering air discharges from the Waihapa production station have specific limits related to particular gases. Special condition 16 of consent 4049-3 set a limit on the nitrogen dioxide concentration at or beyond the production station's boundary. The limit is expressed as 100 µg/m^3 for a 24 hour average or 200 µg/m^3 for a one hour average exposure.

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

The calculated 1-hour and 24-hour theoretical maximum NOx concentrations found at the Waihapa production station during the year under review equates to 6.8µg/m^3 and 3.6 µg/m^3 respectively. The results show that the ambient ground level concentration of NO_x is well below the limits set out by consent 4049-3.