

Petrochem Limited
Kowhai-D Wellsite
Monitoring Programme Report
2016-2018

Technical Report 2018-12

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Executive summary

Petrochem Limited operates a hydrocarbon exploration site located on Manganui Road, in the Waitara River catchment. This site is called Kowhai-D wellsite. This report for the period July 2016 to June 2018 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 four resource consents, which include a total of 47 conditions setting out the requirements that the Company must satisfy. The Company holds one consent to allow it to take and use water,, two consents to discharge effluent and stormwater into an unnamed tributary of the Waitara River, and one consent to discharge emissions into the air at this site.

During the monitoring period, Petrochem Ltd demonstrated an overall high level of environmental performance.

The Council's monitoring programme for the year under review included 16 inspections, 5 water samples collected for physicochemical analysis, 1 biomonitoring survey of receiving waters, no stack emission tests, and no ambient air quality analyses.

The monitoring showed that all samples obtained were in compliance with consent conditions. The monitoring indicated there was no effect on the receiving environment from the activities at the Kowhai-D wellsite. There were no Unauthorised Incidents recording non-compliance in respect of this consent holder during the period under review. Gas combustion associated with hydrocarbon exploration only occurred once at this site, no issue was raised.

During the year, the Company demonstrated a high level of environmental and administrative performance with the resource consents. During the year under review there were no significant issues with silt or sediment controls, once they were installed, and stormwater from the site was well managed with only one discharge observed by Council officers, with any required works being completed in a timely and satisfactory manner.

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.

For reference, in the 2017-2018 year, consent holders were found to achieve a high level of environmental performance and compliance for 76% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 20% 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 is remains at a good level.

This report includes recommendations for the 2018-2019 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 June 2016 to July 2018 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consent held by Petrochem Limited. During this period, a wellsite was established with one well (Kowhai D) tested and hydraulically fractured.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by Petrochem Limited that relate to exploration activities at Kowhai-D wellsite located along Manganui Road in the New Plymouth District.

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 Petrochem Limited use of water, land, and air.

1.1.2 Structure of this report

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

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites through annual programmes;
- the resource consents held by the Petrochem Limited in the Waitara 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 Kowhai-D wellsite.

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 during future drilling operations.

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.

For reference, in the 2017-2018 year, consent holders were found to achieve a high level of environmental performance and compliance for XX% of the consents monitored through the Taranaki tailored monitoring programmes, while for another XX% of the consents, a good level of environmental performance and compliance was achieved.

1.2 Process description

Site description

Petrochem Limited holds 15 year Petroleum Mining Permit No. 51378 to prospect, explore, and mine for condensate, gas, LPG, oil and petroleum within an area of 68.12 km². The Kowhai-D wellsite is one of many sites within this area that have been established in order to explore, evaluate and produce hydrocarbons.

The Kowhai-D wellsite is located approximately 0.7 km from the Manganui and Everett Road intersection approximately 2.7 km from Huirangi as per Figure 1. The Kowhai-D wellsite was established in 2009 and involved the removal of topsoil to create a firm and level foundation on which to erect a drilling rig and house associated equipment. Site establishment also involved the installation of:

- Wastewater control, treatment and disposal facilities;
- A system to collect and control stormwater and contaminants;
- A gas combustion system; and
- Other on-site facilities such as accommodation, parking and storage.

The nearest residence is approximately 700 m away from the wellsite. Bunding, earthworks and good site location helped minimise any potential for off-site effects for the neighbours.



Figure 1 Aerial view of the Kowhai-D wellsite, with approximate regional location

Well development

The process of drilling a well can take a few weeks to several months, depending on the depth of the well, the geology of the area, and whether the well is vertical or horizontal.

Drilling fluids, more commonly known as 'drilling muds', are required in the drilling process for a number of reasons, including:

- As a safety measure to ensure that any pressurised liquids encountered in the rock formation are contained;
- To transport drill cuttings to the surface;
- To cool and lubricate the drilling bit;
- To provide information to the drillers about what is happening down hole and the actual geology being drilled; and
- To maintain well pressure and lubricate the borehole wall to control cave-ins and wash-outs.

The well is drilled progressively using different sized drill bits. The width of the well is widest at the surface as smaller drill bits are used as the well gets deeper. Once each section of the well is drilled, a steel casing is installed. Cement is then pumped down the well to fill the annulus (the space between the steel casing and the surrounding country rock). This process is repeated until the target depth is reached, with each section of steel casing interlocked with the next.

Production tubing is then fitted within the steel casing to the target depth. A packer is fitted between the production tubing and casing to stop oil/gas/produced water from entering the annulus. The packer is pressure tested to ensure it is sealed.

The construction aspects that are most important for a leak-free well include the correct composition and quality of the cement used, the installation method, and the setting time. The aim is to ensure that the cement binds tightly to the steel casing and the rock, and leaves no cavities through which liquids and gases could travel.

Once the well is sealed and tested the casing is perforated at the target depth, allowing fluids and gas to flow freely between the formation and the well.

Management of stormwater, wastewater and solid drilling waste

The Kowhai-D wellsite is located approximately 50 m to the east of the nearest waterbody which is an unnamed tributary of the Waitara River.

Management systems were put in place to avoid any adverse effects on the surrounding environment from exploration and production activities on the wellsite. There are several sources of potential contamination from water and solid waste material which require appropriate management. These include:

- Stormwater from 'clean' areas of the site (e.g. parking areas) which run off during rainfall. There is potential that this runoff will pick up small amounts of hydrocarbons and silt due to the nature of the activities on-site;
- Stormwater which collects in the area surrounding the drilling platform and ancillary drilling equipment. This stormwater has a higher likelihood of contact with potential contaminants, particularly drilling mud;
- Produced water which flows from the producing formation and is separated from the gas and water phase at the surface; and
- Drill cuttings, mud and residual fluid which are separated from the liquid waste generated during drilling.

An important requirement of the site establishment is to ensure that the site is contoured so that all stormwater and any runoff from 'clean' areas of the site flow into perimeter drains. The drains direct stormwater into a skimmer pit system on-site consisting of two settling ponds. Any hydrocarbons present in the stormwater float to the surface and can be removed. The ponds also provide an opportunity for suspended sediment to settle. Treated stormwater is then discharged from the wellsite onto and into land, and consequently into an unnamed tributary of the Waitara River.

Drilling mud and cuttings brought to the surface during drilling operations are separated out using a shale shaker. The drilling mud and some of the water is then reused for the drilling process. Cuttings were collected in bins located at the base of the shaker and disposed of offsite at a consented facility.

Hydraulic fracturing

In late 2012 the Parliamentary Commissioner for the Environment released an interim report on hydraulic fracturing within New Zealand. The purpose of this report is firstly to assess the environmental risks with hydraulic fracturing, and secondly to assess whether the policies, laws, regulations and institutions in New Zealand are adequate for managing these risks. The following discussion has been based upon this report.

The first known hydraulic fracturing operation was in 1989 at Petrocorp's Kaimiro-2 gas well in Taranaki. Since then, almost all of the hydraulic fracturing that has taken place in New Zealand has been done within the Taranaki region.

By the early 2000's New Zealand started exploring options for more unconventional ways of getting access to natural gas, and especially oil. These are considered to be more expensive than conventional drilling, but

as the price of oil has risen and new technologies have been developed, these unconventional methods are growing.

The most common unconventional source of oil and gas in the Taranaki region has been extracting natural gas and oil from 'tight sands'. The boundary between tight sands and conventional reservoirs is ill-defined and generally based on whether the reservoir will have an economic production flow without hydraulic fracturing.

The process of hydraulic fracturing involves using a fracturing fluid, which is primarily water (typically made up of around 95-97% treated water). This fluid also contains various chemicals, including the three main components, which are:

- An inert proppant which keeps the induced fracture open when pumping is stopped, such as medium grained sand, or small ceramic pellets;
- A gelling substance to carry the proppant into the cracks; and
- A de-gelling substance to thin the gel to allow the fracturing fluid to return to the surface while leaving the proppant in the fractures.

The chemicals associated with the fracturing fluid are trucked to the site, stored in concentrated form, and mixed immediately before the hydraulic fracturing commences.

After the casing is perforated at the desired depth, the fracturing fluid is injected under high pressure into the well and is forced through the small holes into the rocks, creating cracks. This high downhole pressure is maintained for a brief period of time (approximately 1 hour) in order to exceed the fracture strength of the reservoir rock and cause artificial fractures.

Once a fracture has been initiated, the fracturing fluid and proppant are carried into the fracture. The placement of proppant in the fractures is assisted by the use of cross-linked gels. These are solutions, which are liquid at the surface but, when mixed, form long-chain polymer bonds and thus become gels that transport the proppant into the formation.

Once in the formation these gels 'break' back with time and temperature to a liquid state and are flowed back to surface as back flow without disturbing the proppant wedge, trapped in the hydraulic fracture. With continued flow, formation hydrocarbon fluids should be drawn into the fracture, through the perforations into the wellbore and to the surface.

[Flaring from exploration activities](#)

It is possible that flaring may occur during the following activities:

- Well testing and clean-up;
- Production testing;
- Emergencies; and
- Maintenance and enhancement activities [well workovers].

1.3 Resource consents

The Company holds five resource consents the details of which are summarised in the table below and outlined in sections 1.3.1 to 1.3.

Table 1 Consents held by Petrochem Limited

Consent number	Purpose	Granted	Review	Expires
10295-1	To take groundwater as produced water.	26 May 2016	June 2021, June 2027	1 June 2033
10294-1	To discharge treated stormwater.	26 May 2016	June 2021, June 2027	1 June 2033
10296-1	To discharge stormwater and sediment, deriving from soil disturbance.	16 May 2016	N/A	1 June 2021
10292-1	To discharge contaminants to air from hydrocarbon exploration.	13 May 2016	June 2021, June 2027	1 June 2033

Each of the consent applications were processed on a non-notified basis as Petrochem Limited obtained the landowner approvals as an affected party, and the Council were satisfied that the environmental effects of the activity would be minor. The consents are discussed in further detail below.

Copies of the consents can be found appended to this report.

1.3.1 Water abstraction permit (groundwater)

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.

Petrochem Limited holds water permit **10295-1** to cover the taking of groundwater, as 'produced water', during hydrocarbon exploration and production activities at the Kowhai-D wellsite. This permit was issued by the Council on 26 May 2016 under Section 87(d) of the RMA. It is due to expire on 1 June 2033.

Conditions 1 and 2 are lapse and review provisions.

The permit is attached to this report in Appendix I.

1.3.2 Water discharge permit (treated stormwater and treated produced water)

Section 15(1)(a) of the *Resource Management Act 1991* (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.

Petrochem Limited holds water discharge permit **10294-1** to cover the discharge of treated stormwater from the hydrocarbon exploration and production operations at the Kowhai-D wellsite onto land and into an unnamed tributary of the Waitara River. This permit was issued by the Council on 26 May 2016 under Section 87(e) of the RMA. It is due to expire on 1 June 2033.

Condition 1 requires the consent holder to adopt the best practicable option.

Condition 2 sets limits on the discharge area.

Condition 3 and 4 detail requirements for notification prior to works, and contingency plans.

Conditions 5 to 9 detail requirements of the stormwater and skimmer pit system.

Conditions 10 to 13 detail requirements for the quality of the discharge and its effect on the receiving environment.

Condition 14 requires the consent holder to ensure no overflow or water seepage is occurring.

Condition 15 requires notification prior to reinstatement of the site.

The last two conditions are lapse and review provisions.

The permit is attached to this report in Appendix I.

1.3.3 Water discharge permit (stormwater and sediment-earthworks)

Section 15(1)(a) of the *Resource Management Act 1991* (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.

Petrochem Limited holds water discharge permit **10296-1** to discharge stormwater and sediment, deriving from the soil disturbance undertaken for the purpose of constructing the Kowhai-D wellsite, onto land where it may enter an unnamed tributary of the Waitara River. This permit was issued by the Council on 16 May 2016 under Section 87(e) of the RMA. It is due to expire on 1 June 2021.

Condition 1 sets limits on the discharge area.

Condition 2 requires the consent holder to adopt the best practicable option.

Condition 3 requires notification prior to works.

Condition 4 details requirements of sediment control measures.

Condition 5 requires the consent holder to meet with a Taranaki Regional Council officer before works commence.

Condition 6 requires sediment control measures to be constructed and in place before the soil is exposed, and remain in place throughout the duration of works.

Condition 7 requires earthworked areas to be stabilised vegetatively after completion of soil disturbance.

The permit is attached to this report in Appendix I.

1.3.4 Air discharge permit (exploration activities)

Section 15(1)(c) of the *Resource Management Act 1991* (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.

Petrochem Limited holds air discharge permit **10292-1** to discharge contaminants to air from hydrocarbon exploration at the Kowhai-D wellsite, including combustion involving flaring or incineration of petroleum recovered from natural deposits, in association with well development or redevelopment and testing or enhancement of well production flows. This permit was issued by the Council on 13 May 2016 under 87(e) of the RMA. It is due to expire on 1 June 2033.

Condition 1 defines terminology related to flaring.

Conditions 2 to 5 detail requirements and set limits for flaring.

Conditions 6 and 7 detail requirements of flaring notifications.

Conditions 8 to 11 set limits on the type of material that can be flared.

Conditions 12 and 13 detail requirements for reporting of information to the Council, and best practice.

Conditions 14 to 16 set limits on the quality and effect of emissions on the receiving environment.

Conditions 17 to 19 detail requirements for design, analysis and reporting of the flare system.

The last two conditions are lapse and review provisions.

The permit is attached to this report in Appendix I.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets 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 Kowhai-D well site consists of seven primary components. They are:

- Programme liaison and management;
- Site inspections;
- Chemical sampling;
- Solid wastes monitoring;
- Air quality monitoring;
- Discharges to land (hydraulic fracturing and deep well injection); and
- Biomonitoring surveys.

The monitoring programme for the Kowhai-D wellsite focused primarily on programme liaison and management, site inspections, chemical sampling, discharges to land and biomonitoring surveys. However, all seven components are discussed below.

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 Kowhai-D site was visited 16 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 from the Kowhai-D skimmer pits adjacent to the discharge point into the unnamed tributary of the Waitara River.

The skimmer pits discharge was sampled on two occasions, and the sample analysed for pH, hydrocarbons, chloride and suspended solids. The unnamed tributary was not sampled during this period.

1.4.5 Solid wastes

The Council monitors any disposal of drill cuttings on site via mix-bury-cover to ensure compliance with resource consent conditions and to determine whether site activities were causing any adverse effects within the receiving environment.

In recent times consent holders have opted to remove drilling waste from the site by contractor and dispose of it at licensed disposal areas (land farming), which are monitored separately.

1.4.6 Biomonitoring surveys

A biological survey was performed on one occasion in an unnamed tributary of the Waitara River to determine whether or not the discharge of treated stormwater and uncontaminated site and process effluent from the site has had a detrimental effect upon the communities of the stream.

2 Results

2.1 Water

2.1.1 Inspections

8 June 2016

A site inspection was undertaken in conjunction with a Petrochem Ltd representative to assess what, if any, works were required to maintain full compliance with resource consents held for these sites. Stormwater systems, silt control measures, flare pit design and location and general maintenance (weed control) of the site were all assessed.

The sites were generally very good with little or no work required. Ring drains and bunds were all in place and effective, flare pits were well suited to minimise off site effects and no flaring was in progress at the time of inspection. Some silt controls needed a tidy up to maintain efficiency.

Mix-bury cover areas, where applicable were noted and all were secure. Weed control was very good, with one site needing a bit of attention. All sites were well presented and maintained.

25 November 2016

A compliance monitoring inspection was carried out at the Kowhai-D to check for compliance with resource consent 10296-1. It was raining at the time of inspection.

It was found that works to construct the access road had commenced. Top soil had been removed and placed on the downhill side of the track. It was observed that no sediment was being released from the area into the surrounding land. No puddles were forming in/along the worked area.

The silt controls on the fence line were in place with only clean stormwater flowing through it. No issues were raised during the inspection.

6 December 2016

A compliance monitoring inspection was carried out at the Kowhai-D wellsite to check for compliance with resource consent conditions.

The inspection found that work had progressed with the construction of the access track. Stormwater from the first section was to flow down the track and into a low area off to the side of the track between a topsoil bund and the track. Silt controls consisted of two silt fences and a drain to direct stormwater to the fence. The silt fences were put in place to capture topsoil that may flow offsite.

Works had commenced near the first culvert with top soil being stripped and placed onto the adjacent paddock. Silt controls for this area had not been set up, however following a conversation with a Petrochem Ltd representative these were to be in by the end of the day. This area had potential to cause adverse effects due to the slope of the track and the catchment above, that flows onto the track. It was advised that stormwater from the paddock above the track would be diverted. It was discussed that the flow of water needed to be slowed in this area.

9 December 2016

A site inspection was undertaken at the Kowhai-D wellsite after a period of recent rain. Due to this rain the access road was damp. No riling was noted along the newly formed topsoil bank adjacent to the access track.

The first silt fence along the fence line did not appear to have been in use. There was no evidence of silt tracking from exposed areas. The second silt fence and drain also appeared to have worked well, although it

did appear that there was not a lot of stormwater flow. The drain had been extended to capture sediment from topsoil further along the access track. The farm track and newly developed access track were separated by a drain in one location to avoid cross contamination of sites. Some stormwater from the external drain was to flow into a 2 by 1 m sediment trap before flowing into a 23 by 1 m retention pond. Stormwater then flows over the bank into the stream. The stream was flowing very clear at the time of inspection. On the farm track past the culvert more drains had been installed to direct stormwater to a filter fence. This area will need to be monitored to ensure there is the correct fall. Works had commenced in the paddock that will contain the wellsite, top soil had been stripped back to clay in areas where the access track is to be located.

The topsoil bund should contain any storm water discharges from the track. Only discharges from this area at this point in time will be from the topsoil that will discharge into the paddock. A stream is located approximately 30 m away. Works had commenced on stripping topsoil from the wellsite area. No controls were in place at the time of inspection.

16 January 2017

A site inspection was undertaken at the Kowhai-D wellsite following removal of most of the equipment associated with the Tiger Rig and Parker 246 from the lay down area on the Production Station site.

The storage area was found to be neat and tidy. The Deepwell reinjection well had been safeguarded by the use of large concrete blocks, this area was clean.

No flaring or odours associated with production of hydrocarbons were noted down wind or off site. The two skimmer pits on the truck load out pad had residential tadpoles and other aquatic species and the other skimmer pits outside of the compound were also inhabited.

25 January 2017

A site inspection was undertaken at the Kowhai-D wellsite to assess stormwater and air discharges. The results of this showed that both systems were not giving rise to any effects, neither were discharging.

All bunds and ring drains were free of contaminants and the processing area was neat and tidy. Some activity on site by way of horizontal directional drilling to under bore pipeline off site to connect up with adjacent well site.

31 January 2017

A site inspection was undertaken at the Kowhai-D wellsite after a period of heavy rain. At the entrance to the site it was noted that the bund, for the diesel tank behind security hut, was full and needed to be emptied.

Further work to the access road had commenced with it being widened and graded. Due to the recent heavy rain it was evident that the silt controls had been effective in capturing suspended solid. No effects noted beyond the controls.

The culvert pipe was still being constructed. Further rock rip rap has been installed. The culvert currently restricts fish passage and work is needed to ensure compliance with this condition. Smaller culverts had been installed under the access track to allow stormwater/groundwater to escape from the inside bank.

The addition of further controls within the drain to restrict the flow of sediment was discussed. Silt controls and sediment pits were under construction at another point along the access road. The wellsite was well under construction with metal being applied and graded. Skimmer pits, flare pit and water storage pit were under construction. Sediment was being collected via a ring drain around the site. The topsoil bund was stabilising naturally in places. Only minor works were required to sure up silt controls and enable fish passage.

2 February 2017

A site inspection was undertaken at Kowhai-D wellsite during wet weather. The first filter fence was holding back a significant volume of clear stormwater. It was observed that the drain alongside the access track contained discoloured stormwater. The second filter fence was ripped allowing stormwater to flow offsite with minimal treatment.

It was noted that along the width of the access track minimal controls were in place to assist in slowing the flow of water which would allow sediment to settle out. Some hay bales onsite were found to be ineffective as water had pushed them aside and in places was flowing around them. Some hay bales were found to be effective. No activity was occurring on site at the time of inspection. The northern side of the wellsite was coping with the minimal stormwater flows. A mooring line had been installed inside the culvert under the access track but had not been positioned correctly to allow for fish passage.

Following the inspection of the wellsite, the sediment controls on the western bank of the Waitara River were checked. The top of the main cutting had been contoured to stop stormwater pouring down the cutting. Stormwater from the top area was directed to the sides. The northern side had been diverted into a small drain that also captured sediment from stockpiled earth. A small sediment trap had been created and was working exceptionally well to treat sediment. Stormwater then flowed overland (grass) and looked reasonably clear. The southern side was not effective at catching stormwater. Stormwater here was observed going through to a small drain that had a hay bale in it that was creating a small pond upstream. This was, however, allowing sediment to settle out of suspension. The main cut was very fragile with a lot of fines present. A trench that spanned the width of the cutting had been created the previous night. At the time of inspection the trench was not visible and no silt controls (except for a few hay bales mid-section) were in place.

Works were being carried out to install controls. Waratahs had been placed in two locations and numerous hay bales had been placed into the cutting. Workers onsite were waiting for equipment before work could continue. Due to the rain at time of inspection stormwater laden with sediment was flowing down the cutting and into the Waitara River. Discolouration of the Waitara River was clearly evident from the discharge of sediment from the cutting. The trench dug the previous night was not visible because it was completely full of sediment. A representative explained that works had been carried out to divert stormwater away from the cutting and install hay bales every 5 m down both sides of the cutting and in front of the silt fence at the bottom of the cutting.

3 February 2017

An inspection of the silt controls along the access track to the Kowhai-D wellsite was undertaken. The inspection found that further controls had been put in place. Some of the controls had been working effectively to capture sediment. These new controls consisted of hay bales and stones placed into the drains to slow the flow of water. Most of the existing controls that had failed the previous day had been fixed. Photos were taken at the time of inspection, a small number of controls needed further attention.

Works were occurring on the western bank of the Waitara River to remove loose material from the cutting and to sure-up existing sediment controls and upgrade existing controls. It was noted that the controls put in place the previous day held a lot of sediment back and were full. These were going to be cleaned out. The rope placed in the culvert to allow for fish access/passage had been adjusted.

27 February 2017

A site inspection was undertaken at Kowhai D wellsite to assess stormwater and air discharges. The southern skimmer pit was full of stormwater but was not discharging. The skimmer pits at the northern end of the site were not full. Water in the pits was clear with sediment having settled to the bottom and sides. Sediment traps in the ring drains were very clear. The coconut matting appeared to be working well to capture

sediment. The sediment trap/silt fence below the southern skimmer pit appeared effective as no silt was observed past this point.

Bunding was in place around the mud shakers/sawdust area as well as the mud tanks and Halliburton area. Dry chemicals were fully bunded to stop the ingress/egress of stormwater. Site was managed and set up well. A small spill of diesel was immediately seen to which staff were notified.

There is good separation between traffic and the rig. Sediment controls along the access track were working well but needed cleaning to remove sediment. It was noted that the likely flow of stormwater/sediment down the access track towards the newly installed culvert may lead to a direct discharge into the stream and this required monitoring during rainfall events.

14 March 2017

A site inspection was undertaken at the Kowhai-D wellsite. This showed that the wellsite had been designed in such a manner that should prevent or minimise any off site effects from stormwater discharges. The very best techniques in silt and sediment control had been implemented; bunds about operational areas were in place, skimmer pits were lined, ring drains were lined with coconut matting and the silt retention cloth had all been incorporated into the system. Any discharge from the site would be onto land some distance away from the nearest waterbody. The site is well situated so that any intrusion of this drilling programme on to adjacent neighbours would be unlikely. The site is well managed and was neat and tidy.

28 March 2017

A site inspection was undertaken at the Kowhai-D wellsite. Drilling operations were normal at time of inspection. Stormwater system, ring drains and bunds were secure and very well constructed, although some matting had to be fixed. No discharges off site. This site is well managed and operated with onsite staff taking interest in its wellbeing.

12 June 2017

A site inspection was undertaken at the Kowhai-D wellsite. The access road silt controls required cleaning as many of them were full of sediment. It was unknown at the time of inspection as to whether sediment had been released into the drain. The banks had been stabilised and were being used by the farmer to graze stock on. The silt controls around the first culvert needed addressing as there was evidence that sediment was overtopping the controls and discharging down the bank into the stream. The culverts are compliant with consent conditions and there was fish access through the culvert via the mussel spat rope. The controls near the entrance to the site were loaded with sediment and needed to be cleaned as sediment was still being released from the banks surrounding the wellsite.

It was found that a significant volume of chemical was being stored onsite without any bunding in place. There were two locations where 44 gallon drums were being stored, and a number of other sites where IBC and small drums were located with no bunding in place. Drilling muds were observed within the bund next to the mud dryer. It is an expected best practice for this mud to be removed from the bund after drilling operations have ceased and before the production testing crew arrive onsite. It was noted that grass was starting to establish in areas around the site and in the ring drain.

No discharges were occurring from the site at the time of inspection. Samples were taken from the skimmer pits to get an indicative discharge sample. It was noted that yellow bund under the generator diesel tank was full of stormwater and appeared to have been overflowing. No flaring was occurring at the time of inspection. It was noted that the sewage tanks were overflowing to land via a buried drain.

The following action is to be taken: Undertake works to ensure all chemicals are appropriately bunded and are maintained in such a way so they are effective.

17 August 2017

A site inspection was undertaken at the Kowhai-D wellsite. It was noted that most areas where soil was exposed had been stabilised with grass. The overview plan, well site layout plan and sediment control management plan were not onsite at the time of inspection so this condition was not assessed. Other measures were agreed to by TRC, and improvements were made as the site progressed. It was noted that the sediment barrier on the access track could have been repositioned and the sediment in front of it removed. This consent and its conditions are being complied with.

No hydraulic fracturing was taking place at the time of inspection. The equipment used to hydraulic fracture had been removed from site.

It was raining at the time of inspection. The site was tidy. No sheens were noted in the puddles. All chemicals on site were bunded. The ring drains were flowing to the skimmer pits. The skimmer pits appeared to be working well to settle out sediment and retain hydrocarbon. The discharge from the pits appeared clear. A discharge sample was taken from the skimmer pits closest to the site gate. The groundwater beneath the last pit at the western end was being pumped out so that works could be undertaken to repair the pit (installation of a metal frame to hold down the liner). It was noted that the discharged groundwater was causing sediment to be released. Staff onsite turned off the pump whilst they looked for an alternate discharge point.

Conditions of this consent were not assessed. The produced water storage tank is contained within a bund. The produced water is transferred to a truck and taken offsite for disposal.

Flaring was occurring at the time of inspection. The flare was clean with no smoke observed. Both high pressure and low pressure separation were in place and being used. A heater was also in place and being used prior to separation.

10 October 2017

The site has been established, and discharges of stormwater are now being monitored via the stormwater wellsite consent. This consent was not assessed at the time of inspection.

Produced water, when flowing from the well, is stored in a tank onsite before being transported offsite for disposal. The tank is bunded to capture and spills that may occur. No issues were raised onsite at the time of inspection with regard to produced water.

A diagnostic fracture injection test (DFIT) operation was about to commence shortly after my inspection onsite. Specific conditions of this consent were not assessed. The hydraulic fracturing company had set up onsite and appeared to have good management procedures in place. Chemicals on site were within appropriate bunds.

No flaring was occurring at this site at the time of inspection.

In general the site is being maintained to a good standard. Bunding is in place and the site is tidy. Recent activity has caused sediment to flow to the skimmer pits. The pits were turbid with what appeared to be very fine silts below 100 gm³. No samples were taken however, as the pits were not discharging.

2.1.2 Results of abstraction and discharge monitoring

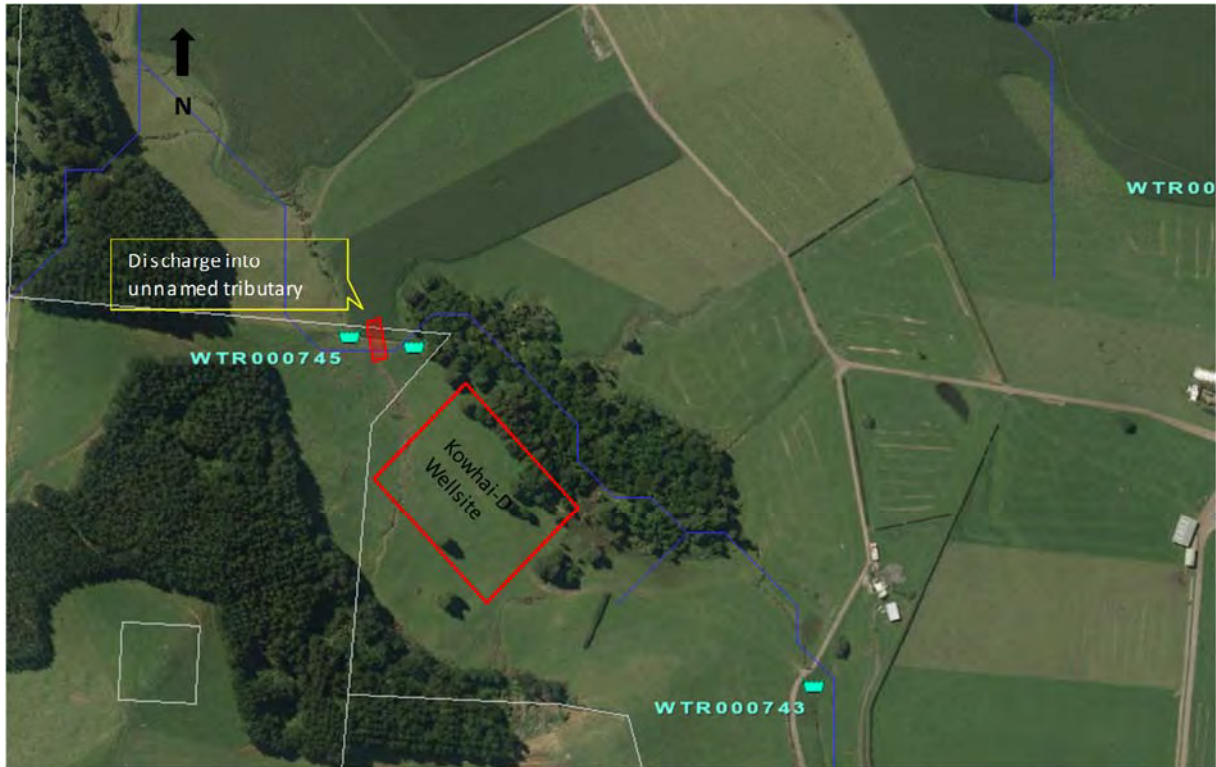


Figure 2 Aerial view of the Kowhai-D wellsite, showing sampling sites along unnamed tributary

During the period under review a total of five stormwater samples were taken. Two samples were obtained from the second skimmer pit, one sample from the first skimmer pit, one sample from the mud tank bund. One sample was also taken from the eastern skimmer pit, as discharge was occurring.

Analysis of the samples obtained showed that all the discharges would have complied with resource consent conditions should a discharge have occurred. The sample taken while discharge was occurring also complied with resource consent conditions.

Table 2 Stormwater sampling results for Kowhai-D wellsite 2016-2018

Date	Chloride g/m ³	Hydrocarbons g/m ³	pH pH	Suspended Solids g/m ³	Sampling Location
12 Jun 2017	17.8	<0.5	8.5	8	Second skimmer pit (NW)
12 Jun 2017	16.4	<0.5	8.0	28	First skimmer pit (NW)
12 Jun 2017	60.6	5.7	7.9	6	Mud Tank bund
12 Jun 2017	30	<0.5	7.1	30	Second skimmer pit (E)
17 Aug 2017	15.1	<0.5	7.1	37	Eastern skimmer pit

2.1.3 Results of receiving environment monitoring

2.1.3.1 Chemical Sampling

During the period under review five discharge samples were taken, from the skimmer pits and the mud tank bund, all on the same day. The results of this sampling operation all were found to comply with corresponding consents.

2.1.3.2 Biomonitoring Surveys

The Council's 'kick-sampling' and 'vegetation sweep' techniques were used at three sites on three occasions to collect benthic macroinvertebrates from an unnamed tributary of the Waitara River in relation to stormwater discharges to land and to this unnamed tributary of the Waitara River from the Kowhai-D wellsite. This has provided data to assess any potential impacts the consented discharges have had on the macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (taxa richness), MCI and SQMCI_s scores for each site.

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

Taxa richnesses were moderate at all sites in the pre-drill survey, and were moderate to moderately low in the post-drill survey. The post-hydraulic fracturing survey again recorded moderate to moderately low taxa richnesses. It is worth noting that taxa abundances at site 2 were low on all occasions, with only 'common' and 'rare' taxa recorded.

MCI scores categorised sites as having 'poor' or 'fair' macroinvertebrate community health. In the pre-drill survey the score recorded at site 1 was significantly lower than at site 3. The post-drill and post-hydraulic fracturing surveys found no significant differences between the three sites. Between surveys, site 1 remained similar, while site 2 recorded a significantly lower score in the post-drill survey than the pre-drill survey, and showed some improvement in the post-hydraulic fracturing survey (which was not significantly different from either the pre-drill or post-drill surveys). Site 3 showed a decreasing MCI score over the three surveys, with the post-hydraulic fracturing survey result being significantly lower than recorded in the pre-drill survey, and with post-drill score being similar to both the pre-drill and post-hydraulic fracturing survey scores.

SQMCI_s scores very low at all sites in all three surveys. Site 1 had had the lowest SQMCI_s score in all three surveys, with difference being significant compared to sites 2 and 3 in the pre-drill and post-drill surveys, and also compared to site 3 in the post-HYDRAULIC FRACTURING survey. The score at site 1 was significantly lower in the post-drill survey compared to both the pre-drill survey and the post-HYDRAULIC FRACTURING survey. The scores at both site 2 and site 3 remained similar between all three surveys.

Overall, the three surveys showed no significant detrimental impacts from the treated stormwater discharges to land and to the unnamed tributary of the Waitara River. The observed results show lower or similar MCI and SQMCI_s scores at site 1, upstream of wellsite discharges, compared to sites 2 and 3 which are downstream of the wellsite discharges. This is likely a result of habitat differences, however if stormwater discharges were causing adverse impacts on this unnamed tributary of the Waitara River, lower results would be expected at sites 2 and 3 compared to site 1 which is not the case in these three surveys. Although decreases in MCI score were noted at all three sites, at site 2 subsequent improvement was recorded, while at site 3 the decline was not significant between any two consecutive surveys.

2.1.4 Air quality monitoring

Air quality monitoring is carried out in association with the well testing and clean-up phase, where flaring can occur. The Council also undertakes sampling of the ambient air quality in the neighbourhood associated

with this. Assessments are made by Inspecting Officers during site inspections to ensure that operators undertake all practicable steps to mitigate any effects from flaring gas.

Only one flaring event was noted during the period under review. It was found that the flare was clean with no noticeable smoke. No other issues regarding air quality associated with the wellsite were noted during the general compliance monitoring inspections.

2.2 Investigations, interventions and Incidents

The monitoring programme for the year was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the Company. During the year matters may arise which require additional activity by the Council, for example provision of advice and information, or investigation of potential or actual 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 2016-2018 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 Kowhai-D wellsite during the period under review found that the site was well managed, with no issues with the silt and sediment controls that were in place. Any minor actual or potential non-compliance with consent conditions were addressed during site inspections. The Company would quickly take steps to ensure that requests made by Council Inspecting Officers were adhered to without delay.

There were no incidents or complaints recorded, and it is considered that all resource consent conditions were complied with during the monitoring period, including the provision of various pieces of information (contingency plan, notifications etc.).

Monitoring has shown that the management on site ensured no effects to the environment occurred during the monitoring period.

It was mentioned that during the setup of the site, sediment controls were installed as a reactive step to sediment runoff, rather than a proactive one. For future works controls should be installed before sediment runoff occurs.

3.2 Environmental effects of exercise of consents

Results of stormwater sampling were within limits prescribed by the consent for the wellsite for all samples. No adverse effects were noted on the receiving environment from the discharges from site.

Small amounts of groundwater may have been encountered as produced water during operations at the wellsite. It was anticipated that the abstraction of groundwater would not impact on any groundwater resource and that the groundwater would not be affected, as it would be protected by the well casing from contamination by drilling activities.

There were no adverse effects on the environment resulting from discharges to the air at the Kowhai-D wellsite. Inspections showed that flaring only occurred once, where it was noted that the flare was emitting no smoke.

The Company implemented various mitigation measures to ensure the storage and use of hazardous substances onsite did not contaminate surface waters and soils. As a result, there were no issues or adverse effects noted as a result of the use of these substances.

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 3-6.

Table 3 Summary of performance for consent 10925-1

Purpose: To take groundwater, as 'produced water', during hydrocarbon exploration and production activities at the Kowhai-D wellsite		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Lapse Condition	Inspection	Yes
2. Review Condition	No provision for review during the period	N/A

Purpose: To take groundwater, as 'produced water', during hydrocarbon exploration and production activities at the Kowhai-D wellsite		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

N/A = not applicable

Table 4 Summary of performance for consent 10294-1

Purpose: To discharge treated stormwater from hydrocarbon exploration and production operations at the Kowhai-D wellsite onto land and into an unnamed tributary of the Waitara River		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option	Inspection	Yes
2. Limits on discharge area	Inspection	Yes
3. Notification of site works	Notification	Yes
4. Requirements of contingency plan	Report Submitted	Yes
5. Requirements of the stormwater design	Inspection	Yes
6. Discharges to pass through skimmer pit	Inspection	Yes
7. Requirements of skimmer pit design	Inspection	Yes
8. Requirements of stormwater system construction	Inspection	Yes
9. Requirements of stormwater system installation	Inspection	Yes
10. Limits on discharge quality	Physicochemical sampling	Yes
11. Limits on pH not covered by condition 10	Physicochemical sampling	Yes
12. Limits in effects on receiving waters	Inspection, sampling	Yes
13. Limits on effects on receiving waters not covered by condition 12	Inspection, sampling	Yes
14. Requirements on overflow and water seepage	Inspection	Yes
15. Notification prior to reinstatement	Notification	N/A
16. Lapse Condition	Inspection	Yes
17. Review Condition	No provision for review during the period	N/A

Purpose: To discharge treated stormwater from hydrocarbon exploration and production operations at the Kowhai-D wellsite onto land and into an unnamed tributary of the Waitara River		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

N/A = not applicable

Table 5 Summary of performance for consent 10296-1

Purpose: To discharge treated stormwater and sediment, deriving from soil disturbance undertaken for the purpose of constructing the Kowhai-D wellsite, onto land where it may enter an unnamed tributary of the Waitara River		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Limits on earthworks stormwater catchment size	Inspection	Yes
2. Consent holder to adopt best practicable option	Inspection	Yes
3. Notification of earthworks	Notification	Yes
4. Requirements of stormwater system design	Inspection	Yes
5. Details of meeting with TRC officer before works commence	Meeting	Yes
6. Requirements of stormwater system construction	Inspection	Yes
7. Requirements upon completion of earthworks	Inspection	Yes
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

N/A = not applicable

Table 6 Summary of performance for consent 10292-1

Purpose: To discharge contaminants to air from hydrocarbon exploration at the Kowhai-D wellsite, including combustion involving flaring or incineration of petroleum recovered from natural deposits, in association with well development or redevelopment and testing or enhancement of well production flows		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Definition of terms	N/A	N/A
2. Limits on chimney height	Inspection	Yes

Purpose: To discharge contaminants to air from hydrocarbon exploration at the Kowhai-D wellsite, including combustion involving flaring or incineration of petroleum recovered from natural deposits, in association with well development or redevelopment and testing or enhancement of well production flows		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
3. Requirements of flare pit design	Inspection	Yes
4. Limits upon location of flaring	Inspection	Yes
5. Limits upon duration of flaring	Inspection	Yes
6. Notification to TRC of flaring	Inspection	Yes
7. Notification to affected parties of flaring	Inspection	Yes
8. Limits upon flaring material	Inspection	Yes
9. Pre-treatment of flared material	Inspection	Yes
10. Conditions on flaring materials when separation not achievable	Inspection	Yes
11. Reinstatement of separation when practical	Inspection	Yes
12. Report on flaring associated with condition 10	Report	Yes
13. Consent holder to adopt best practicable option	Inspection	Yes
14. No offensive odour or smoke beyond the boundary	Inspection	Yes
15. Control of contaminants in emissions	Inspection	Yes
16. Control of contaminants other than in condition 15	Inspection	Yes
17. Gas and condensate analysis	Not requested	N/A
18. Vapour recovery systems to be fitted	Inspection	Yes
19. Requirements of combustion recording and reporting	Report	Yes
20. Lapse Condition	Inspection	Yes
21. Review Condition	No provision for review during the period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

During the year, the Company demonstrated a high level of environmental and high level of administrative performance with the resource consents as defined in Section 1.1.4. During the year under review there were

no unauthorised discharges or incidents relating to activities at the wellsites. Compliance monitoring results showed there were no adverse environmental effects as a result of the exercise of the Company's consents for the period under review. Ratings are as defined in Section 1.1.4.

3.4 Recommendations from the 2016-2018 Report

In the 2016-2018 Report, it was recommended:

1. THAT sediment controls become more of a proactive measure rather than a reactive measure.

3.5 Alterations to monitoring programmes for 2018-2019

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

- the extent of information already made available through monitoring or other means to date;
- its relevance under the RMA;
- the Council's obligations to monitor consented activities and their effects under the RMA;
- the record of administrative and environmental performances of the consent holder; and
- reporting to the regional community.

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

It is proposed that for 2018-2019, monitoring of consented activities at the Kowhai-D wellsite continue at the same level as in 2016-2018. A recommendation to this effect is attached to this report.

It should be noted that the proposed programme represents a reasonable and risk-based level of monitoring for the site(s) in question. The Council reserves the right to subsequently adjust the programme from that initially prepared, should the need arise if potential or actual non-compliance is determined at any time during 2016-2018.

4 Recommendations

1. THAT in the first instance, monitoring of consented activities at Kowhai-D wellsite in the 2018-2019 period continue at the same level as in 2016-2018.
2. THAT should there be issues with environmental or administrative performance in 2018-2019, monitoring may be adjusted to reflect any additional investigation or intervention as found necessary.
3. THAT this report be forwarded to the Company, and to any interested parties upon request.

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.
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.
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.
m ²	Square Metres.
MCI	Macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats.
mS/m	Millisiemens per metre.
Mixing zone	The zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
O&G	Oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons).
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	Measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment.
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).
RMA	<i>Resource Management Act 1991</i> and including all subsequent amendments.
SS	Suspended solids.

SQMCI	Semi quantitative macroinvertebrate community index.
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.
Zn*	Zinc.

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

For further information on analytical methods, contact a Scientific Services Manager

Appendix I

Resource consents held by Petrochem Limited

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

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

Name of
Consent Holder: Petrochem Limited
PO Box 3394
New Plymouth 4341

Decision Date: 13 May 2016

Commencement Date: 13 May 2016

Conditions of Consent

Consent Granted: To discharge contaminants to air from hydrocarbon exploration at the Kowhai-D wellsite, including combustion involving flaring or incineration of petroleum recovered from natural deposits, in association with well development or redevelopment and testing or enhancement of well production flows

Expiry Date: 1 June 2033

Review Date(s): June 2021, June 2027 and in accordance with special condition 21

Site Location: Kowhai-D wellsite, 17 Manganui Road, Everett Park
(Property owner: Clonakillity Farms Limited)

Grid Reference (NZTM) 1710119E-5674986N

*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. For the purposes of this consent:
 - (a) 'flaring' means the uncontrolled or partially controlled open air burning of hydrocarbons derived from or entrained in the well stream. 'Flare', as a verb, has the corresponding meaning and, as noun, means the flame produced by flaring.
 - (b) 'incineration' means the controlled, enclosed burning of formation hydrocarbons within a device designed for the purpose. 'Incinerate' has the corresponding meaning.
 - (c) 'Combustion' means burning generally and includes both flaring and incineration as well as other burning such as fuel in machinery.
2. Incineration shall only occur in a device with a minimum chimney height determined by the method detailed in Appendix VIII of the *Regional Air Quality Plan for Taranaki*.
3. Flaring shall only occur over a pit, or similar containment area, consisting of impermeable material that prevents any liquid from leaking through its base or sidewalls and discharging to land.
4. Flaring and incineration shall only occur within 20 metres of the location defined by 1710119E - 5674986N (NZTM).
5. Discharges to air from flaring or incineration shall not last longer than 15 days, cumulatively, inclusive of testing, clean-up, and completion stages of well development or work-over, per zone to be appraised, with a maximum of 4 zones per well and 8 wells.
6. The consent holder shall notify the Chief Executive, Taranaki Regional Council, at least 24 hours before the flaring or incineration from each zone commences. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
7. At least 24 hours before any flaring or incineration, other than in emergencies, the consent holder shall provide notification of the commencement of flaring or incineration to the occupants of all dwellings within 300 metres of the point of flaring or incineration and all landowners within 200 metres. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and complaints received in respect of any combustion activity.
8. No material shall be flared or incinerated, other than those derived from or entrained in the well stream.
9. To the greatest extent practicable, any material flared is to comprise only hydrocarbons that are first treated by effective liquid and solid removal by separation.

Consent 10292-1.0

10. Subject to condition 9, the discharge of smoke is not provided for by this consent unless effective separation cannot be achieved for reasons beyond the control of the consent holder such that the discharge of liquid hydrocarbons to the flare is unavoidable.
11. If effective separation of gaseous and liquid hydrocarbons as required by condition 9 is not achieved or maintained, then, the consent holder shall reinstate effective separation as soon as practicable and if separation can not be achieved within 3 hours combustion must cease.
12. If liquid hydrocarbon is combusted in accordance with the exception provided for in condition 10 the consent holder shall prepare a report that details:
 - (a) the reasons that separation could not be achieved;
 - (b) the date and time that separation was lost and reinstated;
 - (c) what was done to attempt to reinstate separation and, if the attempt was unsuccessful the reasons why.

The report shall be provided to the Chief Executive, Taranaki Regional Council within 5 working days from the date of combustion of liquid hydrocarbon.

13. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air, including, but not limited to having regard to the prevailing and predicted wind speed and direction at the time of initiation, and throughout, any episode of combustion so as to minimise offsite effects (other than for the maintenance of a pilot flame).
14. Subject to conditions 10 and 11, the discharge shall not cause any objectionable or offensive odour, smoke or dust at or beyond the boundary of the property where the wellsite is located. For the purposes of this condition, 'objectionable or offensive smoke' is defined as smoke of 40% or more obscuration, occurring on more than an occasional or infrequent basis.
15. The consent holder shall control all emissions of carbon monoxide, nitrogen dioxide, fine particles (PM₁₀) and sulphur dioxide to the atmosphere from the site, in order that the maximum ground level concentration of any of these contaminants arising from the exercise of this consent measured under ambient conditions does not exceed the relevant ambient air quality standard as set out in the Resource Management (National Environmental Standards for Air Quality Regulations, 2004) at or beyond the boundary of the property on which the wellsite is located.
16. The consent holder shall control all emissions of contaminants to the atmosphere from the site, other than those expressly provided for under special condition 15, in order that they do not individually or in combination with other contaminants cause a hazardous, noxious, dangerous, offensive or objectionable effect at a distance greater than 100 metres from the emission source.
17. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure C₆ or higher number of compounds.

Consent 10292-1.0

18. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.
19. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council, a 'combustion log' that includes:
 - (a) the date, time and duration of all flaring or incineration episodes;
 - (b) the zone from which flaring or incineration occurred;
 - (c) the volume of substances flared or incinerated;
 - (d) whether there was smoke at any time during the combustion episode and if there was, the time, duration and cause of each 'smoke event'.
20. This consent shall lapse on 30 June 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.
21. 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:
 - (a) during the month of June 2021 and/or June 2027; and/or
 - (b) within 1 month of receiving a report provided in accordance with condition 12;for any of the following purposes:
 - (i) 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
 - (ii) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or
 - (iii) to alter, add or delete limits on mass discharge quantities or ambient concentrations of any contaminant;
 - (iv) reducing emissions or environmental effects that may arise from any loss of separation.

Signed at Stratford on 13 May 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: Petrochem Limited
PO Box 3394
New Plymouth 4341

Decision Date
(Change): 7 March 2017

Commencement Date
(Change): 7 March 2017 (Granted Date: 13 May 2016)

Conditions of Consent

Consent Granted: To discharge contaminants to air from hydrocarbon exploration at the Kowhai-D wellsite, including combustion involving flaring or incineration of petroleum recovered from natural deposits, in association with well development or redevelopment and testing or enhancement of well production flows

Expiry Date: 1 June 2033

Review Date(s): June 2021, June 2027 and in accordance with special condition 21

Site Location: Kowhai-D wellsite, 17 Manganui Road, Everett Park
(Property owner: Clonakillity Farms Limited)

Grid Reference (NZTM) 1710110E-5674909N

*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. For the purposes of this consent:
 - (a) 'flaring' means the uncontrolled or partially controlled open air burning of hydrocarbons derived from or entrained in the well stream. 'Flare', as a verb, has the corresponding meaning and, as noun, means the flame produced by flaring.
 - (b) 'incineration' means the controlled, enclosed burning of formation hydrocarbons within a device designed for the purpose. 'Incinerate' has the corresponding meaning.
 - (c) 'Combustion' means burning generally and includes both flaring and incineration as well as other burning such as fuel in machinery.
2. Incineration shall only occur in a device with a minimum chimney height determined by the method detailed in Appendix VIII of the *Regional Air Quality Plan for Taranaki*.
3. Flaring shall only occur over a pit, or similar containment area, consisting of impermeable material that prevents any liquid from leaking through its base or sidewalls and discharging to land.
4. Flaring and incineration shall only occur within 20 metres of the location defined by 1710110E-5674909N (NZTM).
5. Discharges to air from flaring or incineration shall not last longer than 15 days, cumulatively, inclusive of testing, clean-up, and completion stages of well development or work-over, per zone to be appraised, with a maximum of 4 zones per well and 8 wells.
6. The consent holder shall notify the Chief Executive, Taranaki Regional Council, at least 24 hours before the flaring or incineration from each zone commences. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
7. At least 24 hours before any flaring or incineration, other than in emergencies, the consent holder shall provide notification of the commencement of flaring or incineration to the occupants of all dwellings within 300 metres of the point of flaring or incineration and all landowners within 200 metres. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and complaints received in respect of any combustion activity.
8. No material shall be flared or incinerated, other than those derived from or entrained in the well stream.
9. To the greatest extent practicable, any material flared is to comprise only hydrocarbons that are first treated by effective liquid and solid removal by separation.

Consent 10292-1.1

10. Subject to condition 9, the discharge of smoke is not provided for by this consent unless effective separation cannot be achieved for reasons beyond the control of the consent holder such that the discharge of liquid hydrocarbons to the flare is unavoidable.
11. If effective separation of gaseous and liquid hydrocarbons as required by condition 9 is not achieved or maintained, then, the consent holder shall reinstate effective separation as soon as practicable and if separation can not be achieved within 3 hours combustion must cease.
12. If liquid hydrocarbon is combusted in accordance with the exception provided for in condition 10 the consent holder shall prepare a report that details:
 - (a) the reasons that separation could not be achieved;
 - (b) the date and time that separation was lost and reinstated;
 - (c) what was done to attempt to reinstate separation and, if the attempt was unsuccessful the reasons why.

The report shall be provided to the Chief Executive, Taranaki Regional Council within 5 working days from the date of combustion of liquid hydrocarbon.

13. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air, including, but not limited to having regard to the prevailing and predicted wind speed and direction at the time of initiation, and throughout, any episode of combustion so as to minimise offsite effects (other than for the maintenance of a pilot flame).
14. Subject to conditions 10 and 11, the discharge shall not cause any objectionable or offensive odour, smoke or dust at or beyond the boundary of the property where the wellsite is located. For the purposes of this condition, 'objectionable or offensive smoke' is defined as smoke of 40% or more obscuration, occurring on more than an occasional or infrequent basis.
15. The consent holder shall control all emissions of carbon monoxide, nitrogen dioxide, fine particles (PM₁₀) and sulphur dioxide to the atmosphere from the site, in order that the maximum ground level concentration of any of these contaminants arising from the exercise of this consent measured under ambient conditions does not exceed the relevant ambient air quality standard as set out in the Resource Management (National Environmental Standards for Air Quality Regulations, 2004) at or beyond the boundary of the property on which the wellsite is located.
16. The consent holder shall control all emissions of contaminants to the atmosphere from the site, other than those expressly provided for under special condition 15, in order that they do not individually or in combination with other contaminants cause a hazardous, noxious, dangerous, offensive or objectionable effect at a distance greater than 100 metres from the emission source.
17. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure C₆ or higher number of compounds.

Consent 10292-1.1

18. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.
19. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council, a 'combustion log' that includes:
 - (a) the date, time and duration of all flaring or incineration episodes;
 - (b) the zone from which flaring or incineration occurred;
 - (c) the volume of substances flared or incinerated;
 - (d) whether there was smoke at any time during the combustion episode and if there was, the time, duration and cause of each 'smoke event'.
20. This consent shall lapse on 30 June 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.
21. 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:
 - (a) during the month of June 2021 and/or June 2027; and/or
 - (b) within 1 month of receiving a report provided in accordance with condition 12;for any of the following purposes:
 - (i) 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
 - (ii) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or
 - (iii) to alter, add or delete limits on mass discharge quantities or ambient concentrations of any contaminant;
 - (iv) reducing emissions or environmental effects that may arise from any loss of separation.

Signed at Stratford on 7 March 2017

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: Petrochem Limited
PO Box 3394
New Plymouth 4341

Decision Date: 26 May 2016

Commencement Date: 26 May 2016

Conditions of Consent

Consent Granted: To discharge treated stormwater from hydrocarbon exploration and production operations at the Kowhai-D wellsite onto land and into an unnamed tributary of the Waitara River

Expiry Date: 1 June 2033

Review Date(s): June 2021, June 2027

Site Location: Kowhai-D wellsite, 17 Manganui Road, Everett Park
(Property owner: Clonakillity Farms Limited)

Grid Reference (NZTM) 1710119E-5674986N & 1710217E-5674851N

Catchment: Waitara

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

General condition

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

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment associated with the discharge of contaminants from the site.
2. Stormwater discharged shall be collected from a catchment area of no more than 1.6 Ha.
3. At least 5 working days prior, the consent holder shall advise the Chief Executive, Taranaki Regional Council of the date of each of the following events:
 - a) commencement of any site works (site works includes the introduction of a drilling rig, drilling equipment or any other associated equipment for the purpose of drilling, testing, well stimulation or well workover that may introduce contaminants to the site);
 - b) commencement of any well drilling operation; and
 - c) recommencement of any site works or drilling operations following a period of inactivity exceeding 30 days.

If any of these events is rescheduled or delayed, the consent holder shall immediately provide further notice advising of the new date.

Any advice given in accordance with this condition shall include the consent number and the wellsite name and be emailed to worknotification@trc.govt.nz.

4. The consent holder shall maintain and regularly update a contingency plan that details measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not authorised by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge. The plan shall be approved by the Chief Executive, Taranaki Regional Council, acting in a certification capacity prior to any discharge from the site.
5. Subject to the other conditions of this consent the design, management and maintenance of the stormwater system shall be undertaken in accordance with the information submitted in support of the application for this consent.
6. All discharges from the site, including from any containment pit or hydrocarbon combustion facility (e.g. flare pit, thermal oxidiser), shall flow to a perimeter drain and skimmer pit. Perimeter drains shall be designed, including by having a positive grade and low permeability, to ensure that runoff flows directly to a skimmer pit without ponding.
7. The skimmer pit system shall have a combined capacity of no less than 272 m³ including a 'freeboard' of no less than 128 m³, and be designed to retain any hydrocarbons that enter them.

Consent 10294-1.0

8. All skimmer pits and any other stormwater retention areas shall be lined with an impervious material to prevent seepage through the bed and sidewalls, and all skimmer pits shall have a valve that can be shut off to prevent any discharge from the site.
9. Perimeter drains and skimmer pits necessary to comply with the conditions of this consent shall be installed before any site works commences. Site works includes the introduction of a drilling rig, drilling equipment or any other associated equipment or facilities to the site for any purpose other than for the construction of the site.
10. Subject to condition 11 the constituents in the discharge shall meet the standards shown in the following table.

Constituent	Standard
pH	Within the range 6.0 to 9.0
suspended solids	Concentration not greater than 100 gm ⁻³
total recoverable hydrocarbons	Concentration not greater than 15 gm ⁻³ [as determined by infrared spectroscopic technique]
chloride	Concentration not greater than 230 gm ⁻³

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

11. The pH may exceed 9.0 if the exceedance is a result photosynthetic activity within the skimmer pits, but in any case the discharge shall not result in the pH of the receiving water increasing by more than 0.5 pH units after allowing for a mixing zone of 25 metres.
12. After allowing for a mixing zone of 25 metres, the discharge shall not cause any of the following effects in the unnamed tributary of the Waitara River.
 - a) an increase in the temperature of more than 2 degrees Celsius;
 - b) the filtered carbonaceous biochemical oxygen demand to exceed 2 gm⁻³; or
 - c) the chloride concentration to exceed 50 gm⁻³.
13. After allowing for a mixing zone of 25 metres, the discharge shall not give rise to any of the following effects in the receiving water:
 - a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
 - b) any conspicuous change in the colour or visual clarity;
 - c) any emission of objectionable odour;
 - d) the rendering of fresh water unsuitable for consumption by farm animals;
 - e) any significant adverse effects on aquatic life.
14. The consent holder shall ensure that there is no overflow or subsurface water seepage from the perimeter drains into the re-directed surface water drain at the site.

Consent 10294-1.0

15. The consent holder shall advise the Chief Executive, Taranaki Regional Council, in writing at least 48 hours prior to the reinstatement of the site and the reinstatement shall be carried out so as to minimise adverse effects on stormwater quality. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
16. This consent shall lapse on 30 June 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.
17. 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 2021 and/or June 2027, 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 26 May 2016

For and on behalf of
Taranaki Regional Council

A D McLay
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: Petrochem Limited
PO Box 3394
New Plymouth 4341

Decision Date: 26 May 2016

Commencement Date: 26 May 2016

Conditions of Consent

Consent Granted: To take groundwater, as 'produced water', during hydrocarbon exploration and production activities at the Kowhai-D wellsite

Expiry Date: 1 June 2033

Review Date(s): June 2021, June 2027

Site Location: Kowhai-D wellsite, 17 Manganui Road, Everett Park
(Property owner: Clonakillity Farms Limited)

Grid Reference (NZTM) 1710128E-5674886N

Catchment: Waitara

*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. This consent shall lapse on 30 June 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.
2. 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 2021 and/or June 2027, 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 26 May 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: Petrochem Limited
PO Box 3394
New Plymouth 4341

Decision Date: 16 May 2016

Commencement Date: 16 May 2016

Conditions of Consent

Consent Granted: To discharge stormwater and sediment, deriving from soil disturbance undertaken for the purpose of constructing the Kowhai-D wellsite, onto land where it may enter an unnamed tributary of the Waitara River

Expiry Date: 01 June 2021

Site Location: Kowhai-D wellsite, 17 Manganui Road, Everett Park
(Property owner: Clonakillity Farms Limited)

Grid Reference (NZTM) 1710217E-5674851N

Catchment: Waitara

*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. This consent authorises the discharge of stormwater from no more than 1.6 hectares of land where earthworks is being undertaken for the purpose of establishing the Kowhai-D wellsite, in accordance with the Assessment of Environmental Effects provided with the application, and in particular the:
 - a) Overview Plan, referenced 12245-03-01, Sheet 1, Revision A and dated 21 March 2016;
 - b) Wellsite Layout Plan, , referenced 12245-03-01, Sheet 2, Revision A and dated 21 March 2016;
 - c) Wellsite Sediment Control Management Plan, referenced 12245-03-05, Sheet 1, Revision A and dated 21 March 2016.

In the case of any contradiction between the details and the conditions of this consent, the conditions of this consent shall prevail.

2. 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.
3. At least 7 working days prior to the commencement of works the consent holder shall notify the Taranaki Regional Council of the proposed start date for the work. Notification shall include the consent number and a brief description of the activity consented and shall be emailed to worknotification@trc.govt.nz.
4. All run off from any area of exposed soil shall pass through settlement ponds or sediment traps with a minimum total capacity of:
 - a) 100 cubic metres for every hectare of exposed soil between 1 November to 30 April; and
 - b) 200 cubic metres for every hectare of exposed soil between 1 May to 31 October;unless other sediment control measures that achieve an equivalent standard are agreed to by the Chief Executive of the Taranaki Regional Council.
5. Before commencing any earthworks, the consent holder shall ensure that they (or their representatives) meet on site with a Taranaki Regional Council officer who is directly responsible for monitoring compliance with the conditions of this consent. The purpose of the meeting shall be to obtain specific advice from the Taranaki Regional Council about the measures required to ensure compliance with conditions 2 and 4.

Consent 10296-1.0

6. The sediment control measures necessary to comply with the conditions of this consent shall be constructed before soil is exposed at the site and shall remain in place, in respect of any particular area, until that area is stabilised. The obligation described in condition 4 above shall cease to apply, and accordingly the site erosion and sediment control measures may be removed, in respect of any particular area only when the site is stabilised.

Note: For the purpose of conditions 6 and 7, 'stabilised' in relation to any site or area means inherently resistant to erosion or rendered resistant, such as by using rock or by the application of basecourse, colluvium, grassing, mulch, or another method to the reasonable satisfaction of the Chief Executive, Taranaki Regional Council and as specified in the Taranaki Regional Council's Guidelines for Earthworks in the Taranaki Region, 2006. Where seeding or grassing is used on a surface that is not otherwise resistant to erosion, the surface is considered stabilised once, on reasonable visual inspection by an officer of the Taranaki Regional Council, an 80% vegetative cover has been established.

7. All earthworked areas shall be stabilised vegetatively or otherwise as soon as is practicable and no longer than 6 months after the completion of soil disturbance activities.

Signed at Stratford on 16 May 2016

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

Appendix II

Biomonitoring reports

To Job Managers, Callum MacKenzie and Jane Harvey
From Environmental Scientist, Katie Blakemore
Report No KB044
Document 2046748
Date 03 May 2018

Biomonitoring of an unnamed tributary of the Waitara River in relation to hydrocarbon exploration at Kowhai-D wellsite, February, April and November 2017

Introduction

Biological surveys were carried out in the vicinity of the newly established Kowhai-D on three occasions, to assess the impacts of wellsite activities on the macroinvertebrate fauna of this unnamed tributary of the Waitara River. Petrochem Ltd holds resource consent 10294-1 allowing the discharge of treated stormwater onto land and into an unnamed tributary of the Waitara River. A survey was carried out prior to the commencement of drilling to provide baseline data on the health of the macroinvertebrate communities. Further surveys were undertaken following the completion of drilling but prior to the commencement of hydraulic fracturing (HF), and again following the completion of HF, to determine whether stormwater discharges had caused any detrimental impacts to the macroinvertebrate communities of this unnamed tributary.

Methods

A pre-drill survey was carried out on 16 February 2017 at three sites which were established at the time of sampling (Table 1, Figure 1). A post-drill (and pre-HF) survey was carried out at the same sites on 26 April 2017 and a post-HF survey was carried out on 29 November 2017. Samples were collected using a combination of the standard '400mL kick-sampling' and the 'vegetation sweep' techniques at all three sites in the pre-drill survey and site 1 in the post-drill survey. The 'kick-sampling' technique was used at sites 2 and 3 in the post-drill and post-HF surveys, while the 'vegetation sweep' technique was used at site 1 in the post-drill and post-HF surveys. The 'kick-sampling' and 'vegetation sweep' techniques are respectively very similar to Protocol C1 (hard-bottomed, semi-quantitative) and Protocol C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate sampling in wadeable streams (Stark et al. 2001).

Table 1 Biomonitoring sites in an unnamed tributary of the Waitara River sampled in relation to the Kowhai-D wellsite

Site number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	WTR000743	E1710423 N5674733	5m upstream of farm track	50
2	WTR000744	E1710095 N5675012	Downstream edge of wetland	50
3	WTR000745	E1710042 N5675020	50m downstream of wetland	50

Samples were preserved with Kahle's Fluid and ethanol for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG

protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001). Macroinvertebrate taxa found in each sample were recorded based on the abundance 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 taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 or more MCI units 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

A semi-quantitative MCI value (SQMCIs) 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 SQMCIs is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.



Figure 1 Biomonitoring sites in an unnamed tributary of the Waitara River sampled in relation to the Kowhai-D wellsite

Results

The pre-drill survey was carried out 11 days after a fresh of greater than 3x median flow and 13 days after a fresh of greater than 7x median flow. A steady, moderate, cloudy grey flow was recorded at all three sites. Substrate comprised predominantly hard clay and silt, with fine and coarse gravels also present at the three sites. Site 1 also had sand present, while site 2 had sand and wood/root and site 3 had cobble present. Water temperatures ranged from 15.4 °C- 15.9 °C at the three sites.

Macrophytes were present on the stream margins at all three sites, while leaves and wood were patchy at site 2 but absent at sites 1 and 3. Periphyton was absent at all three sites. Overhanging vegetation and undercut banks provided complete shading at site 1 and partial shading at sites 2 and 3.

The post-drill survey was carried out 8 days after a fresh of greater than 3x median flow and 20 days after a fresh of greater than 7x median flow. A steady, moderate, clear flow was recorded which was uncoloured at site 2, and tannin-stained brown at sites 1 and 3. Substrate at site 1 comprised a mixture of silt, sand, hard clay and wood/root. Site 2 had substrate dominated by cobble and wood/root with silt boulder, gravels and sand present in smaller amounts. Site 3 had substrate dominated by cobble with small amounts of silt, sand, gravels, boulder, hard clay and wood/root present. Water temperatures ranged from 14.2 °C -15.2 °C at the three sites.

Macrophytes were present on the streambed at site 1, absent at site 2 and present on the stream margins at site 3. Moss and leaves were patchy on the streambed at sites 2 and 3 but absent at site 1, and wood was patchy at site 2 only. Periphyton was absent at sites 1 and 2 while patchy filamentous periphyton was recorded at site 3. Overhanging vegetation and undercut banks provided partial shading at all three sites.

The post-HF survey was carried out 21 days after a fresh of greater than both 3x and 7x median flow. A very low, slow, cloudy brown flow was recorded at sites 1 and 3, while at site 2 flows were steady, low and clear brown. Substrate at sites 1 and 2 was dominated by silt and hard clay, with wood/root also present at site 1 and sand, gravels and cobble also present at site 2. Site 3 had substrate dominated by hard clay, sand and fine gravels, with silt, coarse gravel and cobble also present. Water temperatures ranged from 17.4 °C – 18.7 °C at the three sites.

Macrophytes were present on the streambed at site 1 and absent at sites 2 and 3. Moss and leaves were patchy on the streambed at sites 2 and 3 but absent at site 1, and wood was patchy at site 2 only. Periphyton was absent at sites 1 and 2, while slippery periphyton mats were recorded at site 3. Overhanging vegetation and undercut banks provided complete shading at site 1 and partial shading at sites 2 and 3.

Macroinvertebrate communities

Macroinvertebrate statistics for control sites between 50 and 79m altitude in small hill country streams are given in Table 4.

Table 4 Macroinvertebrate statistics for control sites in Taranaki small hill country streams at altitudes between 50 and 79 masl

Metric	Number of samples	Range	Median
Taxa richness	8	13-28	23
MCI	8	68-105	83
SQMCI _s	3	4.3-4.9	4.9

The full results of the pre-drill survey are given in Table 5, while the results of the post-drill survey are provided in Table 6 and the results of the post-HF survey are provided in Table 7.

Table 5 Macroinvertebrate fauna of the unnamed tributary of the Waitara River sampled in relation to the Kowhai-D wellsite on 16 February 2017

Taxa List	Site Number	MCI score	1	2	3
	Site Code		WTR000743	WTR000744	WTR000745
	Sample Number		FWB17090	FWB17091	FWB17092
PLATYHELMINTHES (FLATWORMS)	<i>Cura</i>	3	R	-	-
ANNELIDA (WORMS)	Oligochaeta	1	A	-	A
MOLLUSCA	Lymnaeidae	3	R	-	-
	<i>Physa</i>	3	R	-	-
	<i>Potamopyrgus</i>	4	-	C	A
CRUSTACEA	Ostracoda	1	C	-	A
	Paraleptamphopidae	5	-	R	A
	<i>Paranephrops</i>	5	-	-	R
EPHEMEROPTERA (MAYFLIES)	<i>Austroclima</i>	7	R	-	C
	<i>Zephlebia group</i>	7	C	C	A
HEMIPTERA (BUGS)	<i>Microvelia</i>	3	-	R	-
COLEOPTERA (BEETLES)	Dytiscidae	5	R	-	-
	Ptilodactylidae	8	-	-	R
TRICHOPTERA (CADDISFLIES)	<i>Hydrobiosis</i>	5	R	R	C
	<i>Hydropsyche (Orthopsyche)</i>	9	-	-	R
	<i>Polypsectropus</i>	6	C	R	-
	<i>Psilochorema</i>	6	-	C	C
	<i>Oxyethira</i>	2	R	C	-
	<i>Tripletides</i>	5	-	R	R
	<i>Paralimnophila</i>	6	R	-	-
DIPTERA (TRUE FLIES)	<i>Zelandotipula</i>	6	-	R	-
	Orthoclaadiinae	2	-	-	R
	<i>Polypedilum</i>	3	VA	C	R
	Tanypodinae	5	C	C	C
	Culicidae	3	-	R	-
	<i>Paradixa</i>	4	R	C	-
	Empididae	3	-	-	R
	Muscidae	3	-	-	R
	<i>Austrosimulium</i>	3	A	C	C
	No of taxa			16	15
MCI			80	89	91
SQMCI			3.0	4.3	4.0
EPT (taxa)			4	5	6
%EPT (taxa)			25	33	33
'Tolerant' taxa		'Moderately sensitive' taxa		'Highly sensitive' taxa	

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

Table 6 Macroinvertebrate fauna of the unnamed tributary of the Waitara River sampled in relation to the Kowhai-D wellsite on 26 April 2017

Taxa List	Site Number	MCI score	1	2	3
	Site Code		WTR000743	WTR000744	WTR000745
	Sample Number		FWB17223	FWB17224	FWB17225
PLATYHELMINTHES (FLATWORMS)	<i>Cura</i>	3	C	-	R
NEMERTEA	Nemertea	3	C	-	-
NEMATODA	Nematoda	3	R	R	-
ANNELIDA (WORMS)	Oligochaeta	1	VA	C	C
HIRUDINEA (LEECHES)	Hirudinea	3	-	R	-
MOLLUSCA	Lymnaeidae	3	R	-	-
	<i>Physa</i>	3	C	-	-
	<i>Potamopyrgus</i>	4	C	R	A
CRUSTACEA	Copepoda	5	-	R	-
	Ostracoda	1	VA	R	R
	Paraleptamphopidae	5	-	C	C
EPHEMEROPTERA (MAYFLIES)	<i>Paranephrops</i>	5	-	R	R
	<i>Austroclima</i>	7	C	-	-
	<i>Zephlebia group</i>	7	C	-	C
PLECOPTERA (STONEFLIES)	<i>Acroperla</i>	5	-	-	R
ODONATA (DRAGONFLIES)	<i>Xanthocnemis</i>	4	R	-	-
COLEOPTERA (BEETLES)	Hydrophilidae	5	R	-	-
TRICHOPTERA (CADDISFLIES)	Ecnomidae/Psychomyiidae	6	-	R	-
	<i>Hydrobiosis</i>	5	-	-	R
	<i>Polypsectropus</i>	6	C	-	-
	<i>Psilochorema</i>	6	R	R	-
	<i>Oxyethira</i>	2	R	R	-
	<i>Tripletides</i>	5	R	-	-
DIPTERA (TRUE FLIES)	<i>Zelandotipula</i>	6	-	R	R
	Orthocladiinae	2	R	R	C
	<i>Polypedilum</i>	3	A	-	-
	Tanypodinae	5	R	R	R
ACARINA (MITES)	<i>Austrosimulium</i>	3	A	R	-
	Acarina	5	C	-	-
No of taxa			21	15	12
MCI			77	76	82
SQMCIs			1.9	3.5	3.9
EPT (taxa)			5	2	3
%EPT (taxa)			24	13	25
'Tolerant' taxa		'Moderately sensitive' taxa		'Highly sensitive' taxa	

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

Table 7 Macroinvertebrate fauna of the unnamed tributary of the Waitara River sampled in relation to the Kowhai-D wellsite on 29 November 2017

Taxa List	Site Number	MCI score	1	2	3
	Site Code		WTR000743	WTR000744	WTR000745
	Sample Number		FWB17223	FWB17224	FWB17225
PLATYHELMINTHES (FLATWORMS)	<i>Cura</i>	3	C	-	R
NEMERTEA	Nemertea	3	C	-	-
NEMATODA	Nematoda	3	R	R	-
ANNELIDA (WORMS)	Oligochaeta	1	VA	C	C
HIRUDINEA (LEECHES)	Hirudinea	3	-	R	-
MOLLUSCA	Lymnaeidae	3	R	-	-
	<i>Physa</i>	3	C	-	-
	<i>Potamopyrgus</i>	4	C	R	A
CRUSTACEA	Copepoda	5	-	R	-
	Ostracoda	1	VA	R	R
	Paraleptamphopidae	5	-	C	C
	<i>Paranephrops</i>	5	-	R	R
EPHEMEROPTERA (MAYFLIES)	<i>Austroclima</i>	7	C	-	-
	<i>Zephlebia group</i>	7	C	-	C
PLECOPTERA (STONEFLIES)	<i>Acroperla</i>	5	-	-	R
ODONATA (DRAGONFLIES)	<i>Xanthocnemis</i>	4	R	-	-
COLEOPTERA (BEETLES)	Hydrophilidae	5	R	-	-
TRICHOPTERA (CADDISFLIES)	Ecnomidae/Psychomyiidae	6	-	R	-
	<i>Hydrobiosis</i>	5	-	-	R
	<i>Polypsectropus</i>	6	C	-	-
	<i>Psilochorema</i>	6	R	R	-
	<i>Oxyethira</i>	2	R	R	-
	<i>Tripletides</i>	5	R	-	-
DIPTERA (TRUE FLIES)	<i>Zelandotipula</i>	6	-	R	R
	Orthocladiinae	2	R	R	C
	<i>Polypedilum</i>	3	A	-	-
	Tanypodinae	5	R	R	R
	<i>Austrosimulium</i>	3	A	R	-
ACARINA (MITES)	Acarina	5	C	-	-
No of taxa			21	15	12
MCI			77	76	82
SQMCIs			1.9	3.5	3.9
EPT (taxa)			5	2	3
%EPT (taxa)			24	13	25
'Tolerant' taxa		'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Site 1 - WTR000743

Moderate macroinvertebrate community richnesses of 16, 21 and 15 taxa were recorded in the pre-drill, post-drill and post-HF surveys respectively at this 'control' site, between two and eight taxa less than the median for small hill country streams at similar altitude (Table 4). The macroinvertebrate community in the pre-drill survey was characterised by three 'tolerant' taxa [oligochaete worm, midge larvae (*Polypedilum*) and sandfly larvae (*Austrosimulium*)] (Table 5). The post-drill macroinvertebrate community at this site was characterised by four 'tolerant' taxa, the same three as in the pre-drill survey and one additional taxon [seed shrimp (Ostracoda)] (Table 6). The macroinvertebrate community in the post-HF survey was characterised by one 'tolerant' taxon [midge larvae (*Polypedilum*)] and one 'moderately sensitive' taxon [caddisfly (*Polypsectropus*)] (Table 7).

Similar MCI scores of 80, 77 and 75 were recorded in the three surveys respectively, categorising the site as having 'fair' macroinvertebrate community health in the pre-drill survey and 'poor' macroinvertebrate

community health in the post-drill and post-HF surveys (Table 3). These scores are not significantly different to the median MCI score for small hill country streams at similar altitude (Table 4).

Low SQMCI_s scores of 3.0, 1.9 and 3.4 units were recorded in the three surveys respectively. The score recorded in the post-drill survey is significantly lower (Stark 1998) than that recorded by either the pre-drill or post-HF surveys (which are not significantly different from one another).

Site 2 – WTR000744

Moderate macroinvertebrate community richnesses of 15 taxa were recorded in both the pre-drill and post-drill surveys at this 'primary impact' site. The post-HF survey recorded a moderately low richness of 13 taxa, only two taxa less than the preceding surveys but a substantial ten taxa less than the median richness for small hill country streams at similar altitude (Table 4). In all three surveys, no taxa were recorded as 'abundant' or higher (Table 5, Table 6 and Table 7).

MCI scores of 89, 76 and 83 were recorded in the three surveys respectively, categorising the site as having 'fair' macroinvertebrate community health in the pre-drill and post-HF surveys, while the post-drill survey categorised the site as having 'poor' macroinvertebrate community health (Table 3). The score recorded in the pre-drill survey was significantly higher (Stark 1998) than the post-drill survey, while there were no other significant differences between surveys at this site. All scores were not significantly different (Stark 1998) from the median MCI score of 83 units for small hill country streams at similar altitude (Table 4).

SQMCI_s scores of 4.3, 3.5 and 4.2 were recorded in the pre-drill, post-drill and post-HF surveys respectively. There are no significant differences (Stark 1998) between these scores.

Site 3 –WTR000745

A moderate macroinvertebrate community richness of 18 taxa was recorded at this 'secondary impact' site in the pre-drill survey. The post-drill survey recorded a moderate richness of 15 taxa, while the post-HF survey recorded a moderate richness of 17 taxa. The macroinvertebrate community in the pre-drill survey was characterised by three 'tolerant' taxa [oligochaete worms, mud snail (*Potamopyrgus*) and seed shrimp (Ostracoda)] and two 'moderately sensitive' taxa [amphipod (Paraleptamphopidae) and mayfly (*Zephlebia* group)] (Table 5). The post-drill survey community was characterised by only one 'tolerant' taxon [mud snail (*Potamopyrgus*)] (Table 6). The post HF survey community was again characterised by only one taxon, this time the 'moderately sensitive' taxon [amphipod (Paraleptamphopidae)].

MCI scores of 91, 82 and 78 were recorded in the three surveys respectively, categorising the site as having 'fair' macroinvertebrate community health in the pre-drill and post-drill surveys and 'poor' macroinvertebrate community health in the post-HF survey (Table 3). The score recorded in the pre-drill survey was significantly higher (Stark 1998) than recorded in the post-HF survey, while there were no other significant differences between surveys at this site. All scores were also not significantly different (Stark 1998) from the median MCI score of 83 units for small hill country streams at similar altitude (Table 4).

SQMCI_s scores of 4.0, 3.9 and 4.4 were recorded at this site in three surveys respectively. There are no significant differences (Stark 1998) between any of the three surveys at this site.

Discussion and conclusions

The Council's 'kick-sampling' and 'vegetation sweep' techniques were used at three sites on three occasions to collect benthic macroinvertebrates from an unnamed tributary of the Waitara River in relation to stormwater discharges to land and to this unnamed tributary of the Waitara River from the Kowhai-D wellsite. This has provided data to assess any potential impacts the consented discharges have had on the

macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (taxa richness), MCI and SQMCI_s scores for each site.

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

Taxa richnesses were moderate at all sites in the pre-drill survey, and were moderate to moderately low in the post-drill survey. The post-HF survey again recorded moderate to moderately low taxa richnesses. It is worth noting that taxa abundances at site 2 were low on all occasions, with only 'common' and 'rare' taxa recorded.

MCI scores categorised sites as having 'poor' or 'fair' macroinvertebrate community health. In the pre-drill survey the score recorded at site 1 was significantly lower than at site 3. The post-drill and post-HF surveys found no significant differences between the three sites. Between surveys, site 1 remained similar, while site 2 recorded a significantly lower score in the post-drill survey than the pre-drill survey, and showed some improvement in the post-HF survey (which was not significantly different from either the pre-drill or post-drill surveys). Site 3 showed a decreasing MCI score over the three surveys, with the post-HF survey result being significantly lower than recorded in the pre-drill survey, and with post-drill score being similar to both the pre-drill and post-HF survey scores.

SQMCI_s scores very low at all sites in all three surveys. Site 1 had had the lowest SQMCI_s score in all three surveys, with difference being significant compared to sites 2 and 3 in the pre-drill and post-drill surveys, and also compared to site 3 in the post-HF survey. The score at site 1 was significantly lower in the post-drill survey compared to both the pre-drill survey and the post-HF survey. The scores at both site 2 and site 3 remained similar between all three surveys.

Overall, the three surveys showed no significant detrimental impacts from the treated stormwater discharges to land and to the unnamed tributary of the Waitara River. The observed results show lower or similar MCI and SQMCI_s scores at site 1, upstream of wellsite discharges, compared to sites 2 and 3 which are downstream of the wellsite discharges. This is likely a result of habitat differences, however if stormwater discharges were causing adverse impacts on this unnamed tributary of the Waitara River, lower results would be expected at sites 2 and 3 compared to site 1 which is not the case in these three surveys. Although decreases in MCI score were noted at all three sites, at site 2 subsequent improvement was recorded, while at site 3 the decline was not significant between any two consecutive surveys.

Summary

Three macroinvertebrate surveys were carried out at three sites near the Kowhai-D wellsite in an unnamed tributary of the Waitara River, in relation to drilling and hydraulic fracturing activities at the wellsite. These surveys, undertaken in February, April and November 2017, recorded moderately low to moderate taxa richnesses. MCI scores ranged from 75-91 across the three surveys, characterising the macroinvertebrate community health as 'poor' or 'fair' on all occasions. Site 2 recorded a significant decrease between the pre-drill and post-drill surveys, but improved slightly in the post-HF survey. Site 3 declined slightly between the pre-drill and post-drill surveys, and again between the post-drill and post-HF survey, resulting in a significant decline between the pre-drill and post-HF surveys. The SQMCI_s scores decreased significantly at site 1, but again subsequent improvement was noted. SQMCI_s scores remained similar at sites 2 and 3 between the three surveys. Overall, these surveys provided no evidence that discharges from the Kowhai-D

wellsite have caused any significant detrimental impacts on the macroinvertebrate communities of this unnamed tributary of the Waitara River.

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