

Kea Petroleum Limited  
Puka A Wellsite  
Monitoring Programme Report  
2014  
Technical Report 2014–58

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## Executive summary

Kea Petroleum Limited previously established a hydrocarbon exploration wellsite located off Hu Road, within the Stratford District, in the Patea catchment. This wellsite was initially established for exploration efforts regarding producing wells Puka A (formally called Puka-1) and Puka-2. The wellsite has since had boundaries extended to accommodate production facilities and new exploration well Puka-3. This report covers exploration activities concerning only the Puka-3 well together with production activities at the Puka A and Puka-2 wells, during the monitoring period July 2014 to September 2014. During this period the Puka-3 well was drilled, plugged and abandoned.

**During the monitoring period, Kea Petroleum demonstrated a high level of environmental performance for the Puka-3 well at the Puka A wellsite.**

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

Kea Petroleum Limited holds six resource consents for the activities at the Puka A wellsite, which include a total of 68 consent conditions setting out the requirements that Kea Petroleum Limited must satisfy. Kea Petroleum Limited holds consent 7983-1 to discharge treated stormwater and production water from hydrocarbon exploration and production operations onto and into land; consent 7984-1 to discharge drilling muds, drilling cuttings and drilling wastes onto and into land via mix-bury-cover (not exercised); consent 7985-1 to discharge emissions to air associated with production activities; consent 7986-1 to discharge emissions to air associated with exploration activities (not exercised); consent 7987-1 to take groundwater; and consent 7988-1 to discharge stormwater and sediment from earthworks during the construction of the Puka A wellsite onto and into land (not exercised).

The Council's monitoring programme for the period under review included seven inspections of the site and surrounding environment, at approximately fortnightly intervals. Six stormwater samples and two surface water samples were obtained for analysis. Analysis showed that all but one of the samples obtained were compliant. A discharge sample obtained on 25 August 2014 returned slightly elevated levels of chloride (53.8 g/m<sup>3</sup>), which is well within the NZ drinking water standard. This elevated chloride result was most likely attributed to the abundance of activity associated with the removal of the drill rig and associated equipment from the wellsite at this time. In addition, as the skimmer pit discharge at the wellsite is directly to land, thus the discharge would have reduced through filtration and as it was a temporary and isolated event, the discharge was therefore unlikely to have had any significant or on-going adverse effect on the receiving environment.

Furthermore, biomonitoring surveys were conducted prior to the commencement of drilling activities, and another following the completion of drilling activities at the Puka A wellsite, which concluded that drilling activities at the Puka A wellsite did not cause any impacts on the macroinvertebrate communities within the Waihapa Stream, as there was no change detected between the pre-drilling and post-drilling biomonitoring surveys performed.

Although gas combustion was anticipated in conjunction with exploration activities regarding the Puka-3 well, no gas combustion occurred as the Puka-3 well was not commercially viable and hence was plugged and abandoned. However, production flaring in association with producing wells Puka A and Puka-2 at the wellsite was frequently observed during routine monitoring inspections, in which no offensive or objectionable odours, smoke or dust associated with activities at the wellsite were observed. The drilling fluids and cuttings were disposed of at a consented off-site facility.

The site was generally neat, tidy and well maintained and site staff were cooperative with requests made by officers of the Council, with any required works completed to a satisfactory standard.

During the monitoring period, Kea Petroleum Limited demonstrated a high level of environmental performance and administrative compliance with the resource consents for the Puka-3 well.

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 July 2014 – September 2014 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Kea Petroleum Limited. During this period the Puka-3 well was drilled, plugged and abandoned.

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

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

### **1.1.2 Structure of this report**

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the RMA and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consent held by Kea Petroleum 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 A wellsite during exploration activities associated with the Puka-3 well.

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 1991* (RMA) primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

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

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Taranaki Regional Council is recognising the comprehensive meaning of 'effects' 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 RMA 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:

**Environmental performance** is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year.

**Administrative performance** is concerned with the Company's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

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

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

### **Environmental Performance**

- **High** No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment. The Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.
- **Good** Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self reports, or in response to unauthorised incident reports, but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and quickly. The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

For example:

- High suspended solid values recorded in discharge samples, however the discharge was to land or to receiving waters that were in high flow at the time;
- Strong odour beyond boundary but no residential properties or other recipient nearby.
- **Improvement required** Likely or actual adverse effects of activities on the receiving environment were more than minor, but not substantial. There were some issues noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent minor non-compliant activity could elevate a minor issue to this level. Abatement notices and infringement notices may have been issued in respect of effects.
- **Poor** Likely or actual adverse effects of activities on the receiving environment were significant. There were some items noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent moderate non-compliant activity could elevate an 'improvement required' issue to this level. Typically there were grounds for either a prosecution or an infringement notice in respect of effects.

### **Administrative compliance**

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

- **Good** Perhaps some administrative requirements of the resource consents were not met at a particular time, however this was addressed without repeated interventions from the Council staff. Alternatively adequate reason was provided for matters such as the no or late provision of information, interpretation of 'best practical option' for avoiding potential effects, etc.
- **Improvement required** Repeated interventions to meet the administrative requirements of the resource consents were made by Council staff. These matters took some time to resolve, or remained unresolved at the end of the period under review. The Council may have issued an abatement notice to attain compliance.
- **Poor** Material failings to meet the administrative requirements of the resource consents. Significant intervention by the Council was required. Typically there were grounds for an infringement notice.

For reference, in the 2013-2014 year, 60% 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 29% demonstrated a good level of environmental performance and compliance with their consents.

## 1.2 Process description

### Site description

Kea Petroleum Limited holds the ten year Petroleum Mining Permit No. 51153 to prospect, explore, and mine for condensate, gas, LPG, oil and petroleum within an area of 84.67 km<sup>2</sup>. The Puka A wellsite is one of many sites within this area that have been established in order to explore, evaluate and produce hydrocarbons.

The Puka A wellsite is located approximately 2 km along Hu Road, approximately 4 km from Rawhitiroa, as per Figure 1. The Puka A wellsite was initially established for exploration efforts regarding producing wells Puka A and Puka-2. The wellsite has since had boundaries extended to accommodate production facilities and new exploration well Puka-3. The initial establishment of the wellsite involved the removal of topsoil to create a firm level foundation on which to erect a drilling rig and house associated equipment. Site establishment also involved the installation of:

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

The nearest residence is approximately 1.27 km away from the wellsite. Bunding, earthworks and good site location helped minimise any potential for off-site effects for the neighbours.



**Figure 1** Aerial view depicting the locality of the Puka A wellsite, with approximate regional location (inset)

### Well development

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

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

- As a safety measure to ensure that any 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 A wellsite is located approximately 95 m to the west of the nearest waterbody which is the Waihapa Stream.

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

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

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

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].

## 1.3 Resource consents

### 1.3.1 Background

Kea Petroleum Limited holds six resource consents related to exploration activities at the Puka A wellsite site, as follows:

- Discharge Permit 7983-1; granted 20 September 2012,
- Discharge Permit 7984-1; granted 1 February 2012,
- Discharge Permit 7985-1; granted 1 February 2012,
- Discharge Permit 7986-1; granted 1 February 2012,
- Water Permit 7987-1; granted 1 February 2012, and
- Discharge Permit 7988-1; granted 1 February 2012.

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

Copies of the consents can be found within Appendix I of this report.

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

Section 15(1)(a) of the *Resource Management Act 1991* (RMA) stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations.

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 1.2 above, is necessary to avoid/remedy any adverse effects on water quality.

Kea Petroleum Limited holds water discharge permit 7983-1 to discharge treated stormwater and production operations at the Puka A wellsite onto and into land.

This permit was issued by the Council on 20 September 2012 under Section 87(e) of the RMA. It is due to expire on 1 June 2028.

Consent conditions were imposed on Kea Petroleum Limited to ensure that adverse effects were avoided in the first instance. A summary of conditions can be viewed in Table 3, Section 3.3.

### 1.3.3 Land discharge permit (mix-bury-cover)

Sections 15(1)(b) and (d) of the *Resource Management Act 1991* (RMA) stipulates 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 contaminants associated with mix-bury cover, onto and into land where contaminants may reach water, is a discretionary activity under Rule 44 of the RFWP.

Kea Petroleum Limited holds discharge permit 7984-1 to discharge drilling muds, drilling cuttings and drilling wastes from the Puka A wellsite onto and into land via mix-bury-cover.

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

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

### 1.3.4 Air discharge permit (production activities)

Section 15(1)(c) of the *Resource Management Act 1991* (RMA) stipulates that no person may discharge any contaminant from any industrial or trade premises into air, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

The Council determined that the application to discharge emissions to air associated with the production activities at the Puka A 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 Petroleum Limited holds air discharge permit 7985-1 to discharge emissions to air associated with production activities at the Puka A wellsite, including flaring from well workovers; flaring in emergency situations; and emissions from other miscellaneous activities.

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

Consent conditions were imposed on Kea Petroleum 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.



### 1.3.5 Air discharge permit (exploration activities)

Section 15(1)(c) of the *Resource Management Act 1991* (RMA) stipulates that no person may discharge any contaminant from any industrial or trade premises into air, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

The Council determined that the application to discharge emissions to air associated with the exploration activities at the Puka A 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 steam.*

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 Petroleum Limited holds air discharge permit 7986-1 to discharge emissions to air associated with exploration activities at the Puka A wellsite, including flaring of hydrocarbons associated with well clean-up and well testing; and emissions from other miscellaneous activities.

This permit was issued by the Council on 29 October 2012 under Section 87(e) of the RMA. It is due to expire on 1 June 2028.

Consent conditions were imposed on Kea Petroleum 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.

### 1.3.6 Water abstraction permit (groundwater)

Section 14 of the *Resource Management Act 1991* (RMA) 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 (RFP) 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.*

Any produced water will be from reserves far below that which is used for domestic or farm purposes. Shallow groundwater (which does not have any saltwater content) was 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.

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

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

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

### **1.3.7 Water discharge permit (stormwater and sediment – earthworks)**

Section 15(1)(a) of the *Resource Management Act 1991* (RMA) stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations.

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 Petroleum 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 Petroleum Limited holds water discharge permit 7988-1 to discharge stormwater and sediment from earthworks during the construction of the Puka Awellsite onto and into land.

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

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

## **1.4 Monitoring programme**

### **1.4.1 Introduction**

Section 35 of the *Resource Management Act 1991* (RMA) 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 (hydraulic fracturing and deep well injection); and
- Biomonitoring surveys.

The monitoring programme for the Puka A wellsite focused primarily on programme liaison and management, site inspections, physicochemical sampling, biomonitoring surveys and discharges to land. 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 is a 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 sumps, 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;
- Gas combustion systems, 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 sites upstream and downstream of the discharge point to ensure that resource consent special conditions are complied with and to determine whether site activities were causing any adverse effects within the receiving environment.

#### **1.4.5 Solid wastes**

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

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

#### **1.4.6 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 that plant equipment is working effectively, that there is the provision of liquid and solid separation, and that on site staff have regard to wind direction and speed at the time of flaring.

It is also a requirement that the Council and immediate land owners are notified prior to any gas being flared when practicable. This requirement was checked to ensure compliance with consent conditions and to determine whether site activities were causing any adverse effects within the receiving environment.

#### **1.4.7 Discharges to land (hydraulic fracturing)**

If hydraulic fracturing activities are undertaken at site, sampling and analysis of the hydraulic fracturing, return flow fluids and nearby bores are carried out. These

inspections of the site and surrounding land and water are carried out to ensure that no observable effects have occurred as a result of the discharge to land. Pre and post hydraulic fracturing reports are submitted by the consent holder detailing among other things, the effectiveness of the mitigation measures put in place to protect the environment.

#### **1.4.8 Biomonitoring surveys**

Biomonitoring surveys in any nearby streams may be carried out pre and post occupation of the wellsite 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 A wellsite, adjacent land and streams were inspected seven times during this monitoring period. Below is a copy of the comments that were noted on the day of each inspection.

##### **2 July 2014**

Site inspection was conducted following heavy rainfall, hail and a period of cold weather. The site was set up on two levels with exploration associated activities occurring on the upper platform, and production associated activities and equipment housed on the lower platform. The ring drains and bunds appeared secure. Production flaring was underway with a vigorous flare apparent, but was observed to be burning cleanly and with no smoke or odours. The site was being set up to accommodate the new well (Puka-3). Some modifications and relocations to the structure of pipelines and processing equipment were being undertaken.

##### **7 July 2014**

Inspection found that both Puka A and Puka-2 wells were in production. The product was stored in tanks on-site prior to removal via road tankers. The site was found to be in a clean and tidy order. Ring drains were inspected and found to be working well directing all stormwater through the skimmer pit treatment system prior to discharge onto nearby pasture. Iron oxide was present within the ring drains and skimmer pits, however the discharge appeared to be visually clear. A sample was obtained of the discharge from the skimmer pits to ensure compliance with resource consent conditions. The conductor for the Puka-3 well had been drilled and cased to an approximate depth of 30 m. Works were undertaken by contractors. The drilling of the Puka-3 well was expected to commence in mid August 2014. No pad extensions or significant earthworks were anticipated for the site in relation to the pending drilling campaign. Flaring was occurring at the time of inspection. The flare pit was visually inspected and found to be free of any solid or liquid contaminants. No smoke was being emitted as a result of the flaring activities.

##### **31 July 2014**

At the time of inspection the rig was on-site carrying out a scraper run. Drilling had reached approximately 800 m. Wells Puka A and Puka-2 were still in production with crude being loaded out every second day. Flaring was occurring with a light grey smoke being emitted but was quick to dissipate into the receiving environment. Sawdust was being stored on-site which was applied to any spills. Contaminated gravel was removed and disposed of off-site with cuttings. Skimmer pits were inspected and found to be discharging. A sample was obtained of the discharge. In addition samples were obtained upstream and downstream of the discharge location to ensure compliance with consent conditions.

##### **6 August 2014**

Inspection found that the rig was established on-site and drilling was continuing. Casing and cementing of the top hole was completed and drilling was continuing at a depth of 1,200 metres. All drill cuttings were being removed and disposed of at a consented off-site facility. Wells Puka A and Puka-2 were both producing at the time

of inspection and associated flaring was occurring within the flare pit. The flare was clean burning with no smoke observed. Fresh water was being obtained from the nearby swiftly flowing stream. Personnel on-site were well aware of the permitted activity rule regarding water takes and were keeping daily records on-site recording the volumes of water abstracted. Sawdust was being used on-site to soak up any small spills. The sawdust and any contaminated gravel was then scraped off and disposed of along with the drill cuttings. Inspection was undertaken during a period of heavy rain. As the skimmer pits had been sucked out, no discharge was occurring. However, a sample was obtained from the second skimmer pit to ensure compliance with consent conditions in anticipation of potential discharges. Site staff were advised to monitor the turbidity of the skimmer pits. In addition, sediment control measures may have been required within the ring drains to aid this and ensure compliance with resource consent conditions.

### **13 August 2014**

At the time of inspection the rig remained on-site and drilling of the Puka-3 well was continuing. At time of inspection drilling was continuing past 2,200 metres. The ring drains were in place about the site and appeared to be in a reasonable order directing all stormwater to the skimmer pits for treatment prior to discharge. Site staff were advised to inspect the short portion of piped ring drain located under the access path to the flare pit. The ends of the pipe appeared to be blocked with earth, meaning that there was a slight degree of ponding on the upper side of this area. The area about the cuttings tanks were in reasonable order with sawdust being placed about the area to soak up any spills. Site staff were also advised that once the sawdust had been used to soak up a spill, to scrape the sawdust off the pad and dispose of it in the appropriate manner to prevent any chemicals remaining within the muds from leaching to the skimmer pits. The flare pit was in operation at the time of inspection. No smoke was observed being emitted as a result of the flaring. Skimmer pits were inspected and found to be discharging at the time of inspection. A sample was obtained of the discharge to ensure compliance with resource consent conditions. The discharge was directed into the neighbouring paddock where it was soaking into the ground. No overland flow to surface water was observed during the inspection.

### **25 August 2014**

Inspection found that the drilling of the Puka-3 well on-site had been completed, plugged and abandoned. The rig had been dis-assembled and removed from site. The site was to be cleaned down and re-contoured in the coming days. The ring drain near the flare pit was also to be addressed to ensure that there was a flow within the ring drain. The site was in a clean and tidy order at the time of inspection with all chemicals associated with the drilling programme removed from site. The skimmer pits were inspected and found to be discharging at the time of the inspection. A sample of the discharge was obtained to ensure compliance with resource consent conditions. The stream near the wellsite was visually inspected and found to be running clean and clean.

### **15 September 2014**

Inspection found that the drilling rig had been totally removed from the wellsite. The site pad had been scraped back with new metal brought onto site. At time of inspection both Puka A and Puka-2 wells were in production and associated production flaring was taking place at the wellsite. The flare was clean burning with no smoke being emitted. Work had been undertaken on the ring drains to ensure that



they were flowing towards the skimmer pit treatment system. The skimmer pits were inspected and found to be clean, clear and discharging. A sample was obtained of the discharge to ensure compliance with resource consent conditions.

### 2.1.2 Results of discharge monitoring

During the period under review, a total of six stormwater samples were obtained for analysis. Stormwater was observed discharging from the wellsite skimmer pits on five occasions and five samples were obtained in relation to this. In addition, one sample was obtained from the second skimmer pit to ensure compliance with consent conditions in anticipation of potential discharges.

Analysis of the samples obtained showed that all but one of the samples were compliant or would have compliant with resource consent conditions should a discharge have occurred. Results are detailed in Table 1.

**Table 1** Results of stormwater samples obtained from the Puka A wellsite during the monitoring period under review

Date	Chloride <i>g/m<sup>3</sup></i>	Hydrocarbons <i>g/m<sup>3</sup></i>	pH <i>pH</i>	Suspended Solids <i>g/m<sup>3</sup></i>	Sampling location
07 Jul 2014	26.4	<0.5	7.0	7	Discharge
31 Jul 2014	24.9	<0.5	7.2	15	Discharge
06 Aug 2014	29.8	0.6	6.6	120	Second skimmer pit
13 Aug 2014	40.0	<0.5	6.6	32	Discharge
25 Aug 2014	53.8	<0.5	7.0	9	Discharge
15 Sep 2014	32.8	<0.5	7.0	30	Discharge

A sample obtained on 6 August 2014 returned elevated levels of suspended solids (120 g/m<sup>3</sup>). Although this value exceeds condition 5 (100 g/m<sup>3</sup>) of consent 7983-1 for discharge, no actual non-compliance occurred as this samples was obtained from the skimmer pits to ensure compliance with consent conditions in anticipation of potential discharges. Therefore, no discharges containing elevated levels of suspended solids were released from the skimmer pits into the receiving environment.

The discharge sample obtained on 25 August 2014 returned slightly elevated levels of chloride (53.8 g/m<sup>3</sup>), which exceeds condition 5 (50 g/m<sup>3</sup>) of consent 7983-1. This exceedence was most likely attributed to the abundance of activity associated with the removal of the drill rig and associated equipment from the wellsite at this time. In addition, as the skimmer pit discharge at the Puka A wellsite is directly to land, thus the discharge would have reduced through filtration and as it was a temporary and isolated event, the discharge was therefore unlikely to have had any significant or on-going adverse effect on the receiving environment. For reference, it may be noted that the NZ drinking water standard for chloride is 250g/m<sup>3</sup>. Furthermore, no further exceedences were detected in samples.

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

### 2.1.3 Results of receiving environment monitoring

During the period under review, two samples were obtained in conjunction with the stormwater discharge on 31 July 2014 from the Waihapa Stream to ensure that stormwater discharges were not entering surface water bodies and thus not having and adverse effect on the receiving stream environment. Of the stream samples obtained, no exceedences were recorded in relation to consent 7983-1. Results are detailed in Table 2 and sampling locations can be seen in Figure 2.

**Table 2** Results of samples obtained from the Waihapa Stream on 31 July 2014

Chloride <i>g/m<sup>3</sup></i>	Hydrocarbons <i>g/m<sup>3</sup></i>	pH <i>pH</i>	Suspended Solids <i>g/m<sup>3</sup></i>	Sampling location
16.8	<0.5	7.0	10	Upstream of discharge
16.2	<0.5	7.1	11	Downstream of discharge



**Figure 2** Stormwater and surface water sampling locations at the Puka A wellsite

The receiving surface water body was inspected regularly in conjunction with site inspections. No effects were observed and the stream appeared clear with no visual change in colour or clarity. In addition, no odour, oil, grease films, scum, foam or suspended solids were observed in the stream as a result of activities at the Puka A wellsite during the monitoring period.

## 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 for comments concerning site inspections.

## **2.2.2 Results of discharge monitoring**

Although gas combustion was anticipated in conjunction with exploration activities regarding the Puka-3 well, no gas combustion occurred as the Puka-3 well was not commercially viable and hence plugged and abandoned.

However, production flaring in association with producing wells Puka A and Puka-2 at the wellsite was frequently observed during routine monitoring inspections, in which no offensive or objectionable odours, smoke or dust associated with activities at the Puka A wellsite were observed.

It appeared that Kea Petroleum 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. It appeared that special conditions relating to the control of emissions to air from the combustion of hydrocarbons were largely complied with.

## **2.2.3 Results of receiving environment monitoring**

No chemical monitoring of air quality was undertaken during the monitoring period under review at the Puka A wellsite as gas combustion activities in association with exploration activities did not occur. In addition, control implemented by Kea Petroleum Limited did not give rise to any concerns with regard to air quality.

## **2.2.4 Other ambient monitoring**

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

## **2.3 Land**

### **2.3.1 Inspections**

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

### **2.3.2 Results of discharge and receiving environment monitoring**

Consent 7988-1 to discharge stormwater and sediment from earthworks during the construction of the Puka A wellsite onto and into land was not exercised during the period under review, as the wellsite had already been established for previous exploration efforts regarding wells Puka A and Puka-2 and site upgrades to accommodate the production facilities were completed during the previous monitoring period.

### **2.3.3 Results of discharge and receiving environment monitoring (mix-bury-cover)**

Consent 7984-1 to discharge drilling muds, drilling cuttings and drilling wastes from the Puka A wellsite onto and into land via mix-bury-cover was not exercised during the monitoring period under review. Drilling muds, drilling cuttings and drilling wastes were disposed of at a consented off-site facility.

#### **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 as the site was still in use.

## **2.4 Biomonitoring surveys**

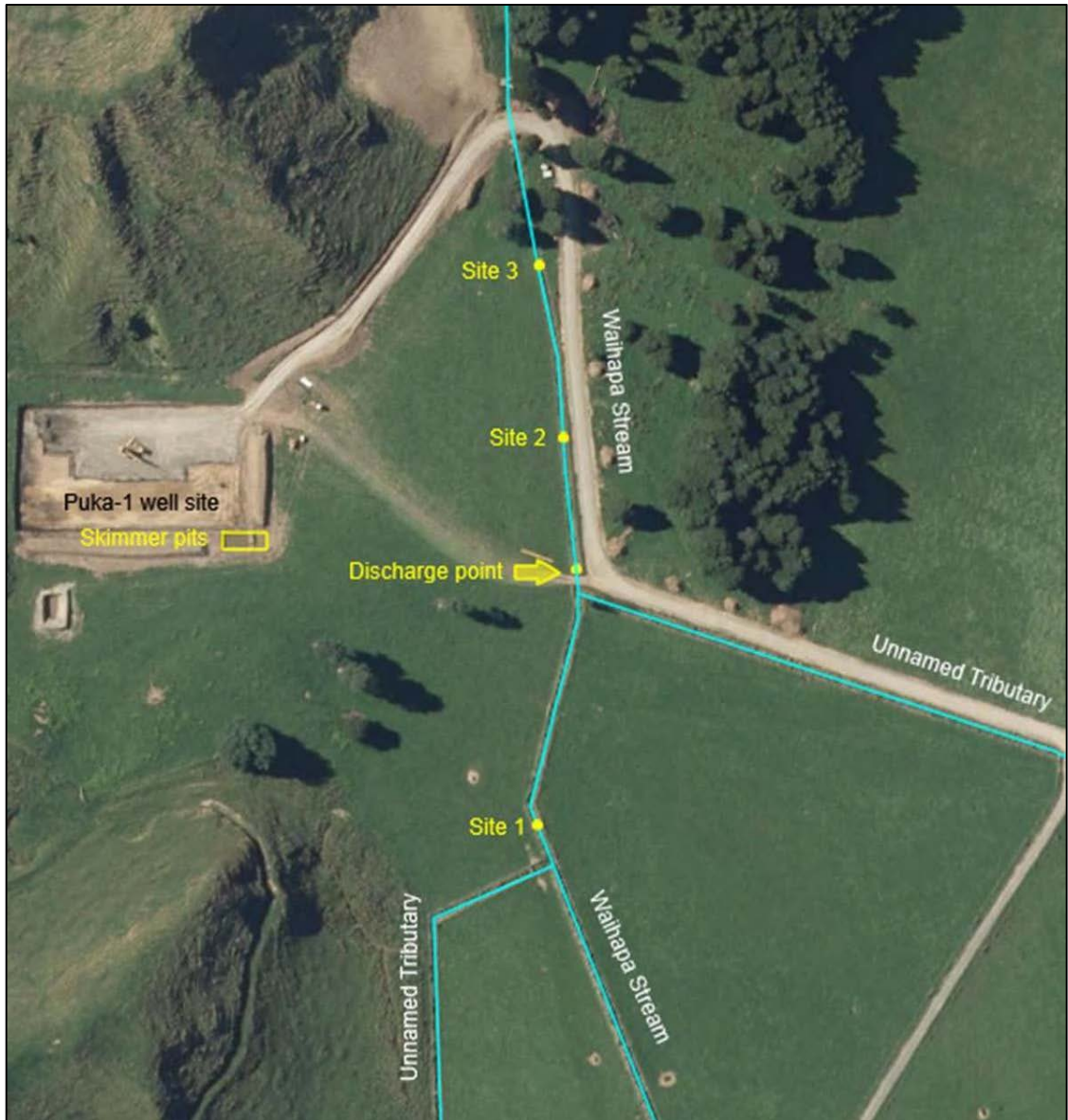
Biomonitoring surveys were performed prior to the commencement of drilling activities on 26 May 2013, and another following the completion of drilling activities on 16 September 2014 at the Puka A wellsite to determine whether or not consented discharges of treated stormwater and production water from hydrocarbon exploration and production operations at the Puka A wellsite onto and into land have had a detrimental effect upon the macroinvertebrate communities of this stream.

Both the pre and post drilling biomonitoring surveys were undertaken at three established sites; 100 m upstream of the Puka A wellsite (site 1), 25 m downstream of the discharge from the Puka A wellsite (site 2) and 80 m downstream of the discharge point (site 3), as seen in Figure 3.

The Council's 'vegetation sweep' sampling technique was used at the three sites to collect streambed macroinvertebrates from the Waihapa Stream. This has provided baseline data for any future assessment of consented discharge effects from the Puka A wellsite on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCI<sub>s</sub> 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<sub>s</sub> 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<sub>s</sub> between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

Summaries of each biomonitoring survey are as follows. A complete copy of the biomonitoring surveys can be found within Appendix II of this report.



**Figure 3** Biomonitors sites in the Waihapa Stream in relation to the Puka A wellsite

### 26 May 2013

This May 2013 survey of three sites, upstream and downstream of the skimmer pit discharge point to land near the stream, was undertaken at the Puka A wellsite. Taxa richnesses 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. 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.

### **16 September 2014**

This September 2014 survey of three sites, upstream and downstream of the skimmer pit discharge point to land near the stream, was undertaken following drilling of the Puka-3 well. Taxa richness 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 23 taxa was found through the reach of the stream surveyed, with seven of these taxa (30 %) found at all three sites and seven taxa (30 %), found at any two of these sites. One 'highly sensitive' taxon was recorded as 'common' at the two sites downstream of the discharge, compared with none upstream.

A comparison of the current survey results with the Puka A pre-drill and post-drill survey results showed no significant variation in SQMCI<sub>s</sub> scores between surveys at all three sites. Only one significant variation in MCI score was recorded which was between the post-drill Puka A survey and the current survey, at site 1. Slight variations in MCI and SQMCI<sub>s</sub> score and taxa richness between sites and surveys is considered to be due to habitat variability rather than a change in water quality.

The MCI scores recorded in this survey indicated that the stream communities were of fair 'health' (TRC, 2013), but 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-3 wellsite has impacted on the biological communities of the Waihapa Stream.

## **2.5 Contingency plan**

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

## **2.6 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 monitoring period under review, the Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with Kea Petroleum Limited's conditions in resource consents or provisions in Regional Plans.

Any minor actual or potential non-compliance with consent conditions were addressed during site inspections. Kea Petroleum Limited staff would quickly take steps to ensure that requests made by Council Inspecting Officers were adhered to.



## **3. Discussion**

### **3.1 Discussion of consent exercise**

Of the six resource consent relating to the Puka A wellsite, consents 7983-1 (to discharge treated stormwater and production water from hydrocarbon exploration and production operations onto and into land), 7985-1 (to discharge emissions to air associated with production activities), and 7987-1 (to take groundwater) were exercised and actively monitored.

The remaining three consents 7984-1 (to discharge drilling muds, drilling cuttings and drilling wastes onto and into land via mix-bury-cover), 7986-1 (to discharge emissions to air associated with exploration activities), and 7988-1 (to discharge stormwater and sediment from earthworks during the construction of the wellsite) were not exercised by Kea Petroleum Limited at the Puka A wellsite 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 in-stream flora and fauna. To mitigate these effects, Kea Petroleum 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 well 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 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 Petroleum 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 if required.

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 site<sup>1</sup>. More recently two studies have focused on field investigations and modelling of emissions from flares involving fracturing fluids.<sup>2</sup>

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 PM<sub>10</sub> found compliance with national standards even in close proximity to the flare. Beyond 120 m from the flare pit, concentrations of polyaromatic 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 any concentrations at which there is any basis for concern over potential health effects.

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

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

<sup>2</sup> Taranaki 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.



- 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 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 are kept by Kea Petroleum Limited and provided to the Council;
- Every endeavor was made by Kea Petroleum 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 Petroleum 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 Petroleum Limited was required to implement the following mitigation measures:

- All potentially hazardous material were used and stored in accordance with the relevant Hazardous Substances and New Organisms regulations;
- All areas containing hazardous chemicals were bunded;
- 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 significant adverse environmental effects observed to water, land or air as a result of the wellsite activities during the monitoring period. The two exceedances of the treated stormwater discharge consent were of no environmental consequence or effect.

### 3.3 Evaluation of performance

A tabular summary of Kea Petroleum Limited's compliance record for the period under review is set out in Tables 3 to 8.

**Table 3** Summary of performance for consent 7983-1 to discharge treated stormwater and production water from hydrocarbon exploration and production operations at the Puka A wellsite onto and into land

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Inspection of site, procedures & processes	Yes
2. 7 days written notice provided to the Council prior to any site works commencing	Notification received	Yes
3. Maximum stormwater catchment area shall be no more than 9000 m <sup>2</sup>	Plans, procedures and processes	Yes
4. All stormwater and produced water shall be directed for treatment through the skimmer pit system prior to discharge. All stormwater pits shall have impermeable side walls and floor.	Inspection	Yes
5. Constituents in discharges shall meet the following standards: a) pH 6.0 – 9.0 b) Suspended solids <100 g/m <sup>3</sup> c) Hydrocarbon <15 g/m <sup>3</sup> d) Chloride 50 g/m <sup>3</sup>	Physicochemical sampling	<b>Mostly</b> – one slightly elevated chloride level
6. The discharge shall have a chloride concentration of no greater than 50 ppm	Physicochemical sampling	<b>No</b> – one slightly elevated chloride level
7. Council to approve prepared contingency plan in relation to the wellsite prior to exercise of consent	Contingency plan approved	Yes
8. The Council shall be advised in writing 48 hrs prior to reinstatement of the site	Notification	N/A
9. Consent shall lapse if not implemented	Exercise of consent confirmed by inspection	N/A
10. 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		<b>High</b>
Overall assessment of administrative performance in respect of this consent		<b>High</b>

**Table 4** Summary of performance for consent 7984-1 to discharge drilling muds, drilling cuttings and drilling wastes from the Puka A wellsite onto and into land via mix-bury-cover

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Inspection, procedures and processes	N/A
2. The Council to be notified 48hrs prior to each mix-bury-cover discharge, including volumes and quantities of material to be discharged	Notification received	N/A
3. Volume of solid drilling wastes discharged shall not exceed 1500 m <sup>3</sup> per well from up to 3 wells	Inspection, procedures and processes	N/A
4. Discharge areas for waste from individual wells are to be kept separate and distinct	Inspection of company records	N/A
5. As far as practicable, all fluids shall be removed from the drilling wastes	Inspection, procedures and processes	N/A
6. All sumps are to be permeable	Inspection	N/A
7. Drilling waste to be mixed with uncontaminated soil	Sampling soil prior to mixing	N/A
8. The mixture of solid drilling wastes and uncontaminated soil shall be covered by at least one metre of uncontaminated soil	Inspection, procedures and processes	N/A
9. Each mix-bury-cover discharge shall be re-vegetated and maintained with pasture cover	Inspection	N/A
10. The cover material is to be compacted and contoured so that stormwater is directed away from the mix-bury-cover site	Inspection	N/A
11. Mix-bury-cover discharge sites are to be as far above the groundwater table as practicable	Inspection	N/A
12. Mix-bury-cover discharge sites must be 30m from any water body, spring or bore	Inspection	N/A
13. 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
14. Chloride levels in each mix-bury-cover shall not exceed 1,600kg	Physicochemical sampling	N/A
15. Nitrogen levels in each mix-bury-cover shall not exceed 400kg	Physicochemical sampling	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
16. The hydrocarbon content of solid drilling waste shall not exceed 1000 mg/kg	Physicochemical sampling	N/A
17. Various parameters in the soil covering the mix-bury-cover to be below agreed limits	Physicochemical sampling	N/A
18. Various metals in the soil covering the mix-bury-cover to be below agreed limits	Physicochemical sampling	N/A
19. Hydrocarbon concentrations in the soil covering the mix-bury-cover shall comply with agreed guideline values	Physicochemical sampling	N/A
20. Level of salts in surface & ground water not to exceed 2,500g/m <sup>3</sup>	Physicochemical sampling	N/A
21. Consent shall lapse if not implemented by date specified	Exercise of consent confirmed by inspection	N/A
22. 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		N/A – consent not exercised

**Table 5** Summary of performance for consent 7985-1 to discharge emissions to air associated with production activities at the Puka A wellsite, including flaring from well workovers, flaring in emergency situations and emissions from other miscellaneous activities

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. 24hrs notice of flaring to the Council (other than purge gas) when flaring is longer than 5 minutes in duration	Inspection	Yes
2. Liquid and solid separation to occur before flaring	Inspection of flare pit	Yes
3. Only substances originating from the well stream shall be combusted within the flare pit	Inspection	Yes
4. Best practicable option to be adopted	Inspections, procedures and processes	Yes
5. No offensive or objectionable odour or smoke at or beyond the boundary	Inspection	Yes
6. All permanent tanks used as hydrocarbon storage vessels fitted with vapour recovery systems	Inspection	Yes
7. Consent holder shall control all emissions of carbon monoxide, nitrogen dioxide, fine particles and sulphur dioxide to the atmosphere	Inspection of company records	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
8. Consent holder shall control all emissions to the atmosphere from the site of contaminants other than those expressly provided for under condition 7	Inspection of company records	Yes
9. Analysis of typical gas and condensate stream from field to be made available to the Council	Not requested	N/A
10. The consent holder shall record and make available to the Council a flaring log	Inspection of company records	Yes
11. Consent shall lapse if not implemented	Confirmed by inspection	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
Overall assessment of administrative performance in respect of this consent		High

**Table 6** Summary of performance for consent 7986-1 to discharge emissions to air associated with exploration activities at the Puka A wellsite including flaring of hydrocarbons associated with well clean-up and well testing, and emissions from other miscellaneous activities

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent shall not be exercised for more than 45 days per zone for each well, for up to six wells	Inspection of records	N/A
2. Council must be notified 24hrs prior to initial flaring of each zone	Notification	N/A
3. Liquid and solid separation to occur before flaring	Inspection of flare pit	N/A
4. Only substances originating from the well stream shall be combusted within the flare pit	Inspection	N/A
5. Best practicable option to be adopted	Inspections, procedures and processes	N/A
6. No offensive or objectionable odour or smoke at or beyond the boundary	Inspection	N/A
7. Consent holder shall control all emissions of carbon monoxide, nitrogen dioxide, fine particles and sulphur dioxide to the atmosphere	Inspection of company records	N/A
8. Consent holder shall control all emissions to the atmosphere from the site of contaminants other than those expressly provided for under condition 7	Inspection of company records	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	Not requested	N/A
10. All permanent tanks used as hydrocarbon storage vessels fitted with vapour recovery systems	Inspection	N/A
11. The consent holder shall record and make available to the Council a flaring log	Inspection of company records	N/A
12. Consent shall lapse if not implemented	Consent exercised	N/A
13. 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		N/A – consent not exercised

**Table 7** Summary of performance for consent 7987-1 to take groundwater that may be encountered during exploration and production operations at the Puka A wellsite

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	No complaints received	Yes
2. The abstraction does not cause the intrusion of salt water into any freshwater aquifer	No complaints received	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	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
Overall assessment of administrative performance in respect of this consent		High

**Table 8** Summary of performance for consent 7988-1 to discharge stormwater and sediment from earthworks during the construction of the Puka A wellsite onto and into land

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Best practicable option to be adopted	Inspections, procedures and processes	N/A
2. 7 days written notice prior to site earthworks commencing	Notification	N/A
3. Consent holder shall notify the Council following the completion of the construction of the wellsite	Notification	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
4. Runoff derived from exposed soil shall pass through settlement ponds or traps	Inspection	N/A
5. Condition 4 will cease to apply and erosion and sediment control measures removed only when the site is stabilised	Inspection	N/A
6. All earth worked areas shall be stabilised as soon as practicable	Inspection	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		N/A – consent not exercised

During the monitoring period, Kea Petroleum Limited demonstrated a high level of environmental performance and administrative compliance with the resource consents. The site was generally neat, tidy, and well maintained. Two exceedances of a discharge consent had no environmental consequence.

### 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 provisions for review are in 2016 and 2017.

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 Alterations to monitoring programmes

In designing and implementing the monitoring programmes for air and water discharges and water abstractions at wellsites 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 wellsite processes within Taranaki.

The Council has routinely monitored wellsite activities for more than 20 years in the region. This work has included in the order of hundreds of water samples and biomonitoring surveys in the vicinity of wellsites, 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 wellsite and associated activities. Furthermore, with regard to hydraulic fracturing activities, baseline groundwater monitoring samples have demonstrated that hydraulic

fracturing discharges have not given rise to any significant adverse effects on groundwater aquifers within the region. However, 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.

In addition, the Council has also noted a desire by some community areas or individuals for a heightened level of information feedback and certainty around the results and outcomes of monitoring at wellsites. The Council has therefore moved to extend the previous regime, to make the sampling and extensive analysis of groundwater and surface waters in the general vicinity of a wellsite where hydraulic fracturing occurs, and biomonitoring of surface water ecosystems, an integral part of the basic monitoring programme for such activities.

Therefore, it is proposed that for any further work at the Puka A wellsite, the new standard programme will continue to be repeated, notwithstanding the lack of any effects or concerns previously found. A recommendation to this effect is attached to this report.



## 4. Recommendations

1. THAT this report be forwarded to the Company, and to any interested parties upon request;
2. THAT the monitoring of future consented activities at Puka A wellsite continue to include biomonitoring surveys;
3. THAT the monitoring of future consented activities include sampling and extensive analysis of both groundwater and surface waters in the general vicinity of the wellsite if hydraulic fracturing is to commence at the Puka A wellsite;
4. THAT, subject to the findings of monitoring of any further activities at the Puka A wellsite consents 7983-1, 7984-1, 7985-1, 7986-1, 7987-1 and 7988-1 shall not be reviewed in 2016 and 2017.

## 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.
E.coli	Escherichia coli, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample.
F	Fluoride.
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
g/m <sup>3</sup>	Grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.
Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.

l/s	Litres per second.
MCI	Macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats.
mS/m	Millisiemens per metre.
Mixing zone	The zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
NH <sub>4</sub>	Ammonium, normally expressed in terms of the mass of nitrogen (N).
NH <sub>3</sub>	Unionised ammonia, normally expressed in terms of the mass of nitrogen (N).
NO <sub>3</sub>	Nitrate, normally expressed in terms of the mass of nitrogen (N).
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
O&G	Oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons).
Pb*	Lead.
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	Measurement of both physical properties(e.g. temperature, clarity, density) and chemical determinants ( e.g. metals and nutrients) to characterise the state of an environment.
PM <sub>10</sub>	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                              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](mailto:worknotification@trc.govt.nz).
3. Stormwater discharged shall be collected from a catchment area of no more than 9000 m<sup>2</sup>.
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.

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

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](mailto: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

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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](mailto: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 m<sup>3</sup> 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.

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 <sup>-1</sup>
total dissolved salts	2500 mg kg <sup>-1</sup>
sodium	460 mg kg <sup>-1</sup>
chloride	700 mg kg <sup>-1</sup>

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:

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

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<sup>-3</sup>.
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

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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* <sup>(1,3,6)</sup> ALL PATHWAYS**  
(all values mg/kg)

Soil Type/ Contaminant	Depth of contamination		
	Surface (<1m)	1m - 4m	> 4m
<b>SAND</b>			
MAHs			
Benzene	1.1 <sup>(v)</sup>	1.9 <sup>(7,v)</sup>	2.4 <sup>(7,v)</sup>
Toluene	(68) <sup>(4,v)</sup>	(94) <sup>(4,m)</sup>	(230) <sup>(4,v)</sup>
Ethylbenzene	(53) <sup>(4,v)</sup>	(92) <sup>(4,7,v)</sup>	(120) <sup>(4,v)</sup>
Xylenes	(48) <sup>(4,v)</sup>	(130) <sup>(4,7,v)</sup>	(180) <sup>(4,v)</sup>
PAHs			
Naphthalene	7.2 <sup>(p)</sup>	70 <sup>(v)</sup>	80 <sup>(v)</sup>
Non-carc. (Pyrene)	(160) <sup>(4,p)</sup>	NA <sup>(2)</sup>	NA <sup>(2)</sup>
Benzo(a)pyrene eq. <sup>(5)</sup>	0.027 <sup>(p)</sup>	(25) <sup>(4,m)</sup>	NA <sup>(2)</sup>
<b>SANDY SILT</b>			
MAHs			
Benzene	1.1 <sup>(v)</sup>	1.9 <sup>(v)</sup>	2.4 <sup>(v)</sup>
Toluene	(82) <sup>(4,v)</sup>	(170) <sup>(4,v)</sup>	(240) <sup>(4,v)</sup>
Ethylbenzene	(59) <sup>(4,v)</sup>	(92) <sup>(4,v)</sup>	(140) <sup>(4,v)</sup>
Xylenes	(59) <sup>(4,v)</sup>	(130) <sup>(4,v)</sup>	(180) <sup>(4,v)</sup>
PAHs			
Naphthalene	7.2 <sup>(p)</sup>	83 <sup>(v)</sup>	(130) <sup>(4,v)</sup>
Non-carc. (Pyrene)	(160) <sup>(4,p)</sup>	NA <sup>(2)</sup>	NA <sup>(2)</sup>
Benzo(a)pyrene eq. <sup>(5)</sup>	0.027 <sup>(p)</sup>	(25) <sup>(4,m)</sup>	NA <sup>(2)</sup>
<b>SILTY CLAY</b>			
MAHs			
Benzene	1.7 <sup>(v)</sup>	4.6 <sup>(v)</sup>	12 <sup>(v)</sup>
Toluene	(210) <sup>(4,v)</sup>	(950) <sup>(4,v)</sup>	(3,000) <sup>(4,v)</sup>
Ethylbenzene	(110) <sup>(4,v)</sup>	(800) <sup>(4,v)</sup>	(2,800) <sup>(4,v)</sup>
Xylenes	(160) <sup>(4,v)</sup>	(710) <sup>(4,v)</sup>	(2,200) <sup>(4,v)</sup>
PAHs			
Naphthalene	7.2 <sup>(p)</sup>	(330) <sup>(4,v)</sup>	(1,100) <sup>(4,v)</sup>
Non-carc. (Pyrene)	(160) <sup>(4,p)</sup>	NA <sup>(2)</sup>	NA <sup>(2)</sup>
Benzo(a)pyrene eq. <sup>(5)</sup>	0.027 <sup>(p)</sup>	(25) <sup>(4,m)</sup>	NA <sup>(2)</sup>

NOTES:

- 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.
- NA indicates contaminant not limiting as estimated health-based criterion is significantly higher than that likely to be encountered on site.
- 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.
- Brackets denote values exceed threshold likely to correspond to formation of residual separate phase hydrocarbons. For further explanation refer to Appendix 4M.
- 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.
- The following notes indicate the limiting pathway for each criterion: v - Volatilisation, s - Soil Ingestion, d - Dermal, p - Produce, m - Maintenance/Excavation
- 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* <sup>(1,3,6)</sup> ALL PATHWAYS**  
**(all values mg/kg)**

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

## 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<sup>(1,3,5,6)</sup> Agricultural use ALL PATHWAYS**  
(all values in mg/kg)

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

## NOTES:

- Criteria for C<sub>10</sub> - C<sub>14</sub> and C<sub>15</sub> - C<sub>36</sub> 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:               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](mailto: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<sub>10</sub>) 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<sub>6</sub> 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

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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                              29 October 2012  
(Change):

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](mailto: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<sub>10</sub>) 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<sub>6</sub> 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

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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

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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 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](mailto: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](mailto: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.*

Consent 7988-1

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

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A D McLay  
**Director - Resource Management**





## **Appendix II**

### **Biomonitoring surveys**



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<sub>s</sub>) 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<sub>s</sub> 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<sub>s</sub> values for the Waihapa Stream prior to and following drilling of Puka-1 well

Site No.	Site Code	No of taxa		MCI value		SQMCI <sub>s</sub> 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<sub>s</sub> scores for control sites at altitudes between 200-249 m ((TRC, 1999 (updated 2012)).

	No. of taxa	MCI value	SQMCI <sub>s</sub> 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
	Site Code		WHP000182	WHP000183	WHP000185
	Sample Number		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
	Paraleptamphopidae	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>Acroperla</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 (*Austrosimulium*)); 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<sub>s</sub> 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 (*Austroclima* 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<sub>s</sub> 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<sub>s</sub> 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 (*Austrosimulium*)); three 'moderately sensitive' taxa (amphipod (*Paracalliope*) and mayflies (*Austroclima* and *Zephlebia group*)), and one 'highly sensitive' taxon, stonefly (*Megaleptoperla*). The SQMCI<sub>s</sub> score of 6.1 units recorded at site 3 in this survey represented a

0.4 unit increase from the SQMCI<sub>s</sub> 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 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<sub>s</sub> 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<sub>s</sub> 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<sub>s</sub> 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<sub>s</sub> scores between surveys at all three sites. Slight variations in MCI and SQMCI<sub>s</sub> 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 Biologist; Brooke Thomas  
Document 1424154  
Date October 2014

## **Biomonitoring of the Waihapa Stream following drilling by Kea Oil & Gas Ltd at the Puka-3 wellsite, September 2014**

### **Introduction**

This biological survey was performed following drilling of the Puka-3 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. Two surveys were also conducted prior to and following drilling of the Puka-1 wellsite which has provided baseline data on the macroinvertebrate community of the stream (Thomas, 2013).

### **Methods**

The council's standard 'kick-sampling' technique was used to collect streambed macroinvertebrates from the Waihapa Stream, downstream of the stormwater discharges from the Puka-3 wellsite (Table 1 and Figure 1). The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

The Puka-3 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 September 2014 at three established sites; 100 m upstream of the wellsite (site 1), 25 m downstream of the wellsite 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-3 wellsite

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



Figure 1 Biomonitors sites in the Waihapa Stream in relation to the Puka-3 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 NZMVG 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<sub>s</sub>) 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<sub>s</sub> 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 morning survey the water temperatures in the stream ranged from 11.4 °C to 11.9°C. A moderate and steady flow of grey, cloudy water was noted at all three sites. The substrate at site 1 comprised predominantly of silt and sand, with smaller proportions of fine and coarse gravels and hard clay. The substrate at site 2 comprised predominantly of silt and gravels with smaller proportions of sand and cobbles. At site 3 the substrate comprised predominantly of gravels with smaller proportions of silt, sand, hard clay and wood and root. No periphyton was noted at site 1, whereas slippery mats of periphyton were recorded at sites 2 and 3. Macrophytes were recorded growing at the edges and on the bed of the stream at all three sites and all sites were partially shaded.

### Macroinvertebrate communities

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

**Table 2** Number of taxa, MCI and SQMCI<sub>s</sub> values for the Waihapa Stream prior to and following drilling of Puka-1 well and following drilling of the Puka-3 well

Site No.	Site Code	No of taxa			MCI value			SQMCI <sub>s</sub> value		
		Pre-drill Puka-1 (Nov 12)	Post-drill Puka-1 (May 13)	Post-drill Puka-3 (Sep 13)	Pre-drill Puka-1 (Nov 12)	Post-drill Puka-1 (May 13)	Post-drill Puka-3 (Sep 13)	Pre-drill Puka-1 (Nov 12)	Post-drill Puka-1 (May 13)	Post-drill Puka-3 (Sep 13)
1	WHP000182	23	14	13	90	104	92	4.8	4.9	4.4
2	WHP000183	20	21	16	96	106	96	5.3	5.5	5.6
3	WHP000185	20	20	15	98	108	99	5.7	6.1	5.4

**Table 3** Range and median number of taxa, MCI values and SQMCI<sub>s</sub> scores for control sites (smaller lowland hill country streams) at altitudes between 200-249 m ((TRC, 1999 (updated 2013)).

	No. of taxa	MCI value	SQMCI <sub>s</sub> value
No. Samples	169	169	90
Range	5-33	52-108	1.5-6.3
Median	18	79	4.0

**Table 4** Macroinvertebrate fauna of the Waihapa Stream in relation to the Puka-3 post-drill survey sampled 16 September 2014

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3
	Site Code		WHP000182	WHP000183	WHP000185
	Sample Number		FWB14237	FWB14238	FWB14239
ANNELIDA (WORMS)	Oligochaeta	1	A	C	C
	Lumbricidae	5	R	-	-
MOLLUSCA	<i>Potamopyrgus</i>	4	A	A	A
CRUSTACEA	<i>Paracalliope</i>	5	A	C	A
	Paraleptamphopidae	5	R	-	C
	<i>Paranephrops</i>	5	R	R	-
EPHEMEROPTERA (MAYFLIES)	<i>Austroclima</i>	7	C	A	A
	<i>Zephlebia group</i>	7	A	A	A
PLECOPTERA (STONEFLIES)	<i>Megaleptoperla</i>	9	-	C	C
	<i>Zelandobius</i>	5	R	R	C
HEMIPTERA (BUGS)	<i>Microvelia</i>	3	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	-	R	C
TRICHOPTERA (CADDISFLIES)	<i>Aoteapsyche</i>	4	-	-	R
	Ecnomidae/Psychomyiidae	6	-	R	R
	<i>Hydrobiosis</i>	5	-	R	-
	<i>Oxyethira</i>	2	-	R	-
	<i>Triplectides</i>	5	R	-	-
DIPTERA (TRUE FLIES)	<i>Aphrophila</i>	5	-	-	R
	Eriopterini	5	C	C	C
	Hexatomini	5	-	R	-
	Orthoclaadiinae	2	-	R	R
	<i>Polypedilum</i>	3	R	-	-
	<i>Austrosimulium</i>	3	-	R	C
No of taxa			13	16	15
MCI			92	96	99
SQMCIs			4.4	5.6	5.4
EPT (taxa)			4	6	6
%EPT (taxa)			31	38	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-3 wellsite**

A moderate community richness of 13 taxa was found at site 1 (Table 2 and Table 4), one taxon fewer than what was recorded in the previous post-drill survey and five 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 (69 %), which was reflected in the MCI score of 92 units. This result was similar to the pre-drill Puka-1 survey result of 90 units, however represented a significant decrease from that recorded in the post-drill Puka-1 survey (by 12 units) although was significantly higher (by 13 units) (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 [oligochaete worms and snail (*Potamopyrgus*)]; and two 'moderately sensitive' taxa [amphipod (*Paracalliope*) and mayfly (*Zephlebia* group)].

The equal numerical dominance of 'tolerant' and 'sensitive' taxa resulted in the SQMCI<sub>s</sub> score of 4.4 units, which was similar to the two previous survey results and slightly higher (by 0.4 unit) than the median score for 'control' sites in similar streams at this altitude (Table 3).

### **Site 2- 25m downstream of discharge from Puka-3 wellsite**

A moderate community richness of 16 taxa was found at site 2 (Table 2 and Table 4), three taxa more than found at site 1, between four and five taxa less than the two previous surveys and two taxa less than the median richness found at similar sites (Table 3). The macroinvertebrate community was again comprised of a significant proportion of 'sensitive' taxa (69 %), which was reflected in the MCI score of 96 units; the same as that recorded during the pre-drill Puka-1 survey and an insignificant four units higher than at the upstream 'control' site. This MCI score was lower than that recorded during the post-drill Puka-1 survey but significantly higher (Stark, 1998) (by 17 units) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 3).

This community was characterised by one 'tolerant' taxon [snail (*Potamopyrgus*)]; and two 'moderately sensitive' taxa [mayflies (*Austroclima* and *Zephlebia* group)].

The numerical dominance of 'sensitive' taxa resulted in the SQMCI<sub>s</sub> score of 5.6 units, which was similar to the two previous survey results and significantly (Stark, 1998) higher (by 1.6 units) than the median score for 'control' sites in similar streams at this altitude (Table 3). Similarly to the Puka-1 survey results, an increase (1.2 units) in SQMCI<sub>s</sub> score was recorded between sites 1 and 2. This significant (Stark, 1998) increase can be attributed to an increased abundance of one 'highly sensitive' taxon [stonefly (*Megaleptoperla*)] which was absent at site 1 and 'common' at site 2.

### **Site 3- 80m downstream of discharge from Puka-3 wellsite**

A moderate community richness of 15 taxa was found at site 3 (Table 2 and Table 4), five taxa less than that recorded in previous two surveys and three taxa less 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 'sensitive' taxa (67 %), which was reflected in the MCI score of 99 units; seven units higher than the upstream 'control' site and similar to the previous pre-drill survey, although less than the more recent post-drill survey. 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 one 'tolerant' taxon [snail (*Potamopyrgus*)]; and three 'moderately sensitive' taxa [amphipod (*Paracalliope*) and mayflies (*Austroclima* and *Zephlebia* group)]. The SQMCI<sub>s</sub> score of 5.4 units recorded at site 3 was similar to the Puka-1 pre-drill survey although represented a 0.7 unit decrease from the SQMCI<sub>s</sub> score recorded in the Puka-1 post-drill survey. It was also a significant 1.4 units higher than the median score for 'control' sites in similar streams at this altitude elsewhere in the region (TRC, 1998 (updated 2013)).

## Summary and Conclusions

The Councils 'kick-sampling' technique was 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-3 wellsite on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCI<sub>s</sub> 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<sub>s</sub> 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<sub>s</sub> between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

This September 2014 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-3 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 23 taxa was found through the reach of the stream surveyed, with seven of these taxa (30 %) found at all three sites and seven taxa (30 %), found at any two of these sites. One 'highly sensitive' taxon was recorded as 'common' at the two sites downstream of the discharge, compared with none upstream.

A comparison of the current survey results with the Puka-1 pre-drill and post-drill survey results showed no significant variation in SQMCI<sub>s</sub> scores between surveys at all three sites. Only one significant variation in MCI score was recorded which was between the post-drill Puka-1 survey and the current survey, at site 1. Slight variations in MCI and SQMCI<sub>s</sub> score and taxa richness between sites and surveys is considered to be due to habitat variability rather than a change in water quality.

The MCI scores recorded in this survey indicated that the stream communities were of fair 'health' (TRC, 2013), but 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-3 wellsite has impacted on the biological communities of the Waihapa Stream.



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