

Kea Oil and Gas Limited
Puka-1 wellsite Exploration Wellsite
Monitoring Programme Report
2012-2013

Technical Report 2013-97

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Executive summary

Kea Oil and Gas Limited established a hydrocarbon exploration site located on Hu Road, within the Eltham district, in the Patea catchment. The site is called Puka-1 wellsite. This report covers the period from February 2012-August 2013. During this period, a wellsite was established, and several wells drilled and tested. The wellsite is now in production.

This report for Kea Oil and Gas Limited describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess Kea Oil and Gas Limited's environmental performance in relation to drilling operations at the Puka-1 wellsite during the period under review, and the results and environmental effects of Kea Oil and Gas Limited's activities.

Kea Oil and Gas Limited holds a total of 6 resource consents for the activities at the Puka-1 wellsite, which include a total of 74 consent conditions setting out the requirements that Kea Oil and Gas Limited must satisfy. Kea Oil and Gas Limited holds consent **7987-1** to take groundwater; consent **7986-1** to discharge emissions to air associated with exploration activities; consent **7988-1** to discharge stormwater and sediment from earthworks during construction onto and into land; consent **7984-1** to discharge drilling muds, drilling cuttings and drilling wastes onto and into land via mix-bury cover; consent **7985-1** to discharge emissions to air associated with production activities; and consent **7983-1** to discharge treated stormwater and produce water associated with exploration activities to land.

The Council's monitoring programme for the period under review included 27 inspections of the site and surrounding environment, at approximately fortnightly intervals. In total 10 stormwater, 2 upstream, and 2 downstream samples were collected for analysis.

Any spills on-site were general cleaned up quickly to avoid the potential for a contaminant to travel to surface water. The site's stormwater system worked effectively.

Owing to the distance of the wellsite to the nearest stream being approximately 70 m, the stream was visually inspected by the Inspecting Officer at every inspection. Chemical analysis and bio-monitoring surveys were undertaken during the monitoring period.

One Abatement Notice was issued during the period under review requiring works to be undertaken to ensure compliance with resource consent 7983-1. Two infringement notices were also issued, one for failing to comply with the abatement notice, and one for a breach of Section 15(1)(b) of the Resource Management Act 1991 (unconsented discharge to land).

The drilling fluids and cuttings were disposed of off site.

During the monitoring period, Kea Oil and Gas Limited demonstrated a high level of environmental performance but a poor level of and compliance with one resource consent during the first period of site occupancy. Compliance was much improved subsequently.

This report includes recommendations for future drilling operations at this site.

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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 February 2012- August 2013 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Kea Oil and Gas Limited. During the period under review Kea Oil and Gas Limited established a wellsite, drilled, and tested several wells.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by Kea Oil and Gas Limited that relate to exploration activities at Puka-1 wellsite located off Hu Road in the Eltham District.

One of the intents of the Resource Management Act 1991 (the Act) 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 Kea Oil and Gas Limited's use of water, land, and air, and is the first report by the Council for the site.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the Act and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consents held by Kea Oil and Gas Limited in the Patea catchment, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted at the Puka-1 wellsite during exploration activities.

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

Section 3 discusses the results, their interpretation, 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 Resource Management Act primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

- (a) the neighbourhood or the wider community around a discharger, and may include cultural and socio-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 (e.g., recreational, cultural, or aesthetic);
- (e) risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Taranaki Regional Council is recognising the comprehensive meaning of 'effects' in as much as is appropriate for each discharge source. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the Resource Management Act to assess the effects of the exercise of consents. In accordance with section 35 of the Resource Management Act 1991, the Council undertakes compliance monitoring for consents and rules in regional plans; and maintains an overview of performance of resource users against regional plans and consents.

Compliance monitoring, including impact monitoring, also enables the Council to continuously assess its own performance in resource management as well as that of resource users particularly consent holders. It further enables the Council to continually re-evaluate its approach and that of consent holders to resource management, and, ultimately, through the refinement of methods, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and consent performance

Besides discussing the various details of the performance and extent of compliance by the consent holder during the period under review, this report also assigns an overall rating. The categories used by the Council, and their interpretation, are as follows:

- a **high** level of environmental performance and compliance indicates that essentially there were no adverse environmental effects to be concerned about, and no, or inconsequential (such as data supplied after a deadline) non-compliance with conditions.
- a **good** level of environmental performance and compliance indicates that adverse environmental effects of activities during the monitoring period were negligible or minor at most, or, 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, or, there were perhaps some items noted on inspection notices for attention but these items were not urgent nor critical, and follow-up inspections showed they have been dealt with, and any

inconsequential non compliances with conditions were resolved positively, co-operatively, and quickly.

- **improvement required (administrative compliance) or improvement required (environmental compliance)** (as appropriate) indicates that the Council may have been obliged to record a verified unauthorised incident involving measurable environmental impacts, and/or, there were measurable environmental effects arising from activities and intervention by Council staff was required and there were matters that required urgent intervention, took some time to resolve, or remained unresolved at the end of the period under review, and/or, there were on-going issues around meeting resource consent conditions even in the absence of environmental effects. Abatement notices may have been issued.
- **poor performance (environmental compliance) or poor performance (administrative compliance)** indicates generally that the Council was obliged to record a verified unauthorised incident involving significant environmental impacts, or there were material failings to comply with resource consent conditions that required significant intervention by the Council even in the absence of environmental effects. Typically there were grounds for either a prosecution or an infringement notice.

For reference, in the 2012-2013 year, 35% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 59% demonstrated a good level of environmental performance and compliance with their consents.

1.2 Process description

Site management

Kea Oil and Gas Limited holds a 5 year Petroleum Mining Permit No. 51153 to prospect, explore, and mine for condensate, gas, LPG, oil and petroleum within an area of 210.8 Km². The Puka-1 wellsite is one of many sites within this area that have been established in order to explore, evaluate and produce hydrocarbons.

The Puka-1 wellsite is located approximately 3.5 km along Hu Road, approximately 9.5 km from Eltham.

The Puka-1 wellsite was established in 2012 and involved the removal of topsoil to create a firm level platform 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 flare pit; and
- Other on-site facilities such as accommodation, parking and storage.

The nearest residence is approximately 800m away from the wellsite. Bunding, earthworks and good site location helped minimise any potential for off-site effects or the neighbours.

Well creation

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 pressurized 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 Puka-1 wellsite is located approximately 70 m to the west of the nearest waterbody which is the Waihapa Stream, a tributary of the Patea catchment.

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 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 the Waihapa Stream, a tributary in the Patea catchment.

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.

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].



Photo 1 Aerial view showing the location of Puka-1 wellsite.

1.3 Resource consents

1.3.1 Background

Kea Oil and Gas Limited holds 6 resource consents related to exploration activities at the Puka-1 wellsite site, as follows:

- Water Permit **7987-1**; granted 1 February 2012,
- Discharge Permit **7986-1**; granted 1 February 2012,
- Discharge permit **7985-1**; granted 1 February 2012,
- Discharge Permit **7988-1**; granted 1 February 2012,
- Discharge Permit **7984-1**; granted 1 February 2012 and
- Discharge Permit **7983-1**; granted 1 February 2012

Each of the consent applications were processed on a non-notified basis as Kea Oil and Gas 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 and the Council reports describing the associated activities are contained within Appendix I of this report.

1.3.2 Water abstraction permit (groundwater)

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

The Council determined that the application to take groundwater fell within Rule 49 of the Regional Freshwater Plan for Taranaki (RFWP) as the rate and daily volume of the groundwater abstraction might exceed that of the permitted activity (Rule 48). Rule 49 provides for groundwater abstraction as a controlled activity, subject to two conditions:

- *The abstraction shall cause not more than a 10% lowering of static water-level by interference with any adjacent bore;*
- *The abstraction shall not cause the intrusion of saltwater into any fresh water aquifer.*

Kea Oil and Gas Limited holds water permit **7987-1** to take groundwater that may be encountered as produced water during exploration and production operations at the Puka-1 wellsite.

Any produced water will be from reserves far below that which is used for domestic or farm purposes. In addition, there are no known groundwater abstractions within a radial distance of 130 m from the wellsite. Shallow groundwater (which does not have any saltwater content) was to be protected by casing within the bore hole. Given these factors, the abstraction would not cause the above effects.

In granting the consent it was considered that the taking of groundwater was unlikely to have any adverse effect on the environment.

The Council was satisfied that the proposed activity would meet all the standards for a controlled activity. It was therefore obliged to grant the consent but imposed conditions in respect of those matters over which it reserved control. Those matters over which the Council reserved its control were:

- Volume and rate of abstraction;
- Daily timing of abstraction;
- Effects on adjacent bores, the aquifer, river levels, wetlands and sea water intrusion;
- Fitting of equipment to regulate flows and to monitor water volumes, levels, flows and pressures;
- Payment of administrative charges;
- Monitoring and report requirements;
- Duration of consent; and
- Review of the conditions of consent and the timing and purpose of the review.

This permit was issued by the Council on 1 February 2012 under Section 87(d) of the Act. It is due to expire on 1 June 2022.

Consent conditions were imposed on Kea Oil and Gas Limited to ensure that adverse effects were avoided in the first instance. A summary of conditions can be viewed within Table 4, Section 3.3.

A copy of the permit is attached to this report in Appendix 1.

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

Section 15(1)(a) of the Act 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.

The Council determined that the application to discharge treated stormwater, treated produced water and surplus drill water fell within Rule 44 of the RFWP, which provides for a discharge as a discretionary activity.

The discharge of stormwater may result in contaminants (e.g. sediment, oil) entering surface water. These contaminants have the potential to smother or detrimentally affect in-stream flora and fauna. On-site management of stormwater, as discussed in Section 1.2 above, is necessary to avoid/remedy any adverse effects on water quality.

Kea Oil and Gas Limited holds water discharge permit **7983-1** to discharge treated stormwater and produced water from hydrocarbon exploration and production operations at the Puka-1 wellsite onto and into land.

Consent conditions were imposed on Kea Oil and Gas Limited to ensure that adverse effects were avoided in the first instance. A summary of conditions can be viewed in Table 8, Section 3.3.

This permit was issued by the Council on 1 February 2012 under Section 87(e) of the Act. It is due to expire on 1 June 2028.

A copy of the permit is attached to this report in Appendix I.

1.3.4 Water discharge permit (stormwater and sediment – earthworks)

Section 15(1)(a) of the Act 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.

Council considered that the application fell under Rule 27 of the RFWP as a controlled activity (which may be non-notified without written approval), subject to one standard/term/condition to be met:

- *A site erosion and sediment control management plan shall be submitted to the Taranaki Regional Council.*

Kea Oil and Gas Limited supplied a site erosion and sediment control management plan in support of the application.

The Council was satisfied that the activity would meet all the standards for a controlled activity. It was therefore obliged to grant the consent but imposed conditions in respect of those matters over which it reserved control. Those matters over which the Council reserved its control were:

- Approval of a site erosion and sediment control management plan and the matters contained therein;
- Setting of conditions relating to adverse effects on water quality and the values of the waterbody;
- Timing of works;
- Any measures necessary to reinstate the land following the completion of the activity;
- Monitoring and information requirements;
- Duration of consent;
- Review of conditions of consent and the timing and purpose of the review; and
- Payment of administrative charges and financial contributions.

Kea Oil and Gas Limited holds water discharge permit **7988-1** to discharge stormwater and sediment from earthworks during construction of the Puka-1 wellsite onto and into land.

This permit was issued by the Council on 1 February 2012 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2017.

Consent conditions were imposed on Kea Oil and Gas Limited to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 9, Section 3.3.

A copy of the permit is attached to this report in Appendix I.

1.3.5 Air discharge permit (exploration activities)

Section 15(1)(c) of the Act 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.

The Council determined that the application to discharge emissions to air associated with the exploration activities at the Puka-1 wellsite fell within Rule 9 of the Regional Air Quality Plan (RAQP).

The standard/term/conditions associated with Rule 9 are as follows:

- *Flare or incinerator point is at least 300 metres from any dwelling house;*
- *The discharge to air from the flare must not last longer than 15 days cumulatively, including of testing, clean-up, and completion stages of well development or work-over, per zone to be appraised; and*
- *No material to be flared or incinerated, other than those derived from or entrained in the well stream.*

Provided the activities were conducted in accordance with the applications and in compliance with the recommended special conditions, then no significant effects were anticipated.

Kea Oil and Gas Limited holds air discharge permit **7986-1** to discharge emissions to air from hydrocarbon exploration activities at the Puka-1 wellsite.

This permit was issued by the Council on 1 February 2012 under Section 87(e) of the Act. It is due to expire on 1 June 2028.

Consent conditions were imposed on Kea Oil and Gas Limited to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 6, Section 3.3.

A copy of the permit is attached to this report in Appendix I.

1.3.6 Air discharge permit (production activities)

Section 15(1)(c) of the Act 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.

The Council determined that the application to discharge emissions to air associated with the production activities at the Puka-1 wellsite fell within Rule 11 of the RAQP.

The standard/term/condition of Rule 11 states that the:

- *Flare or incinerator point is a distance equal to or greater than 300 metres from any dwelling house.*

Kea Oil and Gas Limited holds air discharge permit **7985-1** to discharge emissions to air associated with production activities at the Puka-1 wellsite including flaring associated with emergencies and maintenance and minor emissions from other miscellaneous activities.

This permit was issued by the Council on 1 February 2012 under Section 87(e) of the Act. It is due to expire on 1 June 2028.

Consent conditions were imposed on Kea Oil and Gas Limited to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 5, Section 3.3.

A copy of the permit is attached to this report in Appendix I.

1.3.7 Mix-Bury-Cover (discharge of wastes to land)

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

The discharge of drilling muds, drilling cuttings and drilling wastes onto or into land from hydrocarbon exploration is a controlled activity under Rule 42 of the RFWP.

Rule 42 of the RFWP has four standards/terms/conditions to be met:

- *The discharge shall not result or be liable to result in any contaminant entering surface water;*
- *The discharger must at all times adopt the best practicable option to prevent or minimise any adverse effects of the discharge or discharges to any water body or soil;*
- *The discharge shall contain less than 15 mg/kg oil and grease; and*
- *There shall be no adverse chemical effects on groundwater beyond the site.*

Provided the activity was conducted in a manner consistent with good industry practice, and in accordance with the recommended special conditions, then no significant effects were anticipated.

Kea Oil and Gas Limited holds discharge permit **7984-1** to discharge solid drilling wastes (drilling cuttings and residual drilling fluids) from hydrocarbon exploration activities onto and into land via the mix-bury-cover process.

This permit was issued by the Taranaki Regional Council on 1 February 2012 under Section 87(e) of the Act. It is due to expire on 1 June 2028.

Consent conditions were imposed on Kea Oil and Gas Limited to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 7, Section 3.3.

A copy of the permit is attached to this report in Appendix I.

1.4 Monitoring programme

1.4.1 Introduction

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

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

The monitoring programme for exploration well sites consists of seven primary components. They are:

- Programme liaison and management;
- Site inspections;
- Chemical sampling;
- Solid wastes monitoring;
- Air quality monitoring;
- Discharges to land and
- Ecological surveys.

The monitoring programme for the Puka-1 wellsite focused primarily on programme liaison and management, site inspections, and monitoring of discharges to land and water. 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 reviews, renewals, or new consents, advice on the Council's environmental management strategies and the content of regional plans, and consultation on associated matters.

1.4.3 Site inspections

Inspection and examination of wellsites are fundamental and effective means of monitoring and are undertaken to ensure that good environmental practices are adhered to and resource consent special conditions complied with.

The inspections are based on internationally recognised and endorsed wellsite monitoring best-practice checklists developed by the Alberta Energy Resources Conservation Board and the USEPA, adapted for local application.

The inspections also provide an opportunity for monitoring officers to liaise with staff about on-site operations, monitoring and supervision; discuss matters of concern; and resolve any issues in a quick and informal manner.

Inspections pay special attention to the ring drains, mud sums, treatment by skimmer pits and the final discharge point from the skimmer pit on to land and then any potential receiving waters.

During each inspection the following are checked:

- Weather;
- Flow rate of surface waters in the general vicinity;
- Flow rate of water take;
- Whether pumping of water was occurring;
- General tidiness of site;
- Site layout;
- Ring drains;
- Hazardous substance bunds;
- Treatment by skimmer pits/sedimentation pits;
- Drilling mud;
- Drill cuttings;
- Mud pit capacity and quantity contained in pit;
- Sewage treatment and disposal;
- Cementing waste disposal;
- Surface works;
- Whether flaring was in progress, and if there was a likelihood of flaring, whether the Council had been advised;
- Discharges;
- Surface waters in the vicinity for effects on colour and clarity, aquatic life and odour;
- Site records;

- General observations; and
- Odour (a marker for any hydrocarbon and hazardous chemical contamination).

1.4.4 Chemical sampling

The Council may undertake sampling of discharges from site and from receiving water sites upstream and downstream of the discharge point to ensure that resource consent special conditions are complied with.

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.

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, even if they hold consents for disposal on-site.

1.4.6 Air quality monitoring

Air quality monitoring is carried out in association with the well testing and clean-up phase, where flaring can occur.

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

Inspecting Officers check that plant equipment is working effectively, that there is the provision for liquid and solid separation, and that staff onsite have regard to wind direction and speed at the time of flaring.

The flare pit is also inspected to ensure that solid and liquid hydrocarbons are not combusted within the flare pit.

It is also a requirement that the Council and immediate land owners are notified prior to any gas being flared. This requirement was checked to ensure compliance with the conditions.

1.4.7 Ecological surveys

Ecological surveys in any nearby streams may be carried out pre and post occupation of the well site to assess whether the activities carried out on-site, and associated discharges have had any effect on ecosystems.

2. Results

2.1 Water

2.1.1 Inspections

The Puka-1 wellsite, adjacent land, and streams were inspected 27 times during this monitoring period.

Below is a copy of the comments that were noted on the day of each inspection.

20 February 2012

Earthworks to construct the wellsite were started. The site had been constructed and the ring drains and skimmer pits dug. Consent conditions were being complied with at the time of inspection.

26 March 2012

The well site had been constructed and all earthworks had been completed. Condition 6 of consent 7988-1 requires stabilisation within 6 months. It was therefore recommended that all areas of stockpiled and exposed earth were stabilised.

No flaring was occurring at time of inspection.

Drilling had commenced onsite and no groundwater had been encountered or taken to date. All drilling muds were being taken to a consented land farm for disposal. Wastes were mixed with sawdust before leaving the site by truck.

All stormwater on the site was directed to the skimmer pits where it was discharged onto land and soaked in. The discharge from the exit pipe looked clean. No samples were taken.

It was noted that only 2 days notice was given prior to site works commencing, and not the 7 days required by consent 7983-1. No contingency plan had been received to date.

Kea Petroleum does not hold resource consent to permit the taking of surface water from the stream. Advice was given to ensure that the rate of abstraction should not exceed 1.5l/s, or 5l/s for not more than 30mins/day. Only 50 cubic metres can be abstracted per day. No more than 25% of the instantaneous flow shall be taken.

12 April 2012

There was no staff on site at time of inspection. The inspection was undertaken following heavy rain. The site required cleaning. A small amount of drilling fluids and muds had entered the ring drain. The skimmer pits were not discharging but contained stormwater. The ring drains were effective and flare pit was clear of any drilling fluids.

20 April 2012

An inspection of the wellsite found that drilling had ceased and the rig and associated equipment had been removed from site. The site had not been

reinstated at the time of inspection. It was observed that sawdust, drilling waste, cement waste, drilling mud and oil stains had been discharged onto the site. Some of the cement waste had discharged into the ring drain. A chemical odour was detected on site. During the construction of the ring drain a nova flow pipe and a field tile drain had been severed. The exposed pipes sit within the ring drain and had the potential to allow contaminants to flow via the pipes into the stream. The skimmer pits were full. The water in the pits appeared clear. Due to shallow ground water in the area it was likely that groundwater is entering the skimmer pits through the sidewalls. There was no discharge from the skimmer pits at the time of inspection. It was observed that the flare pit also contained groundwater. No flaring had taken place to date. The septic tank had been left full. All exposed earthworks had vegetation and were becoming stabilised. All drilling wastes had been disposed of offsite. A contingency plan for the site had been received but not approved to date.

Advice was given to remove all contaminants from the site and remove all waste from the sewage tanks and remove all pipes/tile drains from the ring drain so that all water/contaminants discharged into the skimmer pits. Also to ensure that the skimmer pits and flare pit were impermeable so that contaminants could not discharge to land/groundwater.

8 May 2012

An inspection found that the site had been partially cleaned and the skimmer pits had been pumped out following a conversation with staff onsite where they were advised that high chloride results were obtained from the first skimmer pit. The drilling mud/sawdust/oil stains remained on the site. The skimmer pits were half full of groundwater. It was observed that a tile drain had broken when the first skimmer pit was dug. The drain was exposed on two sides of the pit. It was observed that a plastic nova flow pipe and a tile drain were still exposed within the ring drain. Condition 1 and 4 of Resource Consent 7983-1 were not being complied with. The ring drain/skimmer pit and flare pit had been poorly designed and constructed and the best practicable option to prevent or minimise any actual or likely adverse effect on the environment had not been adopted at the time of inspection. An abatement notice was issued requiring remedial works. Further details are in Section 2.5

Advice was given to remove all contaminants from the site and remove all pipes/tile drains from the ring drain. Also to ensure that the skimmer pit was impermeable so that contaminants cannot discharge to land/groundwater.

23 May 2012

A compliance monitoring site inspection was undertaken to ensure compliance with abatement notice.

A rig was being set up on site. The site was tidy. The site had been scraped of contaminants and the scrapings were being removed. The well was shut in and there was no flaring or taking of groundwater. All drilling muds had been disposed of off site. The site was dry and only groundwater was discharging into the skimmer pits.

The abatement notice issued on 8 May required that the skimmer pits be impermeable and to ensure that no stormwater / produced water/contaminants can enter tile drains/nova flow drains/groundwater. The site inspection found that the tile/nova flow drains in the ring drain had still not been removed. The skimmer pit was not impermeable. The abatement notice was not being complied with at the time of inspection. Further details are in Section 2.5.

29 May 2012

An inspection of the site found that the abatement notice was being complied with. The skimmer pits had been lined with plastic. The second pit was not full and no water was discharging offsite. The site was tidy. A rig was on site installing production tubing.

13 June 2012

The site was dry with minimal activity and equipment on site. The well was currently shut in waiting for testing operations to commence. Two diggers were on site reconstructing the flare pit. A plastic liner was being installed and then covered with clay so that the pit was impermeable. It was expected that the works would be completed in two days. The skimmer pits appeared high in suspended solids; however, there was no discharge occurring from the pits.

18 June 2012

The site had been vacated with no activity occurring. Staff from Burgess and Crowley (earthmovers) had completed the reconstruction of the flare pit. The pit had been lined with high density plastic and covered with clay. A nova flow pipe had been laid from the base of the flare pit to the skimmer pit. The site was tidy. It was observed that the water level in both skimmer pits was below the level of discharge. The stream was running clear and the inspecting officer had no concerns with silt runoff to water from the recent earthworks.

9 August 2012

Well testing operations commenced this week. Notification was received that testing operations would commence. All products flowing from the well were passing through a water/oil/gas separator. Gas was being flared at the time of inspection and the separation process appeared to be effective as no smoke was observed. The oil/water storage tanks had been bunded with a plastic liner, ensuring that any spills/leaks from the tanks were captured. The site was tidy. It was raining at the time of inspection and stormwater was discharging from the site. Discharge, downstream and upstream samples were taken to ensure that conditions were being complied with in receiving waters. A portable pump was being stored onsite as a contingency measure and was located next to the skimmer pits.

Staff/contractors had recently had spill response training. The ring drains were flowing well and it was noted that vegetation was starting to grow in the drains.

24 August 2012

No activity was occurring at the time of inspection. The well was shut in and awaiting further resources before testing continued. The site was very tidy and well managed. The only discharge from the site was stormwater which looked

clear. The stormwater was flowing onto a paddock and soaking into the ground. The paddock looked healthy with no evidence of contamination. No issues were raised with staff on site.

18 September 2012

Exploration testing continued onsite. Flaring was occurring at the time of inspection. No smoke was visible discharging from the flare. The site was tidy. A stormwater sample was taken from the second skimmer pit to ensure consent compliance. No issues were raised during the inspection.

24 September 2012

Notification was received alleging that hydrocarbons may be discharging from the banks around the site and entering the ring drain. An inspection was undertaken and it was observed that a sheen was present in some locations within the ring drain. This sheen appeared to be a product associated with iron oxide production. Orange iron oxide was observed discharging from the bank in places. There was no evidence to suggest that the discharge was hydrocarbon. No sample was taken.

8 October 2012

The site was very clean, tidy, and appeared to be well managed. There was good bunding in place. Well testing was continuing. Gas was being flared at the time of inspection and no smoke was observed discharging from the flare. The water level in the skimmer pits had dropped and they were not discharging at the time of inspection. No effects were observed in the adjacent paddock as a result of any previous discharges.

24 October 2012

The site was tidy and clean. No flaring was occurring at the time of inspection. The flare pit was free of hydrocarbons. The skimmer pits were not discharging at the time of inspection. The paddock that the stormwater discharges into looked healthy with no visual sign that any contamination had occurred.

14 November 2012

Earthworks were taking place to increase the site's foot print and level the existing site. A new area below the site was being established to accommodate production facilities. The existing ring drains had been filled in and any release of hydrocarbons from the well might result in a discharge directly to the stream. Options were discussed with the contractors and they agreed to place a bund across the access track during nights to prevent a discharge flowing down the access track. Any product would be captured within the bunded area and overflow into the new earth worked area. A new set of skimmer pits would be installed for the production area once the site had been metaled. The site was dry and consent conditions were being complied with at the time of inspection. The existing skimmer pits were not discharging.

28 November 2012

Drilling of the second well had commenced. There was good bunding on site and the activities were being well managed. The ring drains had been reformed. The skimmer pits were not discharging due to evaporation following a period of fine

weather. Water was being taken from the nearby stream. No issues were raised at the time of inspection.

10 December 2012

The drill rig had been removed from site and the well head was being installed. All chemicals had been removed from site. The site had been scraped and two piles of waste material were awaiting removal. The skimmer pits appeared to be working well. There was no discharge of stormwater from the site at the time of inspection.

7 January 2013

No activity was taking place at the time of inspection with all equipment having been removed. A water sample was taken for analysis from the second skimmer pit. The skimmer pits were not discharging and the water level in the second pit was below the discharge pipe.

11 February 2013

The site was in reasonable condition. A spill had occurred overnight in relation to drilling mud; extra bunding had been put in place to prevent spread of the spill. Cleaning was underway at the time of inspection. Fuel tanks on site were double skinned. Bunding and the ring drain were inspected and complied with requirements. There was no discharge from skimmer pits at the time of inspection, however samples were taken from second skimmer pit to ensure that the discharge would comply with consent conditions should a discharge occur. The lower level skimmer pits were inspected but no samples taken.

27 February 2013

A water sample was taken from the skimmer pit treatment system for analysis to determine whether resource consent conditions would be complied with should a discharge from site occur.

15 March 2013

A water sample was collected for analysis from the second skimmer pit to confirm whether consent conditions would be complied with should a discharge occur.

8 April 2013

The well was shut in while pressure built up in order to carry out another test. Storage tanks onsite were bunded using an impermeable plastic liner. The site was clean and tidy. Flaring had occurred within the flare pit. There was no sign of solids/liquids in the flare pit. The Investigating Officer believed that no produced water had been encountered or taken. The skimmer pits were all well below the point of discharge and no effects were observed in the adjacent paddock as a result of stormwater discharge. Works were being undertaken at the time of inspection to create a new access track onto the site. The ring drain had been temporarily broken and staff onsite were instructed to re-connect the ring drain before the next rainfall event.

2 May 2013

Well testing continued onsite. Flaring was occurring at the time of inspection. A small quantity of black smoke was being emitted; however it quickly dissipated and was not considered objectionable by the Investigating Officer. The site was fully bunded and it was observed to be tidy. Whilst inspecting the site it was noted that the heater unit was positioned in the carpark and any possible spills from this unit or associated pipework would travel into the second set of skimmer pits.

27 May 2013

Inspection found that the upper site was clean and tidy. Flaring was taking place on site. Some black smoke was being produced as a result of the burning, however this quickly dissipated.

A lower site was being developed to install small production facilities. The lower site was wet at time of inspection. New skimmer pits had been developed on the lower site to collect stormwater from both the lower site and the discharge from the original set of skimmer pits at the upper site.

Attention was needed to ensure that no stormwater was leaving the upper site by running across the ground under the pipe which leads from the ring drain to the original set of skimmer pits. A simple earth bund in this location would divert all stormwater to the skimmer pits.

The new access track to the lower site required building up or managing in such a way as to prevent stormwater leaving the lower site via the access track rather than being directed through the skimmer pits. Attention needed to be given to ensure that the suspended solids concentration at point of discharge remained within the consent conditions. Silt fencing about the earth piles on site and a mixture of silt fencing and weirs within the ring drains might also help to control the suspended solid concentration. Resource consent conditions require that all stormwater from site is directed through the skimmer pit system prior to being discharged.

26 June 2013

Site inspection found that construction and earthworks had continued on site. Both wells were shut in and maintenance of the wells was occurring.

All ring drains on site were in good working order. Some of the drains had been cleaned out with the remaining to be cleaned in the coming days. Sediment controls were also being placed in the ring drains about the lower portion of the site. Skimmer pits appeared to be working well.

Some water had been taken from nearby stream to allow testing of newly constructed bunds on site. Volume was within permitted activity.

No flaring was occurring on site. The flare pit was clean and tidy with a small amount of rain water collected in its base.

A sample was taken from the skimmer pit discharge. The discharge was running overland and into a nearby stream. Upstream and downstream samples were also taken.

5 August 2013

A well site inspection found that production was occurring from one well on site. All storage tanks were contained in a lined bunded containment area.

The ring drains were in place and were working well, directing all the stormwater for discharge via the skimmer pit treatment system. Sand bags had been placed in the ring drains to create small weirs in an effort to reduce the suspended solids count. The skimmer pits were not discharging at time of inspection, however samples were taken to ensure that a discharge would comply with consent conditions should a discharge occur.

Flaring was occurring onsite, resulting in a clean burn with no black smoke emitted at the time of inspection.

2.1.2 Results of abstraction and discharge monitoring

During the period under review, stormwater was observed discharging on several occasions. There were 10 skimmer pit stormwater samples collected during the review period for this report and chemical analysis of the stormwater was carried out. Nine of the stormwater samples were collected from the second skimmer pit and one from the first skimmer pit.

Analysis of the samples collected showed that all of the discharges would have been in compliance with resource consent conditions should a discharge have occurred (see further below).

All sewage was directed for treatment through a septic tank system and removed by contractor to a licensed disposal facility.

Inspections of the stormwater discharge found it to be mostly clear. No odours were found to be associated with the discharge.

Table 1 Results of water samples taken from the skimmer pit on seven occasions during the monitoring period

Parameters	Consent limit	3 May 2012	7 January 2013	11 February 2013	27 February 2013	15 March 2013	2 May 2013	27 May 2013	5 August 2013
Chloride (g/m ³)	50	85.4	19	30.1	33.3	35	29.9	14.7	34.6
pH	6-9	6.8	7.5	7.8	8.2	8.1	7.1	6.8	7
Suspended solids (g/m ³)	100	10	<2	7	9	14	8	47	21
Hydrocarbon (g/m ³)	15	-	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	<0.5

Table 2 Results of water sample taken from the skimmer pit discharge as well as upstream and downstream samples collected 9 August 2012

Parameters	Consent limit	Discharge	Upstream	Downstream
Chloride (g/m ³)	50	33.6	13.8	14.4
pH	6-9	7.1	6.9	6.9
Suspended solids (g/m ³)	100	63	17	17
Hydrocarbon (g/m ³)	15	0.7	<0.5	<0.5

Table 3 Results of water sample taken from the skimmer pit discharge as well as upstream and downstream samples collected 26 June 2013

Parameters	Consent limit	Discharge	Upstream	Downstream
Chloride (g/m ³)	50	19.1	15.9	16.4
pH	6-9	7	6.8	6.9
Suspended solids (g/m ³)	100	53	14	16
Hydrocarbon (g/m ³)	15	<0.5	<0.5	<0.5

All of the samples collected by the Council for chemical analysis were well within the applicable consent limits. The sample collected on 3 May 2012 shows a high level of chloride, however, this sample was collected from the first skimmer pit and the skimmer pits were not discharging at the time.

2.1.3 Results of receiving environment monitoring

The receiving surface water body was visually inspected in conjunction with site inspections. No effects were observed and the stream appeared clear with no visual change in colour or clarity. There was also no odour, oil, grease films, scum, foam or suspended solids observed in the stream during the monitoring period.

A pre-drill biomonitoring survey was carried out in November 2012 and a post drill survey was carried out May 2013. A comparison of the pre-drill and post-drill survey results showed no significant variation in MCI and SQMCI_s scores between surveys at all three sites.

The MCI scores recorded in this survey indicated that the stream communities were of fair 'health' but slightly better than the biological health recorded at 'control' sites in similar streams at a comparative altitude elsewhere in the region. There was no indication from the results of the two surveys that the discharge from the Puka-1 wellsite has impacted on the biological communities of the Waihapa Stream.

2.2 Air

2.2.1 Inspections

Air quality monitoring inspections were carried out in conjunction with general compliance monitoring inspections. See Section 2.1.1 above for comments concerning site inspections.

2.2.2 Results of discharge monitoring

The Council were notified by Kea Oil and Gas Limited of its intentions to test the well and flare gas. During inspections of the site the Inspecting Officer found there were no offensive or objectionable odours, smoke or dust associated with activities at Puka-1 wellsite. There were no complaints received by the Council regarding smoke from flaring at the Puka-1 wellsite.

It appeared that Kea Oil and Gas Limited took all practicable steps to mitigate any effects of smoke, which included ensuring that plant equipment was working effectively and having regard to wind direction and speed. In regard to the smoke noted above no offensive or objectionable smoke or odours were observed by Inspecting Officers.

The flare pit was inspected during most inspections to ensure that solid and liquid hydrocarbons were not combusted within the flare pit. There was no evidence to suggest that solid and liquid hydrocarbons were being combusted through the gas flare system.

From observations during site inspections, including the inspection of the flare log maintained by Kea Oil and Gas Limited, it appeared that special conditions relating to the control of emissions to air from the flaring of hydrocarbons were complied with.

2.2.3 Results of receiving environment monitoring

No monitoring of the receiving environment was carried out as inspections found no offensive or objectionable odours, smoke or dust that were associated with activities at the site.

No chemical monitoring of air quality was undertaken during the testing phase of the Puka-1 wellsite as the controls implemented by Kea Oil and Gas Limited did not give rise to any concerns with regard to air quality.

As mentioned in Section 2.2.2, visual inspections of the flare, the flare pit and surrounding area were carried out during monitoring inspections of the site, the Inspecting Officers found there were no offensive or objectionable odours, smoke or dust associated with activities at the Puka-1 wellsite.

2.2.4 Other ambient monitoring

No other ambient air sampling was undertaken, as the controls implemented by Kea Oil and Gas Limited did not give rise to any concerns with regard to air quality.

2.3 Land

2.3.1 Land status

The well site was constructed on a flat rural dairy farming area. Relatively minor earthworks were required to construct the site. The land had not been reinstated at the time of the last inspection on 5 August 2013 as the well was still currently producing, and the site is still in use.

2.4 Contingency plan

Kea Oil and Gas Limited has provided a general contingency plan, as required by Condition 7 of resource consent 7983-1, together with site specific maps. The contingency plan has been reviewed and approved by officers of the Council.

2.5 Investigations, interventions and incidents

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 Unauthorised Incident Register (UIR) includes events where the company concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

Incidents may be alleged to be associated with a particular site. If there is 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 period under review, there was one incident recorded by the Inspecting Officers during inspections.

On 8 May 2012 an inspection found that the site had been partially cleaned and the skimmer pits pumped out following a conversation with a staff member, in which he was advised that high chloride results were obtained from the first skimmer pit. It was observed that drilling mud/sawdust/oil stains still remained onsite. The skimmer pits were half full of groundwater. It was observed that a tile drain had been broken when the first skimmer pit was dug. The drain was exposed on two sides of the pit. It was observed that a plastic nova flow pipe and a tile drain were still exposed within the ring drain. Conditions 1 and 4 of resource consent 7983-1 were not being complied with. The ring drain, skimmer pit and flare pit had been poorly designed and constructed and the best practicable option to prevent or minimise any actual or likely adverse effect on the environment had not been adopted.

Abatement Notice No.11821 was issued requiring works to be undertaken to ensure compliance with Resource Consent 7983-1. Reinspection found that the abatement notice was not being complied with. A letter was sent requesting an explanation for the non-compliance with the abatement notice. As a result of the investigation two Infringement Notices were issued under section 338(1)(a) of the Resource Management Act 1991 and Council's delegated authority. A further reinspection was undertaken and it was found that the abatement notice was being complied with.

3. Discussion

3.1 Discussion of consent exercise

Of the six resource consents relating to the Puka-1 wellsite, consents **7987-1** (take groundwater), **7983-1** (to discharge treated stormwater and produced water), **7986-1** (air discharge associated with exploration), **7985-1** (air discharge associated with production) and **7988-1** (to discharge stormwater and sediment from earthworks during construction), were exercised and actively monitored.

Consent **7984-1** (discharge to land via mix-bury cover) was not exercised during the period under review.

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

3.2 Environmental effects of exercise of consents

Stormwater

The discharge of stormwater from earthworks has the potential for sediment and other contaminants to enter surface water where it may detrimentally affect instream flora and fauna. To mitigate these effects, Kea Oil and Gas Limited established perimeter drains during the construction of the wellsite, and care was taken to ensure runoff from disturbed areas was directed into the drains or directed through adequate silt control structures.

Once the wellsite was constructed, attention was given to controlling stormwater that ran off the wellsite and the associated plant and equipment.

Adverse effects on surface water quality can occur if contaminated water escapes through or from the stormwater system. Interceptor pits are designed to trap sediment and hydrocarbons through gravity separation. Any water that is unsuitable for release via the interceptor pits was directed to the drilling sumps, or removed for off-site disposal.

Kea Oil and Gas Limited also undertook the following mitigation measures in order to minimize off-site adverse effects:

- All stormwater was directed via perimeter drains to the skimmer pits for treatment prior to discharge;
- Additional bunding was constructed around the bulk fuel tank, chemical storage area, and other areas where runoff from areas containing contaminants could occur;
- Regular inspections of the interceptor pits occurred; and
- Maintenance and repairs were carried out as required.

As noted above , there were some deficiencies in the stormwater system during the first part of the period under review. Interceptor pits do not discharge directly to surface water, instead they discharge onto and into land where the discharge usually soaks into the soil before reaching any surface water. However, if high rainfall had

resulted in the discharge reaching the surface water, significant dilution would have occurred.

There are numerous on-site procedures included in drilling and health and safety documentation that are aimed at preventing spills on-site, and further procedures that address clean-up to remedy a spill situation before adverse environmental effects have the opportunity to occur (e.g. bunding of chemicals and bulk fuel).

Groundwater

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.

Flaring

The environmental effects from flaring have been evaluated in monitoring reports prepared by the Council in relation to the flaring emissions from specific wells in the region.

The Council has previously undertaken field studies at two wells (one gas, and the other producing oil and heavier condensates); together with dispersion modelling at a third site¹. More recently two studies have focused on field investigations and modelling of emissions from flares involving fracturing fluids.²

In brief, the previous studies found that measurements of carbon monoxide, carbon dioxide, and methane concentrations to be safe at all points downwind, including within 50 m of the flare pit. Measurements of suspended particulate matter found concentrations typical of background levels, and measurements of PM₁₀ found compliance with national standards even in close proximity to the flare. Beyond 120 m from the flare pit, concentrations of polycyclic aromatic hydrocarbons (PAH) approached background levels, as did levels of dioxins beyond 250 m from the flare.

In summary, the studies established that under combustion conditions of high volume flaring of gases with some light entrained liquids etc., atmospheric concentrations of all contaminants had reduced by a distance of 250 m downwind to become essentially typical of or less than elsewhere in the Taranaki environment (e.g. urban areas). These levels are well below concentrations at which there is any basis for concern over potential health effects.

The measures to be undertaken by Kea Oil and Gas Limited to avoid or mitigate actual or potential adverse environmental impacts on air quality included:

- The use of a test separator to separate solids and fluids from the gas during all well clean-ups, and workover activities where necessary, thus reducing

¹ Taranaki Regional Council, *Fletcher Challenge Energy Taranaki Ltd, Mangahewa 2 Gas Well Air Quality Monitoring Programme Report 1997 – 98*, August 1998.

²Taranaki Regional Council: *Atmospheric Dispersion Modelling of Discharges to Air from the Flaring of Fracturing Fluid*, Backshall, March 2013; and *Investigation of air quality arising from flaring of fracturing fluids -emissions and ambient air quality*, Technical Report 2012–03, Taranaki Regional Council May 2012.

emissions to air. In particular, this would reduce the potential for heavy smoke incidents associated with elevated PAH and dioxin emissions;

- Records of flaring events were kept by Kea Oil and Gas Limited and provided to the Council;
- Every endeavor was made by Kea Oil and Gas Limited to minimise the total volume of gas flared while ensuring that adequate flow and pressure data was gathered to inform their investment decision; and
- Every endeavor was made by Kea Oil and Gas Limited to minimise smoke emissions from the flare.

Odour and dust

Suppression of dust with water was to be implemented if it was apparent that dust may be travelling in such a direction to adversely affect off-site parties. Odour may stem from the product, flare, or some of the chemicals used on-site. Care was taken to minimize the potential for odour emissions (e.g. by keeping containers sealed, and ensuring the flare burnt cleanly).

Hazardous substances

The use and storage of hazardous substances on-site has the potential to contaminate surface water and soils in the event of a spill. In the unlikely event of a serious spill or fire, the storage of flammable materials could have resulted in air, soil and water contamination.

Kea Oil and Gas Limited was required to implement the following mitigation measures:

- All potentially hazardous materials were used and stored in accordance with the relevant Hazardous Substances and New Organisms regulations;
- All areas containing hazardous chemicals were bunded;
- Ignition sources were not permitted on any site;
- Sufficient separation of chemicals from the flare pit were maintained for safety reasons;
- In the unlikely event of a spill escaping from bunded areas, the site perimeter drain and interceptor pit system was implemented to provide secondary containment on-site; and
- A spill contingency plan was prepared that sets out emergency response procedures to be followed in the event of a spill.

Summary

There were no environmental effects observed to water, land or air as a result of exploration drilling during the monitoring period. There were no unauthorised discharges to water or air observed from the Puka-1 wellsite. There were however issues with the initial design and installation of the stormwater system, as described above.

3.3 Evaluation of performance

A tabular summary of Kea Oil and Gas Limited's compliance record for the period under review is set out in Tables 4- 9.

Table 4 Summary of performance for Consent 7987-1 to take groundwater that may be encountered during exploration and production operations

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. The abstraction must not cause more than a 10% lowering of static water level by interference with any adjacent bore	Complaints	Yes – no complaints were received
2. The abstraction does not cause the intrusion of salt water into any freshwater aquifer	Water sampling adjacent bores pre/post drilling	Yes
3. A well log to 1,000 m must be submitted to the Council	Well log to 1,000 m submitted	Yes
4. Consent shall lapse if not implemented by date specified	Notification received and confirmed by inspection	N/A
5. Notice of Council to review consent	Notice of intention not served	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High

Table 5 Summary of performance for Consent 7985-1 to discharge emissions to air associated with production activities

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. 24hrs notice of flaring to the Council when flaring is longer than 5 minutes in duration	Notification received 24hrs prior to flaring	Yes
2. Liquid and solid separation to occur before flaring to minimise smoke emissions	Inspection of flare pit and flare	Yes
3. Only substances originating from well stream to be combusted in flare pit	Visual inspection of site	Yes
4. Best practicable option adopted	Visually inspecting site, procedures and processes	Yes
5. No offensive odour or smoke beyond boundary	Assessment by investigating officer	Yes
6. All storage tanks to have vapour recovery systems fitted.	Visual inspection of site	Yes
7. Control of carbon monoxide	Chemical analysis of emissions	N/A
8. Control of other emissions	Chemical analysis of emissions	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
9. Analysis of typical gas and condensate stream from field to be made available to the Council	Available upon request	N/A
10. Log all flare events longer than 5 minutes (10 minutes aggregate or longer than 120 minutes) including time, duration, zone and reason for flare	Inspection of Company records	Yes
11. Consent shall lapse if not implemented by date specified	Notification of flaring received/	N/A
12. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High

Table 6 Summary of performance for Consent 7986-1 to discharge emissions to air from flaring of hydrocarbon exploration activities

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Flaring shall not occur for more than 15 days per zone, for up to four zones per well, for up to 8 wells	Inspection of records	Yes
2. 24hrs notice of flaring to the Council for initial flare of each zone	Notification received 24hrs prior to flaring	Yes
3. Liquid and solid separation to occur before flaring	Inspection of flare pit and flare	Yes
4. No liquid or solid hydrocarbons are to be combusted in the flare pit	Inspection of flare pit and flare	Yes
5. Best practicable option adopted	Visually inspecting site, procedures and processes	Yes
6. No offensive odour or smoke beyond boundary	Assessment by investigating officer	Yes
7. Control of carbon monoxide	Inspections confirming chemical analysis not required	N/A
8. Control of other emissions	Inspections	N/A
9. Analysis of typical gas and crude oil stream from field to be made available to the Council	Available upon request	N/A
10. All storage tanks to have vapour recovery systems fitted.	Visual inspection of site	N/A
11. Log all flaring including time, duration, zone and volumes flared	Inspection of Company records	Yes
12. Report to the Council the time, duration and cause of each smoke incident	Inspection of Company records	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
13. Consent shall lapse if not implemented by date specified	Exercise of consent confirmed by inspection	Yes
14. Notice of Council to review consent	No provision for review during period	N/A
15. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High

Table 7 Summary of performance for Consent 7984-1 to discharge solid drilling wastes [drilling cuttings and residual drilling fluids] via mix-bury-cover

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. The discharge is to take place in accordance with information submitted in support of application	Confirming discharges were undertaken in accordance with information submitted	N/A – consent not exercised during the period under review
2. Consent Holder to adopt best practicable option at all times	Visually inspecting site, procedures and processes	N/A – consent not exercised during the period under review
3. The Council to be notified 48hrs prior to and after each mix-bury-cover discharge	Ensure notification is received prior to and after each discharge	N/A – consent not exercised during the period under review
4. Records of composition, volumes and quantities of material to be discharged shall be kept	Inspection of company records	N/A – consent not exercised during the period under review
5. The volume of waste discharged shall not exceed 15,000m ³ waste from each well	Visually inspecting site, procedures and processes	N/A – consent not exercised during the period under review
6. Discharge areas for wastes from individual wells shall be kept separate and distinct	Visually inspecting site, procedures and processes	N/A – consent not exercised during the period under review
7. Mix-bury-cover discharge shall not occur within 12 months of any previous mix-bury-cover discharge	Inspection of company records	N/A – consent not exercised during the period under review
8. As far as practicable, all fluids shall be removed from the drilling wastes	Visually inspecting site, procedures and processes	N/A – consent not exercised during the period under review
9. All sumps are to be permeable	Visually inspecting sumps	N/A – consent not exercised during the period under review
10. Drilling waste to be mixed with uncontaminated soil	Sampling soil prior to mixing	N/A – consent not exercised during the period under review

Condition requirement	Means of monitoring during period under review	Compliance achieved?
11. The mixture of solid drilling wastes and uncontaminated soil shall be covered by at least one metre of uncontaminated soil	Visually inspecting site, procedures and processes	N/A – consent not exercised during the period under review
12. Each mix-bury-cover discharge shall be re-vegetated and maintained with pasture cover	Visual inspection of site	N/A – consent not exercised during the period under review
13. The cover material is to be compacted and contoured so that stormwater is directed away from the mix-bury-cover site.	Visual inspection of site	N/A – consent not exercised during the period under review
14. The mix-bury-cover to be as far above the groundwater table as practicable	Visual inspection of site	N/A – consent not exercised during the period under review
15. The mix-bury-cover must be 30m from any water body, spring or bore	Visual inspection of site	N/A – consent not exercised during the period under review
16. The total loading of trace elements in waste is not to exceed Alberta Energy and Utilities Board, 1996, G-50 guidelines	Inspection of company records	N/A – consent not exercised during the period under review
17. Chloride levels in each mix-bury-cover shall not exceed 1,600kg	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
18. Nitrogen levels in each mix-bury-cover shall not exceed 400kg	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
19. The hydrocarbon content of solid drilling waste shall not exceed 15mg/kg	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
20. Various parameters in the soil covering the mix-bury-cover to be below agreed limits	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
21. Various metals in the soil covering the mix-bury-cover to be below agreed limits	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
22. Hydrocarbon concentrations in the soil covering the mix-bury-cover shall comply with agreed guideline values	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
23. Level of salts in surface and ground water not to exceed 2,500g/m ³	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
24. Consent shall lapse if not implemented by date specified	Notification received	N/A – consent not exercised during the period under review

Condition requirement	Means of monitoring during period under review	Compliance achieved?
25. Notice of Council to review consent	Notice of intention not served	N/A – consent not exercised during the period under review
Overall assessment of consent compliance and environmental performance in respect of this consent		N/A – consent not exercised during the period under review

Table 8 Summary of performance for Consent 7983-1 to discharge treated stormwater, and produced water from hydrocarbon exploration and production operations

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Visually inspecting site, procedures and processes	Yes
2. 7 days written notice prior to site works and drilling	Notification received	No, inadequate notice
3. Consent holder to adopt best practicable option at all times	Visually inspecting site, procedures and processes	No
4. Max stormwater catchment area 7,500 m ²	Inspection of site and records	Yes
5. All discharges to be directed for treatment through skimmer pit. Stormwater pits to be impermeable	Visual inspection of stormwater system	Yes
6. Constituents in the discharge shall meet standards	Sampling of discharge	Yes
7. Discharge of chloride shall not exceed 50 ppm	Sampling of discharge	Yes
8. Maintain a contingency plan	Contingency plan received and approved	Yes
9. The stormwater system shall be designed, managed and maintained in accordance with information submitted	By comparing submitted and approved plans with the built site inspection	No
10. Consent shall lapse if not implemented by date specified	Exercise of consent confirmed by inspection	N/A
11. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		Poor

Table 9 Summary of performance for Consent 7988-1 to discharge stormwater and sediment from earthworks during construction.

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Visually inspecting site, procedures and processes	Yes
2. 7 days written notice prior to site earthworks	Notification received	Yes
3. 7 days written notice prior to site operations and drilling	Notification received	Yes
4. All runoff shall pass through settlement ponds or traps with a minimum capacity of 100 m ³	Site erosion and sediment control plan submitted	Yes
5. Condition 4 will not apply when site is stabilised	Visual inspection	Yes
6. All earth worked areas shall be stabilised as soon as practicable	Visual inspection	Yes
Overall assessment of consent compliance and environmental performance in respect of this consent		High

During the monitoring period, Kea Oil and Gas Limited demonstrated a high level of environmental performance, but a poor level of compliance with one of the resource consents during the first period of site occupancy. The site was generally tidy.

3.4 Exercise of optional review of consents

Each resource consent includes a condition which allows the Council to review the consent, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of the resource consent, which were not foreseen at the time the application was considered or which it was not appropriate to deal with at the time. The next provision for review is in June 2016.

Based on the results of monitoring during the period under review, it is considered that there are no grounds that require a review to be pursued.

A recommendation to this effect is presented in section 4.

3.5 Change to any future monitoring programmes

In designing and implementing the monitoring programmes for air and water discharges and water abstractions at well sites in the region, the Council takes into account the extent of information made available by previous and other authorities, its relevance under the Act, the obligations of the Act in terms of monitoring emissions/discharges and effects, and of subsequently reporting to the regional community, the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of well site processes within Taranaki.

The Council has routinely monitored well site activities for more than 20 years in the region. This work has included in the order of hundreds of water samples and bio-monitoring surveys in the vicinity of well sites, and has demonstrated robustly that a monitoring regime based on frequent and comprehensive inspections is rigorous and thorough, in terms of identifying any adverse effects from well site and associated activities. Accordingly the Council had for a time not routinely required the imposition of additional targeted physicochemical and biological monitoring unless a site-specific precautionary approach indicated this would be warranted for certainty and clarity around site effects.

However, the Council has also noted a desire by some community members for a heightened level of information feedback and certainty around the results and outcomes of monitoring at well sites to occur or has occurred. Notwithstanding the long track record of a demonstrable suitability of an inspection-based monitoring programme, the Council has therefore moved to extend the previous regime, to make the sampling and extensive analysis of treated stormwater discharge and bio-monitoring of surface water ecosystems, an integral part of the basic monitoring programme for such activities.

4. Recommendations

1. THAT this report be forwarded to the Company, and to any interested parties upon request;
2. THAT the Company be asked to inform the Council of any intention to either drill, test or undertake reinstatement;
3. THAT, subject to the findings of monitoring of any further activities at the Puka-1 wellsite consents 7984-1, 7986-1, 7983-1, 7985-1 and 7987-1 shall not be reviewed in 2016.

Glossary of common terms and abbreviations

The following abbreviations and terms may have been used within this report:

Al*	aluminium.
As*	arsenic
Biomonitoring	assessing the health of the environment using aquatic organisms
BOD	biochemical oxygen demand. A measure of the presence of degradable organic matter, taking into account the biological conversion of ammonia to nitrate
BODF	biochemical oxygen demand of a filtered sample
Bund	a wall around a tank to contain its contents in the case of a leak
CBOD	carbonaceous biochemical oxygen demand. A measure of the presence of degradable organic matter, excluding the biological conversion of ammonia to nitrate
Cfu	colony forming units. A measure of the concentration of bacteria usually expressed as per 100 millilitre sample
COD	chemical oxygen demand. A measure of the oxygen required to oxidise all matter in a sample by chemical reaction.
Condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m
Cu*	copper
DO	dissolved oxygen
DRP	dissolved reactive phosphorus
<i>E.coli</i>	<i>Escherichia coli</i> , an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample
F	Fluoride
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample
Fresh g/m ³	elevated flow in a stream, such as after heavy rainfall grammes per cubic metre, and equivalent to milligrammes per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures
Incident	an event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred
Intervention	action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring
Investigation	action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident

l/s	litres per second
MCI	macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats
mS/m	millisiemens per metre
Mixing zone	the zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
NH ₄	ammonium, normally expressed in terms of the mass of nitrogen (N)
NH ₃	unionised ammonia, normally expressed in terms of the mass of nitrogen (N)
NO ₃	nitrate, normally expressed in terms of the mass of nitrogen (N)
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water
OandG	oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons)
Pb*	lead
pH	a numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	measurement of both physical properties(e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment
PM ₁₀	relatively fine airborne particles (less than 10 micrometre diameter
Resource consent	refer Section 87 of the RMA. Resource consent include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15)
RMA	Resource Management Act 1991 and subsequent amendments
SS	suspended solids,
Temp	temperature, measured in °C (degrees Celsius)
Turb	turbidity, expressed in NTU
UI	Unauthorised Incident
UIR	Unauthorised Incident Register – contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan
Zn*	zinc

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

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

Appendix I

Resource consents

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

Name of
Consent Holder: Kea Petroleum Limited
PO Box 19140
Wellington 6149

Decision Date: 01 February 2012

Commencement Date: 01 February 2012

Conditions of Consent

Consent Granted: To discharge stormwater and sediment from earthworks during the construction of the Puka-1 wellsite onto and into land

Expiry Date: 01 June 2017

Site Location: Puka-1 wellsite, Hu Road, Eltham
(Property owner: C & E Brown)

Legal Description: Lot 13 DP 1082 (Discharge source & site)

Grid Reference (NZTM) 1720382E-5637755N

Catchment: Patea

Tributary: Waihapa

*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. At least 7 working days before the commencement of earthworks for the purpose of wellsite construction and establishment, the consent holder shall notify the Taranaki Regional Council of the proposed start date for the earthworks. Notification shall include the consent number and a brief description of the activity consented and shall be emailed to worknotification@trc.govt.nz.
3. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing following the completion of the construction of the Puka-1 wellsite and before commencement of any operation of the Puka-1 wellsite. Notification shall be given at least 7 working days before the commencement of the Puka-1 wellsite operation and shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
4. If any area of soil is exposed, all run off from that area 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. The obligation described in condition 4 above shall cease to apply, and accordingly the erosion and sediment control measures can be removed, in respect of any particular site or area of any site, only when the site is stabilised.

Note: For the purpose of conditions 4 and 5, "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.

6. 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.

Note: For the purposes of this condition "stabilised" has the same definition as that set out in condition 5.

Transferred at Stratford on 14 July 2014

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: Kea Petroleum Limited
PO Box 19140
Wellington 6149

Decision Date: 01 February 2012

Commencement Date: 01 February 2012

Conditions of Consent

Consent Granted: To take groundwater that may be encountered during exploration and production operations at the Puka-1 wellsite

Expiry Date: 01 June 2022

Review Date(s): June 2016

Site Location: Puka-1 wellsite, Hu Road, Eltham
(Property owner: C & E Brown)

Legal Description: Lot 13 DP 1082 (Site of take)

Grid Reference (NZTM) 1720306E-5637800N

Catchment: Patea

Tributary: Waihapa

*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 ensure the abstraction does not cause more than a 10% lowering of static water-level by interference with any adjacent bore.
2. The consent holder shall ensure the abstraction does not cause the intrusion of salt water into any freshwater aquifer.
3. The consent holder shall submit a summary well log to a depth of 1000 metres, within three months of the completion of drilling. The report shall:
 - a) include confirmation of datum from which measurements are referenced;
 - b) provide a log to show the true vertical depth to all geological formation tops intersected within the freshwater zone;
 - c) identify the true vertical depth to, and thickness of, any freshwater aquifers intersected by the well;
 - d) identify the true vertical depth to the freshwater-saline water interface in the well.
4. This consent shall lapse on 31 March 2017, 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.
5. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2016, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 14 July 2014

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

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

Name of
Consent Holder: Kea Petroleum Limited
PO Box 19140
Wellington 6149

Decision Date
(Change): 29 October 2012

Commencement Date 29 October 2012 (Granted Date: 01 February 2012)
(Change):

Conditions of Consent

Consent Granted: To discharge emissions to air associated with exploration activities at the Puka-1 wellsite, including:

- flaring of hydrocarbons associated with well clean-up and well testing; and
- emissions from other miscellaneous activities

Expiry Date: 01 June 2028

Review Date(s): June 2016, June 2022

Site Location: Puka-1 wellsite, Hu Road, Eltham
(Property owner: C & E Brown)

Legal Description: Lot 13 DP 1082 (Discharge source & site)

Grid Reference (NZTM) 1720256E-5637790N

*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. Flaring shall not occur on more than 45 days, cumulatively, per zone for each well (with a maximum of 2 zones per well), for up to 6 wells.
2. The consent holder shall notify the Chief Executive, Taranaki Regional Council, at least 24 hours before the initial flaring of each zone being commenced. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
3. To the greatest extent possible, all gas that is flared must first be treated by effective liquid and solid separation and recovery.
4. Only gaseous hydrocarbons originating from the well stream shall be combusted within the flare pit.
5. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air from the flare, including, but not limited to, having regard to the prevailing and predicted wind speed and direction at the time of initiation of, and throughout, any episode of flaring so as to minimise offsite effects (other than for the maintenance of a pilot flare flame).
6. The discharge shall not cause any objectionable or offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.
7. The consent holder shall control all emissions of carbon monoxide, nitrogen dioxide, fine particles (PM_{10}) 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.
8. The consent holder shall control all emissions to the atmosphere from the site of contaminants other than those expressly provided for under special condition 7, in order that they do not individually or in combination with other contaminants cause a hazardous, noxious, dangerous, offensive or objectionable effect at or beyond the boundary of the property on which the wellsite is located.
9. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure C_6 or higher number of compounds.

Consent 7986-1

10. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.
11. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council upon request, a 'flaring log' that includes:
 - a) the date, time and duration of all flaring episodes;
 - b) the zone from which flaring occurred;
 - c) the volume of substances flared;
 - d) whether there was smoke at any time during the flaring episode and if there was, the time, duration and cause of each 'smoke event'.
12. This consent shall lapse on 31 March 2017, 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.
13. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2016 and/or June 2022, for any of the following purposes:
 - a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or
 - b) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or
 - c) to alter, add or delete limits on mass discharge quantities or ambient concentrations of any contaminant.

Transferred at Stratford on 14 July 2014

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

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

Name of
Consent Holder: Kea Petroleum Limited
PO Box 19140
Wellington 6149

Decision Date: 01 February 2012

Commencement Date: 01 February 2012

Conditions of Consent

Consent Granted: To discharge emissions to air associated with production activities at the Puka-1 wellsite, including:

- flaring from well workovers;
- flaring in emergency situations; and
- emissions from other miscellaneous activities

Expiry Date: 01 June 2028

Review Date(s): June 2016, June 2022

Site Location: Puka-1 wellsite, Hu Road, Eltham
(Property owner: C & E Brown)

Legal Description: Lot 13 DP 1082 (Discharge source & site)

Grid Reference (NZTM) 1720256E-5637790N

*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. Other than in emergencies, the consent holder shall notify the Chief Executive, Taranaki Regional Council, whenever the continuous flaring of hydrocarbons (other than purge gas) is expected to occur for more than five minutes in duration. Notification shall be no less than 24 hours before the flaring commences. Notification shall include the consent number and be emailed to worknotification@trc.govt.nz.
2. To the greatest extent possible, all gas that is flared must first be treated by effective liquid and solid separation and recovery.
3. Only gaseous hydrocarbons originating from the well stream shall be combusted within the flare pit.
4. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air from the flare, including, but not limited to, having regard to the prevailing and predicted wind speed and direction at the time of initiation of, and throughout, any episode of flaring so as to minimise offsite effects (other than for the maintenance of a pilot flare flame).
5. The discharge shall not cause any objectionable or offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.
6. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.
7. The consent holder shall control all emissions of carbon monoxide, nitrogen dioxide, fine particles (PM_{10}) 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.
8. The consent holder shall control all emissions to the atmosphere from the site of contaminants other than those expressly provided for under special condition 7, in order that they do not individually or in combination with other contaminants cause a hazardous, noxious, dangerous, offensive or objectionable effect at or beyond the boundary of the property on which the wellsite is located.
9. 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 7985-1

10. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council, a 'flaring log' that includes:
 - a) the date, time and duration of all flaring episodes;
 - b) the zone from which flaring occurred;
 - c) the volume of substances flared;
 - d) whether there was smoke at any time during the flaring episode and if there was, the time, duration and cause of each 'smoke event'.
11. This consent shall lapse on 31 March 2017, 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.
12. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2016 and/or June 2022, for any of the following purposes:
 - a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or
 - b) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or
 - c) to alter, add or delete limits on mass discharge quantities or ambient concentrations of any contaminant.

Transferred at Stratford on 14 July 2014

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

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

Name of
Consent Holder: Kea Petroleum Limited
PO Box 19140
Wellington 6149

Decision Date: 01 February 2012

Commencement Date: 01 February 2012

Conditions of Consent

Consent Granted: To discharge drilling muds, drilling cuttings and drilling wastes from the Puka-1 wellsite onto and into land via mix-bury-cover

Expiry Date: 01 June 2028

Review Date(s): June 2016, June 2022 and/or during the month following each mix-bury-cover discharge

Site Location: Puka-1 wellsite, Hu Road, Eltham
(Property owner: C & E Brown)

Legal Description: Lot 13 DP 1082 (Discharge source & site)

Grid Reference (NZTM) 1720301E-5637740N

Catchment: Patea

Tributary: Waihapa

*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, including but not limited to effects on any waterbody or soil.
2. The consent holder shall notify the Taranaki Regional Council at least 48 hours prior to the commencement of each mix-bury-cover discharge. Notification shall be emailed to worknotification@trc.govt.nz and shall include:
 - a) the consent number;
 - b) the volume and weight or density of the drilling wastes;
 - c) the composition of the drilling wastes (including concentrations of nitrogen, chloride, hydrocarbons, and trace elements), to show that the discharge complies with conditions 13 to 18;
 - d) the location of the discharge area.
3. The volume of solid drilling wastes discharged shall not exceed 1500 m³ per well for up to 3 wells.
4. Mix-bury-cover discharge areas for wastes from individual wells shall be kept separate and distinct.
5. As far as practicable, the consent holder shall ensure that all fluids are removed from the drilling wastes prior to discharge.
6. If the mix-bury-cover discharge is to occur in a lined sump, the impermeable liner shall be perforated or removed where possible.
7. The solid drilling wastes shall be mixed with uncontaminated soil in a mixing ratio of 1 part solid drilling wastes to a minimum of 3 parts uncontaminated soil.
8. The mixture of solid drilling wastes and uncontaminated soil shall be covered by at least one metre of uncontaminated soil.
9. Each mix-bury-cover discharge area shall be revegetated, and thereafter maintained with pasture cover:
 - a) within 6 months of the completion of the discharge; or
 - b) upon reinstatement of the site, if the discharge area is part of the active wellsite area.

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10. The consent holder shall compact, contour, and maintain the soil overlying the mix-bury-cover discharge to ensure that stormwater is directed away from the mix-bury-cover discharge area.
11. The mix-bury-cover discharge shall occur as far above the shallow groundwater table as practicable.
12. The edges of the mix-bury-cover discharge area shall be at least 30 metres from any surface water body, spring, or any pre-existing groundwater supply bore.
13. The total loading of trace elements in the solid drilling wastes for each distinct mix-bury-cover discharge area shall not exceed the total loading limits shown in the following table:

<u>Trace element</u>	<u>Total loading limit</u>
boron	10 kg
cadmium	3 kg
chromium	200 kg
copper	400 kg
lead	200 kg
nickel	50 kg
vanadium	200 kg
zinc	600 kg

14. The loading of chloride shall not exceed 1,600 kg for each distinct mix-bury-cover discharge area.
15. The loading of nitrogen shall not exceed 400 kg for each distinct mix-bury-cover discharge area.
16. The hydrocarbon content of the solid drilling waste shall not exceed 1000 mg/kg on a dry weight basis.
17. Parameters in the soil (at less than 0.5 metre depth) covering the mix-bury-cover discharge area shall not exceed the limits shown in the following table:

<u>Parameter</u>	<u>Limit</u>
conductivity	290 mSm ⁻¹
total dissolved salts	2500 mg kg ⁻¹
sodium	460 mg kg ⁻¹
chloride	700 mg kg ⁻¹

18. The concentrations of metals in the soil covering the mix-bury-cover discharge area (at less than 0.5 metre depth) shall comply with the limits shown in the following table:

<u>Metal</u>	<u>Limit</u>
arsenic	20 mg kg ⁻¹
cadmium	1 mg kg ⁻¹
chromium	600 mg kg ⁻¹
copper	100 mg kg ⁻¹
lead	300 mg kg ⁻¹
mercury	1 mg kg ⁻¹
nickel	60 mg kg ⁻¹
zinc	300 mg kg ⁻¹

19. The concentrations of hydrocarbons in the soil covering the mix-bury-cover discharge area (less than 0.5 metre depth) shall comply with the guideline values for the appropriate soil type in the surface layer set out in Tables 4.12 and 4.15 of the Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (Ministry for the Environment, 1999), appended to this consent (Appendix 2).
20. The exercise of this consent shall not cause the level of total dissolved salts within any surface water or ground water to exceed 2500 gm⁻³.
21. This consent shall lapse on 31 March 2017, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
22. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month following each mix-bury-cover discharge, and/or during the month of June 2016 and/or June 2022, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 14 July 2014

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

Appendix 2

Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand

Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand
Module 4 - Tier 1 Soil Screening Criteria

Table 4.12 Tier 1 soil acceptance criteria Agricultural use^(1,3,6) ALL PATHWAYS
(all values mg/kg)

Soil Type/ Contaminant	Depth of contamination		
	Surface (<1m)	1m - 4m	> 4m
SAND MAHs	Benzene	1.1 ^(v) (68) ^(4,v)	1.9 ^(7,v) (94) ^(4,m)
	Toluene	(53) ^(4,v)	(92) ^(4,7,v) (130) ^(4,7,v)
	Ethylbenzene	(48) ^(4,v)	(230) ^(4,v) (120) ^(4,v)
	Xylenes		(180) ^(4,v)
	PAHs	Naphthalene	7.2 ^(p) (160) ^(4,p)
		Non-carc. (Pyrene)	NA ⁽²⁾ (25) ^(4,m)
		Benzo(a)pyrene eq. ⁽⁵⁾	80 ^(v) NA ⁽²⁾ NA ⁽²⁾
SANDY SILT MAHs	Benzene	1.1 ^(v) (82) ^(4,v)	1.9 ^(v) (170) ^(4,v)
	Toluene	(59) ^(4,v)	(92) ^(4,v) (130) ^(4,v)
	Ethylbenzene	(59) ^(4,v)	(140) ^(4,v) (180) ^(4,v)
	Xylenes		
	PAHs	Naphthalene	7.2 ^(p) (160) ^(4,p)
		Non-carc. (Pyrene)	83 ^(v) NA ⁽²⁾ (25) ^(4,m)
		Benzo(a)pyrene eq. ⁽⁵⁾	(130) ^(4,v) NA ⁽²⁾ NA ⁽²⁾
SILTY CLAY MAHs	Benzene	1.7 ^(v) (210) ^(4,v)	4.6 ^(v) (950) ^(4,v)
	Toluene	(110) ^(4,v)	(800) ^(4,v) (710) ^(4,v)
	Ethylbenzene	(160) ^(4,v)	(2,800) ^(4,v) (2,200) ^(4,v)
	Xylenes		
	PAHs	Naphthalene	7.2 ^(p) (160) ^(4,p)
		Non-carc. (Pyrene)	(330) ^(4,v) NA ⁽²⁾ (25) ^(4,m)
		Benzo(a)pyrene eq. ⁽⁵⁾	(1,100) ^(4,v) NA ⁽²⁾ NA ⁽²⁾

NOTES:

1. Based on protection of human health. Refer to Table 4.20 for protection of groundwater. Site-specific consideration of aesthetic and ecological impacts is required.
2. NA indicates contaminant not limiting as estimated health-based criterion is significantly higher than that likely to be encountered on site.
3. Surface soil acceptance criteria are based on the lower value of volatilisation criteria (Table 4.16), other pathway criteria (Table 4.18) and criteria for the protection of maintenance workers (Table 4.19). Criteria for soils at 1 m are based on the lower value of those arising from volatilisation and maintenance criteria. Criteria for soils at 4 m are based on volatilisation only.
4. Brackets denote values exceed threshold likely to correspond to formation of residual separate phase hydrocarbons. For further explanation refer to Appendix 4M.
5. Risk associated with mixture of carcinogenic PAHs assessed by comparison with criteria based on benzo(a)pyrene equivalent concentration. Refer to Section 4.4.3 for details of the calculation of Benzo(a)pyrene equivalent concentrations.
6. The following notes indicate the limiting pathway for each criterion: v - Volatilisation, s - Soil Ingestion, d - Dermal, p - Produce, m - Maintenance/Excavation
7. Due to the nature of boundary conditions in volatilisation model, calculated criteria for sandy soils are higher than that for silt soil type. Therefore, the criteria for sand are set equal to the criteria for silt. Refer Appendix 4D for details.

Table 4.12 (CONTINUED)
Tier 1 soil acceptance criteria Agricultural use^(1,3,6) ALL PATHWAYS
(all values mg/kg)

Soil Type/ Contaminant	Depth of contamination		
	Surface (<1m)	1m - 4m	> 4m
CLAY			
MAHs			
Benzene	2.7 ^(v) (320) ^(4,v)	8.8 ^(v) (2,400) ^(4,v)	(26) ^(4,v) (8,500) ⁽²⁾
Toluene	(160) ^(4,v)	NA ⁽²⁾	NA ⁽²⁾
Ethylbenzene	(250) ^(4,v)	(1,800) ^(4,v)	(6,500) ^(4,v)
Xylenes			
PAHs			
Naphthalene	7.2 ^(p) (160) ^(4,p)	(360) ^(4,v) NA ⁽²⁾	(1,200) ^(4,v) NA ⁽²⁾
Non-carc. (Pyrene)	0.027 ^(p)	(25) ^(4,m)	NA ⁽²⁾
Benzo(a)pyrene eq. ⁽⁵⁾			
PUMICE			
MAHs			
Benzene	1.2 ^(v) (73) ^(4,v)	2.4 ^(v) (240) ^(4,v)	3.1 ^(v) (350) ^(4,v)
Toluene	(48) ^(4,v)	(140) ^(4,v)	(220) ^(4,v)
Ethylbenzene	(53) ^(4,v)	(180) ^(4,v)	(260) ^(4,v)
Xylenes			
PAHs			
Naphthalene	7.2 ^(p) (160) ^(4,p)	140 ^(v) NA ⁽²⁾	(220) ^(4,v) NA ⁽²⁾
Non-carc. (Pyrene)	0.027 ^(p)	(25) ^(4,m)	NA ⁽²⁾
Benzo(a)pyrene eq. ⁽⁵⁾			
PEATS AND HIGHLY ORGANIC SOILS			
MAHs			
Benzene	5.7 ^(v) (2,500) ^(4,v)	10 ^(v) (2,900) ^(4,v)	13 ^(v) (3,800) ^(4,v)
Toluene	(2,200) ^(4,v)	(2,500) ^(4,v)	(3,200) ^(4,v)
Ethylbenzene	(1,700) ^(4,v)	(2,000) ^(4,v)	(2,600) ^(4,v)
Xylenes			
PAHs			
Naphthalene	7.2 ^(p) (160) ^(4,p)	(2,700) ^(4,v) NA ⁽²⁾	(3,500) ^(4,v) NA ⁽²⁾
Non-carc. (Pyrene)	0.027 ^(p)	(25) ^(4,m)	NA ⁽²⁾
Benzo(a)pyrene eq. ⁽⁵⁾			

NOTES:

1. Based on protection of human health. Refer to Table 4.20 for protection of groundwater. Site-specific consideration of aesthetic and ecological impacts is required.
2. NA indicates contaminant not limiting as estimated health-based criterion is significantly higher than that likely to be encountered on site.
3. Surface soil acceptance criteria are based on the lower value of volatilisation criteria (Table 4.16), other pathway criteria (Table 4.18) and criteria for the protection of maintenance workers (Table 4.19). Criteria for soils at 1 m are based on the lower value of those arising from volatilisation and maintenance criteria. Criteria for soils at 4 m are based on volatilisation only.
4. Brackets denote values exceed threshold likely to correspond to formation of residual separate phase hydrocarbons. For further explanation refer to Appendix 4M.
5. Risk associated with mixture of carcinogenic PAHs assessed by comparison with criteria based on benzo(a)pyrene equivalent concentration. Refer to Section 4.4.3 for details of the calculation of Benzo(a)pyrene equivalent concentrations.
6. The following notes indicate the limiting pathway for each criterion: v - Volatilisation, s - Soil Ingestion, d - Dermal, p - Produce, m - Maintenance/Excavation

Table 4.15 Tier 1 soil acceptance criteria for TPH^(1,3,5,6) Agricultural use ALL PATHWAYS
 (all values in mg/kg)

Soil Type/ Contaminant	Depth of contamination		
	Surface (<1m)	1m - 4m	> 4m
SAND			
C ₇ -C ₉ ⁽⁴⁾	120 ^(m)	120 ^(m)	(3,800) ^(7,v)
C ₁₀ -C ₁₄	58 ^(x)	(560) ^(7,x)	(650) ^(7,x)
C ₁₅ -C ₃₆	(4,000) ^(7,x)	NA ⁽²⁾	NA ⁽²⁾
SANDY SILT			
C ₇ -C ₉ ⁽⁴⁾	(500) ^(7,m)	(500) ^(7,m)	(3,800) ^(7,v)
C ₁₀ -C ₁₄	58 ^(x)	(670) ^(7,x)	(4,900) ^(7,v)
C ₁₅ -C ₃₆	(4,000) ^(7,x)	NA ⁽²⁾	NA ⁽²⁾
SILTY CLAY			
C ₇ -C ₉ ⁽⁴⁾	(2,700) ^(7,v)	(7,300) ^(7,v)	(19,000) ^(7,v)
C ₁₀ -C ₁₄	58 ^(x)	(2,700) ^(7,x)	(8,900) ^(7,x)
C ₁₅ -C ₃₆	(4,000) ^(7,x)	NA ⁽²⁾	NA ⁽²⁾
CLAY			
C ₇ -C ₉ ⁽⁴⁾	(15,000) ^(7,v)	NA ⁽²⁾	NA ⁽²⁾
C ₁₀ -C ₁₄	58 ^(x)	(2,900) ^(7,x)	(9,700) ^(7,x)
C ₁₅ -C ₃₆	(4,000) ^(7,x)	NA ⁽²⁾	NA ⁽²⁾
PUMICE			
C ₇ -C ₉ ⁽⁴⁾	(810) ^(7,m)	(810) ^(7,m)	(4,800) ^(7,v)
C ₁₀ -C ₁₄	58 ^(x)	(1,100) ^(7,x)	(1,800) ^(7,x)
C ₁₅ -C ₃₆	(4,000) ^(7,x)	NA ⁽²⁾	NA ⁽²⁾
PEATS AND HIGHLY ORGANIC SOILS			
C ₇ -C ₉ ⁽⁴⁾	(6,700) ^(7,m)	(6,700) ^(7,m)	NA ⁽²⁾
C ₁₀ -C ₁₄	58 ^(x)	NA ⁽²⁾	NA ⁽²⁾
C ₁₅ -C ₃₆	(4,000) ^(7,x)	NA ⁽²⁾	NA ⁽²⁾

NOTES:

- Criteria for C10 - C14 and C15 - C36 are based on consideration of aliphatic component of TPH measurement and consideration of TPH as a surrogate measure for PAH, consideration of PAHs completed by extrapolation of PAH content of diesel and PAH criteria (refer Table 4.10)
- NA indicates estimated criterion exceeds 20,000 mg/kg. At 20,000 mg/kg residual separate phase is expected to have formed in soil matrix. Some aesthetic impact may be noted.
- Based on protection of human health only. Site specific consideration of aesthetic and ecological impact is required.
- Based on health effects associated with aliphatic component only. Separate consideration of the health effects associated with the aromatic component (i.e. BTEX) is required.
- Soil acceptance criteria are based on the lower value of criteria based on volatilisation (Table 4.16), other pathways (Table 4.18), criteria for the protection of maintenance workers (Table 4.19) and TPH criteria developed as surrogates for PAHs (Table 4.22). Surface soils criteria are based on all three pathways, criteria for soils at 1 m are based on volatilisation and maintenance workers, and criteria for soils at 4 m are based on volatilisation only. PAH surrogate considerations apply at all depths.
- The following notes indicate the limiting pathway for each criterion: v - Volatilisation, s - Soil Ingestion d - Dermal, p - Produce, m - Maintenance/Excavation, x - PAH surrogate
- Brackets denote values exceed threshold likely to correspond to formation of residual separate phase hydrocarbons. For further explanation refer to Appendix 4M.
- Due to the nature of boundary conditions in volatilisation model, calculated criteria for sandy soils are higher than that for silt soil type. Therefore, the criteria for sand are set equal to the criteria for silt. Refer Appendix 4D for details.

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

Name of
Consent Holder: Kea Petroleum Limited
PO Box 19140
Wellington 6149

Decision Date 20 September 2012
(Change):

Commencement Date 20 September 2012 (Granted Date: 01 February 2012)
(Change):

Conditions of Consent

Consent Granted: To discharge treated stormwater and production water from hydrocarbon exploration and production operations at the Puka-1 wellsite onto and into land

Expiry Date: 01 June 2028

Review Date(s): June 2016, June 2022

Site Location: Puka-1 wellsite, Hu Road, Eltham
(Property owner: C & E Brown)

Legal Description: Lot 13 DP 1082 (Discharge source & site)

Grid Reference (NZTM) 1720366E-5637755N

Catchment: Patea

Tributary: Waihapa

*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. The Chief Executive, Taranaki Regional Council, shall be advised in writing at least 7 working days before any site works commencing, and again in writing at least 7 working days before any well drilling operation commencing. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
3. Stormwater discharged shall be collected from a catchment area of no more than 9000 m².
4. All stormwater and produced water shall be directed for treatment through the skimmer pit(s) before being discharged. All stormwater pits shall have impermeable side walls and floor to prevent leakage.
5. Constituents in the discharge shall meet the standards shown in the following table.

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

6. The discharge shall have a chloride concentration no greater than 50 ppm.
7. The consent holder shall maintain a contingency plan that, to the satisfaction of the Chief Executive, Taranaki Regional Council, details measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not authorised by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge.
8. 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.

Consent 7983-1

9. This consent shall lapse on 31 March 2017, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
10. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2016 and/or June 2022, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 14 July 2014

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

Appendix II

Biomonitoring Reports

To Job Manager; Callum MacKenzie
From Freshwater Biologist; Brooke Thomas
Document 1208130
Date 21 June 2012

Biomonitoring of the Waihapa Stream following drilling by Kea Oil & Gas Ltd at the Puka-1 wellsite, May 2013

Introduction

This biological survey was performed following drilling of the Puka-1 well to determine whether or not treated stormwater and uncontaminated site and production water discharges from the drilling site onto land, in the vicinity of the Waihapa Stream had any effects upon the communities of the stream. A survey was also conducted prior to drilling, but following site preparation earthworks, to provide baseline data on the macroinvertebrate community of the stream (Thomas, 2013).

Methods

Two different sampling techniques were used to collect streambed macroinvertebrates in the Waihapa Stream, downstream of the stormwater discharges from the Puka-1 well site. The Council's standard 'kick-sampling' technique was used at site 2 and a combination of the 'kick-sampling' and 'vegetation sweep' sampling techniques were used at sites 1 and 3 (**Error! Reference source not found.**, **Error! Reference source not found.**). The 'kick-sampling' and 'vegetation sweep' techniques are very similar to Protocol C1 (hard-bottomed, semi-quantitative) and C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

The Puka-1 wellsite stormwater and site production water was discharged from a skimmer pit on to land within the vicinity of the stream (Figure 1). This survey was undertaken on 16 May 2013 at three established sites; 100 m upstream of the well site (site 1), 25 m downstream of the well site discharge (site 2) and 80 m downstream of the discharge (site 3).

Table 1: Biomonitoring sites and sampling methods used in the Waihapa Stream related to the Puka-1 wellsite

Site No.	Site code	Grid reference (NZTM)	Location	Sampling method	Altitude (m above sea level)
1	WHP000182	1720472E-5637639N	100m u/s of Puka-1 wellsite	Kick-sweep	210
2	WHP000183	1720476E-5637793N	25m d/s of discharge from Puka-1 wellsite	Streambed kick	210
3	WHP000185	1720468E-5637855N	80m d/s of discharge	Kick-sweep	210



Figure 1 Biomonitoring sites in the Waihapa Stream in relation to the Puka-1 wellsite

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols of sampling macroinvertebrates in wadeable streams (Stark et al, 2001). Macroinvertebrate taxa found in each sample were recorded as:

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

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience.

By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The

MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways.

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ score is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.

Results and discussion

At the time of this late afternoon survey the water temperature in the stream was recorded as 13.4 °C at all three sites. A moderate and steady flow of clear, uncoloured water was noted at all three sites. Substrate was comprised predominantly of sand, with varying amounts of silt and fine and coarse gravel. Due to the nature of the substrate, a greater sampling effort was required at sites 2 and 3, meaning a larger area was covered to collect the desired quantity of sample material. Slippery mats of periphyton were noted at all three sites. Macrophytes were also noted at all sites, both at the edges and on the bed of the stream.

Macroinvertebrate communities

Table 2 summarises the results of the current macroinvertebrate survey performed following drilling of the Puka-1 well, along with results from the pre-drill survey. Comparative data for sites in similar streams in the region are presented in Table 3. The macroinvertebrate fauna recorded by the current survey are presented in Table 4.

Table 2: Number of taxa, MCI and $SQMCI_s$ values for the Waihapa Stream prior to and following drilling of Puka-1 well

Site No.	Site Code	No of taxa		MCI value		$SQMCI_s$ value	
		Pre-drill (Nov 12)	Post-drill (May 13)	Pre-drill (Nov 12)	Post-drill (May 13)	Pre-drill (Nov 12)	Post-drill (May 13)
1	WHP000182	23	14	90	104	4.8	4.9
2	WHP000183	20	21	96	106	5.3	5.5
3	WHP000185	20	20	98	108	5.7	6.1

Table 3: Range and median number of taxa, MCI values and $SQMCI_s$ scores for control sites at altitudes between 200-249 m ((TRC, 1999 (updated 2012)).

	No. of taxa	MCI value	$SQMCI_s$ value
No. Samples	167	167	81
Range	5-33	52-108	1.5-6.3
Median	18	78	4.1

Table 4: Macroinvertebrate fauna of the Waihapa Stream in relation to the Puka-1 post-drill survey sampled 16 May 2013

Taxa List	Site Number	MCI score	1	2	3
			WHP000182	WHP000183	WHP000185
			FWB13201	FWB13202	FWB13203
ANNELIDA (WORMS)	Oligochaeta	1	C	C	C
MOLLUSCA	<i>Potamopyrgus</i>	4	A	C	A
CRUSTACEA	<i>Paracalliope</i>	5	C	VA	A
	<i>Paraleptamphopidae</i>	5	C	C	C
	<i>Paranephrops</i>	5	R	A	C
EPHEMEROPTERA (MAYFLIES)	<i>Austroclima</i>	7	C	A	VA
	<i>Coloburiscus</i>	7	-	R	C
	<i>Zephlebia group</i>	7	A	A	A
PLECOPTERA (STONEFLIES)	<i>Acoperla</i>	5	-	R	R
	<i>Megaleptoperla</i>	9	C	A	A
	<i>Zelandobius</i>	5	-	R	C
COLEOPTERA (BEETLES)	Elmidae	6	-	R	R
	Hydraenidae	8	-	R	-
MEGALOPTERA (DOBSONFLIES)	<i>Archichauliodes</i>	7	R	-	R
TRICHOPTERA (CADDISFLIES)	<i>Aoteapsyche</i>	4	-	A	C
	Ecnomidae/Psychomyiidae	6	-	R	R
	<i>Hydrobiosis</i>	5	-	R	R
	<i>Psilochorema</i>	6	-	R	-
	<i>Triplectides</i>	5	-	R	-
DIPTERA (TRUE FLIES)	Eriopterini	5	C	C	R
	<i>Paralimnophila</i>	6	R	-	R
	<i>Zelandotipula</i>	6	-	-	R
	<i>Paradixa</i>	4	R	-	-
	Empididae	3	-	R	-
	<i>Austrosimulium</i>	3	A	C	A
ACARINA (MITES)	Acarina	5	R	-	-
No of taxa			14	21	20
MCI			104	106	108
SQMCIs			4.9	5.5	6.1
EPT (taxa)			3	11	9
%EPT (taxa)			21	52	45
'Tolerant' taxa		'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Site 1- 100m upstream of Puka-1 wellsite

A moderate community richness of 14 taxa was found at site 1 (Table 2 and Table 4), nine taxa fewer than what was recorded in the pre-drill survey and four taxa less than the median richness found at similar sites elsewhere in the region (Table 3). The macroinvertebrate community continued to contain a significant proportion of 'moderately sensitive' taxa (64%), which was reflected in the MCI score of 104 units. This result represented a significant increase from that recorded in the pre-drill survey (90 MCI units) and was also significantly higher (Stark, 1998) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 3).

The community at this site was characterised by two ‘tolerant’ taxa (abundant snails (*Potamopyrgus*), and sandfly larvae (*Austrosimulum*)); and one ‘moderately sensitive’ mayfly taxon (*Zephlebia* group).

The numerical dominance of ‘tolerant’ taxa was tempered by the number of ‘moderately sensitive’ taxa recorded as common, resulting in a SQMCI_S score of 4.9 units, which was slightly higher (by 0.1 unit) than what was recorded in the pre-drill survey, and higher (0.8 unit) than the median score for ‘control’ sites in similar streams at this altitude (Table 3).

Site 2- 25m downstream of discharge from Puka-1 wellsite

A moderate community richness of twenty one taxa was found at site 2 (Table 2 and Table 4), seven taxa more than found at site 1, one taxon more than what was recorded in the pre-drill survey and three taxa more than the median richness found at similar sites (Table 3). The macroinvertebrate community was again comprised of a significant proportion of ‘moderately sensitive’ taxa (67%), which was reflected in the MCI score of 106 units; 10 units higher than what was recorded during the pre-drill survey and an insignificant two units higher than at the upstream ‘control’ site. This MCI score was significantly higher (Stark, 1998) than the median MCI score for ‘control’ sites in similar streams at comparative altitudes (Table 3).

This community was characterised by one ‘tolerant’ taxon (net-building caddisfly (*Aoteapsyche*)), four ‘moderately sensitive’ taxa (amphipods (*Paracalliope* and *Paraleptamphopidae*), and mayflies (*Astroclima* and *Zephlebia* group)), and one ‘highly sensitive’ taxon, (stonefly (*Megaleptoperla*)). The ‘highly sensitive’ stonefly *Megaleptoperla* and ‘moderately sensitive’ *Zephlebia* mayfly were both not recorded during the pre-drill survey.

The numerical dominance of several ‘sensitive’ taxa resulted in a SQMCI_S score of 5.5 units, which was slightly higher (by 0.2 unit) than what was recorded in the pre-drill survey, and higher (0.9 unit) than the median score for ‘control’ sites in similar streams at this altitude (Table 3). Similarly to the pre-drill survey a small increase (0.6 unit) in SQMCI_S score was recorded between sites 1 and 2. This can be attributed to an increased abundance of sensitive taxa. This and the two other significant differences in individual taxa abundances between these adjacent sites were probably related to subtle variations in habitat between sites 1 and 2 and the effort required to collect each sample.

Site 3- 80m downstream of discharge from Puka-1 wellsite

A moderate community richness of twenty taxa was found at site 3 (Table 2 and Table 4), the same number recorded in the pre-drill survey and two taxa more than the median richness found at similar sites elsewhere in the region (Table 3). The macroinvertebrate community was again comprised of a significant proportion of ‘moderately sensitive’ taxa (75%), which was reflected in the MCI score of 108 units; 10 units higher than the pre-drill survey. This score was a significant 30 units higher (Stark, 1998) than the median MCI score for ‘control’ sites in similar streams at comparative altitudes (Table 3).

This community was characterised by two ‘tolerant’ taxa (snail (*Potamopyrgus*) and sandfly larvae (*Austrosimulum*)); three ‘moderately sensitive’ taxa (amphipod (*Paracalliope*) and mayflies (*Astroclima* and *Zephlebia* group)), and one ‘highly sensitive’ taxon, stonefly (*Megaleptoperla*). The SQMCI_S score of 6.1 units recorded at site 3 in this survey represented a

0.4 unit increase from the SQMCI_S score in the pre-drill survey and was two units higher than the median score for 'control' sites in similar streams at this altitude elsewhere in the region (TRC, 1998 (updated 2012)).

Summary and Conclusions

The Councils 'kick-sampling' and a combination of 'vegetation sweep' and 'kick-sampling' techniques were used at three sites to collect streambed macroinvertebrates from the Waihapa Stream. This has provided data to compare with baseline data for the assessment of skimmer pit discharge effects from the Puka-1 wellsite on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCI_S scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The SQMCI_S takes into account taxa abundances as well as sensitivity to pollution. It may indicate subtle changes in communities, and therefore be the more relevant index if non-organic impacts are occurring. Significant differences in either the MCI or the SQMCI_S between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

This May 2013 survey of three sites, upstream and downstream of the skimmer pit discharge point to land near the stream, was undertaken following drilling at the Puka-1 wellsite. Taxa richness's were moderate and within a narrow range for all sites and the macroinvertebrate communities of the stream contained relatively high proportions of 'moderately sensitive' taxa. A total of 26 taxa was found through the reach of the stream surveyed, with 10 of these taxa (39%) found at all three sites and 9 taxa (35%), found at any two of these sites. The number of taxa recorded in abundance increased downstream of the skimmer pit discharge. In addition, two 'highly sensitive' taxa were recorded downstream of the discharge (compared with none upstream), with one of these taxa being recorded in abundance.

A comparison of the pre-drill and post-drill survey results showed no significant variation in MCI and SQMCI_S scores between surveys at all three sites. Slight variations in MCI and SQMCI_S score and taxa richness between sites and surveys is considered to be due to habitat variability rather than a change in water quality, although sampling effort will also have had an influence.

The MCI scores recorded in this survey indicated that the stream communities were of fair 'health' (TRC, 2013), but slightly better than the biological health recorded at 'control' sites in similar streams at a comparative altitude elsewhere in the region. There was no indication from the results of the two surveys that the discharge from the Puka-1 wellsite has impacted on the biological communities of the Waihapa Stream.

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To Job Manager; Callum MacKenzie
From Freshwater Biologists; Brooke Thomas & Katrina Smith
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Biomonitoring of the Waihapa Stream prior to drilling by Kea Oil & Gas Ltd at the Puka-1 wellsite, November 2012

Introduction

This biological survey was performed prior to drilling of the Puka-1 well, to provide baseline data on the macroinvertebrate community of the Waihapa Stream. A second survey will be performed following drilling of the well, to determine whether or not treated stormwater and discharges of uncontaminated site water and production water onto land (in the vicinity of the stream) have had a detrimental effect upon macroinvertebrate communities of the Waihapa Stream.

Methods

Puka-1 wellsite stormwater and site production water is to be discharged from a skimmer pit on to land within the vicinity of the Waihapa Stream (Figure 1). This survey was undertaken on 27 November 2012 at three newly established sites; 100 m upstream of the well site (site 1), 25 m downstream of the well site discharge (site 2) and 80 m downstream of the discharge (site 3).

Two different sampling techniques were used to collect streambed macroinvertebrates in the Waihapa Stream, downstream of the stormwater discharges from the Puka-1 well site. The Council's standard 'kick-sampling' technique was used at site 2 and a combination of the 'kick-sampling' and 'vegetation sweep' sampling techniques were used at sites 1 and 3 (**Error! Reference source not found., Error! Reference source not found.**). The 'kick-sampling' and 'vegetation sweep' techniques are very similar to Protocol C1 (hard-bottomed, semi-quantitative) and C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Table 1: Biomonitoring sites and sampling methods used in the Waihapa Stream related to the Puka-1 wellsite

Site No.	Site code	Grid reference (NZTM)	Location	Sampling method	Altitude (m asl)
1	WHP000182	1720472E-5637639N	100m u/s of Puka-1 wellsite	Kick-sweep	210
2	WHP000183	1720476E-5637793N	25m d/s of discharge from Puka-1 wellsite	Streambed kick	210
3	WHP000185	1720468E-5637855N	80m d/s of discharge	Kick-sweep	210



Figure 1 Biomonitoring sites in the Waihapa Stream in relation to the Puka-1 wellsite

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology which uses Protocol P1 of NZMWG protocols of sampling macroinvertebrates in wadeable streams (Stark et al, 2001). Macroinvertebrate taxa found in each sample were recorded as:

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

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience.

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

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.

Results and discussion

At the time of this late morning survey stream temperatures were 18.5°C (site 1), 15.1°C (site 2), and 15.4 °C (site 3). A low flow of clear, uncoloured water was noted at all three sites. Substrate at all three sites was comprised predominantly of sand, with varying amounts of silt, gravel, wood and tree roots.

Slippery mats of periphyton growth were noted on the stream bed at sites 2 and 3, with no periphyton recorded at site 1. At sites 1 and 3 macrophytes were recorded both on the stream bed and at the edges of the bank. At site 2 macrophytes were recorded at bank edges only. Sites 1 and 2 were partially shaded by high, steep sided banks, whereas no shading was recorded at site 3.

Macroinvertebrate communities

Table 2 summarises the results of this macroinvertebrate survey performed prior to drilling of the Puka-1 wellsite. Comparative data for sites in similar streams are presented in Table 3. The macroinvertebrate fauna recorded by the current survey are presented in Table 4.

Table 2: Number of taxa, MCI and $SQMCI_s$ in the Waihapa Stream prior to drilling of Puka-1 wellsite.

Site No.	No taxa	MCI value	$SQMCI_s$ value
1	23	90	4.8
2	20	96	5.3
3	20	98	5.7

Table 3: Range and median number of taxa, MCI values and $SQMCI_s$ scores for control sites at altitudes between 200 and 249 m asl ((TRC, 1999 (updated 2012)).

	No. of taxa	MCI value	$SQMCI_s$ value
No. Samples	167	167	81
Range	5-33	52-108	1.5-6.3
Median	18	78	4.1

Table 4: Macroinvertebrate fauna of the Waihapa Stream in relation to the Puka-1 pre-drill survey sampled 27 November 2012

Taxa List	Site Number Site Code Sample Number	MCI score	1	2	3
			WHP000182	WHP000183	WHP000185
			FWB12443	FWB12444	FWB12445
NEMATODA	Nematoda	3	R	-	-
ANNELIDA (WORMS)	Oligochaeta	1	C	C	C
MOLLUSCA	<i>Potamopyrgus</i>	4	XA	C	A
CRUSTACEA	Ostracoda	1	R	-	-
	<i>Paracalliope</i>	5	VA	A	C
	Paraleptamphopidae	5	VA	A	A
	Talitridae	5	R	-	R
	<i>Paranephrops</i>	5	R	R	C
EPHEMEROPTERA (MAYFLIES)	<i>Austroclima</i>	7	VA	VA	VA
	<i>Zephlebia group</i>	7	VA	C	A
PLECOPTERA (STONEFLIES)	<i>Acoperla</i>	5	-	R	-
	<i>Megaleptoperla</i>	9	R	R	R
	<i>Zelandobius</i>	5	R	R	C
HEMIPTERA (BUGS)	<i>Microvelia</i>	3	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	R	R	C
	Dytiscidae	5	R	-	-
MEGALOPTERA (DOBSONFLIES)	<i>Archichauliodes</i>	7	-	R	-
TRICHOPTERA (CADDISFLIES)	<i>Aoteapsyche</i>	4	R	A	R
	Ecnomidae/Psychomyiidae	6	-	C	C
	<i>Hydrobiosis</i>	5	C	C	R
	<i>Psilochorema</i>	6	-	-	R
	<i>Oxyethira</i>	2	-	R	R
DIPTERA (TRUE FLIES)	<i>Aphrophila</i>	5	-	R	-
	Eriopterini	5	C	-	C
	<i>Paralimnophila</i>	6	-	-	R
	<i>Zelandotipula</i>	6	C	-	-
	Orthocladiinae	2	C	A	C
	<i>Paradixa</i>	4	R	-	-
	Empididae	3	C	R	-
	<i>Austrosimulium</i>	3	A	A	A
No of taxa		23	20	20	
MCI		90	96	98	
SQMCIs		4.8	5.3	5.7	
EPT (taxa)		6	8	8	
%EPT (taxa)		26	40	40	
'Tolerant' taxa		'Moderately sensitive' taxa		'Highly sensitive' taxa	

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

Site 1- 100m upstream of Puka-1 wellsite

A moderate community richness of twenty three taxa was found at site 1 (Table 2 and Table 4), five taxa more than the median richness found at similar sites elsewhere in the region (Table 3). The macroinvertebrate community was comprised of a significant proportion of 'moderately sensitive' taxa (52%), which was reflected in the MCI score of 90 units. This MCI score was significantly higher (Stark, 1998) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 3).

The community at this site was characterised by two ‘tolerant’ taxa (extremely abundant snail (*Potamopyrgus*), and sandfly larvae (*Austrosimulum*)); and four ‘moderately sensitive’ taxa (amphipods (*Paracalliope* and *Paraleptamphopidae*) and mayflies (*Astroclima* and *Zephlebia group*)); all of which were very abundant.

The numerical dominance of several ‘moderately sensitive’ taxa and the ‘tolerant’ snail in particular, resulted in a SQMCI_S score of 4.8 units, which was slightly higher (by 0.7 unit) than the median score for ‘control’ sites in similar streams at this altitude (Table 3).

Site 2- 25m downstream of discharge from Puka-1 wellsite

A moderate community richness of twenty taxa was found at site 2 (Table 2 and Table 4), three taxa fewer than found at site 1, and two taxa more than the median richness found at similar sites (Table 3). The macroinvertebrate community was comprised of a significant proportion of ‘moderately sensitive’ taxa (60%), which was reflected in the MCI score of 96 units, and was an insignificant 6 units higher than recorded at the upstream ‘control’ site. This MCI score was significantly higher (Stark, 1998) than the median MCI score for ‘control’ sites in similar streams at comparative altitudes (Table 3).

This community was characterised by three ‘tolerant’ taxa (net-building caddisfly (*Aoteapsyche*), orthoclad midges, and sandfly larvae (*Austrosimulum*)); and three ‘moderately sensitive’ taxa (amphipods (*Paracalliope* and *Paraleptamphopidae*) and mayfly (*Astroclima*)). A significant reduction in the number of ‘tolerant’ snails between sites 1 and 2 was principally responsible for the small increase of 0.5 unit in SQMCI_S score in a downstream direction. This and up to four other significant differences in individual taxa abundances between these adjacent sites were probably related to subtle variations in habitat between sites 1 and 2 (in the absence of any drilling activities at the time of or preceding this survey).

Site 3- 80m downstream of discharge from Puka-1 wellsite

A moderate community richness of twenty taxa was found at site 3 (Table 2 and Table 4), two taxa more than the median richness found at similar sites elsewhere in the region (Table 3). The macroinvertebrate community was again comprised of a significant proportion of ‘moderately sensitive’ taxa (65%), which was reflected in the MCI score of 98 units, the highest score at any of the three sites but not significantly different to scores upstream. This score was a significant 20 units higher (Stark, 1998) than the median MCI score for ‘control’ sites in similar streams at comparative altitudes (Table 3).

This community was characterised by two ‘tolerant’ taxa (snail (*Potamopyrgus*) and sandfly larvae (*Austrosimulum*)); and the moderately sensitive taxa (paraleptamphopid amphipods and mayflies (*Astroclima* and *Zephlebia group*)); not very dissimilar from the characteristic taxa of the two communities upstream at sites 1 and 2. Increased numerical abundances of mayflies and decreased numbers within two ‘tolerant’ taxa in particular resulted in a further downstream increase of 0.4 unit in SQMCI_S score between sites 2 and 3. This SQMCI_S score was 1.6 units higher than the median score for ‘control’ sites in similar streams at this altitude elsewhere the region (TRC, 1999 (updated 2012)).

Summary and Conclusions

The Councils ‘kick-sampling’ and a combination of ‘vegetation sweep’ and ‘kick-sampling’ techniques were used at three sites to collect streambed macroinvertebrates from the Waihapā Stream. This has provided baseline data for any future assessment of skimmer pit discharge

effects from the Puka-1 wellsite on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCIs scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The SQMCIs takes into account taxa abundances as well as sensitivity to pollution. It may indicate subtle changes in communities, and therefore be the more relevant index if non-organic impacts are occurring. Significant differences in either the MCI or the SQMCIs between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

This November 2012 survey of three sites, upstream and downstream of the intended skimmer pit discharge point to land near the stream, was undertaken prior to drilling at the Puka-1 wellsite but following site construction. Taxa richnesses were moderate and within a narrow range for all sites and the macroinvertebrates communities of the stream contained relatively high proportions of 'moderately sensitive' taxa but no significant numbers of 'highly sensitive' taxa. A total of 30 taxa was found through the reach of the stream surveyed, with 14 of these taxa (47%) found at all three sites and 19 taxa (63%) found at any two of these sites. Characteristic taxa were relatively similar between sites with two 'moderately sensitive' taxa and one 'tolerant' taxon abundant at all three sites.

There were no significant differences in MCI scores between sites, despite subtle differences in habitat. These MCI scores indicated that the stream communities were of fair 'health' (TRC, 2013) but slightly better than the biological health recorded at 'control' sites in similar streams at a comparative altitude elsewhere in the region.

A further survey will be conducted following the completion of all drilling and well-testing activities at the Puka-1 wellsite, to determine whether any discharges to land, in the vicinity of the Waihapa Stream, have had effects on the macroinvertebrate communities of this stream.

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