

Cheal Petroleum Limited
Cheal-B Exploration Wellsite
Monitoring Programme Report
2011-2013

Technical Report 2013–110

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Executive summary

Cheal Petroleum Limited operate a hydrocarbon exploration site located on Taylor Road, within the Stratford district, in the Patea catchment. The site is called Cheal-B wellsite. This report covers the period from February 2011- October 2013. During this period, a well was drilled and tested. The wellsite is now in production; however more wells are being drilled.

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

Cheal Petroleum Limited holds a total of 6 resource consents for the activities at the Cheal-B wellsite, which include a total of 100 consent conditions setting out the requirements that Cheal Petroleum Limited must satisfy. Cheal Petroleum Limited holds consent **6813-1** to discharge emissions to air associated with exploration activities; consent **6816-1** to discharge stormwater and sediment from earthworks during construction onto and into land; consent **6814-1** to discharge emissions to air associated with production activities; consent **6815-1** to discharge treated stormwater and produced water associated with exploration activities to land; consent **6817-1** to discharge drilling muds, drilling cuttings and drilling wastes to land via mixed bury cover; and consent **7907-1** to discharge stormwater and sediment from earthworks during expansion of Cheal-B wellsite.

The Council's monitoring programme for the period under review included 31 inspections of the site and surrounding environment, at approximately fortnightly intervals. In total 15 stormwater samples were collected for chemical analysis.

The monitoring showed that, in general, good processes and procedures were implemented. A strong focus on the environment by all personnel ensured that the site was mostly clean and tidy. Any spills on-site were quickly cleaned up to avoid the potential for a contaminant to travel to surface water. The site's stormwater system worked effectively.

The distance from the wellsite to the nearest stream was approximately 30 m. The stream was visually inspected by an Inspecting Officer on each occasion. Bio-monitoring surveys were undertaken at the Cheal-B wellsite. There was no indication from the results of the surveys that the discharge from the Cheal-B wellsite had impacted on the biological communities of the Ngaere Stream.

Staff on-site were cooperative with requests made by officers of the Council, with any required works being completed quickly and to a satisfactory standard.

The drilling fluids and cuttings were disposed of off site.

During the monitoring period, Cheal Petroleum Limited demonstrated a high level of environmental performance and compliance with the resource consents. The site was generally neat, tidy, and well maintained.

This report includes recommendations for future drilling operations at this and other sites.

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period February 2011- October 2013 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Cheal Petroleum Limited. During the period under review, Cheal Petroleum Limited drilled and tested 5 wells.

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

One of the intents of the Resource Management Act 1991 (the Act) is that environmental management should be integrated across all media, so that a consent holder's use of water, air, and land should be considered from a single comprehensive environmental perspective. Accordingly, the Council generally implements integrated environmental monitoring programmes and reports the results of the programmes jointly. This report discusses the environmental effects of Cheal Petroleum Limited's use of water, land, and air, and is the 2nd report by the Council for the site.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the Act and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consents held by Cheal 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 Cheal-B wellsite during exploration activities.

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

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

Section 4 presents recommendations to be implemented during future drilling operations.

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

1.1.3 The Resource Management Act (1991) and monitoring

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

- (a) the neighbourhood or the wider community around a discharger, and may include cultural and socio-economic effects;
- (b) physical effects on the locality, including landscape, amenity and visual effects;
- (c) ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;
- (d) natural and physical resources having special significance (e.g., recreational, cultural, or aesthetic); and
- (e) risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Taranaki Regional Council is recognising the comprehensive meaning of 'effects' in as much as is appropriate for each discharge source. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the Resource Management Act to assess the effects of the exercise of consents. In accordance with section 35 of the Resource Management Act 1991, the Council undertakes compliance monitoring for consents and rules in regional plans; and maintains an overview of performance of resource users against regional plans and consents. Compliance monitoring, including impact monitoring, also enables the Council to continuously assess its own performance in resource management as well as that of resource users particularly consent holders. It further enables the Council to continually re-evaluate its approach and that of consent holders to resource management, and, ultimately, through the refinement of methods, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and consent performance

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

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

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

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

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

1.2 Process description

Site management

Cheal Petroleum Limited holds a 10 year Petroleum Mining Permit No. 38156 to prospect, explore, and mine for condensate, gas, LPG, oil and petroleum within an area of 30 Km². The Cheal-B wellsite is one of many sites within this area that have been established in order to explore, evaluate and produce hydrocarbons.

The Cheal-B wellsite is located approximately 800 m along Taylor Road, approximately 3 km from Stratford.

The Cheal-B wellsite was established in 2006 and involved the removal of topsoil to create a firm level platform on which to erect a drilling rig and house associated equipment. Site establishment also involved the installation of:

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

The nearest residence is approximately 300 m away from the wellsite. Bunding, earthworks and good site location helped minimise any potential for off-site effects for the neighbours.

Well creation

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

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

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

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

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

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

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

Management of stormwater, wastewater and solid drilling waste

The Cheal-B wellsite is located approximately 30 m to the west of the nearest waterbody which is the Ngaere Stream, a tributary of the Patea catchment.

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

- Stormwater from 'clean' areas of the site [e.g. parking areas] which run off during rainfall. There is potential that this runoff will pick up small amounts of hydrocarbons and silt due to the nature of the activities on-site;

- Stormwater which collects in the area surrounding the drilling platform and ancillary drilling equipment. This stormwater has a higher likelihood of contact with potential contaminants, particularly drilling mud;
- Produced water which flows from the producing formation and is separated from the gas and water phase at the surface; and
- Drill cuttings, mud and residual fluid which are separated from the liquid waste generated during drilling.

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

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

Flaring from exploration activities

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

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



Photo 1 Aerial view showing the location of Cheal-B wellsite.

1.3 Resource consents

1.3.1 Background

Cheal Petroleum Limited holds 6 resource consents related to exploration activities at the Cheal-B wellsite site, as follows:

- Discharge Permit **6813-1**; granted 23 March 2006,
- Discharge Permit **6814-1**; granted 23 March 2006,
- Discharge Permit **6815-1**; granted 23 March 2006,
- Discharge Permit **6816-1**; granted 23 March 2006,
- Discharge Permit **6817-1**; granted 23 March 2006, and
- Discharge Permit **7907-1**; granted 25 August 2011.

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

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

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

The Council determined that the applications 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.

Cheal Petroleum Limited holds water discharge permit **6815-1** to discharge treated stormwater and produced water from hydrocarbon exploration and production operations at the Cheal-B wellsite onto and into land.

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

This permit was issued by the Council on 23 March 2006, under Section 87(e) of the Act. It is due to expire on 1 June 2022.

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

1.3.3 Water discharge permit (stormwater and sediment – earthworks)

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

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

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

Cheal 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.

Cheal Petroleum Limited holds water discharge permit **6816-1** to discharge stormwater and sediment from earthworks during construction of the Cheal-B wellsite onto and into land.

This permit was issued by the Council on 23 March 2006, under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2022.

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

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

Cheal Petroleum Limited holds water discharge permit **7907-1** to discharge stormwater and sediment from earthworks during expansion of the Cheal-B wellsite onto and into land.

This permit was issued by the Council on 25 August 2011, under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2016.

Consent conditions were imposed on Cheal Petroleum Limited to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 10, Section 3.3.

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

1.3.4 Air discharge permit (exploration activities)

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

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

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

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

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

Cheal Petroleum Limited holds air discharge permit **6813-1** to discharge emissions to air from hydrocarbon exploration activities at the Cheal-B wellsite.

This permit was issued by the Council on 23 March 2006, under Section 87(e) of the Act. It is due to expire on 1 June 2022.

Consent conditions were imposed on Cheal 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.

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

1.3.5 Air discharge permit (production activities)

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

The Council determined that the application to discharge emissions to air associated with the production activities at the Cheal-B 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.*

Cheal Petroleum Limited holds air discharge permit **6814-1** to discharge emissions to air associated with production activities at the Cheal-B wellsite including flaring associated with emergencies and maintenance and minor emissions from other miscellaneous activities.

This permit was issued by the Council on 23 March 2006, under Section 87(e) of the Act. It is due to expire on 1 June 2022.

Consent conditions were imposed on Cheal 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.

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

1.3.6 Mix-Bury-Cover

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

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

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

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

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

Cheal Petroleum Limited holds discharge permit **6817-1** to discharge solid drilling wastes (drilling cuttings and residual drilling fluids) from hydrocarbon exploration activities onto and into land via mix-bury-cover.

This permit was issued by the Taranaki Regional Council on 23 March 2006, under Section 87(e) of the Act. It is due to expire on 1 June 2022.

Consent conditions were imposed on Cheal-B to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 7, Section 3.3.

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

1.4 Monitoring programme

1.4.1 Introduction

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

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

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

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

The monitoring programme for the Cheal-B wellsite focused primarily on programme liaison and management, site inspections, and discharges to land. However, all six 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 pits on to land and then any potential receiving waters.

During each inspection the following are checked:

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

1.4.4 Chemical sampling

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

1.4.5 Solid wastes

The Council monitors any disposal of drill cuttings on-site via mix-bury-cover to ensure compliance with resource consent conditions.

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

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

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

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

1.4.7 Biomonitoring surveys

During the period under review three biomonitoring surveys of the Ngaere Stream were carried out pre and post drilling of the well to assess whether the activities carried out on-site, and associated discharges have had any effect on the biological communities of the Ngaere Stream.

2. Results

2.1 Water

2.1.1 Inspections

The Cheal-B wellsite, adjacent land and streams were inspected **31** times during this monitoring period.

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

9 February 2011

Notification had been received that drilling works were to commence on well 4. The site inspection was carried out prior to the rig starting on site. The ring drains were working well directing water through the skimmer pits. The site was well established and silt control measures such as tree planting had been put in place. Some of the ring drains were overgrown with weeds. The water in the ring drains at the time of inspection was clean. The location of the sewage tanks was unknown at the time of inspection.

21 February 2011

Staff on site were spraying the road to stop dust. Production of oil from the existing well was occurring. The rig was erected and drilling had not commenced. The ring drains were mostly free of water. Some parts of the ring drain contained stagnant water that was home to frogs. The skimmer pits were full and contained tadpoles. The valve on the exit pipe from the skimmer pit was closed while drilling took place. High bunding was in place around the cement tanks with a small sump installed to capture any discharge. There was also high bunding in place for the chemicals. There was a small sewage leak observed where the pipe entered the tank; the site manager was advised of this and action had been taken to fix it.

28 February 2011

The site was dry. Most of the ring drains were also dry. The first skimmer pit was cloudy but the second pit was clear and discharging. There was excellent bunding in place around the mud tanks, chemicals and cement tanks. The sewage system had been repaired and was working well. The site was being well managed.

8 March 2011

The drilling operation had been completed and the rig removed from site. Tanks and equipment were being removed from site at the time of inspection. The skimmer pits were full and discoloured due to heavy rainfall. The ring drains were running clear. The sewage tank was empty and most of the pipework had been removed. The wall of one bund had been broken to release water that had built up inside the bund. Consent conditions had been complied with. Further clean up of the bunded areas was required.

29 September 2011

The site had been modified to accommodate additional exploration wells. There were some silt control issues to be addressed. Advice was given to place hay bales in the ring drains as a silt control measure.

3 October 2011

The site was tidy and dry at the time of inspection. The ring drains were dry. Water was being brought onto site and stored in skimmer pits. There were no chemicals used on site for current operations. The exposed soil from earthworks was drying out. The D tank used to capture silt/sediment had been removed and a new settlement pond had been built. Only clean water from a spring was entering the new pond and discharging from site. It appeared that all consent conditions were being complied with at time of inspection.

14 November 2011

The site was dry. The ring drains were mostly dry but spring water was flowing into the skimmer pits from a section of the drain. The skimmer pits were discharging clear water to land where it flowed overland into the settlement pond associated with the earthworks on site, the pond was not discharging at time of inspection. Water from the settlement pond was being pumped back to the site and reused. Earthworks were continuing onsite. Good bunding of equipment and chemicals was observed. It was reported earlier in the week that a drum of glycol had been spilt on site and had been cleaned up; there was no evidence of the spill during the site visit. It appeared that all consent conditions were being complied with at time of inspection.

24 November 2011

The site was wet from rain overnight. All puddles were clear with no hydrocarbon sheen observed. The ring drains were running clear. The skimmer pits appeared discoloured; however, the discharge into the settlement pond below the site was clear. There was no discharge of stormwater/spring water from the settlement pond. Photos were taken. All waste from the well was being disposed of off site. No water was being taken from the stream as water was being reused and pumped back to the site from the settlement pond. No flaring had occurred from the most recently drilled well. Earthworks were continuing on site. All stormwater flowing from the exposed area was clear and drained to the settlement pond. It appeared that consent conditions were being complied with at time of inspection.

19 December 2011

The site was dry. The ring drains contained discoloured stormwater in places. The settlement pond below the site was also discoloured but was not discharging at the time of inspection. Water downstream of the discharge point looked clean and clear. A water sample from the settlement pond, as well as a downstream and two upstream samples were taken for analysis. A drill rig was being set up with drilling to commence later in the week.

12 January 2012

No flaring was taking place. All stormwater collected in the ponds was being removed via vacuum truck and disposed of offsite. All drilling wastes were also being disposed of offsite.

No drilling was taking place at the time of inspection. The rig was in the process of being erected above the C7 well. There was good bunding of chemicals and bulk fuels.

8 February 2012

The rig had been removed from site, as well as most of the equipment. Some chemical remained on site but was in the process of being removed at the time of inspection. No stormwater was discharging from site. No flaring was taking place. All drilling muds had been disposed of offsite.

28 February 2012

No drilling operations were occurring at the time of inspection. Equipment was being removed from site. The site was tidy. There were no discharges to water, land or air.

26 March 2012

There was not a lot of activity occurring on site at the time of inspection. Inter-drill were on site drilling the first 35m of the C8 well. The ring drains were clean. The skimmer pits were discharging clear water onto land, from where it could flow through a lagoon/swamp area before reaching the stream. The spring water settlement pond was discoloured because a nearby bank had eroded during heavy rain, causing sediment to flow into the pond. The discharge was clear.

20 April 2012

It was observed that there was clean water in the ring drains with vegetation growing in and around the ring drains; sections of the ring drains contained iron oxide that was leaching from the surrounding land. The discharge from the skimmer pits looked clean and clear. No flaring was occurring on site as all hydrocarbons were piped to Cheal A. The only activity occurring on site was the lagging of pipes. The site was tidy. All earthworks had been completed. It was observed that piles of earth were situated on site (leftover from the earthworks). The temperature of the stream was 10.6 upstream and 10.7 downstream (Celsius). No effects were observed in the stream. No samples were taken.

13 September 2012

No exploration drilling was occurring at the time of inspection. Production operations were taking place. The site was tidy. Stormwater/groundwater was discharging from the site. A water sample was taken from the second skimmer pit for analysis. There were no issues raised during the inspection.

8 October 2012

Heavy rain was falling at the time of inspection. Silt and sediment was observed flowing over the site into the ring drains and mixing with clear stormwater/spring water. The skimmer pits were clear and discharging. Grasses were observed growing in the discharge drain. No samples were taken during the inspection. No effects were observed as a result of stormwater/spring water discharging offsite. Groundwater was not discharging from the pipe below the site and the groundwater retention pond was almost empty.

17 October 2012

The drill rig and associated equipment was onsite and being set up. Bunding was being constructed for chemicals/bulk storage containers. Clear stormwater was discharging from the site. No issues were raised at the time of inspection.

24 October 2012

The site was clean, tidy and dry. Drilling operations were taking place. The ring drains contained clear running spring water. Tadpoles were observed in the ring drain. The skimmer pits were discharging at the time of inspection. Bunding was in place around the trucks. There were good processes in place to avoid any spills.

6 November 2012

Drilling continued onsite. The ring drains appeared clear. The skimmer pits were slightly discoloured, but the discharge looked clear. The site was tidy and dry. The area around the mud tanks was clean and tidy. There were no issues raised at the time of inspection.

14 November 2012

The site was reasonably tidy following the cement job to secure the casing. Some minor spills had occurred but most were within bunded areas and contained. The ring drains were clean and the skimmer pits were clear. A water sample was taken from the discharge drain for analysis.

27 November 2012

The site was dry following a period of fine weather. The site was very clean and tidy with only a small number of minor stains observed on the ground. The skimmer pits were discharging clear water. It was observed that frogs were living in the skimmer pits. No issues were raised at the time of inspection.

10 December 2012

The target depth had been reached and drilling had stopped. The rig was being disassembled and removed from the site. The discharge of stormwater from the site looked clear. Grasses around the open drain continue to grow. Water samples were not collected during this inspection.

7 January 2013

There was no activity occurring at the time of inspection. The site was clean and tidy. A sample was taken from the second skimmer pit. A freshwater crayfish and a frog were observed in the second pit.

12 February 2013

The site was clean and dry. The skimmer pits were not discharging at the time of inspection. Samples were taken from the second skimmer pit to ensure that consent conditions would be complied with should a discharge occur.

27 February 2013

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

26 March 2013

This notice was to advise that a stormwater sample was taken from the skimmer pit system to confirm whether consent conditions would be complied with should a discharge occur.

27 May 2013

Wire-lining was taking place on site with a small workover rig also being set up. The site was clean and tidy with no signs of spills or material about the site that may have an adverse effect on the environment.

The ring drains and skimmer pits both appeared to be in a good working order. The skimmer pits were not discharging at the time of inspection, however samples were taken to ensure that a discharge would comply with consent conditions should a discharge occur.

26 June 2013

The rig was onsite completing a well workover. It was expected to take approximately one week.

The site appeared to be in a clean and tidy condition at the time of inspection. The ring drains were inspected and appeared to be working well, directing all site run-off to the skimmer pit system prior to discharge.

There was a slight oil sheen observed in the first skimmer pit and a sample was taken. The sheen was contained within the first pit via the goose neck pipe. This may be organic in origin; however, lab tests would confirm its characteristics. The retention of hydrocarbon within the first skimmer pit indicated it was working as intended.

There was no discharge from pits at the time of inspection. The receiving waters were inspected visually and found to be clean and uncontaminated from any wellsite activities.

26 July 2013

Site inspection of the Cheal-B wellsite found that little activity was occurring on site. Wire lining was taking place; however, the recent well work-over had been completed.

Inspection of the skimmer pits found that the hydrocarbon sheen on the surface remained. A sample was taken from this pit. Skimmer pits were discharging at the time of the inspection. Samples were taken to ensure that the discharge complies with resource consent conditions.

There was a large volume of stormwater ponded in the ring drain running along the right hand side of the site.

7 August 2013

Inspection found that no exploration activities were taking place on the site.

The site was in a clean and tidy condition. The skimmer pits were full but not discharging at the time of the inspection. The second skimmer pit appeared to have good water quality; however, the first skimmer pit had a sheen of hydrocarbons on the surface which were being retained in the 1st skimmer pit.

The depth of the ring drains meant that water was ponding within the drains rather than being directed for treatment via the skimmer pit treatment system. This issue was raised in the inspection notice following site inspection on 26 July 2013.

Works were required to be completed to ensure that all site water was directed for treatment in the skimmer pit treatment system rather than ponding in the ring drain.

17 October 2013

Site inspection completed following notification received by the Council in relation to the construction of new skimmer pits on site.

Inspection found that construction of the new skimmer pits had been completed. Skimmer pits and discharge location remained unchanged, however the new pits were now lined and had a much larger volume.

The pits appeared to be well lined, with a shut off valve in place at the exit of the second pit. A good quality swale had been constructed to direct and treat any potential overflow following extreme rainfall events.

Works had also been completed on the ring drains to ensure that they flow towards the skimmer pits and prevent pooling or ponding within the drains. At the time of the inspection the skimmer pits were discharging as a result of the ring drains along the western edge of the site being fed by springs. The drains on the eastern edge of the site were dry.

The discharge quality was clean and clear from the skimmer pits. No samples were taken.

In general the upgrade to the site appeared to be thorough and of good quality.

2.1.2 Results of abstraction and discharge monitoring

There were 15 samples collected during the review period for this report and chemical analysis of the stormwater was carried out.

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

On 26 June 2013 a sample taken from the first skimmer pit showed an elevated level of hydrocarbon. The consent limit for hydrocarbons is 15 g/m³; the sample was over 10 times the consented limit at 161 g/m³; however, the hydrocarbons were confined to the skimmer pits as per design, and no discharge to the receiving environment was observed. There was no breach of consent.

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

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

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

Parameters	Consent limit	13 September 2012	15 November 2012	7 January 2013	12 February 2013	27 February 2013	26 March 2013	27 May 2013
Chloride (g/m ³)	50	17	20.4	19.9	14.2	19.7	27.0	11.0
pH	6.5-8.5	6.6	7.2	7.3	7.0	7.2	7.6	6.8
Suspended solids (g/m ³)	100	4	4	<2	4	9	14	11
Hydrocarbon (g/m ³)	15	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Table 2 Results of water sample taken from the skimmer pit as well as upstream and downstream collected 19 December 2011

Parameters	Consent limit	Skimmer Pit	Upstream of culvert (440m upstream of discharge)	Upstream	Downstream
Chloride (g/m ³)	50	18.7	17.0	17.8	18.0
pH	6.5-8.5	6.9	7.2	7.2	7.2
Suspended solids (g/m ³)	100	49	86	<2	6
Hydrocarbon (g/m ³)	15	<0.5	<0.5	<0.5	<0.5

Table 3 Results of water sample taken from the 1st and 2nd skimmer pits collected 26 June 2013

Parameters	Consent limit	1 st Skimmer Pit	2 nd Skimmer Pit
Chloride (g/m ³)	50	-	19.2
pH	6.5-8.5	-	6.7
Suspended solids (g/m ³)	100	-	4
Hydrocarbon (g/m ³)	15	161	-

Retention of hydrocarbons within the first skimmer pit indicated that it was working as designed, to intercept and retain any spillage of hydrocarbons on site.

Table 4 Results of water sample taken from the discharge and the skimmer pit collected 26 July 2013

Parameters	Consent limit	Discharge	Skimmer Pit
Chloride (g/m ³)	50	21.6	-
pH	6.5-8.5	6.9	-
Suspended solids (g/m ³)	100	12	-
Hydrocarbon (g/m ³)	15	<0.5	0.8

2.1.3 Results of receiving environment monitoring

The authorised discharges offsite were onto land from the skimmer pits. It is considered that the discharge was unlikely to reach surface water body due to the small catchment area of the site and the distance to any surface water body beyond the discharge point from the skimmer pits.

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

The pre drilling biomonitoring survey was undertaken in December 2011 and the post drilling survey undertaken in February 2012. The last biomonitoring survey was undertaken in November 2012.

The MCI scores recorded in the survey indicated that the stream communities were of reasonable 'health' and were considered to be typical of what might be expected of a stream originating from a swampy area (i.e. Ngaere Swamp). There was no indication from the results of the surveys that the discharge from the Cheal-B wellsite had impacted on the biological communities of the Ngaere Stream.

2.2 Air

2.2.1 Inspections

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

2.2.2 Results of discharge monitoring

Cheal Petroleum Limited did not undertake any flaring as permitted by resource consents 6813-1 and 6814-1.

2.2.3 Results of receiving environment monitoring

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

No chemical monitoring of air quality was undertaken during the testing phase of the Cheal-B wellsite as the controls implemented by Cheal Petroleum Limited did not give rise to any concerns with regard to air quality.

During monitoring inspections of the site the Inspecting Officers found there were no offensive or objectionable odours, smoke or dust associated with activities at the Cheal-B wellsite.

No flarepit was established at the Cheal-B wellsite. All product from Cheal-B is piped to Cheal-A and all flaring associated with wells drilled at the Cheal-B site is undertaken at the Cheal-A site.

2.2.4 Other ambient monitoring

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

2.3 Land

2.3.1 Land status

The land had not been reinstated at the time of the last inspection on 17 October 2013 as the well was still producing, and the site still in use.

2.4 Contingency plan

Cheal Petroleum Limited has provided a general contingency plan, as required by Special Condition 4 of recourse consent **6815-1** with site specific map of the Cheal-B wellsite. The contingency plan has been reviewed and approved by officers of the Council.

2.5 Investigations, interventions and incidents

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

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

Any minor actual or potential non-compliance with consent conditions were addressed during site inspections. Cheal Petroleum Limited staff would quickly take steps to ensure that requests made by Council Inspecting Officers were adhered to without delay.

3. Discussion

3.1 Discussion of consent exercise

Of the 6 resource consents relating to the Cheal-B wellsite, **6815-1** (to discharge treated stormwater and produced water), **6816-1** (to discharge stormwater and sediment from earthworks during construction); and **7907-1** (to discharge silt and sediment from earthworks during expansion of the site) were exercised and actively monitored.

Flaring in association with production and exploration activities was not undertaken during the monitoring period as permitted by resource consent **6813-1** (air discharge associated with exploration) and consents **6814-1** (air discharge associated with production).

Discharge of drilling muds, drilling cuttings and drilling waste from hydrocarbon exploration via mixed bury cover as permitted by resource consent **6817-1** was not exercised during the monitoring period. Drilling waste was transported off site to a consented facility.

It is considered that all remaining resource consent conditions were complied with during the monitoring period, including the provision of various pieces of information (contingency plan, notifications etc.).

Monitoring has shown that the management on-site ensured 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, Cheal 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 site 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.

Cheal Petroleum Limited also undertook the following mitigation measures in order to minimise 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 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 site¹. More recently two studies have focused on field investigations and modelling of emissions from flares involving fracturing fluids.²

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

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

² 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 measures to be undertaken by Cheal Petroleum Limited to avoid or mitigate actual or potential adverse environmental impacts on air quality included:

- The use of a test separator to separate solids and fluids from the gas during all well clean-ups, and workover activities where necessary, thus reducing emissions to air. In particular, this would reduce the potential for heavy smoke incidents associated with elevated PAH and dioxin emissions;
- Records of flaring events were to be kept by Cheal Petroleum Limited and provided to the Council;
- Every endeavour was to be made by Cheal 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 endeavour was to be made by Cheal Petroleum Limited to minimise smoke emissions from the flare.
- Gas for flaring was in the event piped to the Cheal A facilities for flaring, rather than flared at the Cheal B wellsite.

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 minimise 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.

Cheal 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;
- Ignition sources were not permitted on any site;
- Sufficient separation of chemicals from the flare pit were maintained for safety reasons;
- In the unlikely event of a spill escaping from bunded areas, the site perimeter drain and interceptor pit system was implemented to provide secondary containment on-site; and
- A spill contingency plan was prepared that sets out emergency response procedures to be followed in the event of a spill.

Summary

There were no environmental effects observed to water, land or air as a result of the exploration drilling during the monitoring period. There were no unauthorised discharges observed from the Cheal-B wellsite.

3.3 Evaluation of performance

A summary of Cheal Petroleum Limited's compliance record for the period under review is set out in Tables 5-10.

Table 5 Summary of performance for Consent **6814-1** to discharge emissions to air associated with production activities

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. 24hrs notice of flaring to the Council when flaring is longer than 5 minutes in duration	Notification received 24hrs prior to flaring	N/A – consent not exercised
2. Liquid and solid separation to occur before flaring to minimise smoke emissions	Inspection of flare pit and flare	N/A – consent not exercised
3. Only substances originating from well stream to be combusted in flare pit	Visual inspection of site	N/A – consent not exercised
4. Best practicable option adopted	Visually inspecting site, procedures & processes	N/A – consent not exercised
5. No offensive odour or smoke beyond boundary	Assessment by investigating officer	N/A – consent not exercised
6. All storage tanks to have vapour recovery systems fitted.	Visual inspection of site	N/A – consent not exercised
7. Control of carbon monoxide	Chemical analysis of emissions	N/A – consent not exercised
8. Control of other emissions	Chemical analysis of emissions	N/A – consent not exercised
9. Analysis of typical gas and condensate stream from field to be made available to the Council	Available upon request	N/A – consent not exercised
10. Log all flare events longer than 5 minutes (10 minutes aggregate or longer than 120 minutes) including time, duration, zone and reason for flare	Inspection of Company records	N/A – consent not exercised
11. Consent shall lapse if not implemented by date specified	Notification of flaring received/not received	N/A – consent not exercised
12. Notice of Council to review consent	No provision for review during period	N/A – consent not exercised
Overall assessment of consent compliance and environmental performance in respect of this consent		N/A – consent not exercised

Table 6 Summary of performance for Consent **6813-1** to discharge emissions to air from flaring of hydrocarbon exploration activities

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Flaring shall not occur for more than 15 days per zone, for up to four zones per well, for up to 8 wells	Inspection of records	N/A – consent not exercised
2. 24hrs notice of flaring to the Council for initial flare of each zone	Notification received 24hrs prior to flaring	N/A – consent not exercised
3. Liquid and solid separation to occur before flaring to minimise smoke emissions	Inspection of flare pit and flare	N/A – consent not exercised
4. No liquid or solid hydrocarbons are to be combusted in the flare pit	Inspection of flare pit and flare	N/A – consent not exercised
5. Best practicable option adopted	Visually inspecting site, procedures & processes	N/A – consent not exercised
6. No offensive odour or smoke beyond boundary	Assessment by investigating officer	N/A – consent not exercised
7. Control of carbon monoxide	Inspections confirming chemical analysis not required	N/A – consent not exercised
8. Control of other emissions	Inspections	N/A – consent not exercised
9. Analysis of typical gas and crude oil stream from field to be made available to the Council	Available upon request	N/A – consent not exercised
10. All storage tanks to have vapour recovery systems fitted.	Visual inspection of site	N/A – consent not exercised
11. Log all flaring including time, duration, zone and volumes flared	Inspection of Company records	N/A – consent not exercised
12. Report to the Council the time, duration and cause of each smoke incident	Inspection of Company records	N/A – consent not exercised
13. Consent shall lapse if not implemented by date specified	Exercise of consent confirmed by inspection	N/A – consent not exercised
14. Notice of Council to review consent	No provision for review during period	N/A – consent not exercised
15. Notice of Council to review consent	No provision for review during period	N/A – consent not exercised
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 **6817-1** to discharge solid drilling wastes [drilling cuttings and residual drilling fluids] via mix-bury-cover

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

Condition requirement	Means of monitoring during period under review	Compliance achieved?
14. The mix-bury-cover to be as far above the groundwater table as practicable	Visual inspection of site	N/A – consent not exercised during the period under review
15. The mix-bury-cover must be 30m from any water body, spring or bore	Visual inspection of site	N/A – consent not exercised during the period under review
16. The total loading of trace elements in waste is not to exceed Alberta Energy and Utilities Board, 1996, G-50 guidelines	Inspection of company records	N/A – consent not exercised during the period under review
17. Chloride levels in each mix-bury-cover shall not exceed 1,600kg	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
18. Nitrogen levels in each mix-bury-cover shall not exceed 400kg	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
19. The hydrocarbon content of solid drilling waste shall not exceed 15mg/kg	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
20. Various parameters in the soil covering the mix-bury-cover to be below agreed limits	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
21. Various metals in the soil covering the mix-bury-cover to be below agreed limits	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
22. Hydrocarbon concentrations in the soil covering the mix-bury-cover shall comply with agreed guideline values	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
23. Level of salts in surface & ground water not to exceed 2,500g/m ³	Sample mix-bury-cover to ensure compliance	N/A – consent not exercised during the period under review
24. Consent shall lapse if not implemented by date specified	Notification received/not received	N/A – consent not exercised during the period under review
25. Notice of Council to review consent	Notice of intention served/not served	N/A – consent not exercised during the period under review
Overall assessment of consent compliance and environmental performance in respect of this consent		N/A – consent not exercised during the period under review

Table 8 Summary of performance for Consent **6815-1** to discharge treated stormwater, and produced water from hydrocarbon exploration and production operations

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Visually inspecting site, procedures & processes	Yes
2. Maximum stormwater catchment area of 15,000 m ²	Inspection of site and records	Yes
3. 7 days written notice prior to site works and drilling	Notification received	Yes
4. Maintain a contingency plan	Contingency plan received and approved	Yes
5. All discharges to be directed for treatment through skimmer pit. Stormwater pits to be impermeable	Visual inspection of stormwater system	Yes
6. Storage of hazardous substances	Inspection of site and records	Yes
7. Constituents in the discharge shall meet standards	Sampling of discharge	Yes
8. Discharge shall not increase temperature of receiving waters after mixing zone	Sampling of discharge	Yes
9. Discharge shall not negative effects on receiving waters	By comparing submitted & approved plans with the built site inspection	Yes
10. Discharge onto or into land shall occur a minimum of 30m from any surface water body.	Visual inspection of stormwater system	Yes
11. 48 hours notification of reinstatement	N/A	N/A
12. Consent shall lapse if not implemented by date specified	Exercise of consent confirmed by inspection	Yes
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		High

Table 9 Summary of performance for Consent **6816-1** to discharge stormwater and sediment from earthworks during construction

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Visually inspecting site, procedures & processes	Yes
2. Submit management plan	Notification received	Yes
3. 7 days written notice prior to site earthworks	Notification received	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
4. Constituents in the discharge shall meet standards	Visual inspection of stormwater system	Yes
5. Management of earthworks	Visual inspection	Yes
6. Earthworks shall be stabilised vegetatively	Visual inspection	Yes
7. Consent shall lapse if not implemented by date specified	Exercise of consent confirmed by inspection	Yes
8. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High

Table 10 Summary of performance for Consent **7907-1** to discharge silt and sediment from earthworks during expansion of the Cheal-B site 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	Visually inspecting site, procedures & processes	Yes
2. Runoff from exposed areas of soil to be directed through settlement ponds	Visual inspection of stormwater system	Yes
3. Silt control measures can be removed following site stabilisation	Visual inspection	Yes
4. Earthwork areas to be stabilised vegetatively	Visual inspection	Yes
5. Notification 7 days prior to works starting	Notification received	Yes
Overall assessment of consent compliance and environmental performance in respect of this consent		High

During the monitoring period, Cheal Petroleum Limited demonstrated a high level of environmental performance and compliance with the resource consents.

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.

Based on the results of monitoring during the period under review, it is considered that there are no grounds that require a review to be pursued. A recommendation to this effect is presented in section 4.

3.5 Change to any future monitoring programmes

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

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

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

Biomonitoring was implemented in the vicinity of the Cheal B wellsite during the period under review.

The monitoring of future consented activities at the Cheal-B wellsite shall again include an ecological survey.

A recommendation to this effect is present in section 4 of this report.

4. Recommendations

1. THAT this report be forwarded to the Company, and to any interested parties upon request;
2. THAT the Company be asked to inform the Council of the intention to either drill, test or undertake reinstatement;
3. THAT the monitoring of future consented activities at Cheal-B wellsite shall again include an ecological survey;
4. THAT subject to the findings of any further activity at the Cheal-B wellsite, the option for review of consents 6813-1, 6814-1, 6815-1, 6816-1, 6817-1, and 7907-1 in June 2016 not be exercised, on the grounds that current conditions are adequate to ensure environmental protection.

Glossary of common terms and abbreviations

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

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

l/s	litres per second
MCI	macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats
mS/m	millisiemens per metre
Mixing zone	the zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
NH ₄	ammonium, normally expressed in terms of the mass of nitrogen (N)
NH ₃	unionised ammonia, normally expressed in terms of the mass of nitrogen (N)
NO ₃	nitrate, normally expressed in terms of the mass of nitrogen (N)
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water
O&G	oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons)
Pb*	lead
pH	a numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment
PM ₁₀	relatively fine airborne particles (less than 10 micrometre diameter)
Resource consent	refer Section 87 of the RMA. Resource 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

CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz

Please quote our file number
on all correspondence

Name of Consent Holder: Cheal Petroleum Limited
1407-1050 Burrard Street
Vancouver BC
CANADA V6Z 253

New Address:
P O Box 262
Stratford 4352

Consent Granted Date: 23 March 2006

Conditions of Consent

Consent Granted: To discharge drilling muds, drilling cuttings and drilling wastes from hydrocarbon exploration activities at the Cheal-B wellsite onto and into land via mix bury cover at or about (NZTM) 1712585E-5640816N

Expiry Date: 1 June 2022

Review Date(s): June 2010, June 2016

Site Location: Cheal-B wellsite, 2 Taylor Road, Stratford
[Property owner: RC & CA Taylor]

Legal Description: Lot 1 DP 18576 Lots 1& 2 DP 20526 Blk VI Ngaere SD

Catchment: Patea

Tributary: Ngaere

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

Consent 6817-1

General conditions

- a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
 - i) the administration, monitoring and supervision of this consent; and
 - ii) charges authorised by regulations.

Special conditions

1. This consent allows for the discharge of up to 3000 m³ of solid drilling wastes [including drill cuttings and residual fluids] by way of mix-bury-cover into land on the Cheal-B wellsite and surrounding land.
2. Prior to the exercise of this consent for each separate mix-bury-cover discharge the consent holder shall provide to the written satisfaction of the Chief Executive, Taranaki Regional Council, a report describing proposed mix-bury-cover, including area, location, nature of material, means of compliance with conditions, etc, and the results of any relevant monitoring of existing mix-bury-cover discharge sites under this consent. In any case additional mix-bury-cover discharges shall not take place under this consent within 12 months of any previous mix-bury-cover discharge, unless this requirement is waived in writing by the Chief Executive, Taranaki Regional Council.
3. The consent holder shall ensure that the discharge, licensed by this consent, takes place in general accordance with the information submitted in support of application 4121. In particular but without limitation, any amendment to the location of the mix-bury-cover site, pre-treatment of solids, changes to fluids/additives, method of mix-bury-cover, or post burial site management, shall be advised to the Chief Executive, Taranaki Regional Council, prior to any discharge to the mix-bury-cover site, and shall not provide or result in any less environmental protection than that set out or provided for in the information submitted in support of application 4121.
4. The consent holder shall notify the Taranaki Regional Council at least 48 hours prior to commencement, and upon completion of the discharge to the mix-bury-cover site[s].

Consent 6817-1

5. The consent holder shall keep records of the composition and volumes of the material to be discharged, including records of quantities and types of drilling fluids and additives used [materials and their composition], and shall forward the records to the Taranaki Regional Council prior to the discharge.
6. The edge of the mix-bury-cover zone shall be at least 30 metres from any surface water body, spring, or any pre-existing groundwater supply bore.
7. All ponded water shall be removed from the drilling waste holding receptacle prior to the recovery/mixing operation.
8. If sumps are used as drilling waste holding receptacles on the site, and the sump is to be used for a disposal area, the impermeable liner shall be perforated, and where possible removed, so that it no longer encloses the solid drilling wastes.
9. The solid drilling wastes [drill cuttings and residual fluids] shall be incorporated with uncontaminated soils with a mixing ratio of 1 part solid drilling wastes [drill cuttings, additives and residual fluids] to a minimum of 3 parts uncontaminated soil.
10. The placement of the solid drilling wastes [drill cuttings and residual fluids] shall, as far as practicable, be above the watertable.
11. The total loading of trace elements in the solid drilling wastes to be disposed of in the mix-bury-cover operation shall not exceed those listed in Table 3-1 of the Alberta Energy and Utilities Board, 1996, G-50 guidelines.
12. The loading of chloride must not exceed 1,600 kg for each distinct mix-bury-cover disposal area for wastes from an individual well.
13. The loading of nitrogen must not exceed 400 kg for each distinct mix-bury-cover disposal area for wastes from an individual well.
14. The hydrocarbon content of the soil waste mix shall not exceed 0.0015% [15 mg/kg] on a dry weight basis.
15. The exercise of this consent shall not result in a level of total dissolved salts within any surface water or ground water of more than 2500 gm⁻³.
16. The disposal of solid drilling wastes shall comply with the heavy metal receiving environment concentration limits specified in Table C, Section 9, Public Guidelines for the Safe Use of Sewage Effluent and Sewage Sludge on Land, Ministry of Health, 1992.

Consent 6817-1

17. The solid drilling wastes [drill cuttings and residual fluids] shall be covered by at least one metre of uncontaminated soil, and shall be revegetated and thereafter maintained with pasture cover within 6 months of the completion of any mix-bury-cover operation.
18. The consent holder shall compact and contour the cover material such that all surface stormwater is directed away from the mix-bury-cover site and shall maintain the cover layer of soil so as to ensure its integrity at all times to the satisfaction of the Chief Executive, Taranaki Regional Council.
19. 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 adverse effects on the environment arising from the discharge, including but not limited to any water body or soil.
20. The exercise of this consent shall not lead, or be liable to lead, to a direct discharge of contaminants to a surface water body.
21. The exercise of this consent shall not result in any adverse impacts on groundwater as a result of leaching, or on surface water including aquatic ecosystems, and/or result in a change to the suitability of use of the receiving water as determined by the Chief Executive, Taranaki Regional Council.
22. At any time the levels of hydrocarbons in the soil shall comply with the guideline values for the designated soil type in the surface layer [less than 0.5 metre depth] 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].
23. At any time the upper [less than 0.5 metre depth] soil levels shall not exceed the following limits: conductivity 290 mSm⁻¹; total dissolved salts 2500 gm⁻³; sodium 460 gm⁻³; and chloride 700 gm⁻³.
24. The consent holder may apply to the Taranaki Regional Council for a change or cancellation of any of the conditions of this consent in accordance with section 127(1)(a) of the Resource Management Act 1991 to take account of operational requirements or the results of monitoring.
25. The Taranaki Regional Council may review any or all of the conditions of this consent within two months of receiving data on the volume and composition of the material under condition 5 for the purpose of assessing the adequacy of monitoring and mitigation measures.

Consent 6817-1

26. This consent shall lapse on the expiry of five years after the date of issue of this consent, 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.

27. 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 2010 and/or 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 28 October 2009

For and on behalf of
Taranaki Regional Council



Director ~~Resource Management~~



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

CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz

Please quote our file number
on all correspondence

Name of
Consent Holder: Cheal Petroleum Limited
P O Box 402
NEW PLYMOUTH 4340



Decision Date
[Change]: 24 August 2011

Commencement
Date [Change]: 24 August 2011 [Granted: 23 March 2006]

Conditions of Consent



Consent Granted: To discharge emissions to air from flaring of hydrocarbons and miscellaneous emissions associated with drill stem testing, well clean up, initial well testing and production testing associated with up to 14 wells at the Cheal-B wellsite at or about (NZTM) 1712640E-5640861N

Expiry Date: 1 June 2022

Review Date(s): June 2016

Site Location: Cheal-B wellsite, 2 Taylor Road, Stratford
[Property owner: RC & CA Taylor]

Legal Description: Lot 1 DP 18576 Lots 1 & 2 DP 20526 Blk VI Ngaere SD
[Discharge source & site]

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

General condition

- a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
 - i) the administration, monitoring and supervision of this consent; and
 - ii) charges authorised by regulations.



Special conditions

Duration

1. This consent shall not be exercised for more than an accumulated duration of 15 days per zone, allowing 3 zones to be tested per well, for up to 14 wells. The time interval specified in this condition refers to that period during which this consent is exercised and is not regarded as continuous elapsed time from the first exercise of this consent.

Information and notification

2. Prior to the commencement of testing, the consent holder shall supply to the Chief Executive, Taranaki Regional Council, a final site layout plan, demonstrating configuration of the facilities and equipment so as to avoid or mitigate the potential effects of air emissions.
3. The Taranaki Regional Council shall be notified within 24 hours prior to the initial flaring of each zone being commenced.
4. At least 24 hours prior to any flaring, the consent holder shall undertake all practicable measures to notify residents within 1000 metres of the wellsite of the commencement of flaring. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and/or complaints received.
5. No alteration shall be made to plant equipment or processes which may substantially alter the nature or quantity of flare emissions or other wellsite emissions, including but not limited to the recovery of produced gas, other than as notified in this consent application, without prior consultation with the Chief Executive, Taranaki Regional Council.

Flaring

6. Other than for the maintenance of a pilot flare flame, the consent holder shall have regard to the prevailing and predicted wind speed and direction at the time of initiation of any episode of flaring or other combustion of hydrocarbons.
7. All gas being flared, at any time during well clean-up, drill stem testing, initial testing, or production testing, or at any other time, must first be treated by effective liquid and solid separation and recovery, as far as is practicable to ensure that smoke emission during flaring is minimised.
8. If separation cannot be implemented and/or maintained at any time while there is a flow from the well, whether natural or induced, then the consent holder shall notify the Chief Executive, Taranaki Regional Council, and shall in any case re-establish liquid separation and recovery within three hours.
9. No liquid or solid hydrocarbons shall be combusted through the gas flare system.
10. As soon as is practicable after flow commences, the separated gas shall be combusted so that emissions of smoke are minimised.
11. 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 the flare emission, emissions from the flare pit, or any other emissions from the wellsite [including use of a separator during well clean-up]. This requirement applies in addition to any of the specific requirements set out in conditions 1, 6, 7, 8, 9 and 10.
12. Only substances originating from the well stream and treated as outlined by conditions 7, 8, 9, 10 and 11 are to be combusted within the flare pit.
13. The consent holder shall not discharge any contaminant to air authorised by this consent at a rate or a quantity such that the contaminant, whether alone or in combination with other contaminants, is or is liable to be hazardous or toxic or noxious at or beyond the boundary of the wellsite, or beyond 100 metres of the flare, whichever distance is greater.
14. There shall not be any offensive odour or smoke, as determined by an enforcement officer of the Taranaki Regional Council, beyond the boundary of the wellsite or beyond 100 metres of the flare, whichever distance is greater, arising from the exercise of this consent
15. The opacity of any smoke emissions shall not exceed a level of 1 as measured on the Ringelmann Scale for more than four minutes cumulative duration in any 60-minute period.
16. The consent holder shall control all emissions of carbon monoxide to the atmosphere from the flare, whether alone or in conjunction with any other emissions from the wellsite, in order that the maximum ground level concentration of carbon monoxide arising from the exercise of this consent measured under ambient conditions does not exceed 10 mg/m³ [eight-hour average exposure], or 30 mg/m³ one-hour average exposure] at or beyond the boundary of the wellsite or beyond 100 metres from the flare, whichever distance is greater.

17. The consent holder shall control all emissions of nitrogen oxides to the atmosphere from the flare, whether alone or in conjunction with any other emissions from the wellsite, in order that the maximum ground level concentration of nitrogen dioxide arising from the exercise of this consent measured under ambient conditions does not exceed 100 mg/m³ [24-hour average exposure], or 200 mg/m³ [1-hour average exposure] at or beyond the boundary of the wellsite, or beyond 100 metres from the flare, whichever distance is greater.
18. The consent holder shall control emissions to the atmosphere from the wellsite and flare of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides, whether alone or in conjunction with any emissions from the flare, in order that the maximum ground level concentration for any particular contaminant arising from the exercise of this consent measured at or beyond the boundary of the wellsite or beyond 100 metres from the flare, whichever distance is greater, is not increased above background levels:
 - a) by more than 1/30th of the relevant Occupational Threshold Value-Time Weighted Average, or by more than the Short Term Exposure Limit at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour]; or
 - b) if no Short Term Exposure Limit is set, by more than three times the Time Weighted Average at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour].

Recording and reporting information

19. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and crude oil stream from the field, covering sulphur compound content and the content of carbon compounds of structure C₆ or higher number of compounds.
20. The consent holder shall keep and make available to the Chief Executive, Taranaki Regional Council, upon request, a record of all smoke-emitting incidents noting time, duration and cause.
21. The consent holder shall keep and make available to the Chief Executive, Taranaki Regional Council, logs of all flaring, including time, duration and [as far as is practicable] volumes of substances flared.

Lapse and Review

22. This consent shall lapse on the expiry of five years after the date of issue of this consent, 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.

Consent 6813-1

23. 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 2010 and/or 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.

Signed at Stratford on 24 August 2011

For and on behalf of
Taranaki Regional Council



Director-Resource Management



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

CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz

Please quote our file number
on all correspondence

Name of
Consent Holder: Cheal Petroleum Limited
P O Box 402
NEW PLYMOUTH 4340

Decision Date: 25 August 2011

Commencement
Date: 25 August 2011

Conditions of Consent

Consent Granted: To discharge stormwater and sediment from earthworks during expansion of the Cheal-B wellsite onto and into land in the vicinity of the Ngaere Stream in the Patea catchment at or about (NZTM) 1712638E-5640842N

Expiry Date: 1 June 2016

Site Location: Cheal-B wellsite, Taylor Road, Stratford

Legal Description: Lot 1 DP 18576 Blk VI Ngaere SD
[Discharge source & site]

Catchment: Patea

Tributary: Ngaere

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 to section 36 of the Resource Management Act.

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment associated with the discharge of contaminants from the site.
2. 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.
3. The obligation described in condition 2 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 3 and 4 "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.

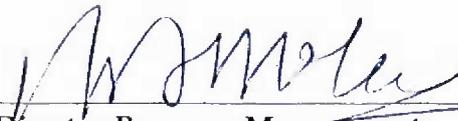
4. All earthworked areas shall be stabilised vegetatively or otherwise as soon as is practicable immediately following completion of soil disturbance activities.

Consent 7907-1

5. At least 7 working days prior to the commencement of earthworks 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.

Signed at Stratford on 25 August 2011

For and on behalf of
Taranaki Regional Council



Director-Resource Management



Discharge Permit
Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
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Please quote our file number
on all correspondence

Name of Consent Holder: Cheal Petroleum Limited
1407-1050 Burrard Street
Vancouver BC
CANADA V6Z 2S3

New Address:
P O Box 402
New Plymouth 4340

Consent Granted Date: 23 March 2006

Conditions of Consent

Consent Granted: To discharge stormwater and sediment from earthworks during construction of the Cheal-B wellsite onto and into land in the vicinity of an unnamed tributary of the Ngaere Stream and the Ngaere Stream in the Patea catchment at or about (NZTM) 1712621E-5640731N

Expiry Date: 1 June 2022

Review Date(s): June 2010, June 2016

Site Location: Cheal-B wellsite, 2 Taylor Road, Stratford
[Property owner: RC & CA Taylor]

Legal Description: Lot 1 DP 18576 Lots 1& 2 DP 20526 Blk VI Ngaere SD

Catchment: Patea

Tributary: Ngaere

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

General conditions

- a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
 - i) the administration, monitoring and supervision of this consent; and
 - ii) charges authorised by regulations.

Special conditions

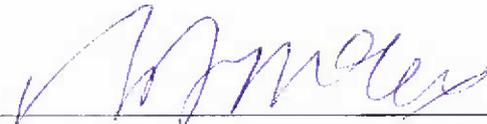
1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 the Resource Management Act 1991, to prevent or minimise the discharge of sediment to any surface water body and to prevent or minimise any adverse effects of the discharge on any surface water body.
2. Prior to the exercise of this consent, the consent holder shall provide for the written approval of the Chief Executive, Taranaki Regional Council, a site erosion and sediment control management plan.
3. The Chief Executive, Taranaki Regional Council, shall be advised in writing at least 7 days prior to wellsite and access works commencing.
4. After allowing for reasonable mixing, being a mixing zone extending seven times the width of the surface water body at the point of discharge, the discharge shall not give rise to any of the following effects in any surface water body:
 - a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
 - b) any conspicuous change in the colour or visual clarity;
 - c) any emission of objectionable odour;
 - d) the rendering of fresh water unsuitable for consumption by farm animals;
 - e) any significant adverse effects on aquatic life.
5. The design and management of the earthworks and control of the stormwater discharge shall be generally undertaken in accordance with the information submitted in support of application 4120, and to the satisfaction of the Chief Executive, Taranaki Regional Council.
6. All earthwork areas shall be stabilised vegetatively or otherwise as soon as is practicable immediately following completion of soil disturbance activities to the satisfaction of the Chief Executive, Taranaki Regional Council.

Consent 6816-1

7. This consent shall lapse on the expiry of five years after the date of issue of this consent, 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.
8. 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 2010 and/or 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 28 October 2009

For and on behalf of
Taranaki Regional Council



Director-Resource Management



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

CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz

Please quote our file number
on all correspondence

Name of Consent Holder: Cheal Petroleum Limited
1407-1050 Burrard Street
Vancouver BC
CANADA V6Z 2S3

New Address:
P O Box 402
New Plymouth 4340

Consent Granted Date: 23 March 2006

Conditions of Consent

Consent Granted: To discharge emissions to air during flaring from well workovers and in emergency situations and miscellaneous emissions associated with production activities at the Cheal-B wellsite at or about (NZTM) 1712688E-5640749N

Expiry Date: 1 June 2022

Review Date(s): June 2010, June 2016

Site Location: Cheal-B wellsite, 2 Taylor Road, Stratford
[Property owner: RC & CA Taylor]

Legal Description: Lot 1 DP 18576 Lot 1 2 DP 20526 Blk VI Ngaere SD

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

General conditions

- a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, **within** the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
 - i) the administration, monitoring and supervision of this consent; and
 - ii) charges authorised by regulations.

Special conditions

Information and notification

1. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least one month prior to the establishment of production operations at the Cheal-B wellsite.
2. At least 24 hours prior to any flaring, other than in emergencies, the consent holder shall undertake all practicable measures to notify residents within 1000 metres of the site of the commencement of flaring. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and/or complaints received.
3. The consent holder shall, whenever practicable, 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, as far as practicable, be no less than 24 hours prior to such flaring being commenced.
4. No alteration shall be made to plant equipment or processes which may substantially alter the nature or quantity of flare emissions or other site emissions, including but not limited to the recovery of produced gas, other than as notified in this consent application, without prior consultation with the Chief Executive, Taranaki Regional Council, and the consent holder shall obtain any necessary approvals under the Resource Management Act 1991.

Emissions from the site

5. Other than for the maintenance of a pilot flare flame, the consent holder shall have regard to the prevailing and predicted wind speed and direction at the time of initiation of any episode of flaring or other combustion of hydrocarbons.

Consent 6814-1

6. All gas being flared, at any time must first be treated by effective liquid and solid separation and recovery, as far as is practicable, to ensure that smoke emission during flaring is minimised.
7. If separation cannot be implemented and/or maintained at any time while there is a flow from the well, whether natural or induced, then the consent holder shall notify the Chief Executive, Taranaki Regional Council, and shall in any case re-establish liquid and solid separation and recovery within three hours.
8. Subject to special conditions 6 and 7, no liquid or solid hydrocarbons shall be combusted through the gas flare system other than in an emergency.
9. Only substances originating from the well stream and treated as outlined by conditions 6, 7, 8, and 10 shall be combusted within the flare pit.
10. 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 or any other emissions to air from the Cheal-B wellsite. Any adoption of the best practicable option as outlined in this special condition shall be to the satisfaction of the Chief Executive, Taranaki Regional Council.
11. The consent holder shall not discharge any contaminant to air authorised by this consent at a rate or a quantity such that the contaminant, whether alone or in combination with other contaminants, is or is liable to be hazardous or toxic or noxious at or beyond the boundary of the wellsite, or beyond 100 metres of the flare, whichever distance is greater.
12. There shall not be any offensive odour or smoke, as determined by an enforcement officer of the Taranaki Regional Council, beyond the boundary of the wellsite or beyond 100 metres of the flare, whichever distance is greater, arising from the exercise of this consent.
13. All hydrocarbon storage vessels shall be fitted with vapour recovery systems.
14. The opacity of any smoke emissions shall not exceed a level of 1 as measured on the Ringelmann Scale for more than four minutes cumulative duration in any 60-minute period.
15. The consent holder shall control all emissions of carbon monoxide to the atmosphere from the flare, whether alone or in conjunction with any other emissions from the wellsite, in order that the maximum ground level concentration of carbon monoxide arising from the exercise of this consent measured under ambient conditions does not exceed 10 mg/m³ [eight-hour average exposure], or 30 mg/m³ one-hour average exposure] at or beyond the boundary of the wellsite or beyond 100 metres from the flare, whichever distance is greater.

Consent 6814-1

16. The consent holder shall control all emissions of nitrogen oxides to the atmosphere from the flare, whether alone or in conjunction with any other emissions from the wellsite, in order that the maximum ground level concentration of nitrogen dioxide arising from the exercise of this consent measured under ambient conditions does not exceed 100 mg/m³ [24-hour average exposure], or 200 mg/m³ [1-hour average exposure] at or beyond the boundary of the wellsite, or beyond 100 metres from the flare, whichever distance is greater.
17. The consent holder shall control emissions to the atmosphere from the wellsite and flare of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides, whether alone or in conjunction with any emissions from the flare, in order that the maximum ground level concentration for any particular contaminant arising from the exercise of this consent measured at or beyond the boundary of the wellsite or beyond 100 metres from the flare, whichever distance is greater, is not increased above background levels:
 - a) by more than 1/30th of the relevant Occupational Threshold Value-Time Weighted Average, or by more than the Short Term Exposure Limit at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour]; or
 - b) if no Short Term Exposure Limit is set, by more than three times the Time Weighted Average at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour].
18. The flare pit shall be located 300 metres from all dwellinghouses. In this case the flare pit should be 300 metres from the Vosseler/Turner dwelling-house [Legal Description 1 DP 19529 Blk VI Ngaere SD] and the Frost dwelling-house [Legal Description Lot 1 DP 19125 Blk VI Ngaere SD].

Recording and reporting information

19. The consent holder shall keep and make available to the Chief Executive, Taranaki Regional Council, upon request, a record of all smoke-emitting incidents noting time, duration and cause.
20. The consent holder shall keep and maintain a log of all continuous flaring incidents longer than five minutes, and any intermittent flaring lasting for an aggregate of ten minutes or longer in any 120-minute period. Such a log shall contain the date, the start and finish times, the quantity and type of material flared, and the reason for flaring. This log shall be made available to the Chief Executive, Taranaki Regional Council, upon request, and summarised annually in the report required under condition 21.

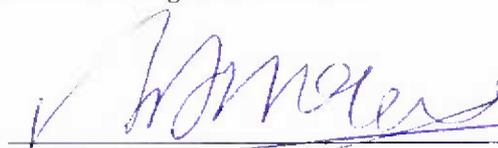
21. The consent holder shall provide to the Taranaki Regional Council during May of each year, for the duration of this consent, a report:
- i) detailing any energy efficiency measures implemented on the site;
 - ii) detailing smoke emissions as required under condition 19;
 - iii) detailing any measures to reduce smoke emissions;
 - iv) detailing any measures to reduce flaring;
 - v) addressing any other issue relevant to the minimisation or mitigation of emissions from the flare;
 - vi) detailing any complaints received and any measures undertaken to address complaints; and
 - vii) reviewing all options and technological advances relevant to the reduction or mitigation of any discharge to air from the site, how these might be applicable and/or implemented at the site, and the benefits and costs of these advances.
22. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and crude oil stream from the field, covering sulphur compound content and the content of carbon compounds of structure C₆ or higher number of compounds.

Lapse and Review

23. This consent shall lapse on the expiry of 16 years after the date of issue of this consent, 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.
24. 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 2010 and/or 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 28 October 2009

For and on behalf of
Taranaki Regional Council



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: Cheal Petroleum Limited
 P O Box 402
 NEW PLYMOUTH 4340

Decision Date 18 September 2013
(Change):

Commencement Date 18 September 2013 (Granted: 23 March 2006)
(Change):

Conditions of Consent

Consent Granted: To discharge treated stormwater and treated produced
 water from hydrocarbon exploration and production
 operations at the Cheal-B wellsite onto and into land in the
 vicinity of the Ngaere Stream in the Patea catchment

Expiry Date: 1 June 2022

Review Date(s): June 2016

Site Location: Cheal-B wellsite, 2 Taylor Road, Stratford
 (Property owner: RC & CA Taylor)

Legal Description: Lot 1 DP 18576 Lots 1& 2 DP 20526 Blk VI Ngaere SD
 (Discharge source & site)

Grid Reference (NZTM) 1712675E-5640813N

Catchment: Patea

Tributary: Ngaere

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

General conditions

- a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
 - i) the administration, monitoring and supervision of this consent; and
 - ii) charges authorised by regulations.

Special conditions

1. 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 adverse effects of the discharge.
2. The maximum stormwater catchment area shall be no more than 15,000 m².
3. The Chief Executive, Taranaki Regional Council, shall be advised in writing at least 7 days prior to any site works commencing, and again in writing at least 7 days prior to any well drilling operation commencing.
4. Prior to the exercise of this consent, the consent holder shall provide for the written approval of the Chief Executive, Taranaki Regional Council, site specific details relating to contingency planning for the wellsite.
5. All stormwater and produced water to be discharged under this permit shall be directed for treatment through the stormwater treatment system for discharge in accordance with the special conditions of this consent.
6. Any above ground hazardous substances storage areas shall be bunded with drainage to sumps, or other appropriate recovery systems, and not to the stormwater catchment.
7. The following concentrations shall not be exceeded in the discharge:

Component	Concentration
pH (range)	6.5 - 8.5
suspended solids	100 gm ⁻³
total recoverable hydrocarbons (infrared spectroscopic technique)	15 gm ⁻³
chloride	50 gm ⁻³

This condition shall apply prior to the entry of the treated stormwater and produced water either onto and into land, or into surface water, at a designated sampling point approved by the Chief Executive, Taranaki Regional Council.

8. After allowing for reasonable mixing, within a mixing zone extending seven times the width of the water body downstream of a designated discharge point, the discharge shall not give rise to an increase in temperature of more than 2 degrees Celsius.
9. After allowing for reasonable mixing, within a mixing zone extending seven times the width of the water body downstream of a designated discharge point, the discharge shall not give rise to any of the following effects in the receiving waters:
 - a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
 - b) any conspicuous change in the colour or visual clarity;
 - c) any emission of objectionable odour;
 - d) the rendering of fresh water unsuitable for consumption by farm animals;
 - e) any significant adverse effects on aquatic life.
10. The discharge onto and into land shall occur a minimum of 30 metres from any surface water body. Discharge shall be onto and into land and there shall be no direct discharge to surface water.
11. The Chief Executive, Taranaki Regional Council, shall be advised in writing at least 48 hours prior to the reinstatement of the site and the reinstatement shall be carried out so as to minimise effects on stormwater quality.
12. This consent shall lapse on the expiry of five years after the date of issue of this consent, 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 2010 and/or 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.

Signed at Stratford on 18 September 2013

For and on behalf of
Taranaki Regional Council



Director-Resource Management

Appendix II

Biomonitoring Survey reports

To Job Manager, Callum MacKenzie
 From Scientific Officer – Freshwater Biology, Katrina Smith
 Document 1060811
 Report No KS005
 Date 30 September 2014

Biomonitoring of the Ngaere Stream following drilling by Cheal Petroleum Limited at the Cheal-B well site, February 2012

Introduction

This biological survey was performed following completion of drilling at the Cheal-B well site, 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 stream have had a detrimental effect upon the communities of the stream.

A survey was conducted in December 2011 prior to drilling, to provide baseline data on the macroinvertebrate community of the reach of the Ngaere Stream adjacent to the well site (Smith, 2012).

Methods

This post-drill survey was undertaken on 9 February 2012 at three sites established at the time of the pre-drill survey (Table 1 and Figure 1).

The standard ‘vegetation sweep’ sampling technique was used at site 1 to collect streambed macroinvertebrates (Table 1, Figure 1). This ‘sweep-net’ technique is very similar to Protocol C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

A combination of ‘vegetation sweep’ sampling and ‘kick-sampling’ was used at sites 2 and 3. The standard ‘kick-sampling’ technique is very similar to protocol C1 (hardbottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1 Biomonitoring sites in the Ngaere Stream related to the Cheal-B well site

Site No.	Site code	Grid reference (NZTM)	Location	Sampling method	Time of Sampling (NZST)	Temperature (°C)
1	NGR000010	1712709E-5640717N	5m u/s of Cheal-B well site	Sweep	12.50	15.8
2	NGR000012	1712740E-5640761N	10m d/s Cheal-B well site discharge	Kick-sweep	12.30	15.7
3	NGR000014	1712891E-5640691N	180m d/s of Cheal-B well site discharge	Kick-sweep	11.55	16.0

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

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

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

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

A semi-quantitative MCI value (SQMCI_s) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the SQMCI_s 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 early afternoon (1155 to 1250) survey the water temperatures in the Ngaere Stream ranged between 15.7°C and 16.0°C. A cloudy, uncoloured moderate flow of water was present at all sites. Substrate composition at all three sites comprised silt, sand, and fine gravels, although at site 2 the substrate also included root material.

Periphyton growth was limited to only filamentous algae at site 1, with no periphyton recorded at sites 2 and 3. At sites 1 and 3, macrophyte growth was recorded in the bed and at the edges of the stream, whereas no macrophyte growth was recorded at site 2. Sites 1 and 3 were partially shaded and site 2 completely shaded by a mixture of native regenerating scrub and exotics.



Figure 1 Biomonitors sites in the Ngaere Stream sampled in relation to the Cheal-B well site

Macroinvertebrate communities

Table 2 summarises the results of the macroinvertebrate survey performed prior to and following drilling of at the Cheal-B wellsite, with the results of this February 2012 survey presented in Table 4. Table 3 summarises statistics for lowland stream control sites located at a similar altitude to the sample sites ((TRC,1999 (updated 2011)).

Table 2 Number of taxa, MCI and SQMCI_s values for the Unnamed Tributary prior to and following drilling at Cheal-B well site

Site No.	Site Code	No of taxa		MCI value		SQMCI _s value	
		Pre-drill (Dec 11)	Post-drill (Feb 12)	Pre-drill (Dec 11)	Post-drill (Feb 12)	Pre-drill (Dec 11)	Post-drill (Feb 12)
1	NGR000010	33	20	81	82	2.2	2.2
2	NGR000012	31	16	90	93	4.3	4.7
3	NGR000014	21	26	74	85	3.8	4.0

Table 3 Range and median number of taxa, MCI values and SQMCI_s scores for smaller lowland stream control sites at a similar altitude ((TRC, 1999 (updated 2011)).

	No. of taxa	MCI value	SQMCI _s value
No. samples	159	159	75
Range	5-29	52-108	1.5-6.3
Median	18	78	4.1

Table 4 Macroinvertebrate fauna of the Ngaere Stream in relation to the Cheal-B post-drill survey sampled on 9 February 2012

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3
	Site Code		NGR000010	NGR000012	NGR000014
	Sample Number		FWB12097	FWB12098	FWB12099
NEMERTEA	Nemertea	3	-	C	C
ANNELIDA (WORMS)	Oligochaeta	1	VA	A	A
	Lumbricidae	5	-	A	-
MOLLUSCA	Lymnaeidae	3	R	-	-
	<i>Physa</i>	3	-	-	C
	<i>Potamopyrgus</i>	4	C	VA	XA
CRUSTACEA	Copepoda	5	R	-	-
	Ostracoda	1	A	-	VA
	<i>Paracalliope</i>	5	A	-	XA
	Paraleptamphopidae	5	C	VA	-
	Talitridae	5	-	-	R
	<i>Paranephrops</i>	5	-	-	A
EPHEMEROPTERA (MAYFLIES)	<i>Austroclima</i>	7	-	C	R
	<i>Zephlebia</i> group	7	C	A	C
ODONATA (DRAGONFLIES)	<i>Antipodochlora</i>	5	-	-	R
	<i>Xanthocnemis</i>	4	R	-	R
	<i>Hemicordulia</i>	5	R	-	-
HEMIPTERA (BUGS)	<i>Microvelia</i>	3	R	-	R
COLEOPTERA (BEETLES)	Dytiscidae	5	-	-	R
	Hydraenidae	8	-	-	R
TRICHOPTERA (CADDISFLIES)	<i>Hydrobiosis</i>	5	-	C	R
	<i>Orthopsyche</i>	9	-	A	-
	<i>Polypsectropus</i>	6	R	-	R
	<i>Psilochorema</i>	6	R	R	R
	Oeconesidae	5	-	R	-
	<i>Oxyethira</i>	2	A	C	A
	<i>Paroxyethira</i>	2	-	-	C
	<i>Triplectides</i>	5	C	R	C
	DIPTERA (TRUE FLIES)	Hexatomini	5	-	R
	<i>Paralimnophila</i>	6	R	-	-
	<i>Zelandotipula</i>	6	-	-	C
	Orthoclaadiinae	2	R	C	C
	<i>Polypedilum</i>	3	-	-	R
	Tanypodinae	5	R	-	-
	<i>Paradixa</i>	4	R	-	C
	<i>Austrosimulium</i>	3	C	C	VA
No of taxa			20	16	26
MCI			82	93	85
SQMCIs			2.2	4.7	4.0
EPT (taxa)			4	7	6
%EPT (taxa)			20	44	23
'Tolerant' taxa		'Moderately sensitive' taxa		'Highly sensitive' taxa	

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

Site 1- 5 metres upstream of discharge

A total of twenty taxa was found at site 1 which was a decrease of 13 taxa from the pre-drill survey conducted in December 2011 (Table 2). Six of the taxa recorded at site one in the pre-drill survey decreased markedly in abundance in this post-drill survey. These taxa included the sandfly larvae (*Austrosimulium*), three other true flies (*Chironomus*, Orthocladiinae and Tanyptodinae), a beetle (*Dytiscidae*) and a dragonfly (*Xanthocnemis*).

Half of the macroinvertebrate community at site 1 consisted of 'sensitive' taxa which is consistent with the moderately high MCI score of 82 units. This MCI score was similar to the MCI score of 81 units recorded at site 1 in the pre-drill survey. The MCI scores recorded at site 1 in both surveys were significantly higher (Stark, 1998) than the median MCI score for other lowland stream control sites at a similar altitude (Table 3).

In this survey, the macroinvertebrate community was dominated by 'tolerant' oligochaete worms which were recorded as very abundant (Table 4). Other taxa recorded as abundant were the 'sensitive' amphipod *Paracalliope* and two 'tolerant' taxa, ostracod seed shrimp and the caddisfly *Oxyethira*. The numerical dominance of the more 'tolerant' taxa (oligochaete worms) at site 1 has resulted in a low SQMCI_s score of 2.2 units which has remained unchanged between the two surveys. In reference to Table 3, this SQMCI_s score was significantly lower (Stark, 1998) than the median SQMCI_s score for other lowland control sites ((TRC, 1999 (updated 2011)).

Site 2 – 10 metres downstream of discharge

Sixteen taxa were recorded at site 2. This result represented a marked decrease in taxa richness from the pre-drill survey of thirty one taxa (Table 2). The decline in taxa richness recorded at site 2 was most likely due to habitat variability between the two surveys.

Two taxa dominated the community at site 2; the snail (*Potamopyrgus*), amphipods Paraleptamphopidae were very abundant (Table 4). Two worms (Oligochaete and Lumbricidae), the mayfly *Zephelbia*, and a caddisfly *Orthopsyche* were also recorded as abundant. The majority of these taxa decreased by one abundance category in this survey from the pre-drill survey.

A small increase in the proportion of 'sensitive' taxa in the community was recorded in this survey (62%) compared to the pre-drill survey (54%) (Table 2). This was reflected in a slight increase of 3 units in the MCI score for the site between the pre-drill and the post-drill surveys. The MCI score recorded at site 2 in this survey (93 units) is significantly higher (Stark, 1998) than that recorded at site one (82 units) and compared to the median MCI score for other lowland control sites (78 units) ((TRC, 1999 (updated 2011)).

The SQMCI_s score slightly increased from the pre-drill survey, due mainly to the increase in abundance of one 'highly sensitive' taxon ((caddisfly (*Orthopsyche*)), and the decrease in abundance of 'tolerant' taxa such as the sandfly larvae (*Austrosimulium*), the didix fly (*Paradixa*) and oligochaete worms.

Site 3- 180 metres downstream of discharge

A richness of twenty six taxa was recorded for site 3 (Table 2). This was similar to the taxa richness (21 taxa) recorded at the site in the pre-drill survey. The community at this site was dominated by the 'moderately sensitive' amphipod (*Paracalliope*) and three 'tolerant' taxa, the snail (*Potamopyrgus*), ostracod seed shrimps and sandfly larvae (*Austrosimulium*) (Table 4).

Two 'moderately sensitive' taxa ((the caddisfly (*Oxyethira*) and freshwater crayfish (*Paranephrops*)) and one 'tolerant' taxon, oligochaete worms were also recorded as abundant.

The community contained a moderate proportion of 'sensitive' taxa (50%), which resulted in an MCI score of 85 units. This MCI score is significantly higher than the MCI score of 74 units recorded at this site by the pre-drill survey, due to an increase in the proportion of 'sensitive' taxa in this survey. The MCI score for site 3 was similar to that at site 1 and was significantly higher (Stark, 1998) than the median MCI score for other lowland streams ((TRC, 1999 (updated 2011)) (Table 3). The SQMCI_s score of 4.0 units recorded for this survey represented only a minor increase in the SQMCI_s from the pre-drill survey.

Summary and Conclusions

A combination of the Council's standard 'vegetation- sweep' and 'kick-sampling' techniques was used at three sites to collect streambed macroinvertebrates from the Ngaere Stream to assess whether skimmer pit discharges from the Cheal-B well site have had any adverse effects on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI and SQMCI_s scores for each site.

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

This February 2012 survey of three sites upstream and downstream of the skimmer pit discharge point to land near the stream was undertaken following completion of drilling at the Cheal-B wellsite.

All three sites contained a relatively moderate proportion of 'sensitive' taxa and recorded moderate MCI scores which significantly exceeded the median MCI score for other lowland streams at the same altitude. Differences observed in the macroinvertebrate communities between sites is likely to reflect the variation in habitat sampled.

A comparison of the pre-drill and post-drill survey results showed minimal variation in MCI and SQMCI_s scores for sites 1 and 2 between surveys. Taxa richness recorded at both sites decreased markedly from the pre-drill survey which is considered to be due to habitat variability rather than a change in water quality. For site 3, numbers of taxa and SQMCI_s score were similar between surveys. However, there was a significant increase in the MCI score for site 3 in the post-drill survey which was due to an increase in the proportion of 'sensitive' taxa present in the community.

Overall, these results indicate a reasonable water quality and are considered to be typical of what might be expected from a stream originating from a swampy area (i.e. Ngaere Swamp). There was no indication from the results of the two surveys that the discharge from the Cheal B wellsite has impacted on the biological communities of the Ngaere Stream.

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To Job Manager, Callum MacKenzie
 From Scientific Officer – Freshwater Biology, Katrina Smith
 Document 1011643
 Report No KS002
 Date 30 September 2014

Biomonitoring of the Ngaere Stream prior to drilling by Cheal Petroleum Limited at the Cheal-B well site, December 2011

Introduction

This biological survey was performed prior to drilling at the Cheal-B well site, to provide baseline data on the macroinvertebrate community of the reach of the Ngaere Stream in the vicinity of Cheal-B wellsite. An additional survey will be undertaken on completion of drilling activities at the site, 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 stream have had any detrimental effects upon the communities of the stream.

Methods

Cheal-B well site stormwater and site production water is to be discharged from a skimmer pit on to land within the vicinity of the Ngaere stream (Figure 1). The survey was undertaken on 21 December 2011 at three newly established sites, situated 5 m upstream of the well site discharge point (site 1), 10 m downstream of the well site discharge (site 2), and 180 m downstream of the discharge (site 3). It should be noted that there was a landfill site situated upstream of all three sites which is currently consented.

The standard 'vegetation sweep' sampling technique was used at site 1 to collect streambed macroinvertebrates in the Ngaere Stream upstream of the stormwater discharges from the Cheal-B well site (Table 1, Figure 1). The 'sweep-net' technique is very similar to Protocol C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

A combination of 'vegetation sweep' sampling and 'kick-sampling' was used at sites 2 and 3. The standard 'kick-sampling' technique is very similar to protocol C1 (hardbottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1 Biomonitoring sites in the Ngaere Stream related to the Cheal-B well site

Site No.	Site code	Grid reference (NZTM)	Location	Sampling method
1	NGR000010	1712709E-5640717N	5m u/s of Cheal-B well site	Sweep
2	NGR000012	1712740E-5640761N	10m d/s Cheal-B well site discharge	Kick-sweep
3	NGR000014	1712891E-5640691N	180m d/s of Cheal-B well site discharge	Kick-sweep

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

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

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

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

A semi-quantitative MCI value (SQMCI_s) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the SQMCI_s 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 afternoon (12.10 to 13.10 hrs) survey there was a clear, uncoloured moderate flow of water at all three sites. The substrate composition at site 1 was silt, at site 2 the substrate was predominantly tree root and wood and site 3 consisted of fine gravel, sand and silt.

Periphyton growth was limited to only slippery mats at site 3, with no periphyton recorded at sites 1 and 2. At sites 1 and 2, macrophyte growth was limited to the edges of the stream whereas macrophytes were recorded in the bed of the stream and on the banks at site 3. Sites 1 and 3 were partially shaded and site 2 completely shaded by a mixture of native regenerating scrub and exotics.



Figure 1 Biomonitoring sites in the Ngaere Stream sampled in relation to the Cheal-B well site

Macroinvertebrate communities

Table 2 summarises the results of the macroinvertebrate survey performed prior to drilling at the Cheal-B well site, with the full results of this December 2011 survey presented in Table 4. Table 3 summarises statistics for lowland stream control sites located at a similar altitude to the sample sites ((TRC, 1999 (updated 2011)).

Table 2 Number of taxa, MCI and SQMCI_s values for the Unnamed Tributary prior to drilling of Cheal-B well

Site No.	No taxa	MCI value	SQMCI _s value
1	33	81	2.2
2	31	90	4.3
3	21	74	3.8

Table 3 Range and median number of taxa, MCI values and SQMCI_s scores for smaller lowland stream control sites at a similar altitude ((TRC, 1999 (updated 2011)).

	No. of taxa	MCI value	SQMCI _s value
No. Samples	159	159	75
Range	5-29	52-108	1.5-6.3
Median	18	78	4.1

Site 1- 5 metres upstream of discharge

Thirty three taxa (33) were found at site 1 (Table 2). Almost half of the macroinvertebrate community consisted of 'sensitive' taxa (45%), which resulted in the moderate MCI score of 81 units. This MCI score was significantly higher than the median MCI for other lowland stream control sites at a similar altitude (Table 3).

'Tolerant' oligochaete worms were the most abundant taxa recorded at site 1. The 'sensitive' amphipod *Paracalliope* and two tolerant taxa (the ostracod seed shrimps and sandfly larvae (*Austromulium*)) were extremely abundant. The dominance of the more 'tolerant' taxa resulted in a low SQMCI_s score of 2.2 units. In reference to Table 3, this SQMCI_s score was significantly lower than the median SQMCI_s score for other lowland control sites ((TRC, 1999 (updated 2011))).

Site 2 – 10 metres downstream of discharge

A total of thirty-one taxa were found at site 2 (Table 2). This was similar to that recorded at site 1 upstream. Five taxa dominated the community at site 2; the snail *Potamopyrgus*, the amphipod *Paraleptamphopidae* were found to be extremely abundant, while oligochaete worms, mayfly (*Zephelbia* group) and sandfly larvae (*Austrosimulium*) were very abundant.

A moderate proportion of the community (54% of taxa) were 'sensitive' taxa which resulted in the MCI score (90 units) which was 9 units higher than the MCI score recorded at site 1 upstream and also significantly higher than the median MCI score for other lowland stream control sites ((TRC, 1999 (updated 2011))). The SQMCI_s score of 4.3 reflected the numerical dominance of 'sensitive' taxa in the community and was considerably higher than that recorded for site 1 (which was dominated by more 'tolerant' taxa). This SQMCI_s score was more typical of the median score for other lowland stream control sites (Table 3).

Site 3- 180 metres downstream of discharge

A lower richness of twenty one taxa was recorded for site 3. The community at this site was dominated by the 'moderately sensitive' amphipod (*Paracalliope*) and two 'tolerant' taxa, the snail (*Potamopyrgus*) and sandfly larvae (*Austrosimulium*) (Table 4). The 'moderately sensitive' taxa mayfly (*Zephelbia* group), and two 'tolerant' taxa ostracod seed shrimps and oligochaete worms were recorded as abundant.

The community was comprised of a very low proportion of 'sensitive' taxa (28%), which resulted in the MCI score of 74 units. This MCI score was significantly lower by 16 units than the MCI score recorded at site 2. The results indicate a marked decrease in the percentage of 'sensitive' taxa from site 2 (51%) to site 3 (28%). The main reason may have been due to the significant difference in substrate composition between the two sites; the substrate at site 2 was predominantly wood and roots while site 3 largely comprised fine gravels, sand and silt. The presence of a small dam located between sites 2 and 3 may also have limited the recruitment (by downstream drift) of more 'sensitive taxa' at site 3, downstream of the dam.

The SQMCI_s for site 3 of 3.8 units was slightly lower than the value at site 2 but well above the value found at site. The taxa richness, MCI and SQMCI_s scores recorded at site 3 were similar to the medians for other lowland control streams (Table 2).

Table 4 Macroinvertebrate fauna of the Ngaere Stream in relation to the Cheal-B pre-drill survey sampled on 21 December 2011

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3
	Site Code		NGR000010	NGR000012	NGR000014
	Sample Number		FWB11311	FWB11312	FWB11313
PLATYHELMINTHES	<i>Cura</i>	3	-	-	R
NEMERTEA	Nemertea	3	-	P	C
NEMATODA	Nematoda	3	R	R	C
ANNELIDA	Oligochaeta	1	XA	VA	A
	Lumbricidae	5	-	C	R
MOLLUSCA	Lymnaeidae	3	R	R	-
	<i>Physa</i>	3	R	R	R
	<i>Potamopyrgus</i>	4	C	XA	VA
CRUSTACEA	Copepoda	5	R	-	-
	Ostracoda	1	VA	C	A
	<i>Paracalliope</i>	5	VA	C	VA
	Paraleptamphopidae	5	A	XA	-
	Talitridae	5	-	R	-
EPHEMEROPTERA	<i>Austroclima</i>	7	-	C	-
	<i>Zephlebia</i> group	7	A	VA	A
PLECOPTERA	<i>Acroperla</i>	5	-	R	-
ODONATA	<i>Austrolestes</i>	4	R	-	-
	<i>Antipodochlora</i>	5	R	-	-
	<i>Xanthocnemis</i>	4	A	-	C
	<i>Procordulia</i>	5	C	-	-
HEMIPTERA	<i>Anisops</i>	5	R	-	-
	<i>Microvelia</i>	3	C	R	R
COLEOPTERA	Dytiscidae	5	A	R	-
	Hydrophilidae	5	-	R	-
	Ptilodactylidae	8	-	R	-
TRICHOPTERA	<i>Hydrobiosis</i>	5	R	C	-
	<i>Orthopsyche</i>	9	R	C	-
	<i>Plectrocnemia</i>	8	-	-	R
	<i>Polypsectropus</i>	6	C	R	-
	<i>Psilochorema</i>	6	C	C	-
	<i>Oxyethira</i>	2	C	-	-
	<i>Paroxyethira</i>	2	-	-	R
	<i>Triplectides</i>	5	C	C	R
	<i>Paralimnophila</i>	6	R	-	-
DIPTERA	<i>Zelandotipula</i>	6	-	R	-
	<i>Chironomus</i>	1	A	-	-
	Orthoclaadiinae	2	A	C	C
	<i>Polypedilum</i>	3	R	R	-
	Tanypodinae	5	A	-	-
	Ceratopogonidae	3	R	-	-
	Culicidae	3	C	-	-
	<i>Paradixa</i>	4	C	C	R
	Empididae	3	R	R	R
	Ephyridae	4	-	R	R
	<i>Austrosimulium</i>	3	VA	VA	VA
	ACARINA	Acarina	5	-	R
No of taxa			33	31	21
MCI			81	90	74
SQMCIs			2.2	4.3	3.8
EPT (taxa)			6	8	3
%EPT (taxa)			18	26	14
'Tolerant' taxa		'Moderately sensitive' taxa	'Highly sensitive' taxa		

Summary and Conclusions

A combination of the Council's standard 'vegetation-sweep' and 'kick-sampling' techniques was used at three sites to collect streambed macroinvertebrates from the Ngaere Stream to provide baseline data necessary for the later assessment of whether skimmer pit discharges from the Cheal-B well site might have had any adverse effects on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI and SQMCI_s scores for each site.

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

This December 2011 survey of three sites (upstream and downstream) of the intended skimmer pit discharge point to land near the stream was undertaken prior to drilling at the Cheal-B wellsite but following site construction.

Sites 1 and 2 were relatively similar in the macroinvertebrate community composition with both sites having relatively high taxonomic richnesses. However, site 2 recorded a higher MCI and a significantly higher SQMCI_s than site 1. This is likely to have been related to the better habitat at site 2. There was a marked decline in taxonomic richness at site 3 which also recorded the lowest MCI score of all three sites. In particular, there was a significant decrease in MCI score between sites 2 and 3 which is most likely due to a significant difference in the substrate composition between the two sites. The wood and root dominated substrate recorded at site 2 may have provided more suitable and stable habitat for more 'sensitive taxa' compared to site 3 which was largely comprised of fine gravels and sandy substrate. In addition to this, the presence of a dam between sites 2 and 3 may have impacted on the recruitment of 'sensitive taxa' at site 3, downstream of the dam.

The differences observed in the macroinvertebrate communities between the sites is likely to have reflected the variation in habitat. Overall, these results indicate a reasonable water quality and are considered to be typical of what might be expected from a stream with swamp headwaters.

Due to the variation between sites recorded in this survey, it is considered that the comparison of results from each site before and after drilling is the more useful way of assessing any potential impacts of the discharge from Cheal-B wellsite. Therefore, it is proposed that a survey will be conducted during and on completion of drilling and well-testing activities at Cheal-B wellsite to determine whether any discharges to land in the vicinity of the unnamed tributary have had any detrimental effects on the macroinvertebrate communities of this stream.

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To Job Manager; Callum MacKenzie
From Freshwater Biologist; Brooke Thomas
Document 1214698
Date 28 June 2013

Biomonitoring of the Ngaere Stream following drilling by Cheal Petroleum Limited at the Cheal-B well site, November 2012

Introduction

This biological survey was performed during on-going drilling operations at the Cheal-B wellsite, 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 Ngaere Stream had any effects upon the communities of the stream. This follow-up survey followed two previous surveys; one conducted prior to drilling (Smith, 2012), but following site preparation earthworks (to provide baseline data on the macroinvertebrate community of the stream), and the other following drilling activities at the Cheal-B wellsite (Smith, 2012).

Methods

To collect streambed macroinvertebrates in the Ngaere Stream (downstream of the stormwater discharges from the Cheal-B well site), two sampling methods were employed. The 'vegetation sweep' sampling technique was used at sites 1 and 3, while a combination of the 'vegetation sweep' and 'kick-sampling' technique was used at site 2 (Table 1, Figure 1). 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 Cheal-B wellsite stormwater and site production water was discharged from a skimmer pit on to land within the vicinity of the Ngaere Stream (Figure 1). This survey was undertaken on 16 November 2012 at three established sites; 5 m upstream of Cheal-B well site (site 1), 10 m downstream Cheal-B well site discharge (site 2), and 180 m downstream of Cheal-B well site discharge (site 3).

Table 1: Biomonitoring sites in the Ngaere Stream related to the Cheal-B well site

Site No.	Site code	Grid reference (NZTM)	Location	Sampling method	Time of Sampling (NZST)
1	NGR000010	1712709E-5640717N	5m u/s of Cheal-B well site	Sweep	1045
2	NGR000012	1712740E-5640761N	10m d/s Cheal-B well site discharge	Kick-sweep	1030
3	NGR000014	1712891E-5640691N	180m d/s of Cheal-B well site discharge	Sweep	1000



Figure 1 Biomonitoring sites in the Ngaere Stream sampled in relation to the Cheal-B well site

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

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

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

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

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

Results and discussion

At the time of this late morning survey, stream temperatures were recorded as 12.7°C (sites 1 and 2) and 12.3°C (site 3). A moderate flow of clear, uncoloured water was noted at all three sites. Substrate at site 1 was comprised predominantly of silt, with a small amount of sand. Substrate at site 2 was comprised predominantly of willow roots with equal amounts of silt, sand and fine and coarse gravels. At site 3, substrate was comprised predominantly of silt with equal amounts of sand and fine and coarse gravels. Slippery mats of periphyton were noted at sites 2 and 3 only. Macrophytes were noted at all three 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 during on-going drilling operations of the Cheal-B wellsite, along with results from the pre-drill and post-drill surveys. Comparative data for sites in similar streams in the region are presented in Table 3. The macroinvertebrate fauna recorded by the current survey are presented in Table 4.

Table 2: Number of taxa, MCI and SQMCI_s values for the Ngaere Stream prior to and following drilling of Cheal-B well.

Site no	Site code	No of taxa			MCI value			SQMCI _s value		
		Pre-drill (Dec 11)	Post-drill (Feb 12)	Follow-up (Nov 12)	Pre-drill (Dec 11)	Post-drill (Feb 12)	Follow-up (Nov 12)	Pre-drill (Dec 11)	Post-drill (Feb 12)	Follow-up (Nov 12)
1	NGR000010	33	20	24	81	82	93	2.2	2.2	5.7
2	NGR000012	31	16	19	90	93	86	4.3	4.7	4.5
3	NGR000014	21	26	21	74	85	79	3.8	4.0	3.0

Table 3: Range and median number of taxa, MCI values and SQMCI_s scores for smaller lowland stream control sites at a similar altitude ((TRC, 1999 (updated 2012)).

	No. of taxa	MCI value	SQMCI _s value
No. samples	167	167	81
Range	5-33	52-108	1.5-6.3
Median	18	78	4.1

Table 4: Macroinvertebrate fauna of the Ngaere Stream in relation to the Cheal-B follow-up survey sampled 16 November 2012.

Taxa List	Site Number	MCI score	1	2	3
	Site Code		NGR000010	NGR000012	NGR000014
	Sample Number		FWB12418	FWB12419	FWB12420
PLATYHELMINTHES (FLATWORMS)	<i>Cura</i>	3	R	R	-
NEMERTEA	Nemertea	3	-	R	R
NEMATODA	Nematoda	3	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	A	VA
	Lumbricidae	5	-	R	R
MOLLUSCA	<i>Gyraulus</i>	3	-	R	-
	<i>Physa</i>	3	R	-	R
	<i>Potamopyrgus</i>	4	C	XA	C
CRUSTACEA	Ostracoda	1	-	-	A
	<i>Paracalliope</i>	5	C	A	VA
	Paraleptamphopidae	5	A	VA	-
	<i>Paranephrops</i>	5	R	-	R
EPHEMEROPTERA (MAYFLIES)	<i>Austroclima</i>	7	-	A	R
	<i>Neozephlebia</i>	7	C	C	-
	<i>Zephlebia group</i>	7	VA	VA	C
ODONATA (DRAGONFLIES)	<i>Antipodochlora</i>	5	R	-	-
	<i>Xanthocnemis</i>	4	C	-	R
HEMIPTERA (BUGS)	<i>Microvelia</i>	3	C	-	-
COLEOPTERA (BEETLES)	Dytiscidae	5	C	-	-
	Hydrophilidae	5	R	-	-
	Scirtidae	8	R	-	-
TRICHOPTERA (CADDISFLIES)	<i>Hydrobiosis</i>	5	R	R	R
	<i>Orthopsyche</i>	9	-	C	-
	<i>Polypsectropus</i>	6	C	-	R
	<i>Psilochorema</i>	6	R	-	R
	Oeconesidae	5	-	C	C
	<i>Oxyethira</i>	2	-	R	R
	<i>Triplectides</i>	5	C	-	R
DIPTERA (TRUE FLIES)	<i>Chironomus</i>	1	-	-	R
	<i>Corynoneura</i>	3	R	-	-
	Orthoclaadiinae	2	C	A	A
	Tanypodinae	5	R	-	-
	<i>Paradixa</i>	4	C	-	-
	Empididae	3	R	-	-
	Psychodidae	1	-	R	-
	<i>Austrosimulium</i>	3	A	A	C
	ACARINA (MITES)	Acarina	5	-	R
No of taxa			24	19	21
MCI			93	86	79
SQMCIs			5.7	4.5	3.0
EPT (taxa)			6	6	7
%EPT (taxa)			25	32	33
'Tolerant' taxa		'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Site 1- 5 metres upstream of discharge

A moderate community richness of twenty four taxa was found at site 1 (Table 2 and Table 4). This was four taxa more than what was recorded in the post-drill survey but nine fewer than what was recorded in the pre-drill survey and six taxa more than the median richness found at similar sites elsewhere in the region (Table 3). The macroinvertebrate community contained a significant proportion of 'moderately sensitive' taxa (54%), which was reflected in the MCI score of 93 units. This result represented a significant increase from 81 MCI units recorded in the pre-drill survey and 82 MCI units recorded in the post-drill survey 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 one 'tolerant' taxon (sandfly larvae (*Austrosimulium*)) and two 'moderately sensitive' taxa (amphipod (*Paraleptamphopidae*) and mayfly (*Zephlebia group*)). Two 'tolerant' taxa which characterised site one in the previous two surveys were absent during the current survey. This included oligochaete worms and seed shrimp (Ostracoda).

The numerical dominance of two 'moderately sensitive' taxa, and a decrease in abundance of 'tolerant' taxa, resulted in a SQMCI_s score of 5.7 units, which was significantly higher (by 3.5 units) than what was recorded in the previous two surveys, and significantly higher (1.6 units) than the median score for 'control' sites in similar streams at this altitude (Stark, 1998).

Site 2- 10 metres downstream of discharge

A moderate community richness of nineteen taxa was found at site 2 (Table 2 and Table 4), representing a decrease of twelve taxa from the pre-drill survey. However, this richness was similar to what was recorded in the post-drill survey and similar to the median richness found at sites of a comparative altitude (Table 3). The macroinvertebrate community was comprised of equal proportions of 'moderately sensitive' (47%) and 'tolerant' (47%) taxa, which was reflected in the MCI score of 86 units; an insignificant 4 units fewer than what was recorded during the pre-drill survey, and an insignificant 7 units fewer than what was recorded in the post-drill survey. This MCI score was slightly higher (Stark, 1998) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 3).

This community was characterised by four 'tolerant' taxa (extremely abundant snail (*Potamopyrgus*), sandfly larvae (*Austrosimulium*), oligochaete worms and orthoclad midges); and four 'moderately sensitive' taxa (amphipods (*Paracalliope* and *Paraleptamphopidae*), and mayflies (*Austroclima* and *Zephlebia group*)). Of these eight taxa, five were also characteristic taxa of the macroinvertebrate communities recorded in the pre-drill and post-drill survey.

An equal dominance of 'tolerant' and 'moderately sensitive' taxa resulted in a SQMCI_s score of 4.5 units, which was slightly higher (by 0.2 unit) than what was recorded in the pre-drill survey, but lower (0.2 unit) than what was recorded in the post-drill survey and an insignificant 0.4 unit greater than the median score for 'control' sites in similar streams at this altitude (Table 3).

Site 3- 180 metres downstream of discharge

A moderate community richness of twenty one taxa was found at site 3 (Table 2 and Table 4), three taxa fewer than the upstream control site, but the same as what was recorded during the pre-drill survey. This was two taxa more than the median richness found at similar sites elsewhere in the region (Table 3). In comparison to the two upstream sites, the macroinvertebrate community was comprised of a larger proportion of 'tolerant' taxa (52%), which was reflected in the MCI score of 79 units; an insignificant 5 units higher than the pre-drill survey. This score was only one unit higher (Stark, 1998) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 3).

This community was characterised by three 'tolerant' taxa (Oligochaete worms, seed shrimp (Ostracoda), true fly larvae (Orthoclaadiinae)); and one 'moderately sensitive' taxa (amphipod (*Paracalliope*)). A similar community composition (excluding true fly larvae (Orthoclaadiinae)) was recorded in the pre-drill and post-drill surveys.

The SQMCI_s score of 3.0 units recorded at site 3 represented a 0.8 unit decrease from the SQMCI_s score in the pre-drill survey and a 1 unit decrease from the SQMCI_s score in the post-drill survey. It was a significant 1.1 units fewer than the median score for 'control' sites in similar streams at this altitude elsewhere the region (TRC, 1999 (updated 2012)); which can be attributed to the numerical dominance of 'tolerant' taxa.

Summary and Conclusions

A combination of the Council's standard 'vegetation sweep' and 'kick-sampling' techniques was used at three sites to collect streambed macroinvertebrates from the Ngaere Stream. This has provided data to compare with previous data, for the assessment of skimmer pit discharge effects from the Cheal-B wellsite on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCI_s scores for each site.

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

This November 2012 survey of three sites, upstream and downstream of the skimmer pit discharge point to land near the Ngaere stream, was undertaken during drilling activities at the Cheal-B wellsite. Taxa richness's were moderate and similar to numbers found in 'control' streams at comparative altitudes elsewhere in the region. At site 1, the SQMCI_s score showed a significant increase from the previous two surveys and from the median SQMCI_s score for 'control' sites at similar altitudes; a reflection of an increased numerical abundance of 'sensitive' taxa. No significant changes to MCI and SQMCI_s scores were recorded at site 2 between the three surveys. At site 3, the SQMCI_s score decreased significantly (1 unit) from the post-drill report and from the median SQMCI_s score for 'control' sites at similar altitudes (1.1 units). However, there was no significant difference between the current survey results and the pre-drill results, suggesting that this decrease, and other variations in MCI and SQMCI_s

scores between sites and surveys is considered a reflection of habitat variability, and differences in sampling effort, rather than a change in water quality.

The MCI scores recorded in this survey indicated that the stream communities were of reasonable 'health' (TRC, 2013), and are considered to be typical of what might be expected from a stream originating from a swampy area (i.e. Ngaere Swamp). There was no indication from the results of the two surveys that the discharge from the Cheal-B wellsite has impacted on the biological communities of the Ngaere Stream.

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