TAG Oil (NZ) Limited
Cheal-C Wellsite
Monitoring Programme Report
2011-2014

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Executive summary

TAG Oil (NZ) Limited re-entered an established wellsite for further hydrocarbon exploration located on Brookes Road, within the Stratford district, in the Waingongoro catchment. The site is called Cheal-C wellsite. This report covers the period from April 2011 to July 2014. During this period, four wells were drilled and tested (C1, C2, C3 and C4), and one well drilled, tested, and hydraulically fractured (Cardiff-3).

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

During the monitoring period, the Company demonstrated an overall good level of environmental performance and compliance with the resource consents.

TAG Oil (NZ) Limited holds a total of seven resource consents for the activities at the Cheal-C wellsite, which include a total of 101 consent conditions setting out the requirements that TAG Oil (NZ) Limited must satisfy. TAG Oil (NZ) Limited holds consent 6403-1 to discharge treated stormwater, treated produced water and treated wastewater onto and into land; consent 6404-1 to discharge stormwater and sediment from earthworks during construction onto and into land; consent 6405-1 to discharge drilling muds, cuttings and wastes from hydrocarbon exploration onto and into land via mix-bury cover (not exercised during monitoring period under review); consent 7780-1 to take and use water from an unnamed tributary of the Mangawharawhara Stream; consent 9262-1 to discharge emissions to air associated with production activities; consent 9285-1 to discharge emissions to air from flaring of hydrocarbon exploration activities; and consent 9397-1 to discharge contaminants associated with hydraulic fracturing activities into land.

The Council's monitoring programme for the period under review included 65 inspections of the site and surrounding environment, at approximately fortnightly intervals. 20 stormwater samples, 15 surface water samples, four groundwater samples, one hydraulic fracture fluid sample and one return fracture fluid sample were obtained for analysis. Furthermore, biomonitoring surveys were performed prior to the commencement of hydraulic fracturing activities, and following their completion at the Cheal-C wellsite.

TAG Oil (NZ) Limited notified the Council of its intention to combust gas intermittently on 17 July 2012, 18 January 2013, 15 July 2013, 21 February 2014 and 24 March 2014. Following these dates, gas combustion occurred intermittently over the course of a few days in conjunction with well testing. No offensive or objectionable odours, smoke or dust associated with activities at the wellsite were observed. The drilling fluids and cuttings were disposed of at a consented off site facility.

The site was generally neat and tidy, although ongoing maintenance was required regarding the ring drains, as silt and sediment build up was at times excessive and subsequently resulted in a high suspended solid level on one discharge occasion during a heavy rainfall event. No adverse environmental effects were noted. However, given the failure by the Company to adequately maintain the ring-drains and skimmer pits one abatement notice (to

remedy the facilities) and one infringement notice (for breaching the discharge limit) were issued in relation to these events.

Taking into account that conditions on one consent were found to be breached on one occasion during the three years and 65 inspections covered by this report, but without adverse environmental consequences, overall TAG Oil (NZ) Limited demonstrated a good level of both environmental and administrative performance and compliance with the seven resource consents during the monitoring period. The site was generally neat, tidy and well maintained and site staff were cooperative with requests made by officers of the Council, with any required works completed to a satisfactory standard and in a timely manner.

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

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period April 2011 to July 2014 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consent held by TAG Oil (NZ) Limited. During this period, two wells were drilled (C3 and C4), four wells tested (C1, C2, C3 and C4) and one well drilled, tested, and hydraulically fractured (Cardiff-3).

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by TAG Oil (NZ) Limited that relate to exploration activities at Cheal-C wellsite located off Brookes Road, in the Stratford District.

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

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the RMA and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consent held by TAG Oil (NZ) Limited in the Waingongoro 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-C 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 1991* (RMA) primarily addresses environmental `effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

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

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

1.1.4 Evaluation of environmental and consent performance

Besides discussing the various details of the performance and extent of compliance by the consent holder/s during the period under review, this report also assigns a rating as to each Company's environmental and administrative performance.

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

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

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

Environmental Performance

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

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

  For example:

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

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

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

Administrative compliance

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

- **Good** Perhaps some administrative requirements of the resource consents were not met at a particular time, however this was addressed without repeated interventions from the Council staff. Alternatively adequate reason

was provided for matters such as the no or late provision of information, interpretation of 'best practical option' for avoiding potential effects, etc.

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

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

For reference, in the 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. In the 2013-2014 year, 60% of consent holders achieved a high level of environmental performance and compliance with their consents, while another 29% demonstrated good level of environmental performance and compliance.

1.2 Process description

Site description

TAG Oil (NZ) Limited holds a ten year Petroleum Mining Permit No. 38156 to prospect, explore, and mine for condensate, gas, LPG, oil and petroleum within an area of 30.30 km^2. The Cheal-C wellsite is one of many sites within this area that have been established in order to explore, evaluate and produce hydrocarbons.

The Cheal-C wellsite was initially established for previous exploration efforts and has since been transferred to TAG Oil (NZ) Limited and had site upgrades to accommodate further exploration efforts. The Cheal-C wellsite is located approximately 1.4 km along Brookes Road, approximately 2 km from Stratford.

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

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

The nearest residence is approximately 600 m away from the wellsite. Bunding, earthworks and good site location helped minimise any potential for off site effects for the neighbours.

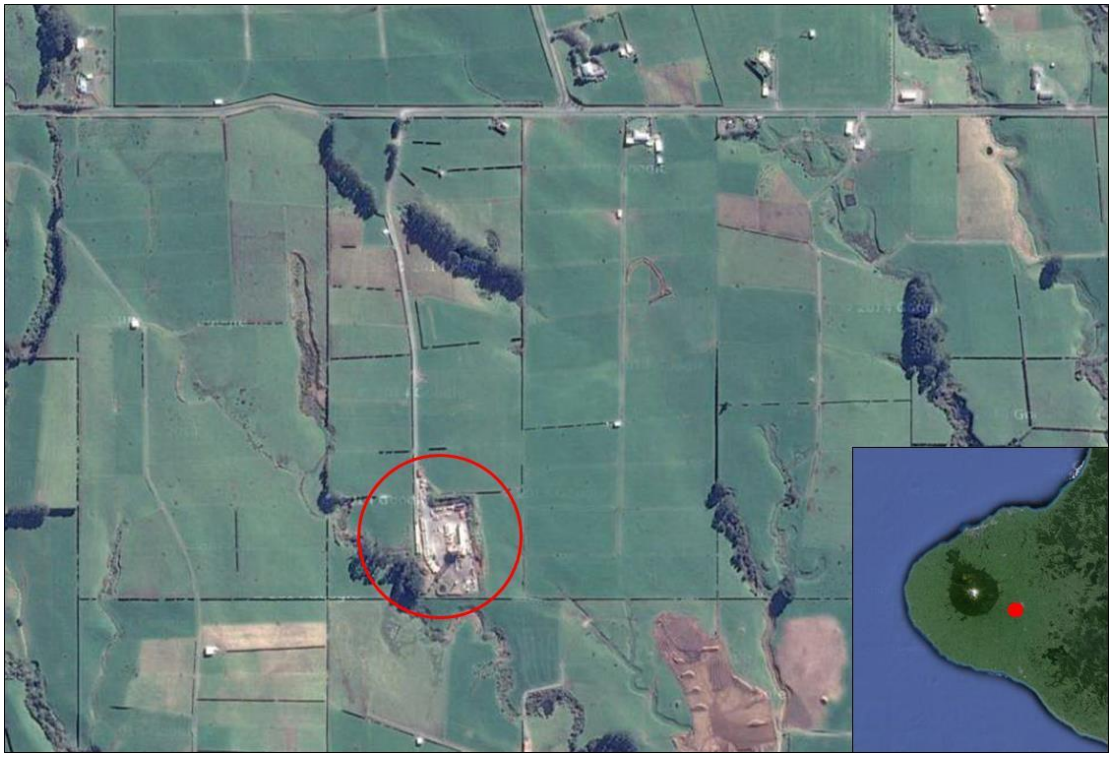

Figure 1 Aerial view depicting the locality of the Cheal-C wellsite, with approximate regional location (inset)

Well development

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

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

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

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

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

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

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

Management of stormwater, wastewater and solid drilling waste

The Cheal-C wellsite is located approximately 40 m to the North east of the nearest waterbody, which is an unnamed tributary of the Mangawharawhara Stream.

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

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

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

Hydraulic fracturing

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

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

By the early 2000's New Zealand started exploring options for more unconventional ways of getting access to natural gas, and especially oil. These are considered to be more expensive than conventional drilling, but as the price of oil has risen and new technologies have been developed, these unconventional methods are growing.

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

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

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

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

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

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

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

Flaring from exploration activities

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

- Well testing and clean-up;

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

1.3 Resource consents

1.3.1 Background

TAG Oil (NZ) Limited holds seven resource consents related to exploration activities at the Cheal-C wellsite site, as follows:

- Discharge Permit 6403-1; granted 22 July 2004,
- Discharge Permit 6404-1; granted 22 July 2004,
- Discharge Permit 6405-1; granted 22 July 2004 (not exercised),
- Water Permit 7780-1; granted 9 February 2011,
- Discharge Permit 9262-1; granted 11 June 2012,
- Discharge Permit 9285-1; granted 13 June 2012 and
- Discharge Permit 9397-1; granted 19 September 2013.

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

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

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

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

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

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

TAG Oil (NZ) Limited holds water discharge permit 6403-1 to discharge treated stormwater, treated produced water and treated wastewater at the Cheal-C wellsite onto and into land in the vicinity of an unnamed tributary of the Mangawharawhara Stream.

This permit was issued by the Council on 22 July 2004 under Section 87(e) of the RMA. It is due to expire on 1 June 2023.
Consent conditions were imposed on TAG Oil (NZ) Limited to ensure that adverse effects were avoided in the first instance. A summary of conditions can be viewed in Table 6, Section 3.3.

1.3.3 Water discharge permit (stormwater and sediment – earthworks)

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

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.*

TAG Oil (NZ) 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.

TAG Oil (NZ) Limited holds water discharge permit 6404-1 to discharge stormwater and sediment from earthworks during construction of the Cheal-C wellsite onto and into land and into an unnamed tributary of the Mangawharawhara Stream.

This permit was issued by the Council on 22 July 2004 under Section 87(e) of the RMA. It is due to expire on 1 June 2023.

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

1.3.4 Land discharge permit (mix-bury cover)

Sections 15(1)(b) and (d) of the *Resource Management Act 1991* (RMA) stipulates that no person may discharge any contaminant onto land if it may then enter water, or from any industrial or trade premises onto land under any circumstances, unless the

activity is expressly allowed for by a resource consent , a rule in a regional plan, or by national regulations.

The discharge of contaminants associated with mix-bury cover, onto and into land where contaminants may reach water, is a discretionary activity under Rule 44 of the RFWP.

TAG Oil (NZ) Limited holds discharge permit 6405-1 to discharge drilling muds, drilling cuttings and drilling wastes from hydrocarbon exploration activities at the Cheal-C wellsite onto and into land via mix-bury cover.

This permit was issued by the Council on 22 July 2004 under Section 87(e) of the RMA. It is due to expire on 1 June 2023.

Consent conditions were imposed on TAG Oil (NZ) 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.

1.3.5 Water abstraction permit (surface water)

Section 14 of the *Resource Management Act 1991* (RMA) stipulates that no person may take, use, dam or divert any water, unless the activity is expressly allowed for by resource consent or a rule in a regional plan, or it falls within some particular categories set out in Section 14.

The Council determined that the application to take surface water fell within Rule 16 of the Regional Freshwater Plan for Taranaki (RFWP) as the rate and daily volume of the groundwater abstraction might exceeded that of the permitted activity (Rule 15). Rule 15 provides for surface water abstraction as a permitted activity, subject to the following conditions:

- *The rate of abstraction for anyone property described in a particular certificate of title shall not exceed 1.5 l/s; or 5 l/s for not more than 30 mins/day for temporary taking and use of surface water;*
- *The volume of extraction for any one property described in a particular certificate of title shall not exceed 50 m^3 in any one day;*
- *No more than 25% of the instantaneous flow, measured at the point of abstraction shall be taken.*

TAG Oil (NZ) Limited holds water permit 7780-1 to take and use water from an unnamed tributary of the Mangawharawhara Stream for hydrocarbon exploration activities at the Cheal-C wellsite.

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

The Council was satisfied that the proposed activity would meet all the standards for a discretionary 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:

- Payment of administrative charges;
- Volume and rate of abstraction;
- Abstraction records;
- Implementation of the best practicable option; and
- Appropriate screen installation on intake structure.

This permit was issued by the Council on 9 February 2011 under Section 87(d) of the RMA. It is due to expire on 1 June 2014.

Consent conditions were imposed on TAG Oil (NZ) Limited to ensure that adverse effects were avoided in the first instance. A summary of conditions can be viewed within Table 9, Section 3.3.

1.3.6 Air discharge permit (production activities)

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

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

TAG Oil (NZ) Limited holds air discharge permit 9262-1 to discharge emissions to air associated with production activities from up to 10 wells at the Cheal-C wellsite, including flaring associated with emergencies and maintenance, emissions from gas treatment or production plants and minor emissions from other miscellaneous activities.

This permit was issued by the Council on 11 June 2012 under Section 87(e) of the RMA. It is due to expire 1 June 2029.

Consent conditions were imposed on TAG Oil (NZ) 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.

1.3.7 Air discharge permit (exploration activities)

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

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

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

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

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

TAG Oil (NZ) Limited holds air discharge permit 9285-1 to discharge emissions to air from flaring of hydrocarbon exploration activities associated with up to seven wells at the Cheal-C wellsite, including flaring of hydrocarbons associated with well clean-up and well testing and emissions from other miscellaneous activities.

This permit was issued by the Council on 13 June 2012 under Section 87(e) of the RMA. It is due to expire on 1 June 2023.

Consent conditions were imposed on TAG Oil (NZ) Limited to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 11, Section 3.3.

1.3.8 Discharges to land (hydraulic fracturing)

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

The rule is a "catch all" rule as there is currently no specific rule for the discharge of hydraulic fracturing contaminants. The rule is set out below:

> *Discharge of contaminants onto or into land restricted by s15(1)(b) [where contaminants may reach water] and s15(1)(d) [where the discharge is from industrial or trade premises] of the Resource Management Act 1991 which is not expressly provided for in Rules 21-42 or which is provided for but does not meet the standards, terms or conditions and any other discharge of contaminants to land which is provided for in Rules 21-42 but which does not meet the standards, terms or conditions of those rules [irrespective of whether the discharges are from industrial or trade premises or are likely to reach water].*

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

TAG Oil (NZ) Limited holds discharge permit 9397-1 to discharge contaminants associated with hydraulic fracturing activities into land at depths greater than 3,700 mTVDss beneath the Cheal-C wellsite.

This permit was issued by the Council on 19 September 2013 under Section 87(e) of the RMA. It is due to expire on 1 June 2021.

Consent conditions were imposed on TAG Oil (NZ) Limited to ensure that adverse effects are avoided in the first instance. A summary of conditions can be viewed in Table 12, Section 3.3.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the *Resource Management Act 1991* (RMA) sets out obligation/s upon the Council to: gather information, monitor, and conduct research on the exercise of resource consent and the effects arising, within the Taranaki region and report upon these.

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

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

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

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

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council in ongoing liaison with resource consent holders over consent conditions and their interpretation and application, in discussion over monitoring requirements, preparation for any 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 (now the Alberta Energy Regulator) 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, gas combustion systems and the final discharge point from the skimmer pit on to land and then any potential receiving waters.

During each inspection the following are checked:

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

1.4.4 Chemical sampling

The Council may undertake sampling of discharges from site and from sites upstream and downstream of the discharge point to ensure that resource consent special conditions are complied with and to determine whether site activities were causing any adverse effects within the receiving environment.

1.4.5 Solid wastes

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

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

1.4.6 Air quality monitoring

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

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

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

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

1.4.7 Discharges to land (hydraulic fracturing)

Sampling and analysis of the hydraulic fracturing, return flow fluids and nearby bores were carried out during the period under review. In addition, inspections of the site and surrounding land and water were carried out to ensure that no observable effects had occurred as a result of the discharge to land. Pre and post hydraulic fracturing reports were submitted by the consent holder detailing among other things, the effectiveness of the mitigation measures put in place to protect the environment.

1.4.8 Biomonitoring surveys

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

2. Results

2.1 Water

2.1.1 Inspections

The Cheal-C wellsite, adjacent land and streams were inspected 65 times during this monitoring period. Below is a copy of the comments that were noted on the day of each inspection.

17 May 2011
A pre drill meeting was held on site. Ring drains appeared clean with water discharging into the skimmer pits, and the water quality appeared good. The second skimmer pit was observed discharging onto land and then ultimately to water. A container was to be placed adjacent to the cementing truck for wash down purposes. Old containers were utilised for the storage of wet and dry chemicals on site and the containers were to be placed within an earth bund once sumps had been positioned within the containers. The bulk fuel tank was observed within an earth bund that was appropriately lined.

23 May 2011
Consent conditions were discussed with on site staff and operators. Earth bunds were implemented and appeared to be working well. The wash down area for the cementing truck appeared clean and tidy with new installations completed. Mud tanks and pumps had been bunded and sawdust visible on the ground. The site in general was clean, tidy and the ring drains were dry. The water appeared clear within the skimmer pits and no discharges from site were occurring at the time of inspection. Discussions were held with on site staff regarding the earthworks at the South western perimeter of the site. Vegetation was needed to stabilise the ground in accordance with consent conditions.

30 May 2011
The site appeared clean and tidy with adequate bunding around stored chemicals and fuel, mud pumps and tanks. Silt controls had been implemented within the ring drain. Skimmer pits appeared discoloured but were not discharging at the time of inspection. It was noted that stormwater had been discharging from the site via land prior to entering the stream; no downstream effects were observed in relation to the discharges. Site staff were advised to sow grass seeds or other appropriate vegetation adjacent to the skimmer pits and stream bank in accordance with consent conditions.

7 June 2011
Rig equipment was in the process of being taken off site. Chemicals were still well bunded. Skimmer pits were observed to be highly discoloured, however the receiving waters were also discoloured due to silt and sediment entering the system further upstream, which was most likely attributed to heavy rainfall preceding the inspection. Any effect from sediment leaving the site was likely to be minor. The exposed section of earth at the southern end of the site had been stabilised via vegetation in accordance with consent conditions.

15 June 2011
Stormwater was not discharging from site at the time of inspection. However it was noted that silt and sediment were entering the ring drain at the southern end of the

site from stockpiled earth. It was also noted that attempts had been made to prevent the silt from entering the ring drain. Site staff were advised to remove the stockpiled earth and place further silt controls in the ring drain to reduce silt and sediment from entering the skimmer pits and subsequently discharging from site.

18 July 2011
The site appeared clean and tidy with ring drains mostly dry. The skimmer pits appeared discoloured, yet no stormwater was discharging from the site at time of inspection. Hydrocarbons were observed within the base of flare pit; the Council were advised by site staff that the liquid within the flare pit would be removed via sucker truck imminently.

28 July 2011
The rig and associated equipment were in the process of being removed from site. The site was wet with mud observed in places. The flare pit had been cleaned of hydrocarbons and the remainder of water within the pit was clean with no visible hydrocarbon sheen. Skimmer pits appeared very discoloured, yet were not discharging at the time of inspection. Site staff were advised that silt control measures (such as hay bales) should be implemented within the ring drain to prevent silt and sediment from entering the skimmer pits.

19 September 2011
The site was in the process of assembling rig equipment for further exploration drilling. Stormwater drainage and skimmer pit systems were in place and appeared in good condition.

23 September 2011
The rig and associated equipment was still in the process of being assembled. The site and ring drains were dry at the time of inspection. The first skimmer pit was full of discoloured stormwater and the second skimmer pit was mostly full but not discharging. A pump had been set up to drain the skimmer pits and reuse stormwater as it was the intention of TAG/Ensign to have zero discharges from the site. A pump had also been installed to take water from the nearby stream. Good chemical bunding had been implemented on site.

3 October 2011
No discharges from site were occurring at time of inspection and no water was being abstracted from the stream. Drilling wastes were being disposed of off site at a consented facility. The site in general was tidy and well bunded.

6 October 2011
Heavy rainfall preceded the inspection, subsequently the site was sodden and the ring drains contained flowing water. Water was being abstracted from the nearby stream, no effects were observed and a record of abstraction volumes, rates and times were being maintained. No flaring was occurring at time of inspection and all drilling muds, drill cuttings and drilling wastes were being disposed of off site at a consented facility. Skimmer pits were inspected and found to be discharging at the time of inspection. A sample was obtained of the discharge. Additional samples were obtained upstream and downstream of the discharge point.

11 October 2011
Light rainfall was occurring at the time of inspection. Water within ring drains was observed to be flowing clean. Good bunding was implemented about the site. The rig was being prepared for transportation to another TAG wellsite. Skimmer pits were both full but not discharging at time of inspection.

20 October 2011
The rig had since been moved to another nearby TAG wellsite. A small store of chemical had been left on site within an adequately bunded area. The mud tanks had been removed from the ground and the area covered with earth. Ring drains and skimmer pits were inspected and found not to be discharging. No flaring or testing equipment was yet on site and the water abstraction pump had been removed. Site staff were advised to submit the water abstraction log as required by consent conditions and that all silt and sediment was to be removed from the skimmer pits.

14 November 2011
Operations had commenced on testing the C1 well. Equipment had been brought on site and was being assembled. No water was being taken from the stream and the site appeared dry. Skimmer pits were inspected and found not to be discharging at the time of inspection.

1 December 2011
Testing had commenced on site. Equipment associated with testing included (but was not limited to) a heater, generator, separator and storage tank, most of which had been bunded. A small spill of oil had occurred within the bunded area and was immediately cleaned up. Some minor spills were noted outside of the bunded areas; on site staff were advised to clean up any remaining contaminants so that they did not have the potential to mix with stormwater and discharge off site. The ring drains appeared dry. The skimmer pits were shallow and appeared to be in need of a clean out. Site staff were advised to clean out all silt and sediment from the skimmer pits to ensure that they operated effectively.

12 January 2012
Testing was continuing on site. A small volume of gas was being produced and utilised rather than being flared. Adequate bunding was being implemented on site. No water was being taken from the stream, but was being trucked in when required. Skimmer pits were inspected and found to have been cleaned of silt and sediment and not discharging. Stormwater on site appeared clean.

20 February 2012
Testing was continuing on site. Flaring had occurred since the last inspection and no visible effects were evident. The flare pit was clean as was the rest of the site. Skimmer pits were inspected and found to be mostly empty and not discharging.

26 March 2012
While testing was continuing, a new drill rig was being assembled on site. Site staff were anticipating the arrival of equipment prior to the commencement of drilling wells C3 and C4. Bunding had been appropriately implemented with the generator, fuel tank and separator individually bunded and an earth bund had been constructed about the testing area. The site was tidy and ring drains were dry. The abstraction of water from the stream was to commence again, however the pump

was yet to be re-installed. Drilling waste was to be disposed of at a consented off site facility. No flaring had occurred during days prior to inspection. Skimmer pits were inspected and found not to be discharging.

20 April 2012

Drilling operations were anticipated to commence at the end of April (2012). Discussions were held with site operation managers regarding drilling waste containers, skimmer pits, flare pit and containment pits. It was outlined that all were required to be impermeable, as per consent conditions. There had been no recent earthworks, flaring, or abstraction of surface water. There was no storage of chemicals on site at time of inspection. Skimmer pits were inspected and found to be half full and not discharging.

30 April 2012

Drilling had not yet commenced. No earthworks were taking place at the time of inspection, however site staff advised that earthworks were anticipated in order to increase the size of the skimmer pits, create a new access track to the stream for water pump installation (anticipated to be installed at a later stage in the week) and to construct an impermeable layer in the base of the flare pit. No flaring was occurring during inspection and any gas that was exiting the wells was utilised to power the generators situated on site. Skimmer pits were inspected and found not to be discharging.

10 May 2012

Drilling of well C3 had commenced. The water pump had been installed with appropriate screened intake structures and records of abstraction volumes and rates were being kept. Personnel on site had been advised to monitor the original sewage tanks to ensure the sewage did not enter the stormwater ring drain. All drilling waste was being disposed of off site at a consented facility. Chemicals were appropriately bunded and stored in containers. All stormwater from the site was directed for treatment through the skimmer pits, which had recently been pumped out and found to be not discharging at the time of inspection. A zero discharge approach was being undertaken whilst the rig was on site.

17 May 2012

Heavy rainfall preceded the site inspection, subsequently the site was sodden and the ring drains were flooded in areas. The stream was flowing clear with no visual change in clarity between upstream and downstream sites. Earthworks that were undertaken to construct access down to the stream had been completed and it was anticipated that stabilisation would occur when the weather became fine. The water pump was not in use at the time of inspection and had been removed from the stream edge. However, the intake structure had been left in the stream. Abstraction logs were checked and approximately 164 m^3 of stream water had been taken over the preceding seven days, which complied with the consent's requirements. All drilling wastes were being disposed of at a consented off site facility. Skimmer pits were inspected and found not to be discharging. Both skimmer pits appeared very discoloured and it was recommended that the skimmer pits be pumped out to mitigate a suspended solid consent breach.

24 May 2012
Drilling was on hold while repairs were being made to the mud pump. The water take system was anticipated to be replaced with a semi-submersible electric pump, mitigating any potential for accidental discharge from the diesel powered pump initially installed. Approximately 25 m^3 of water had been abstracted from the stream during the week. The stream appeared clear. The site had been compacted to reduce silt and sediment runoff into the ring drain; furthermore a silt trap was to be installed within the ring drain to further reduce the amount of silt and sediment entering the skimmer pit system. Sumps were also anticipated to be installed around the rig and mud tanks to assist in capturing any contaminants that may discharge on or from the site. Site staff were advised to ensure that exposed earth near the stream was to be stabilised via vegetation or otherwise as soon as practicable following the stream access earthworks. Skimmer pits were inspected and found not to be discharging as they had been pumped out since the last inspection.

8 June 2012
Drilling had again commenced. No flaring, earthworks or surface water takes were occurring at the time of inspection. Skimmer pits were inspected and found not to be discharging.

13 June 2012
The rig had been repositioned to drill another well at the site, drilling was anticipated to commence later that evening. The site in general appeared neat and tidy. It was noted that a silt mat had been installed in the ring drain in two locations to assist in reducing suspended solid concentrations within the skimmer pits. Abstraction logs were checked and water had not been abstracted from the stream for the preceding 10 days. Drilling mud was being stored onsite and was anticipated to be used for the next drilled well. Skimmer pits were inspected and found not to be discharging as the first skimmer pit was nearly empty and the second pit had water being pumped and used onsite.

18 June 2012
Drilling of well C4 had commenced. No flaring had yet occurred on site during this drilling. The site was tidy and good bunding had been implemented. The waste storage tank had been recessed into the ground and a plastic liner was installed under the tank to stop any potential contaminants discharging into the ground. The area around the storage container was very clean and tidy. The silt socks in the ring drain appeared to be working well. No water had been abstracted from the stream, instead water was being extracted from the skimmer pits and utilised. As such, skimmer pits were inspected and found not to be discharging as the pits were near empty at the time of inspection.

2 July 2012
Drilling of well C4 was continuing. The site in general was tidy and bunds were in place around the rig where drilling muds had been spilt onto the ground as a result of operations. A bund had also been installed around the bulk mud tanks. The ring drains were mostly dry with some minor ponding in areas. In addition the silt controls in the ring drains appeared to be working effectively. Skimmer pits were inspected and found to not be discharging as both were empty. As a result of this water had been extracted from the stream, the abstraction log was maintained to reflect this. The stream was running clear with no visual effects observed.

13 July 2012
The rig and associated equipment had been shifted to another TAG wellsite and a work-over rig was being assembled at the time of inspection at the Cheal-C wellsite. Production testing of wells C1 and C2 was also continuing. No flaring was occurring in conjunction with these activities. Most chemicals had been removed from site. The ring drains were mostly dry however it was noted that some drilling mud had entered the ring drain near where the mud tanks were stored. The silt bags that were located in the ring drains had a large amount of silt built up. Site staff were advised to immediately remove the drilling mud from ring drains and to clear the drains of accumulated silt. No water was being abstracted from the stream as the pump and bund had been removed from the stream edge. Skimmer pits were inspected and found not to be discharging at the time of inspection. A sample was obtained from the second skimmer pit. Additional samples were obtained upstream and downstream of the discharge point.

19 July 2012
Well testing was continuing on site. It was noted that some drilling mud had spilt onto the ground in and outside of the bund that surrounded the mud storage containers. A small amount of drilling mud was also observed within the ring drains. Site staff were advised to immediately remove all drilling mud that had been spilt across the site, particularly within the ring drains. Skimmer pits were inspected and found to be discharging at the time of inspection. A sample was obtained of the discharge and additional samples were obtained upstream and downstream of the discharge point.

27 July 2012
Well testing was continuing on site. Spilt drilling mud had been removed from in and around the mud storage bund and ring drain. The site in general appeared clean and tidy. Skimmer pits were inspected and found not to be discharging. A sample was obtained from the second skimmer pit to ensure compliance with consent conditions in anticipation of potential discharges.

9 August 2012
All wells were shut in as no testing or drilling was occurring at the site at the time of inspection. No hydrocarbon sheens were observed on site, in the flare pit, ring drain or skimmer pits. Flaring had occurred but had since ceased due to the excessive noise generated from the flare. Flaring was anticipated to resume once the flare pit had been reinstated.

24 August 2012
Well testing had commenced again. The site appeared clean and tidy. Works were occurring to remove contaminated soil from the base of the flare pit, prior to lining and reconstructing the flare pit for further use.

13 September 2012
Testing was continuing on site. Bulk storage tanks and drilling equipment were being stored on site in an appropriate manner. The site appeared clean and tidy. Skimmer pits were inspected and found not to be discharging. A sample was obtained from the second skimmer pit.

27 September 2012
Testing was continuing on site. The flaring of gas was anticipated to occur the following day. The flare pit reconstruction was complete with PVC liner installed. In addition the skimmer pits had also been lined with PVC, however it was outlined to site staff that the culvert between the first and second skimmer pits was required to be replaced with a goose neck pipe.

8 October 2012
Inspection occurred during a heavy rainfall event. The site was unmanned at the time of inspection. Flaring had been occurring and successful separation was evident as no liquid or solid hydrocarbons were observed within the flare pit. No discharges were occurring from site as the skimmer pits had been cleaned out so that repairs could be undertaken.

24 October 2012
Testing was continuing on site. The site appeared dry, clean and tidy. No flaring was occurring and no issues were raised at the time of inspection.

14 November 2012
Well testing was anticipated to cease at the end of the week and equipment to be removed from the site. The site appeared dry, clean and tidy, yet some areas of the site would need to be remediated as there were small amounts of oil/grease on the ground from machinery and equipment. The ring drains were dry and the skimmer pits appeared clear and free of hydrocarbon sheen. No flaring was occurring on site.

12 December 2012
The site appeared neat and tidy during inspection. No effects from flaring activities were observed. The pipe to skimmer pits had been displaced for pipeline installation purposes and was anticipated to be re-installed later in the day.

22 January 2013
Skimmer pits were inspected and found not to be discharging. A sample was obtained from the second skimmer pit to ensure compliance with consent conditions in anticipation of potential discharges.

11 February 2013
Further pipeline installations were occurring during inspection. The site had been marginally extended and discussions were held with on site staff regarding the capacity of the skimmer pits. It was proposed that the skimmer pits needed upgrading to cope with additional runoff resulting from the catchment increase and construction activity. Minor subsidence was noted alongside the retainment wall near the skimmer pits which was to be repaired. The site in general was neat and tidy and no odours or effects from flaring were observed.

12 February 2013
Testing was continuing on site with little other activity occurring at the time of inspection. The site appeared clean, tidy and dry. Skimmer pits were inspected and found not to be discharging. A sample was obtained from the second skimmer pit to ensure compliance with consent conditions in anticipation of potential discharges.

27 February 2013
Skimmer pits were inspected and found not to be discharging. A sample was obtained from the second skimmer pit to ensure compliance with consent conditions in anticipation of potential discharges.

26 March 2013
Skimmer pits were inspected and found not to be discharging. A sample was obtained from the second skimmer pit to ensure compliance with consent conditions in anticipation of potential discharges.

29 April 2013
The site appeared neat and tidy during inspection. An additional skimmer pit was to be constructed on the eastern boundary of the site and notification had been received regarding this. Minimal flaring was occurring and no off site effects were observed. Ring drains and bunds were clear and fit for purpose.

23 May 2013
Heavy rainfall preceded the inspection. The site appeared neat and tidy. Skimmer pits were abundant with discoloured water resultant of increased runoff generated by heavy rainfall in conjunction with construction. No adverse effects were visible within the receiving waters. The ring drain on the eastern boundary of the site had collapsed and required immediate repair, this was discussed further with on site staff.

27 May 2013
Limited activity was occurring on site during inspection. The site appeared clean and tidy and product was successfully piped through to the Cheal A Production Station. Both ring drains and skimmer pits appeared to be in good operational order. Skimmer pits were inspected and found not to be discharging. A sample was obtained from the second skimmer pit.

21 June 2013
No personnel were present on site during inspection as limited activity was noted. Site appeared to be clean and tidy. Ring drains were in place and in good operational order. It was noted that the drain along the forefront of the flare pit potentially required some attention to prevent ponding; it was suggested that a slight lowering of the discharge pipe into the first skimmer pit may assist. Skimmer pits were inspected and found to be discharging at the time of inspection. A sample was obtained of the discharge and additional samples were obtained upstream and downstream of the discharge point.

6 August 2013
A workover rig was being assembled following the completion of works on site. A cellar had been installed on site in anticipation of drilling operations that were to commence. Ring drains at the site appeared to have had works completed, however the depth of the ring drains resulted in water ponding within the drains rather than being directed for treatment via the skimmer pit system. Site staff were advised to complete works to ensure that all site water was directed for treatment via the skimmer pits. Skimmer pits were inspected and found not to be discharging, water quality in the pits appeared good. Inspection of the nearby stream found that it was flowing clear and clean.

2 September 2013
The wellsite had been slightly extended to accommodate the required drilling equipment for pending drilling operations. The drilling rig had been assembled on site and was anticipated to commence drilling before the end of the day. New septic tanks had been installed on site and appeared to be operating well and were maintained regularly. Water was being abstracted from the adjacent stream. Ring drains had been cleaned out and contoured to ensure that all stormwater flowed towards the skimmer pits without inundating the treatment system. Skimmer pits were inspected and found not to be discharging. No samples were obtained as the pits were to be pumped out and utilised to produce drilling mud.

13 September 2013
Discussions were held with on site staff regarding further works that were required to ensure ponding did not occur in ring drains and all surface water was directed to the skimmer pits. Earth bunds also required sediment control measures to prevent sediment leaving the site and entering skimmer pits (hydro-seeding was recommended in relation to this). Some ponding was also visible about the wellsite which needed to be addressed. Skimmer pits were inspected and found not to be discharging. A sample was obtained from the second skimmer pit.

24 September 2013
Works on ring drains had not yet commenced to ensure surface water was being directed to the skimmer pits. Some works had been completed to the pad. Skimmer pits were inspected and found to be discharging at the time of inspection. A sample was obtained of the discharge and additional samples were obtained upstream and downstream of the discharge point.

4 October 2013
Ring drain works had not yet commenced, discussions were held with on site staff and outlined that contractors had surveyed the drain and were anticipating the works to commence in the foreseeable future. Skimmer pits were inspected and found to be discharging. A sample was obtained from the second skimmer pit.

11 October 2013
Contractors were on site cementing well Cardiff-3 at the time of inspection. Silt controls had been implemented in relation to un-vegetated earth banks. Skimmer pits were inspected and found to be discharging at the time of inspection. A sample was obtained of the discharge and additional samples were obtained upstream and downstream of the discharge point. Ring drain works were still yet to commence which contravened Section 15(1)(b) of the Resource Management Act and special conditions 6 and 7 of resource consent 6403-1. Abatement notice 12116 was issued, requiring these works to be undertaken.

21 October 2013
During inspection of the production facility it was noted that holes in bunding around tanks to be filled in and a large hole leading to a condensate tank also needed to be filled in. Ring drain works were not yet completed. Skimmer pits were inspected and found to be discharging at the time of inspection. A sample was obtained of the discharge and additional samples were obtained upstream and downstream of the discharge point. The discharge sample obtained during the previous inspection returned elevated concentrations of suspended solids (230

g/m^3), which contravened Section 15(1)(b) of the Resource Management Act and special condition 10 of resource consent 6403-1. Infringement notice EAC-20053 was issued. No adverse effects in the nearby stream were noted.

1 November 2013
Notification of the commencement of works had been lodged and received with the Council. Works were anticipated to be carried out over a seven to ten day period on the south-western ring drain, tank bund and production area pad holes. Skimmer pits were inspected and found not to be discharging. A sample was obtained from second skimmer pit.

15 November 2013
All bunding around the production area had been repaired and silt control measures were installed within the ring drain. An area of the ring drain had been graded to equalise that of the skimmer pit entry level. Further sediment controls had also been installed after the skimmer pit outflow valves. Skimmer pits had been pumped out and the levels were below the discharge point. A remediation plan was to be submitted after further Council consultation which outlined site works that were required in order to ensure compliance with consent 6403-1. Abatement notice 12116 had been issued on 11 October with an enforcement date of 17 January 2014.

22 November 2013
Production and chemical storage areas appeared clean and tidy. Ring drain works had not yet commenced however silt controls had been established. In addition, an environmental contractor was on site during inspection assessing works that were to be completed in order to ensure compliance with consent 6403-1. Skimmer pits were inspected and found to still be below the discharge point.

2 December 2013
All chemical and fuel storage areas were appropriately bunded and covered. Earthworks equipment was stored on site with interim works on the south perimeter ring drain anticipated to commence later in the week. Skimmer pits were inspected and found not to be discharging. A sample was obtained from the second skimmer pit. Consent 6403-1 was not yet compliant at time of inspection, however a remediation plan was under consultation.

13 December 2013
Interim inspection was conducted regarding Abatement notice 12116. A number of works were already underway. Ring drain works had commenced with concrete settling troughs installed, but were yet to be filled in. Chemical storage beds that were not being utilised were removed from the ring drain, however further works on this section of drain were yet to be completed. A bio-sock had been installed around the ring drain perimeter to reduce sediment intrusion into the perimeter drain.

23 December 2013
A sucker truck was on site removing fluids from the tank bund area during inspection. The main pad area appeared clean and tidy. Ring drain works and concrete settling troughs had been installed within the drains and backfilled. No materials had yet been removed from the drains to improve flow to skimmer pits. Skimmer pits were inspected and found not to be discharging. A sample was obtained from the second skimmer pit.

16 January 2014
The chemical storage area appeared clean and tidy with all chemicals appropriately protected. Skimmer pits had been pumped out and the levels were below the discharge point. Interim silt control measures installed within the far ring drain appeared satisfactory until final remediation plans could be completed.

18 February 2014
The drilling campaign had been completed and the rig demobilised. A substantial amount of rig equipment was stored on site. Earthworks had been carried out and completed. The ring drain had been re-cut and new larger skimmer pits were installed. Abatement notice 12116 and subsequently resource consent 6403-1 were compliant at time of inspection. Site works had been conducted to a high standard. All resource consents were compliant at time of inspection.

20 March 2014
Site inspection was conducted in anticipation of the hydraulic fracturing programme that was scheduled to commence on 24 March 2014. Fracturing equipment had been assembled and proppant was appropriately stored near the centre of the site, secured and covered. Chemical drums were appropriately stored within a portable impermeable bund. Ring drains had been re-contoured and the earth bunds on the outer side of the ring drains had increased in size. Earth bunds had been hydro-seeded. Some silt and sediment controls were installed within the ring drains at the entrance to the skimmer pits. It was advised that further silt and sediment controls should be installed within the ring drain system until the drains and corresponding earth bunds stabilize. At the time of inspection the first skimmer pit had a small quantity of sediment laden water in its base, while the second skimmer pit remained empty. A flare tank was established at the southern end of the site. Some empty plastic drums were located on site, some of which, although empty were noted to have fallen over, while others had missing lids. On site staff were asked to either arrange for the drums to be removed from site or have the lids replaced. No water was being abstracted from the stream. All water required for the pending fracturing operation had been imported onto the site.

24 March 2014
Site inspection was conducted regarding the hydraulic fracturing programme for well Cardiff-3. The well had been stimulated with one zone targeted. No water was being abstracted from the stream, but rather was being trucked in. Site set up was appropriate with all equipment assembled and positioned within the ring drains. All chemicals were stored within an artificial impermeable lined bund. Once the chemicals were used the empty drums were replaced and stored within the bunded area to prevent spills. Drip trays were in place under the blender to contain any potential spills. Steel bins were located on site as temporary store for any spills and/or unwanted liquid material, which was then disposed of via contractors at an appropriate facility. Skimmer pits were inspected and found not to be discharging as minimal stormwater was contained within. Receiving waters were also inspected and found to be clean and clear. No spills or accidents were observed during the hydraulic fracturing operation with all chemicals and liquid contained within the closed pumping system and directed into the well. It was anticipated that the well would be flowed back soon after the completion of the well stimulation and a heater, separator and flare tank were set up on site to process the flow back material. A sample of the fracturing fluid was obtained for analysis.

8 May 2014
Rig equipment was being stored on site. Recent hydro seeding was well established. An inspection of the receiving waters found no adverse effects. Skimmer pits were inspected and found not to be discharging. A sample was obtained from the second skimmer pit.

2.1.2 Results of discharge monitoring

During the period under review a total of 20 stormwater samples were obtained. Stormwater was observed discharging from the wellsite skimmer pits on six occasions, six samples were obtained in conjunction with this. The remaining 14 stormwater samples were obtained from the second skimmer pit to ensure compliance with consent conditions in anticipation of potential discharges.

Analysis of the samples obtained showed that all but four of the samples would have been compliant with resource consent conditions should a discharge have occurred. Results are detailed in Table 1 and sampling locations can be seen in Figure 2.

Table 1 Results of stormwater samples obtained from the Cheal-C wellsite during the monitoring period

Date	Chloride *g/m³*	Hydrocarbons *g/m³*	pH *pH*	Suspended Solids *g/m³*	Sampling location
06 Oct 2011	28.3	-	6.8	40	Discharge
13 Jul 2012	79.6	<0.5	6.8	52	Second skimmer pit
19 Jul 2012	48.0	<0.5	6.8	57	Discharge
27 Jul 2012	19.8	25	6.9	59	Second skimmer pit
13 Sep 2012	16	4.5	6.9	50	Second skimmer pit
22 Jan 2013	8.4	<0.5	7.1	42	Second skimmer pit
12 Feb 2013	7.0	1.2	6.9	16	Second skimmer pit
27 Feb 2013	7.4	<0.5	7.1	5	Second skimmer pit
26 Mar 2013	11.6	<0.5	7.8	28	Second skimmer pit
27 May 2013	3.9	0.5	6.7	120	Second skimmer pit
21 Jun 2013	16.6	<0.5	6.6	41	Discharge
13 Sep 2013	28.2	1.6	7.0	49	Second skimmer pit
24 Sep 2013	17.3	<0.5	7.4	50	Discharge
04 Oct 2013	13.4	0.6	7.3	72	Second skimmer pit
11 Oct 2013	20.1	<0.5	7.4	230	Discharge
21 Oct 2013	13.9	<0.5	8.0	7	Discharge
01 Nov 2013	4.8	1.4	7.0	120	Second skimmer pit
02 Dec 2013	4.1	<0.5	7.0	45	Second skimmer pit
23 Dec 2013	4.2	<0.5	7.3	18	Second skimmer pit
08 May 2014	6.4	<0.5	7.3	23	Second skimmer pit

Samples obtained on 13 July 2012, 27 May 2013 and 1 November 2013 returned elevated levels of chlorides or suspended solids. Although these values exceed the limits as specified by condition 13 of consent 6403-1, no actual non-compliances occurred as these samples were obtained from the skimmer pit to ensure compliance with consent conditions in anticipation of potential discharges. Therefore, no discharges containing elevated levels of chlorides or suspended solids were released from the skimmer pits into the receiving environment in relation to these samples.

The discharge sample obtained on 11 October 2013 returned an elevated level of suspended solids (230 g/m^3), which contravened Section 15(1)(b) of the Resource Management Act and special condition 10 of resource consent 6403-1, and infringement notice EAC-20053 was issued. This high suspended solid count was most likely attributed to the lack of works undertaken to rectify the ring drains to an operational manner. Works were completed in due time following abatement and no further exceedances were detected in samples. In addition, the discharge was to land, and no adverse effects were noted in the nearby stream.

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

2.1.3 Results of receiving environment monitoring

During the period under review, 12 samples were obtained in conjunction with the stormwater discharges on 6 October 2011, 19 July 2012, 21 June 2013, 24 September 2013, 11 October 2013 and 21 October 2013 from an unnamed tributary of the Mangawharawhara Stream to ensure that stormwater discharges were not having an adverse effect on the receiving stream environment. Another two samples were obtained on 13 July 2012 from an unnamed tributary of the Mangawharawhara Stream and another on 25 March 2014 following the completion of the hydraulic fracturing campaign. Of the stream samples obtained, no exceedances were recorded in relation to consent 6403-1. Results are detailed in Table 2 and sampling locations can be seen in Figure 2.

Table 2 Samples obtained from an unnamed tributary of the Mangawharawhara Stream during the monitoring period under review

Date	Chloride *g/m^3*	Conductivity *mS/m@20C*	Hydrocarbons *g/m^3*	pH *pH*	Sampling location
06 Oct 2011	13.7	-	-	6.6	Upstream of discharge
	14.4	-	-	6.7	Downstream of discharge
13 Jul 2012	12.4	10.0	<0.5	6.8	Upstream sample
	13.3	9.9	<0.5	7.1	Downstream sample
19 Jul 2012	-	9.2	-	6.6	Upstream of discharge
	-	9.4	-	6.7	Downstream of discharge
21 Jun 2013	13.8	9.9	<0.5	6.6	Upstream of discharge
	13.0	9.9	<0.5	6.6	Downstream of discharge
24 Sep 2013	12.8	9.8	<0.5	6.8	Upstream of discharge
	12.6	9.8	<0.5	6.7	Downstream of discharge
11 Oct 2013	12.8	9.9	<0.5	7.0	Upstream of discharge
	13.0	9.9	<0.5	7.0	Downstream of discharge
21 Oct 2013	12.3	9.6	<0.5	6.8	Upstream of discharge
	12.2	9.6	<0.5	6.8	Downstream of discharge
25 Mar 2014	12.2	-	<0.5	7.2	Post fracturing stream sample

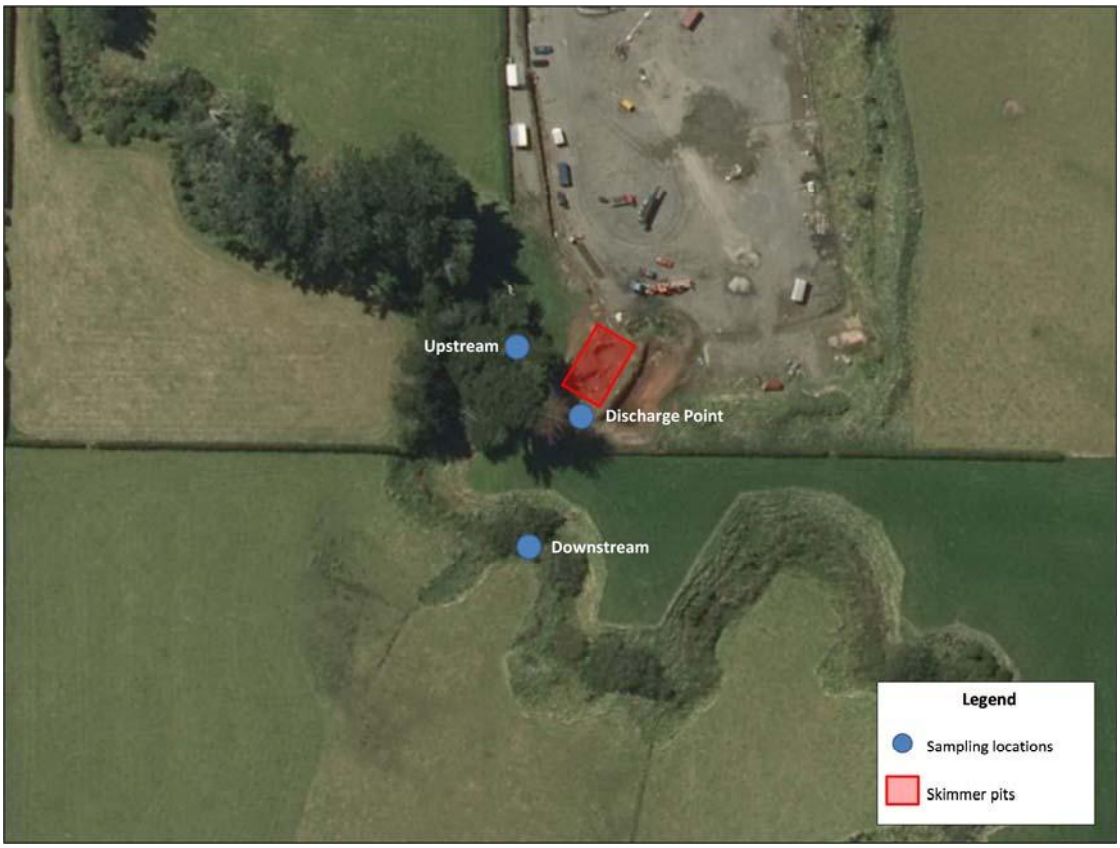

Figure 2 Stormwater and surface water sampling locations at the Cheal-C wellsite

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

2.2 Air

2.2.1 Inspections

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

2.2.2 Results of discharge monitoring

TAG Oil (NZ) Limited notified the Council of its intention to combust gas at the Cheal-C wellsite on 17 July 2012, 18 January 2013, 15 July 2013, 21 February 2014 and 24 March 2014. Following these dates, gas combustion occurred intermittently over the course of a few days in conjunction with well testing. During this time a flare tank was largely employed for the combustion of gas, although a flare pit was also utilised at the beginning of the monitoring period to maintain a pilot flare and for emergency gas combustion / depressurisation.

During routine inspections, no offensive or objectionable odours, smoke or dust associated with activities at the Cheal-C wellsite were observed. From observations

during site inspections, including the inspection of the flare log maintained by TAG Oil (NZ) Limited, it appeared that special conditions relating to the control of emissions to air from the combustion of hydrocarbons were largely complied with.

2.2.3 Results of receiving environment monitoring

No chemical monitoring of air quality was undertaken during the testing phase of the Cheal-C wellsite as gas combustion activities were minimal and the controls implemented by TAG Oil (NZ) Limited did not give rise to any concerns with regard to air quality.

2.2.4 Other ambient monitoring

No other ambient air sampling was undertaken, as the controls implemented by TAG Oil (NZ) Limited did not give rise to any concerns with regard to air quality.

2.3 Land

2.3.1 Inspections

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

2.3.2 Results of discharge and receiving environment monitoring (hydraulic fracturing)

TAG Oil (NZ) Limited notified the Council of the proposed hydraulic fracturing discharge operations for well Cardiff-3. The Council developed the Cheal-C wellsite groundwater monitoring programme in consultation with TAG Oil (NZ) Limited. This monitoring programme included two sampling locations which were selected based on their proximity to the Cheal-C wellsite and their individual construction and usage characteristics. The site selection is designed to provide a sample set representative of groundwater abstractions in the area surrounding the site. Table 3 outlines the details of the sites selected for inclusion in the programme. Figure 3 shows the sampling sites in relation to the wellsite.

Table 3 Cheal-C wellsite associated groundwater monitoring bore details

Site No.	Easting (m)	Northing (m)
GND2274	1710730	5642351
GND2446	1710384	5641602

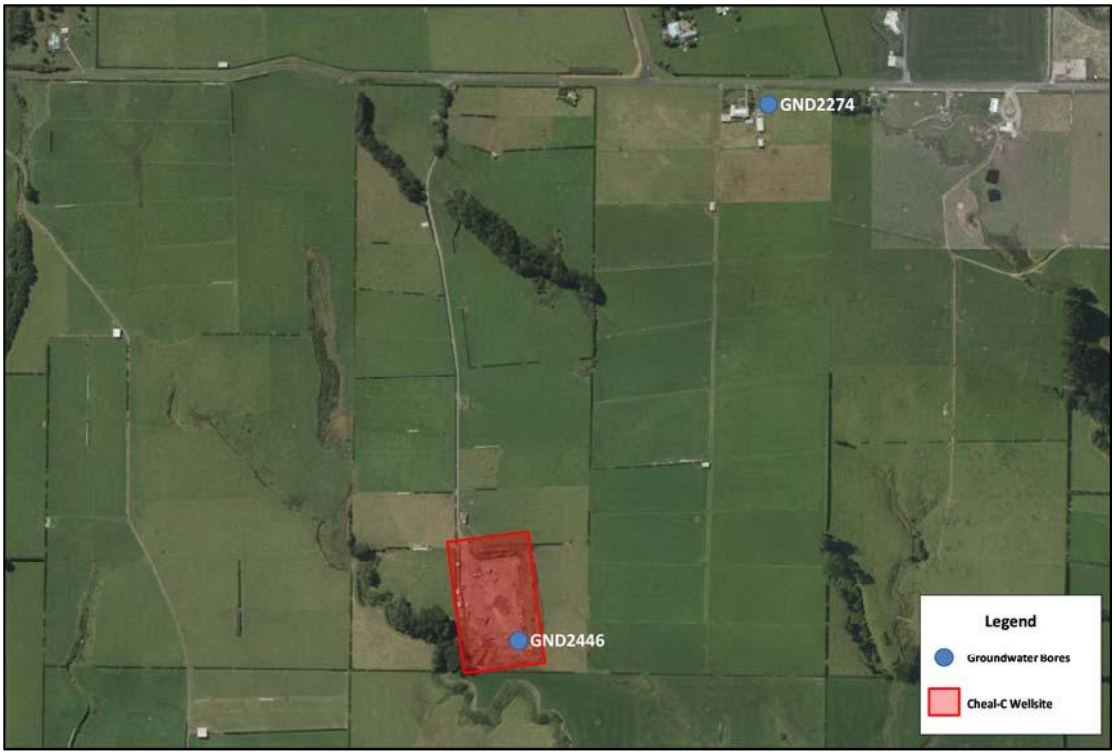

Figure 3 Aerial photo depicting the locality of the Cheal-C wellsite and associated groundwater monitoring bores

The monitoring programme requires an initial 12 months of groundwater monitoring. Groundwater samples will be obtained from the sampling sites recorded in Table 3 at the following specified intervals:

- Pre-hydraulic fracturing (baseline sample); and
- Three months after initial hydraulic fracturing event.

When hydraulic fracturing activities are completed at the wellsite, a minimum of one sample is then obtained on an annual basis.

The original wellsite groundwater monitoring programmes involved the analysis for certain parameters. However, the range of parameters being analysed for has evolved since the first consent for hydraulic fracturing was issued. Therefore, the groundwater monitoring programme was subsequently revised and approved by the Chief Executive of the Council. As such, the Council decided the Cheal-C wellsite groundwater monitoring programme should follow the latest range. The revised parameters that were analysed are as follows:

- pH;
- Conductivity;
- Major ions (Ca, Mg, K, Na, total alkalinity, bromide, chloride, nitrate-nitrogen, and sulphate);
- Trace metals (barium, copper, iron, manganese, nickel and zinc);
- Total petroleum hydrocarbons;
- Formaldehyde;
- Dissolved methane and ethane gas;
- Methanol;

- Glycols;
- Benzene, toluene, ethylbenzene, and xylenes (BTEX); and
- Carbon-13 composition of any dissolved methane gas discovered (^{13}C-CH_4).

In order to assess whether the discharge of fracturing fluids had contaminated or put at risk usable freshwater aquifers above the stated point of discharge, groundwater samples were taken as per the monitoring programme outlined above.

The results of the groundwater monitoring programme are detailed in Tables 4 and 5.

Table 4 Pre and post hydraulic fracturing results obtained from groundwater monitoring bore GND2274

Parameter	Unit	Pre-frac 13 Mar 2014	Post-frac 23 Jun 2014
Alkalinity (total)	g/m3 CaCO3	29	28
Barium	mg/kg	0.036	0.039
Benzene	g/m3	<0.0010	<0.0010
Bicarbonate	g/m3 HCO3	35.4	34.2
Bromine (dissolved)	g/m3	0.052	0.047
Calcium	g/m3	9.8	9.7
Chloride	g/m3	11.7	10.6
Conductivity	mS/m@20C	12.6	11.8
Copper (dissolved)	g/m3	0.021	0.036
Ethane	g/m3	<0.003	<0.003
Ethylbenzene	g/m3	<0.0010	<0.0010
Ethylene	g/m3	<0.003	<0.003
Ethylene glycol	g/m3	<4	<4
Formaldehyde	g/m3	<0.02	<0.02
Hardness (total)	g/m3 CaCO3	32	31
Hydrocarbons	g/m3	<0.7	<0.7
Iron (dissolved)	g/m3	<0.02	<0.02
Manganese (dissolved)	g/m3	0.0023	0.0024
Magnesium	g/m3	1.92	1.76
Mercury (dissolved)	g/m3	<0.00008	<0.00008
Methane	g/m3	<0.002	<0.002
Methanol	g/m3	<2	<2
Nickel	mg/kg	<0.0005	<0.0005
Nitrate nitrogen	g/m3 N	1.61	1.48
Nitrite/nitrate nitrogen	g/m3 N	1.61	1.48
Nitrite nitrogen	g/m3 N	<0.002	<0.002
pH	pH	6.4	6.6
Potassium	g/m3	3.3	3.0
Propylene glycol	g/m3	<4	<4
Sodium	g/m3	8.3	8.3
Static water level	m	3.905	2.345
Sulphate	g/m3	5.8	5.0
Sum of Anions	meq/l	1.14	1.07
Sum of Cations	meq/l	1.09	1.07
Temperature	Deg.C	14.3	11.5
Toluene	g/m3	<0.0010	<0.0010
Total dissolved solids	g/m3	90	92

Parameter	Unit	Pre-frac 13 Mar 2014	Post-frac 23 Jun 2014
meta-Xylene	g/m^3	<0.002	<0.002
ortha-Xylene	g/m^3	<0.0010	<0.0010
Zinc (dissolved)	g/m^3	0.0078	0.0165

Table 5 Pre and post hydraulic fracturing results obtained from groundwater monitoring bore GND2446

Parameter	Unit	Pre-frac 17 Mar 2014	Post-frac 12 Jun 2014
Alkalinity (total)	g/m^3 CaCO3	97	115
Barium	mg/kg	0.025	0.038
Benzene	g/m^3	<0.0010	<0.0010
Bicarbonate	g/m^3 HCO3	118.3	140.3
Bromine (dissolved)	g/m^3	0.050	0.047
Calcium	g/m^3	8.7	10.7
Chloride	g/m^3	11.0	11.9
Conductivity	mS/m@20C	22.5	27
Copper (dissolved)	g/m^3	0.0017	<0.0005
Ethane	g/m^3	<0.003	<0.003
Ethylbenzene	g/m^3	<0.0010	<0.0010
Ethylene	g/m^3	<0.003	<0.003
Ethylene glycol	g/m^3	<4	<4
Formaldehyde	g/m^3	<0.02	<0.02
Hardness (total)	g/m^3 CaCO3	38	47
Hydrocarbons	g/m^3	<0.7	<0.7
Iron (dissolved)	g/m^3	13.4	17.9
Manganese (dissolved)	g/m^3	0.41	0.36
Magnesium	g/m^3	3.8	5.0
Mercury (dissolved)	g/m^3	<0.00008	<0.00008
Methane	g/m^3	13.7	23
Methanol	g/m^3	<2	<2
Nickel	mg/kg	<0.0005	<0.0005
Nitrate nitrogen	g/m^3 N	<0.002	0.7
Nitrite/nitrate nitrogen	g/m^3 N	<0.002	0.8
Nitrite nitrogen	g/m^3 N	<0.002	<0.2
pH	pH	7.1	6.8
Potassium	g/m^3	10.4	12.8
Propylene glycol	g/m^3	<4	<4
Sodium	g/m^3	22	25
Static water level	m	4.635	3.947
Sulphate	g/m^3	<0.5	<0.5
Sum of Anions	meq/l	2.3	2.7
Sum of Cations	meq/l	2.5	3.0
Temperature	Deg.C	16.9	12.8
Toluene	g/m^3	0.0046	<0.0010
Total dissolved solids	g/m^3	170	199
meta-Xylene	g/m^3	<0.002	<0.002
ortha-Xylene	g/m^3	<0.0010	<0.0010
Zinc (dissolved)	g/m^3	0.0163	0.0047

The results in Tables 4 and 5 show parameters that are all within the typical range for background Taranaki shallow groundwater. It is considered that the slight variations

seen between samples are not a result of hydraulic fracturing operations, but are natural variances in groundwater between sites and as seasons change. No levels are of any environmental significance.

In conjunction with the groundwater monitoring programme, prior to the initial hydraulic fracturing process of the Cardiff-3 well, a sample of the fracture fluids was obtained. Once hydraulic fracturing had commenced, fracture fluids returning to the well head (known as return or 'flowback' fluids) were also sampled and analysed for the same parameters as the groundwater samples. A site inspection undertaken during the hydraulic fracturing operation on 24 March 2014 found that there were no observed effects from the discharge. The results of the hydraulic fracturing campaign at the Cheal-C wellsite returned levels that are of no environmental significance. Results are detailed in Table 6.

Table 6 Hydraulic fracture fluid and return hydraulic fracture fluid results obtained from the Cardiff-3 well

Parameter	unit	Fracture fluid 24 March 2014	Return fluid 26 March 2014
Alkalinity (total)	g/m^3 CaCO3	-	1940
Barium	mg/kg	-	6.0
Benzene	g/m^3	<0.0010	1.60
Bicarbonate	g/m^3 HCO3	-	1991
Bromine (dissolved)	g/m^3	-	2.7
Calcium	g/m^3	-	14
Chloride	g/m^3	-	1370
Conductivity	mS/m@20C	-	775
Copper (dissolved)	g/m^3	-	0.033
Ethane	g/m^3	-	0.43
Ethylbenzene	g/m^3	0.0025	0.192
Ethylene	g/m^3	-	<0.003
Ethylene glycol	g/m^3	620	75
Formaldehyde	g/m^3	-	1.7
Hardness (total)	g/m^3 CaCO3	-	45
Hydrocarbons	g/m^3	76	500
Iron (dissolved)	g/m^3	-	42
Manganese (dissolved)	g/m^3	-	3.2
Magnesium	g/m^3	-	3
Methane	g/m^3	-	1.54
Methanol	g/m^3	<2	3
Nickel	mg/kg	-	0.03
Nitrate nitrogen	g/m^3 N	-	<0.002
Nitrite/Nitrate nitrogen	g/m^3 N	-	0.013
Nitrite nitrogen	g/m^3 N	-	0.011
pH	pH	-	7.4
Potassium	g/m^3	-	99
Propylene glycol	g/m^3	<4	<4
Sodium	g/m^3	-	1640
Sulphate	g/m^3	-	34
Sulphur (dissolved)	g/m^3	-	11
Toluene	g/m^3	0.0024	2.7
Total dissolved solids	g/m^3	-	7800
meta-Xylene	g/m^3	0.006	1.27
ortha-Xylene	g/m^3	0.0026	0.50
Zinc (dissolved)	g/m^3	-	0.47

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

Consent 6405-1 to discharge drilling muds, drilling cuttings and drilling wastes from hydrocarbon exploration activities at the Cheal-C wellsite onto and into land via mix-bury cover was not exercised throughout the monitoring period under review. Drilling muds, drilling cuttings and drilling wastes were disposed of at a consented off site facility.

2.3.4 Land status

The wellsite was constructed on relatively flat rural dairy farming area. Relatively minor earthworks were required to construct the site. The land had not been reinstated at the time of the last inspection (8 May 2014) as the site was still in use.

2.4 Biomonitoring surveys

Biomonitoring surveys were performed prior to the commencement of hydraulic fracturing activities on 7 March 2014, and following the completion of hydraulic fracturing activities on 31 March 2014, at the Cheal-C wellsite to determine whether or not consented discharges of treated stormwater and uncontaminated site water and production water onto land near the unnamed tributary of the Mangawharawhara Stream have had a detrimental effect upon the macroinvertebrate communities of this stream.

Both the pre and post hydraulic fracturing biomonitoring surveys were undertaken at three established sites; 25 m upstream of the Cheal-C wellsite discharge (site 1), 50 m downstream of the Cheal-C wellsite discharge (site 2) and 100 m downstream of the Cheal-C wellsite discharge (site 3), as seen in Figure 4.

The Councils' 'vegetation sweep' sampling technique was used at the three sites to collect streambed macroinvertebrates from the unnamed tributary of the Mangawharawhara Stream. This has provided baseline data for any future assessment of consented discharge effects from the Cheal-C 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.

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

Figure 4 Biomonitoring sites in the unnamed tributary of the Mangawharawhara Stream in relation to the Cheal-C wellsite

7 March 2014

This March 2014 survey of three sites upstream and downstream of the skimmer pit discharge to land near the stream, was undertaken prior to hydraulic fracturing of the Cheal-C wellsite.

The three sites surveyed were relatively similar in macroinvertebrate community composition with low to moderate taxonomic richnesses (number of taxa). A total of 25 taxa was found through the reach of the stream surveyed, with 3 of these taxa (12%) found at all three sites and 5 taxa (20%) found at any two of these sites. One 'sensitive' taxon was abundant at all three sites. SQMCI$_S$ scores recorded at site 1 and site 3 were significantly lower than the medians recorded from other ring plain streams arising outside of the National Park at similar altitudes, whereas site 2 was significantly higher (TRC, 1999 (updated 2013)).The MCI score recorded at site 1 was significantly lower than those recorded at site 2 and site 3, similarly the MCI score recorded at site 3 was significantly less than that recorded at site 2. In addition, MCI scores for all sites were significantly less than the median MCI scores for comparable streams within the region. The moderately low taxa richness and MCI scores recorded in this survey are reflective of the habitat which was limited by very low and slow flows. The MCI scores indicated that the stream macroinvertebrate communities were of 'poor' to 'fair' health (TRC, 2014).

31 March 2014

This March 2014 survey of three sites, upstream and downstream of the skimmer pit discharge point to land near the stream, was undertaken following hydraulic fracturing at the Cheal-C wellsite. Taxa richnesses were low to moderate. The

macroinvertebrate communities of the stream contained slightly more 'sensitive' than 'tolerant' taxa. A total of 16 taxa was found through the reach of the stream surveyed, with 5 of these taxa (31%) found at all three sites and 3 taxa (19%), found at any two of these sites. The number of taxa recorded in abundance increased at site 2, downstream of the skimmer pit discharge, and was the same as the control site at site 3.

A comparison of the pre-HF and post-HF survey results showed a significant increase in MCI and $SQMCI_s$ scores at site 1, but no significant changes at site 2 and site 3. Slight variations in MCI and $SQMCI_S$ scores and taxa richness, particularly at site 2 compared with site 1 and site 3 are considered to be due to habitat variability rather than a change in water quality.

The MCI scores recorded in this survey indicated that the stream communities were of poor to fair 'health' (TRC, 2014), slightly worse than the biological health recorded at 'control' sites in similar streams at a comparative altitude elsewhere in the region. This, in part, can be attributed to the habitat which was limited by very low and slow flows. There was no indication from the results of the two surveys that any discharge from the Cheal-C wellsite has impacted on the biological communities of the unnamed tributary of the Mangawharawhara Stream.

2.5 Contingency plan

TAG Oil (NZ) Limited have provided a general contingency plan, as required by Condition 4 of resource consent 6403-1 with site specific maps which cover all onshore sites that they operate. The contingency plan has been reviewed and approved by officers of the Council.

2.6 Investigations, interventions and incidents

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

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

In the period under review, there were issues around maintenance of the ring-drains and skimmer pits observed by the inspecting officers; one abatement notice and one infringement notice were issued to TAG Oil (NZ) Limited in relation to these non-compliances.

An inspecting officer visited the site on 11 October 2013 where rainfall events and sediment continued to inundate the site and the already sediment laden ring drains and stormwater treatment system. This contravened Section 15(1)(b) of the Resource

Management Act and special conditions 6 and 7 of resource consent 6403-1. Abatement notice 12116 was issued which required TAG Oil (NZ) Limited to undertake works to restore and maintain the ring drain to a full operational manner and ensure all stormwater, produced water and wastewater was directed through the stormwater treatment system, mitigating the potential for direct unauthorised discharges from the site to occur.

A discharge sample also obtained on 11 October 2013 returned elevated levels of suspended solids (230 g/m^3), which contravened Section 15(1)(b) of the Resource Management Act and special condition 10 of resource consent 6403-1. Infringement notice EAC-20053 was issued to TAG Oil (NZ) Limited. This discharge was to land and no adverse environmental effects were noted in the nearby stream. This high suspended solid count was most likely attributed to the lack of works undertaken at this point to rectify the ring drains to an operational manner. Works were later completed within the required timeframe and with appropriate notification following abatement notice 12116, and no further exceedances were detected in samples.

The Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with TAG Oil (NZ) Limited's conditions in resource consents or provisions in Regional Plans. There were no non-compliances in relation to drilling, gas combustion or fracturing activities.

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

3. Discussion

3.1 Discussion of consent exercise

Of the seven resource consents relating to the Cheal-C wellsite, consents 6403-1 (to discharge treated stormwater, treated produced water and treated wastewater onto and into land), 6404-1 (to discharge stormwater and sediment from earthworks during construction onto and into land), 7780-1 (to take and use water from an unnamed tributary of the Mangawharawhara Stream), 9262-1 (to discharge emissions to air associated with production activities), 9285-1 (to discharge emissions to air from flaring of hydrocarbon exploration activities), and 9397-1 (to discharge contaminants associated with hydraulic fracturing activities into land) were exercised and actively monitored.

The discharge of drilling muds, cuttings and wastes from hydrocarbon exploration via mix-bury cover was not exercised during the monitoring period under review as permitted by resource consent 6405-1. Drilling waste was transported off site to a consented facility.

Other than as noted in section 2.6, 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 significant adverse 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, TAG Oil (NZ) 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.

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.

TAG Oil (NZ) Limited also undertook the following mitigation measures in order to minimize off site adverse effects:

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

- Maintenance and repairs were carried out if required.

Interceptor pits do not discharge directly to surface water, instead they discharge onto and into land where the discharge usually soaks into the soil before reaching any surface water. However, if high rainfall had resulted in the discharge reaching the surface water, significant dilution would have occurred. As noted previously, on occasion the Company was directed by the Council to attend to the matter of maintenance of the stormwater system.

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, from contamination by drilling or fracturing activities.

Flaring

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

The Council has previously undertaken field studies at two wells (one gas, and the other producing oil and heavier condensates); together with dispersion modelling at a third site[1]. 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 PM_{10} 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.

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[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 TAG Oil (NZ) 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;
- The use of a flare tank was utilised more in preference to a flare pit;
- Records of flaring events are kept by TAG Oil (NZ) Limited and provided to the Council;
- Efforts were made by TAG Oil (NZ) 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
- Efforts were made by TAG Oil (NZ) Limited to minimise smoke emissions from the flare.

Odour and dust

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

Hazardous substances

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

TAG Oil (NZ) 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;
- Endeavors were made to complete separation of chemicals from the flare pit and flare tank 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.

Hydraulic fracturing

The process of hydraulic fracturing results in some chemicals (e.g. clay stabilisers) being absorbed into the rock, where some may be residually trapped near the fracture face. The chemicals used in the fracturing process are classified as hazardous substances. However, these additives used in the process make up less than 5% of the

total volume of fluid, the remaining being water and proppant. In a concentrated form some of the chemicals used in the fluid are toxic, but prior to the activity they are highly diluted as part of the process. The majority of the fluid returns to the surface for controlled disposal at a consented facility.

Hence, there is a discharge of contaminants (energy, chemicals, water and inert sand/ small ceramic pellets) to land at considerable depth that has minor and temporary changes to the physical and chemical condition of the land (reservoir) in a way that does not affect other foreseeable users of the land and water resources.

The interval fractured is generally over 3 km below the surface. It is isolated by a considerable thickness of impermeable rock. The reservoir sands are known to contain hydrocarbons at pressures that exceed hydrostatic pressure, proving that the cap rock is relatively impermeable to the flow of water and hydrocarbons over very long time scales and high pressures.

The potential for the hydraulic fracturing activities to trigger seismic activity, particularly if located near faults within the formation has also been raised as a concern by some individuals. However, hydraulic fracturing is designed to create certain fractures in the rock and on a geological scale these are insignificant. The fissures created by the fracturing discharge are generally less than 400 m long, several mm wide and roughly 20 m thick into reservoir rock. These are very small features on a geological scale, and are not envisaged to create any increased risk of significant seismic activity.

The risk of the reservoir being fractured with a failure of the geological seal causing fracture fluids to migrate upwards and contaminate groundwater resources is considered extremely low. This is a result of numerous geological seals acting as natural barriers that stop any fracture fluids migrating upward.

Concern has also been raised that shallow groundwater may become contaminated from chemicals used in the hydraulic fracturing process. It is alleged that fluids may return to the surface via poorly sealed well casing or via cracks created through the fracturing process, rendering groundwater unsafe for human consumption. These hydro-geological risks of hydraulic fracturing affecting potable groundwater arise from two potential sources. The integrity of the well being used for the hydraulic fracturing, including the well casing and cement programme; and the geologic integrity of the reservoir seal and seals above this.

As a result of fracture design and modelling, coupled with extensive monitoring, the potential for groundwater to be impacted by hydraulic fracturing of a properly constructed well is extremely low and highly unlikely.

Summary

There were no significant adverse environmental effects observed to water, land or air as a result of the wellsite activities during the monitoring period.

3.3 Evaluation of performance

A tabular summary of TAG Oil (NZ) Limited's compliance record for the period under review is set out in Tables 7 to 13.

Table 7 Summary of performance for consent 6403-1 to discharge treated stormwater, treated produced water and treated wastewater at the Cheal-C wellsite onto and into land in the vicinity of an unnamed tributary of the Mangawharawhara Stream in the Waingongoro catchment

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	No – continued issues with silt and sediment controls at site. One abatement notice and one infringement notice issued, during the three year monitoring period
2. Maximum stormwater catchment area shall be no more than 16,000 m^2	Plans, procedures and processes	Yes
3. 7 days written notice provided to the Council prior to site works and drilling	Notification received	Yes
4. Council to approve prepared contingency plan in relation to the wellsite prior to exercise of consent	Contingency plan approved	Yes
5. Consent holder shall keep and maintain records of every discharge operation from the sump(s)	Inspection of records	Yes
6. All stormwater, produced water, and wastewater to be directed for treatment through the stormwater treatment system	Inspection	No – continued issues with silt and sediment controls at site. One abatement notice issued, during the three year monitoring period
7. All discharges from the site shall flow to a perimeter drain and skimmer pit	Inspection	No - continued issues with silt and sediment controls at site. One abatement notice issued, during the three year monitoring period
8. Skimmer pits shall have a combined capacity of no less than 330 m^3 and retain hydrocarbons	Inspection and physicochemical sampling	Yes
9. All stormwater pits shall be lined with impervious material	Inspection	Yes
10. The stormwater system shall be	Comparative inspections in accordance with	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
designed, managed and maintained in accordance with information submitted	information submitted	
11. Any above ground hazardous substances storage areas shall be bunded with drainage to sumps or other appropriate recovery systems	Inspection	Yes
12. Discharges onto and into land shall occur a minimum of 20 metres away from any surface water body	Inspection	Yes
13. Constituents in discharges shall meet the following standards: a) pH 6.5 – 8.5 b) Suspended solids <100 g/m^3 c) Hydrocarbon <15 g/m^3 d) Chloride 50 g/m^3	Physicochemical sampling	No – one suspended solid exceedance detected in discharge sample. Infringement notice issued
14. Following a mixing zone of 25 m , discharges shall not give rise to: a) An increase in temperature of more than 2°C b) Biochemical oxygen demand of more than 2.00gm^{-3} c) Unionised ammonia expressed as nitrogen of more than 0.02gm^{-3}	Physicochemical sampling	Yes
15. Following the mixing zone, the discharge shall not give rise to adverse effects in/on the receiving waters	Inspection	Yes
16. Exercise of consent shall not result in a level of total dissolved salts within any surface water body or groundwater of more than 2500gm^{-3}	Physicochemical sampling	Yes
17. The Council shall be advised in writing 48 hrs prior to reinstatement of the site	Notification	N/A
18. Consent shall lapse if not implemented	Exercise of consent confirmed by inspection	N/A
19. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		Poor Good

Table 8 Summary of performance for consent 6404-1 to discharge stormwater and sediment from earthworks during construction of the Cheal-C wellsite onto and into land and into an unnamed tributary of the Mangawharawhara Stream in the Waingongoro catchment

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. 7 days written notice prior to site earthworks commencing	Notification received	Yes
3. Post mixing zone, the discharge shall not give rise to adverse effects within any surface water body	Inspection and physicochemical sampling	Yes
4. Earthwork areas and control of stormwater discharge shall be designed, managed and maintained in accordance with information submitted	Comparative inspections in accordance with information submitted	Yes
5. All earth worked areas shall be stabilised as soon as practicable	Inspection	Yes
6. Consent shall lapse if not implemented	Exercise of consent confirmed by inspection	Yes
7. Notice of Council to review consent	No provision for review during period	Yes
Overall assessment of environmental performance and compliance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

Table 9 Summary of performance for consent 6405-1 to discharge drilling muds, drilling cuttings and drilling wastes from hydrocarbon exploration activities at the Cheal-C wellsite onto and into land via mix-bury cover

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. The volume of waste discharged shall not exceed 1,800m^3	Inspection, procedures and processes	N/A
2. Prior to exercise of consent the consent holder must provide to the Council for each discharge in writing a scope of the proposed mix-bury cover discharge	Notification	N/A
3. 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
4. The Council to be notified 48hrs prior to and completion of each mix-bury cover discharge	Notification	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
5. Records of composition, volumes and quantities of material to be discharged shall be kept	Inspection of Company records	N/A
6. Mix-bury cover operations must be 30m from any surface water body, spring or bore	Inspection	N/A
7. All ponded water to be removed from drilling waste retention receptacle prior to recovery/mixing operations	Inspection	N/A
8. All sumps to be permeable	Inspection	N/A
9. Solid drilling wastes to be incorporated with uncontaminated soils	No drilling wastes remediated on site via mix-bury cover during the period under review	N/A
10. Placement of solid drilling wastes shall as far as practicable be above the water table	No drilling wastes remediated on site via mix-bury cover during the period under review	N/A
11. 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
12. Chloride levels in each mix-bury cover activity shall not exceed 1,600kg	Physicochemical sampling	N/A
13. Nitrogen levels in each mix-bury-cover shall not exceed 400kg	Physicochemical sampling	N/A
14. The hydrocarbon content of solid drilling waste shall not exceed 15mg/kg	Physicochemical sampling	N/A
15. Level of total dissolved salts within any surface water or groundwater must not exceed 2,500 g/m^3	Physicochemical sampling	N/A
16. Various metals in the soil covering the mix-bury cover to be below agreed limits	Physicochemical sampling	N/A
17. Mixture of solid drilling wastes and uncontaminated soil shall be covered by at least 0.5 m of uncontaminated soil and shall be re-vegetated and maintained with pasture cover	Inspection, procedures & processes	N/A
18. The cover material must be compacted and contoured so that stormwater is directed away from the	Inspection	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
mix-bury cover site		
19. Consent holder to adopt best practicable option at all times	Inspection, procedures and processes	N/A
20. Exercise of consent shall not lead to a direct discharge of contaminants to a surface water body	Inspection	N/A
21. Exercise of consent shall not result in any adverse impact on groundwater, surface water or aquatic ecosystems	Inspection and physicochemical sampling	N/A
22. Hydrocarbon concentrations in the soil covering the mix-bury cover site shall comply with agreed guideline values	Physicochemical sampling	N/A
23. Soil levels shall not exceed the following parameters: a. Conductivity 290 mSm^{-1} b. Total dissolved salts 2500 g/m^3 c. Sodium 460 g/m^3 d. Chloride 700 g/m^3	Physicochemical sampling	N/A
24. Consent holder may apply to the Council for a change or cancellation of the conditions of this consent	No applications lodged during period under review	N/A
25. The Council may review any or all of the consent conditions within two months of receiving data regarding condition 2	No reviews made during period under review	N/A
26. Consent shall lapse if not implemented by date specified	Consent not exercised during period under review	N/A
27. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of environmental performance and compliance in respect of this consent		N/A – Consent not exercised
Overall assessment of administrative performance in respect of this consent		N/A – Consent not exercised

Table 10 Summary of performance for consent 7780-1 to take and use water from an unnamed tributary of the Mangawharawhara Stream for hydrocarbon exploration activities at the Cheal-C wellsite

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Volume of water abstracted shall not exceed 2 litres per second and 350 cubic metres in a 7-day period	Inspection of abstraction logs	Yes
2. Consent holder shall maintain a record of abstractions and make available to the Council upon request	Inspection of abstraction logs	Yes
3. Consent holder shall take all reasonable steps to avoid, remedy or mitigate any adverse effect on the environment arising from the exercise of this consent	Inspections	Yes
4. Intake structure must be appropriately screened to avoid the entrainment of fish	Inspection of structure	Yes
Overall assessment of environmental performance and compliance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

Table 11 Summary of performance for consent 9262-1 to discharge emissions to air associated with production activities from up to 10 wells at the Cheal-C wellsite, including: flaring associated with emergencies (including operational emergencies) and maintenance; emissions from gas treatment or production plants; and minor emissions from other miscellaneous activities

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Council must be notified 24hrs prior to flaring when practicable	Notification	Yes
2. All gas flared must first be treated by effective liquid and solid separation and recovery	Inspection of flare pit and flare tank	Yes
3. No material to be flared or incinerated, other than those derived from or entrained in the well stream	Inspection of flare pit and flare tank	Yes
4. Best practicable option to be adopted	Inspections, procedures and processes	Yes
5. No offensive or objectionable odour or smoke at or beyond the boundary	Inspection	Yes
6. All permanent tanks used as hydrocarbon storage vessels fitted with vapour recovery systems	Inspection	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
7. Report submitted to the Council annually detailing gas combustion and potential mitigation measures adopted in relation to the production station; and any further mitigation measures adopted and complaints received	Report received	Yes
8. Control of carbon monoxide, nitrogen dioxide, sulphur dioxide and fine particles	Inspection of Company records	Yes
9. Control of other emissions	Inspection of Company records	Yes
10. Analysis of typical gas and condensate stream from field to be made available to the Council	Available upon request	Yes
11. Log all flaring including date, time, duration, zone, volumes flared and smoke events	Inspection of Company records	Yes
12. Consent shall lapse if not implemented	Consent exercised	N/A
13. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of environmental performance and compliance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

Table 12 Summary of performance for consent 9285-1 to discharge emissions to air from flaring of hydrocarbon exploration activities associated with up to seven wells at the Cheal-C wellsite, including: flaring of hydrocarbons associated well clean-up and well testing; and emissions from other miscellaneous activities

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent shall not be exercised for more than an accumulated duration of 45 days per zone	Inspection of records	Yes
2. Council must be notified 24hrs prior to initial flaring of each zone	Notification received	Yes
3. Location of flare shall be NZTM: 1710372E – 5641664N	Inspection	Yes
4. Flare pit shall be located at least 300 metres from any dwelling house	Inspection	Yes
5. All gas flared must first be treated by effective liquid and solid separation and recovery	Inspection of flare pit and flare tank	Yes
6. Only substances originating from the well stream shall be combusted	Inspection of flare pit and flare tank	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
7. Best practicable option to be adopted	Inspections, procedures and processes	Yes
8. No offensive or objectionable odour or smoke at or beyond the boundary	Inspection	Yes
9. Control of carbon monoxide, nitrogen dioxide, sulphur dioxide and fine particles	Inspection of Company records	Yes
10. Control of other emissions	Inspection of Company records	Yes
11. Analysis of typical gas and condensate stream from field to be made available to the Council	Available upon request	N/A
12. All permanent tanks used as hydrocarbon storage vessels fitted with vapour recovery systems	Inspection	Yes
13. Consent holder shall make available to the Council a flaring log detailing all flaring events including time, duration, zone, volumes flared and smoke events	Inspection of Company records	Yes
14. Consent shall lapse if not implemented	Consent exercised	N/A
15. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of environmental performance and compliance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

Table 13 Summary of performance for consent 9397-1 to discharge contaminants associated with hydraulic fracturing activities into land at depths greater than 3,700 mTVDss beneath the Cardiff-3 well located at the Cheal-C wellsite

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Any discharge shall occur below 3,700 mTVDSS	Inspection of Company records	Yes
2. There shall be no discharge of hydraulic fracturing fluids into the reservoir after 1 June 2016	-	N/A
3. Exercise of consent shall not contaminate or put at risk freshwater	Sampling fresh water bores pre/post discharge	Yes
4. Consent holder shall undertake sampling programme	Inspection and sampling fresh water bores pre/post discharge	Yes
5. Groundwater monitoring bores may be installed as required	Site assessment	Yes
6. Sampling programme shall follow recognised field parameters	Inspection, procedures and processes	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
7. Sampling programme shall follow recognised field procedures	Inspection, procedures and processes	Yes
8. Consent holder to undertake well and equipment pressure testing	Inspection of company records	Yes
9. A pre-fracturing discharge report is to be provided to the Council 14 days prior to the second and subsequent discharges	Pre-fracturing discharge report received	Yes
10. Consent holder shall provide notification prior to each hydraulic fracture discharge	Notification received	Yes
11. A post-fracturing discharge report is to be provided to the Council within 60 days after the discharge has ceased	Post-fracturing discharge report received	Yes
12. The reports outlined in conditions 9 and 11 must be emailed to consents@trc.govt.nz	Reports received via email	Yes
13. The consent holder shall provide access to a location where samples of hydraulic fracturing fluids and return fluids can be obtained by the Council officers	Provided	Yes
14. Consent holder to adopt best practicable option at all times	Inspection, physicochemical sampling, procedures and processes	Yes
15. The fracture fluid shall be comprised of no less than 91% water	Sample of discharge and return fluids	Yes
16. Notice of Council to review consent	No provision for review	N/A
Overall assessment of environmental performance and compliance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

Taking into account that conditions relating to stormwater management systems on one consent were breached during the first part of the monitoring period, resulting in a non-complying discharge on one occasion that had no environmental effects, then overall during the three year monitoring period under review, TAG Oil (NZ) Limited demonstrated a good level of environmental and administrative performance and compliance with the resource consents. The incidents that occurred during the period under review have been discussed in Section 2.5.

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 2015 and 2017.

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

3.5 Alterations to monitoring programmes

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

The Council has routinely monitored wellsite activities for more than 20 years in the region. This work has included in the order of hundreds of water samples and biomonitoring surveys in the vicinity of wellsites, and has demonstrated robustly that a monitoring regime based on frequent and comprehensive inspections is rigorous and thorough, in terms of identifying any adverse effects from wellsite and associated activities. Furthermore, with regard to hydraulic fracturing activities, baseline groundwater monitoring samples have demonstrated that hydraulic fracturing discharges have not given rise to any significant adverse effects on groundwater aquifers within the region. However, the Council had for a time not routinely required the imposition of additional targeted physicochemical and biological monitoring unless a site-specific precautionary approach indicated this would be warranted for certainty and clarity around site effects.

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

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

4. Recommendations

1. THAT this report be forwarded to the Company, and to any interested parties upon request;

2. THAT the monitoring of future consented activities at Cheal-C wellsite continue to include the sampling and extensive analysis of both groundwater and surface waters in the general vicinity of a wellsite where hydraulic fracturing occurs;

3. THAT the monitoring of future consented activities at Cheal-C wellsite continues to include biomonitoring surveys;

4. THAT, subject to the findings of monitoring of any further activities at the Cheal-C wellsite consents 6403-1, 6404-1, 6405-1, 7780-1, 9262-1, 9285-1 and 9397-1 shall not be reviewed in 2017.

Glossary of common terms and abbreviations

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

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

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

Name of Consent Holder:	Cheal Petroleum Limited P O Box 402 NEW PLYMOUTH 4340
Decision Date (Change):	07 February 2014
Commencement Date (Change):	07 February 2014 (Granted: 22 July 2004)

Conditions of Consent

Consent Granted:	To discharge treated stormwater, treated produced water and treated wastewater at the Cheal-C wellsite onto and into land in the vicinity of an unnamed tributary of the Mangawharawhara Stream in the Waingongoro catchment
Expiry Date:	1 June 2023
Review Date(s):	June 2017
Site Location:	Cheal-C wellsite, Brookes Road, Stratford (Property owner: VD & FP Hancock)
Legal Description:	Sec 13 Blk V Ngaere SD
Grid Reference (NZTM)	1710351E-5641664N
Catchment:	Waingongoro
Tributary:	Mangawharawhara

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 on any water body.

2. The maximum stormwater catchment area shall be no more than 16,000 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. The consent holder shall keep records of every discharge operation from the sump[s], including:

    a) records of all additives used at the wellsite during the drilling process;
    b) volume discharged;
    c) time of discharge events;
    d) chemical analysis of the wastes;

    and shall make the records available to the Chief Executive, Taranaki Regional Council, upon request.

6. All stormwater, produced water, and wastewater 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 permit.

7. All discharges from the site, including from any containment pit or hydrocarbon combustion facility (e.g. flare pit, thermal oxidiser), shall flow to a perimeter drain and skimmer pit. Perimeter drains shall be designed, including by having a positive grade and low permeability, to ensure that runoff flows directly to a skimmer pit without ponding.

8. Skimmer pits shall have a combined capacity of no less than 330 m3 including a 'dead storage' of no less than 131 m3, and be designed to retain any hydrocarbons that enter them.

9. All skimmer pits and any other stormwater retention areas shall be lined with an impervious material to prevent seepage through the bed and sidewalls, and all skimmer pits shall have a valve that can be shut off to prevent any discharge from the site.

10. Subject to the other conditions of this consent the design, management and maintenance of the stormwater system shall be in accordance with the information submitted in support of the original application and any subsequent application to change the consent conditions.

11. 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.

12. The discharge onto and into land shall occur a minimum of 20 metres from any surface water body.

13. 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, treated produced water, and treated wastewater either onto and into land or into surface water at a designated sampling point approved by the Chief Executive, Taranaki Regional Council.

14. 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 of the unnamed tributary:

a) an increase in temperature of more than 2 degrees Celsius;
b) biochemical oxygen demand of more than 2.00 gm^{-3}; and
c) unionised ammonia expressed as nitrogen of more than 0.02 gm^{-3}.

15. 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 of the unnamed tributary:

    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.

16. The exercise of this consent shall not result in a level of total dissolved salts within any surface waterbody or groundwater of more than 2500 gm^{-3}.

17. 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.

18. 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.

19. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2011 and/or June 2017, 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

For and on behalf of
Taranaki Regional Council

_____

A D McLay
Director-Resource Management

Discharge Permit

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

Name of Consent Holder:	Cheal Petroleum Limited P O Box 402 NEW PLYMOUTH 4340
Decision Date:	19 September 2013
Commencement Date:	19 September 2013

Conditions of Consent

Consent Granted:	To discharge contaminants associated with hydraulic fracturing activities into land at depths greater than 3,700 mTVDss beneath the Cardiff-3 well located at the Cheal-C wellsite
Expiry Date:	1 June 2021
Review Date(s):	June Annually
Site Location:	Cheal-C wellsite, 127 Brookes Road, Stratford (Property owner: V Hancock)
Legal Description:	Sec 13 Blk V Ngaere SD (Discharge source & site)
Grid Reference (NZTM)	1710351E-5641664N
Catchment:	Waingongoro
Tributary:	Mangawharawhara

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

General condition

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

Special conditions

1. The discharge point shall be deeper than 3700 mTVDss.

   Note: mTVDss = metres true vertical depth subsea, i.e. the true vertical depth in metres below mean sea level.

2. There shall be no discharge of hydraulic fracturing fluids into the reservoir after 1 June 2016.

3. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water). Usable fresh groundwater is defined as any groundwater having a Total Dissolved Solids concentration of less than 1000 mg/l.

4. The consent holder shall undertake a programme of sampling and testing that monitors the effects of the exercise of this consent on fresh water resources to assess compliance with condition 3 (the 'Monitoring Programme'). The Monitoring Programme shall be certified by the Chief Executive, Taranaki Regional Council ('the Chief Executive'), before this consent is exercised, and shall include:

   (a) the location of the discharge point(s);
   (b) the location of sampling sites; and
   (c) sampling frequency with reference to a hydraulic fracturing programme.

5. Depending on the suitability of existing bores within 500 metres of the wellsite for obtaining a representative groundwater sample, it may be necessary for the Monitoring Programme to include installation of, and sampling from, a monitoring bore. The bore would be of a depth, location and design determined after consultation with the Chief Executive, Taranaki Regional Council and installed in accordance with NZS 4411:2001.

6. All water samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for:

   (a) pH;
   (b) conductivity;
   (c) total dissolved solids;
   (d) major ions (Ca, Mg, K, Na, total alkalinity, bromide, chloride, nitrate-nitrogen, and sulphate);
   (e) trace metals (barium, copper, iron, manganese, nickel, and zinc);
   (f) total petroleum hydrocarbons;
   (g) formaldehyde;
   (h) dissolved methane and ethane gas;
   (i) methanol;
   (j) glycols;
   (k) benzene, toluene, ethylbenzene, and xylenes (BTEX); and
   (l) carbon-13 composition of any dissolved methane gas discovered ($^{13}C\text{-}CH_4$).

Note: The samples required, under conditions 4 and 6 could be taken and analysed by the Taranaki Regional Council or other contracted party on behalf of the consent holder.

7. All sampling and analysis shall be undertaken in accordance with a *Sampling and Analysis Plan*, which shall be submitted to the Chief Executive for review and certification before the first sampling is undertaken. This plan shall specify the use of standard protocols recognised to constitute good professional practice including quality control and assurance. An International Accreditation New Zealand (IANZ) accredited laboratory shall be used for all sample analysis. Results shall be provided to the Chief Executive within 30 days of sampling and shall include supporting quality control and assurance information. These results will be used to assess compliance with condition 3.

   Note: The Sampling and Analysis Plan may be combined with the Monitoring Programme required by condition 4.

8. The consent holder shall undertake well and equipment pressure testing prior to any hydraulic fracture programme on a given well to ensure any discharge will not affect the integrity of the well and hydraulic fracturing equipment.

9. Any hydraulic fracture discharge shall only occur after the consent holder has provided a comprehensive 'Pre-fracturing discharge report' to the Chief Executive. The report shall be provided at least 14 days before the discharge is proposed to commence and shall detail the hydraulic fracturing programme proposed, including as a minimum:

   (a) the specific well in which each discharge is to occur, the intended fracture interval(s) ('fracture interval' is the discrete subsurface zone to receive a hydraulic fracture treatment), and the duration of the hydraulic fracturing programme;
   (b) the number of discharges proposed and the geographical position (i.e. depth and lateral position) of each intended discharge point;
   (c) the total volume of fracture fluid planned to be pumped down the well, including mini- fracture treatments, and their intended composition, including a list of all contaminants and Material Safety Data Sheets for all the chemicals to be used;
   (d) the results of the reviews required by condition 14;
   (e) results of modelling showing an assessment of the likely extent and dimensions of the fractures that will be generated by the discharge;
   (f) the preventative and mitigation measures to be in place to ensure the discharge does not cause adverse environmental effects and complies with condition 3;
   (g) the extent and permeability characteristics of the geology above the discharge point to the surface;
   (h) any identified faults within the modeled fracture length plus a margin of 50%, and the potential for adverse environmental effects due to the presence of the identified faults;
   (i) the burst pressure of the well and the anticipated maximum well and discharge pressures and the duration of the pressures; and
   (j) details of the disposal of any returned fluids, including any consents that are relied on to authorise the disposal.

   Note: For the avoidance of doubt, the information provided with a resource consent application would usually be sufficient to constitute a 'Pre-fracturing discharge report' for any imminent hydraulic fracturing discharge. The Pre-fracturing discharge report provided for any later discharge may refer to the resource consent application or earlier Pre-fracturing discharge reports noting any differences.

10. The consent holder shall notify the Taranaki Regional Council of each discharge by emailing worknotification@trc.govt.nz. Notification shall include the date that the discharge is to occur and identify the 'Pre-fracturing discharge report', required by condition 9, which details the discharge. Where practicable and reasonable notice shall be given between 3 days and 14 days before the discharge occurs, but in any event 24 hours notice shall be given.

11. At the conclusion of a hydraulic fracturing programme on a given well, the consent holder shall submit a comprehensive 'Post-fracturing discharge report' to the Chief Executive. The report shall be provided within 60 days after the programme is completed and, as a minimum, shall contain:

    (a) confirmation of the interval(s) where fracturing occurred for that programme, and the geographical position (i.e. depth and lateral position) of the discharge point for each fracture interval;
    (b) the contaminant volumes and compositions discharged into each fracture interval;
    (c) the volume of return fluids from each fracture interval;
    (d) an analysis for the constituents set out in conditions 6(a)to 6(k), in a return fluid sample taken within the first two hours of flow back, for each fracture interval if flowed back individually, or for the well if flowed back with all intervals comingled;
    (e) an estimate of the volume of fluids (and proppant) remaining underground;
    (f) the volume of water produced with the hydrocarbons (produced water) over the period beginning at the start of the hydraulic fracturing programme and ending 50 days after the programme is completed or after that period of production;
    (g) an assessment of the extent and dimensions of the fractures that were generated by the discharge, based on modelling undertaken after the discharge has occurred and other diagnostic techniques, including production analysis, available to determine fracture length, height and containment;
    (h) the results of pressure testing required by condition 8, and the top hole pressure (psi), slurry rate (bpm), surface proppant concentration (lb/gal), bottom hole proppant concentration (lb/gal), and calculated bottom hole pressure (psi), as well as predicted values for each of these parameters; prior to, during and after each hydraulic fracture treatment;
    (i) details of the disposal of any returned fluids, including any consents that are relied on to authorise the disposal;
    (j) details of any incidents where hydraulic fracture fluid is unable to pass through the well perforations (screen outs) that occurred, their likely cause and implications for compliance with conditions 1 and 3; and
    (k) an assessment of the effectiveness of the mitigation measures in place with specific reference to those described in the application for this consent.

12. The reports described in conditions 9 and 11 shall be emailed to consents@trc.govt.nz with a reference to the number of this consent.

13. The consent holder shall provide access to a location where the Taranaki Regional Council officers can obtain a sample of the hydraulic fracturing fluids and the return fluids.

14. 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 minimize any actual or likely adverse effect of the activity on the environment by, as a minimum, ensuring that:

    (a) the discharge is contained within the fracture interval;
    (b) regular reviews are undertaken of the preventative and mitigation measures adopted to ensure the discharge does not cause adverse environmental effects; and
    (c) regular reviews of the chemicals used are undertaken with a view to reducing the toxicity of the chemicals used.

15. The fracture fluid shall be comprised of no less than 91% water and proppant by volume.

16. The Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June each year, for the purposes of:

    (a) ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or

    (b) further specifying the best practicable option as required by condition 14; and/or

    (c) ensuring hydraulic fracturing operations appropriately take into account any best practice guidance published by a recognised industry association or environmental regulator.

Signed at Stratford on 19 September 2013

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:	13 June 2012
Commencement Date:	13 June 2012

Conditions of Consent

Consent Granted:	To discharge emissions to air from flaring of hydrocarbon exploration activities associated with up to seven wells at the Cheal-C wellsite, including: • flaring of hydrocarbons associated well clean-up and well testing; and • emissions from other miscellaneous activities at or about (NZTM) 1710372E-5641664N
Expiry Date:	1 June 2023
Review Date(s):	June 2017
Site Location:	Cheal-C wellsite, 127 Brookes Road, Stratford (Property owner: V Hancock)
Legal Description:	Sec 13 Blk V Ngaere SD (Discharge source & site)

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

General condition

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

Special conditions

1. Flaring shall not occur on more than 4 days (96 hours), cumulatively, per zone for each well (with a maximum of 4 zones per well), for up to 7 wells.

2. The consent holder shall notify the Chief Executive, Taranaki Regional Council, at least 24 hours before the initial flaring of each zone being commenced. Notification shall include the consent number and a brief description of the activity consented and emailed to worknotification@trc.govt.nz.

3. The location of the flare shall be at NZTM: 1710372E-5641664N.

4. The flare pit shall be located at least 300 metres from any dwelling house that existed at the time of the granting of this consent.

5. To the greatest extent possible, all gas that is flared must first be treated by effective liquid and solid separation and recovery.

6. Only gaseous hydrocarbons originating from the well stream shall be combusted within the flare pit.

7. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air from the flare, including, but not limited to, having regard to the prevailing and predicted wind speed and direction at the time of initiation of, and throughout, any episode of flaring so as to minimise offsite effects (other than for the maintenance of a pilot flare flame).

8. The discharge shall not cause any objectionable or offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.

9. The consent holder shall control all emissions of carbon monoxide, nitrogen dioxide, fine particles (PM_{10}) and sulphur dioxide to the atmosphere from the site, in order that the maximum ground level concentration of any of these contaminants arising from the exercise of this consent measured under ambient conditions does not exceed the relevant ambient air quality standard as set out in the Resource Management (National Environmental Standards for Air Quality Regulations, 2004) at or beyond the boundary of the property on which the wellsite is located.

10. The consent holder shall control all emissions to the atmosphere from the site of contaminants other than those expressly provided for under special condition 9, in order that they do not individually or in combination with other contaminants cause a hazardous, noxious, dangerous, offensive or objectionable effect at or beyond the boundary of the property on which the wellsite is located.

11. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure C_6 or higher number of compounds.

12. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.

13. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council upon request, a 'flaring log' that includes:

    a) the date, time and duration of all flaring episodes;

    b) the zone from which flaring occurred;

    c) the volume of substances flared;

    d) whether there was smoke at any time during the flaring episode and if there was, the time, duration and cause of each 'smoke event'.

14. This consent shall lapse on 30 June 2017, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

15. 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 2017, for any of the following purposes:

    a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or

    b) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or

    c) to alter, add or delete limits on mass discharge quantities or ambient concentrations of any contaminant.

Signed at Stratford on 13 June 2012

For and on behalf of
Taranaki Regional Council

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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:	11 June 2012
Commencement Date:	11 June 2012

Conditions of Consent

Consent Granted:	To discharge emissions to air associated with production activities from up to 10 wells at the Cheal-C wellsite, including: • flaring associated with emergencies (including operational emergencies) and maintenance; • emissions from gas treatment or production plants; and • minor emissions from other miscellaneous activities at or about (NZTM) 1710372E-5641664N
Expiry Date:	1 June 2029
Review Date(s):	June 2017, June 2023
Site Location:	Cheal-C wellsite, 127 Brookes Road, Stratford (Property owner: V Hancock)
Legal Description:	Sec 13 Blk V Ngaere SD (Discharge source & site)

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

General condition

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

Special conditions

1. Other than in emergencies, the consent holder shall notify the Chief Executive, Taranaki Regional Council, whenever the continuous flaring of hydrocarbons (other than purge gas) is expected to occur for more than five minutes in duration. Notification shall be no less than 24 hours before the flaring commences. Notification shall include the consent number and be emailed to worknotification@trc.govt.nz.

2. To the greatest extent possible, all gas that is flared must first be treated by effective liquid and solid separation and recovery.

3. Only gaseous hydrocarbons originating from the well stream shall be combusted within the flare pit.

4. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air from the flare, including, but not limited to, having regard to the prevailing and predicted wind speed and direction at the time of initiation of, and throughout, any episode of flaring so as to minimise offsite effects (other than for the maintenance of a pilot flare flame).

5. The discharge shall not cause any objectionable or offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.

6. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.

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

   a) detailing gas combustion at the production station;

   b) detailing any measures to reduce smoke emissions from the production station;

   c) addressing any measures to reduce flaring from the production station;

   d) addressing any other issue relevant to the minimisation or mitigation of emissions from the site; and

   e) detailing any complaints received about activities on the site, and any measures undertaken to address complaints.

8. The consent holder shall control all emissions of carbon monoxide, nitrogen dioxide, fine particles (PM_{10}) and sulphur dioxide to the atmosphere from the site, in order that the maximum ground level concentration of any of these contaminants arising from the exercise of this consent measured under ambient conditions does not exceed the relevant ambient air quality standard as set out in the Resource Management (National Environmental Standards for Air Quality Regulations, 2004) at or beyond the boundary of the property on which the wellsite is located.

9. The consent holder shall control all emissions to the atmosphere from the site of contaminants other than those expressly provided for under special condition 8, in order that they do not individually or in combination with other contaminants cause a hazardous, noxious, dangerous, offensive or objectionable effect at or beyond the boundary of the property on which the wellsite is located.

10. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure C_6 or higher number of compounds.

11. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council, a 'flaring log' for each well that includes:

    a) the date, time and duration of all flaring episodes;

    b) the volume of substances flared;

    c) whether there was smoke at any time during the flaring episode and if there was, the time, duration and cause of each 'smoke event'.

12. This consent shall lapse on 30 June 2017, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

13. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2017 and/or June 2023, for any of the following purposes:

    a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or

    b) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or

    c) to alter, add or delete limits on mass discharge quantities or ambient concentrations of any contaminant.

Signed at Stratford on 11 June 2012

For and on behalf of
Taranaki Regional Council

_____

Director-Resource Management

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

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 262 STRATFORD 4352	**New Address:** P O Box 402 New Plymouth 4340
Decision Date:	22 July 2004	
Commencement Date:	22 July 2004	

Conditions of Consent

Consent Granted:	To discharge drilling muds, drilling cuttings and drilling wastes from hydrocarbon exploration activities at the Cardiff wellsite onto and into land via mix-bury cover at or about (NZTM) 1710351E-5641664N
Expiry Date:	1 June 2023
Review Date(s):	June 2011, June 2017
Site Location:	Cardiff wellsite, Brookes Road, Stratford [Property owner: VD & FP Hancock]
Legal Description:	Sec 13 Blk V Ngaere SD
Catchment:	Waingongoro
Tributary:	Mangawharawhara

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. This consent allows for the discharge of up to 1,800 cubic metres of solid drilling wastes [including drill cuttings and residual fluids] by way of mix-bury-cover into land on the Cardiff wellsite and surrounding land. Mix-bury-cover discharge areas for wastes from individual wells shall be kept separate and distinct.

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 3127. 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 3127.

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].

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.

17. The solid drilling wastes [drill cuttings and residual fluids] shall be covered by at least 0.5 m 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 2 for the purpose of assessing the adequacy of monitoring and mitigation measures.

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 2011 and/or June 2017, 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 24 December 2010

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Consent 7780-1

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

Water 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 262 STRATFORD 4352	**New Address:** P O Box 402 New Plymouth 4340
Decision Date:	9 February 2011	
Commencement Date:	9 February 2011	

Conditions of Consent

Consent Granted:	To take and use water from an unnamed tributary of the Mangawharawhara Stream for hydrocarbon exploration activities at the Cardiff-3 wellsite at or about (NZTM) 1710298E-5641613N
Expiry Date:	1 June 2014
Site Location:	Cardiff-3 wellsite, 127 Brookes Road, Stratford [Property owner: VD Hancock]
Legal Description:	Sec 13 Blk V Ngaere SD [Site of take & use]
Catchment:	Waingongoro
Tributary:	Mangawharawhara

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

General condition

a. The consent holder shall pay to the Taranaki Regional Council [the 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 volume of water taken shall not exceed 2 litres per second and 350 cubic metres in a 7-day period.

2. The consent holder shall maintain a record of the abstraction including date, pumping hours and daily volume abstracted and make these records available to the Chief Executive, Taranaki Regional Council upon request.

3. Notwithstanding the terms and conditions of this consent the consent holder shall take all reasonable steps to avoid, remedy or mitigate any adverse effect on the environment arising from the exercise of this consent, including, but not limited to, the efficient and conservative use of water.

4. The consent holder shall ensure that the intake structure is appropriately screened to avoid the entrainment of fish.

Signed at Stratford on 9 February 2011

For and on behalf of
Taranaki Regional Council

Director-Resource Management

TARANAKI REGIONAL COUNCIL
CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
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Please quote our file number on all correspondence

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 262 STRATFORD 4352
Decision Date:	22 July 2004
Commencement Date:	22 July 2004

Conditions of Consent

Consent Granted:	To discharge stormwater and sediment from earthworks during construction of the Cardiff wellsite onto and into land and into an unnamed tributary of the Mangawharawhara Stream in the Waingongoro catchment at or about (NZTM) 1710351E-5641664N
Expiry Date:	1 June 2023
Review Date(s):	June 2011, June 2017
Site Location:	Cardiff wellsite, Brookes Road, Stratford [Property owners: VD & FP Hancock]
Legal Description:	Sec 13 Blk V Ngaere SD
Catchment:	Waingongoro
Tributary:	Mangawharawhara

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. The Chief Executive, Taranaki Regional Council, shall be advised in writing at least 7 days prior to wellsite and access works commencing.

3. 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.

4. 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 3126, and to the satisfaction of the Chief Executive, Taranaki Regional Council.

5. 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.

6. 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.

7. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2011 and/or June 2017, 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 24 December 2010

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Appendix II

Biomonitoring surveys

To Job Manager; Callum MacKenzie
From Freshwater Biologist; Brooke Thomas
Document 1369887
Date 03 July 2014

Biomonitoring of an unnamed tributary of the Mangawharawhara Stream following hydraulic fracturing by Tag Oil Ltd Ltd at Cheal C wellsite, March 2014

Introduction

This biological survey was performed following hydraulic fracturing of the Cheal C well to determine whether or not treated stormwater and uncontaminated site and production water discharges onto land, in the vicinity of the unnamed tributary of the Mangawharawhara Stream had any effects upon the macroinvertebrate communities of the stream. A survey was also conducted prior to hydraulic fracturing, to provide baseline data on the macroinvertebrate community of this stream (Thomas, 2014).

Methods

The Cheal C wellsite stormwater and site production water was discharged from a skimmer pit on to land within the vicinity of the unnamed tributary of the Mangawharawhara Stream (Figure 1). This survey was undertaken on 31 March 2013 at three established sites ; 25 m upstream of the Cheal C wellsite discharge (site 1), 50 m downstream of the Cheal C wellsite discharge (site 2) and 100 m downstream of the Cheal C wellsite discharge (site 3) (Table 1and Figure 1).

Two different sampling techniques were used to collect streambed macroinvertebrates from the unnamed tributary of the Mangawharawhara Stream, downstream of the stormwater discharges from the Cheal C well site. The Council's 'vegetation sweep' technique was used at site 2 and a combination of the 'kick-sampling' and 'vegetation sweep' sampling techniques were used at sites 1 and 3 (Table 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).

Table 1: Biomonitoring sites and sampling methods used in the unnamed tributary of the Mangawharawhara Stream related to the Cheal C wellsite

Site no.	Site code	Grid reference (NZTM)	Location	Sampling method	Altitude m asl
1	MWW000217	1710311E-5641604N	25 m u/s of Cheal C wellsite discharge	Kick- sweep	300
2	MWW000219	1710315E-5641542N	50m d/s of Cheal C wellsite discharge	Vegetation sweep	300
3	MWW000221	1710348E-5641498N	100m d/s of Cheal C wellsite discharge	Kick- sweep	300

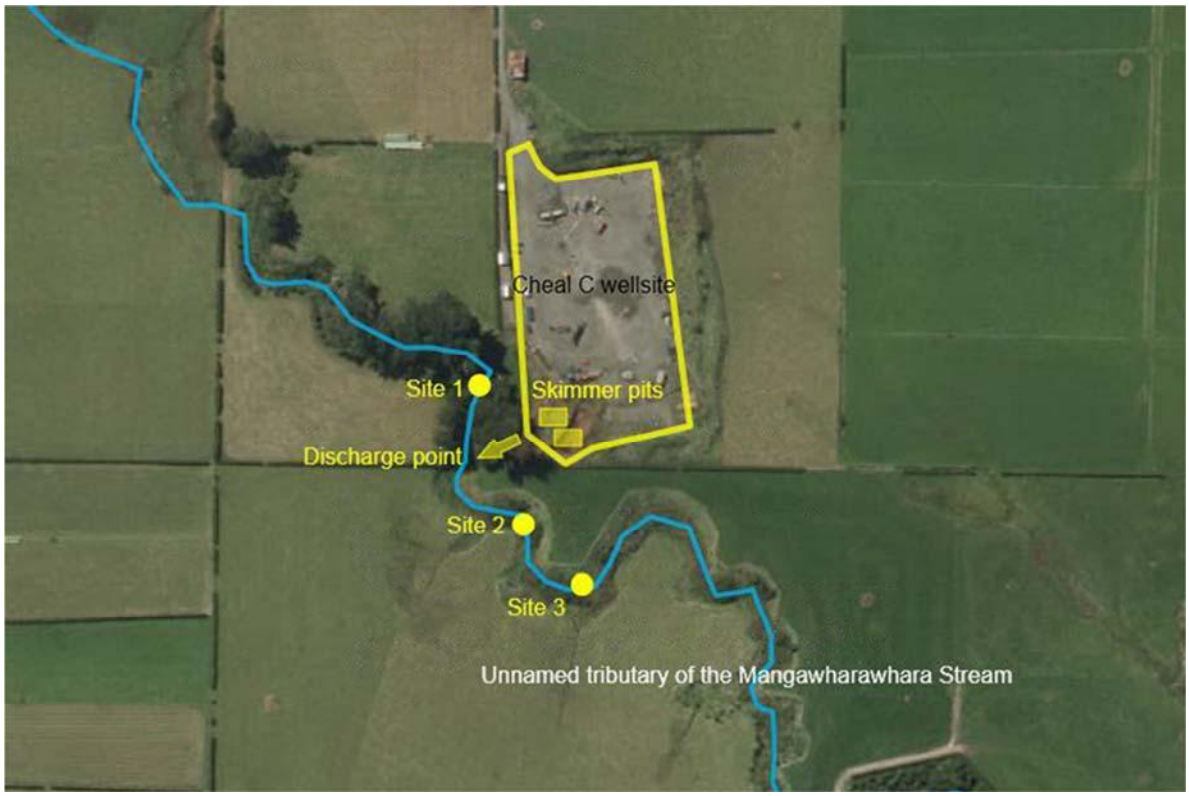

Figure 1 Biomonitoring sites in the unnamed tributary of the Mangawharawhara Stream in relation to the Cheal C wellsite

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

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

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

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

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

Results and discussion

At the time of this mid morning survey the water temperatures in the unnamed tributary of the Mangawharawhara Stream ranged from 11.7 to 12.2 ºC. A very low and very slow flow of clear, uncoloured water was recorded at all three sites. Substrate was comprised of silt at site 2 and site 3 and of silt and wood and root at site 1. Patchy mats of periphyton were recorded at site 1, and no periphyton was recorded at site 2 and site 3. Macrophytes were recorded growing on the edges of the stream at site 1 and site 3 and on the edges and bed of the stream at site 2. Site 1 and site 2 were partially shaded by overhanging vegetation, whereas site 3 was completely shaded.

Macroinvertebrate communities

Table 2 summarises the results of the current macroinvertebrate survey following hydraulic fracturing (HF) of the Cheal C well, along with results from the survey carried out 07 March 2014 prior to hydraulic fracturing. 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 unnamed tributary of the Mangawharawhara Stream prior to and following hydraulic fracturing of Cheal C well

Site No.	Site Code	No of taxa		MCI value		$SQMCI_s$ value	
		Pre-HF (Mar 07 2014)	Post-HF (Mar 31 2014)	Pre-HF (Mar 07 2014)	Post-HF (Mar 31 2014)	Pre-HF (Mar 07 2014)	Post-HF (Mar 31 2014)
1	MWW000217	10	7	64	77	1.8	2.9
2	MWW000219	16	15	80	80	4.9	5.0
3	MWW000221	10	7	76	71	1.8	1.8

Table 3: Range and median number of taxa, MCI values and $SQMCI_s$ scores for ring plain streams rising outside of the National Park at altitudes 300-349 m asl ((TRC, 1999 (updated 2013)).

	No. of taxa	MCI value	$SQMCI_s$ value
No. Samples	44	44	25
Range	9-34	76-129	1.5-7.4
Median	23	100	4

Table 4: Macroinvertebrate fauna of unnamed tributary of the Mangawharawhara Stream in relation to the Cheal C post-HF survey sampled 31 March 2014

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3
	Site Code		MWW000217	MWW000219	MWW000221
	Sample Number		FWB14189	FWB14190	FWB14191
ANNELIDA (WORMS)	Oligochaeta	1	VA	R	VA
CRUSTACEA	Ostracoda	1	A	R	A
	Paracalliope	5	VA	XA	A
	Paranephrops	5	-	R	-
EPHEMEROPTERA (MAYFLIES)	*Zephlebia group*	7	R	A	-
ODONATA (DRAGONFLIES)	*Xanthocnemis*	4	-	R	-
HEMIPTERA (BUGS)	*Microvelia*	3	-	R	-
TRICHOPTERA (CADDISFLIES)	*Polyplectropus*	6	-	A	-
	Psilochorema	6	-	R	-
	Triplectides	5	-	R	R
DIPTERA (TRUE FLIES)	*Paralimnophila*	6	R	-	R
	Orthocladiinae	2	R	A	A
	Polypedilum	3	-	R	-
	Tanypodinae	5	C	R	C
	Paradixa	4	-	C	-
	Empididae	3	-	R	-
	No of taxa		7	15	7
	MCI		77	80	71
	SQMCIs		2.9	5.0	1.8
	EPT (taxa)		1	4	1
	%EPT (taxa)		14	27	14
'Tolerant' taxa	'Moderately sensitive' taxa		'Highly sensitive' taxa		

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

Site 1- 25 m upstream of Cheal C wellsite discharge

A low community richness of seven taxa was found at site 1 (Table 2 and Table 4), three taxa fewer than what was recorded in the pre-HF survey and sixteen taxa less 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 (57%), which was reflected in the MCI score of 77 units. This result represented a significant increase from that recorded in the pre-HF survey (64 MCI units) but was significantly lower (Stark, 1998) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 3).

The community at this site was characterised by two 'tolerant' taxa, (oligochaete worms and seed shrimp (Ostracoda)); and one 'sensitive' taxon, (amphipod (*Paracalliope*)).

The numerical dominance of 'tolerant' taxa resulted in a $SQMCI_S$ score of 2.9 units, which was significantly higher (by 1.1 units) than what was recorded in the pre-HF survey, but was significantly lower (by 1.1 units) than the median score for 'control' sites in similar streams at this altitude (Table 3).

Site 2- 50 m downstream of Cheal C wellsite discharge

A moderate community richness of fifteen taxa was found at site 2 (Table 2and Table 4), eight taxa more than found at site 1, one taxon less than what was recorded in the pre-HF survey and eight taxa less than the median richness found at similar sites (Table 3). The macroinvertebrate community contained a larger proportion of 'tolerant' taxa (53%), which was reflected in the MCI score of 80 units; the same as what was recorded during the pre-HF survey and an insignificant three units higher than at the upstream 'control' site. This MCI score was significantly lower (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 three 'sensitive' taxa (amphipod (*Paracalliope*), caddisfly (*Polyplectropus*) and mayfly (*Zephlebia group*)), and one 'tolerant' taxon (orthoclad midges).

The numerical dominance of several 'sensitive' taxa resulted in a $SQMCI_S$ score of 5.0 units, which was slightly higher (by 0.1 unit) than what was recorded in the pre-HF survey, and significantly higher (by 1.0 unit) than the median score for 'control' sites in similar streams at this altitude (Table 3). Similarly to the pre-HF survey an increase (2.1 units) in $SQMCI_S$ score was recorded between sites 1 and 2. This can be attributed to an increase in macrophyte cover both on the edges of the stream and the streambed providing habitat for increased abundances of sensitive taxa.

Site 3- 100 m downstream of Cheal C wellsite discharge

A low community richness of seven taxa was found at site 3 (Table 2 and Table 4), three taxa less than recorded in the pre-HF survey and sixteen taxa fewer than the median richness found at similar sites elsewhere in the region (Table 3). The macroinvertebrate community was comprised of a larger proportion of 'sensitive' taxa (57%), which was reflected in the MCI score of 71 units; an insignificant 5 units fewer than the pre-HF survey. This score was a significant 29 units fewer (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 three 'tolerant' taxa (oligochaete worms, orthoclad midges and seed shrimp (Ostracoda)); and one 'sensitive' taxon, (amphipod (*Paracalliope*)).

The $SQMCI_S$ score of 1.8 units recorded at site 3 in this survey was the same $SQMCI_s$ score in the pre-HF survey and was 2.2 units fewer than the median score for 'control' sites in similar streams at this altitude elsewhere the region (TRC, 1998 (updated 2012)).

Summary and Conclusions

The Councils 'vegetation sweep' and a combination of the 'vegetation sweep' and 'kick-sampling' techniques were used at three sites to collect streambed macroinvertebrates from the unnamed tributary of the Mangawharawhara Stream. This has provided data to compare with baseline data for the assessment of skimmer pit discharge effects from the Cheal C 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 March 2014 survey of three sites, upstream and downstream of the skimmer pit discharge point to land near the stream, was undertaken following hydraulic fracturing at the Cheal C wellsite. Taxa richness's were low to moderate. The macroinvertebrate communities of the stream contained slightly more 'sensitive' than 'tolerant' taxa. A total of 16 taxa was found through the reach of the stream surveyed, with 5 of these taxa (31%) found at all three sites and 3 taxa (19%), found at any two of these sites. The number of taxa recorded in abundance increased at site 2, downstream of the skimmer pit discharge, and was the same as the control site at site 3.

A comparison of the pre-HF and post-HF survey results showed a significant increase in MCI and $SQMCI_s$ scores at site 1, but no significant changes at site 2 and site 3. Slight variations in MCI and $SQMCI_S$ scores and taxa richness, particularly at site 2 compared with site 1 and site 3 are considered to be due to habitat variability rather than a change in water quality.

The MCI scores recorded in this survey indicated that the stream communities were of poor to fair 'health' (TRC, 2014), slightly worse than the biological health recorded at 'control' sites in similar streams at a comparative altitude elsewhere in the region. This, in part, can be attributed to the habitat which was limited by very low and slow flows. There was no indication from the results of the two surveys that the discharge from the Cheal C wellsite has impacted on the biological communities of the unnamed tributary of the Mangawharawhara Stream.

References

Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. *Water and Soil* Miscellaneous Publication No. 87.

Stark JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. *New Zealand Journal of Marine and Freshwater Research 32(1)*: 55-66.

Stark JD, 1999: An evaluation of Taranaki Regional Council's SQMCI biomonitoring index. Cawthron Institute, Nelson. Cawthron Report No. 472.

Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103. 57p.

Thomas BT, 2014: Biomonitoring of the unnamed tributary of the Mangawharawhara Stream prior to drilling by Tag Oil Ltd at the Cheal C wellsite, March 2014. TRC report BT015.

TRC, 1999: Some statistics from the Taranaki Regional Council database (FWB) of freshwater macroinvertebrate surveys performed during the period from January 1980 to 31 December 1998 (statistics updated October 2013). Technical Report 99-17.

TRC, 2014: Fresh Water Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2012-2013. TRC Technical Report 2013-48. 243p.

To Job Manager; Callum MacKenzie
From Freshwater Biologist; Brooke Thomas
Report No BT015
Document 1369248
Date 02 July 2014

Biomonitoring of an unnamed tributary of the Mangawharawhara Stream prior to hydraulic fracturing by Tag Oil Ltd at Cheal C wellsite, March 2014

Introduction

This biological survey was performed prior to hydraulic fracturing (HF) of the Cheal C well, to provide baseline data on the macroinvertebrate community of the unnamed tributary of the Mangawharawhara Stream. A second survey will be performed following hydraulic fracturing, to determine whether or not consented discharges of treated stormwater and uncontaminated site water and production water onto land near the unnamed tributary of the Mangawharawhara Stream have had a detrimental effect upon the macroinvertebrate communities of this stream.

Methods

Cheal C wellsite stormwater and site production water has been consented for discharge on to land near the unnamed tributary of the Mangawharawhara Stream (Figure 1). This pre-HF survey was undertaken on 07 March 2014 at three established sites; 25 m upstream of the Cheal C wellsite discharge (site 1), 50 m downstream of the Cheal C wellsite discharge (site 2) and 100 m downstream of the Cheal C wellsite discharge (site 3) (Table 1) (Figure 1).

The Council's standard 'vegetation sweep' sampling technique was used at all three sites to collect streambed macroinvertebrates from the unnamed tributary of the Mangawharawhara Stream upstream and downstream of the proposed discharges from the Cheal C wellsite. The 'vegetation sweep' sampling 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).

Table 1: Biomonitoring sites and sampling methods used in the unnamed tributary of the Mangawharawhara Stream related to the Cheal C wellsite.

Site no.	Site code	Grid reference (NZTM)	Location	Sampling method	Altitude m asl
1	MWW000217	1710311E-5641604N	25 m u/s of Cheal C wellsite discharge	Vegetation sweep	300
2	MWW000219	1710315E-5641542N	50m d/s of Cheal C wellsite discharge	Vegetation sweep	300
3	MWW000221	1710348E-5641498N	100m d/s of Cheal C wellsite discharge	Vegetation sweep	300

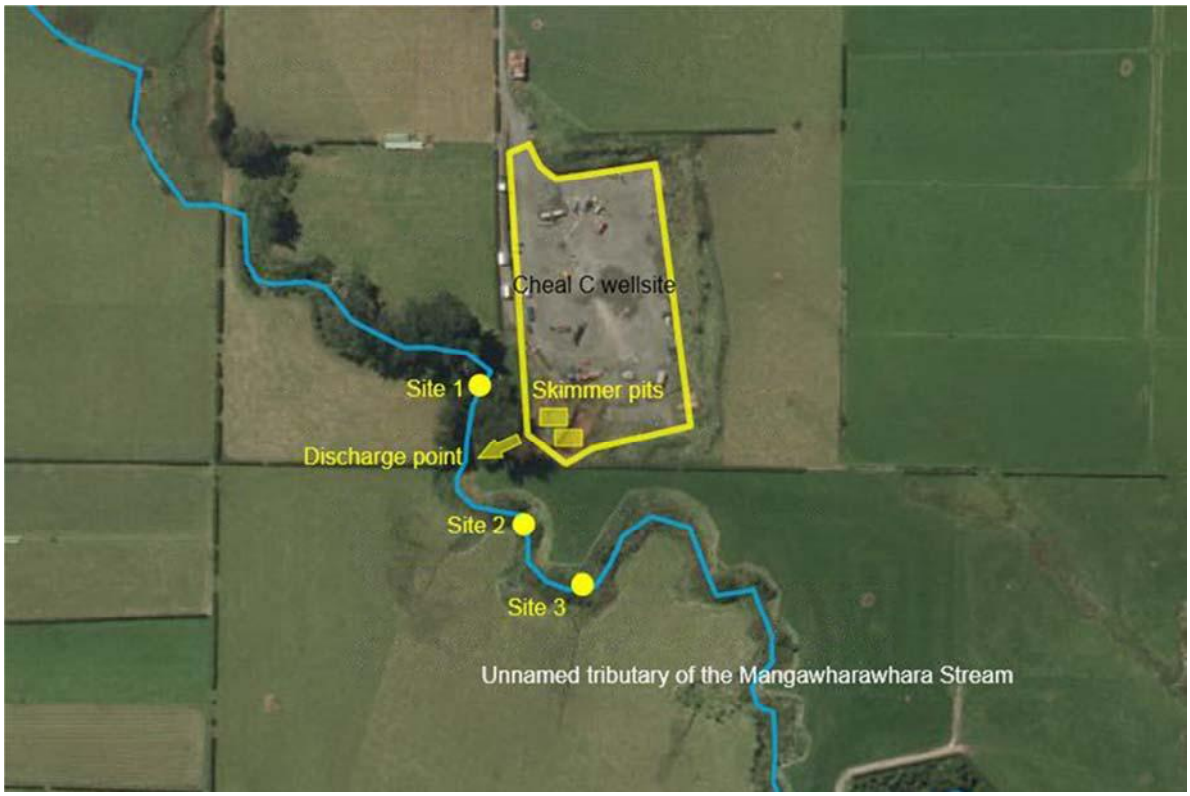

Figure 1 Biomonitoring sites in the unnamed tributary of the Mangawharawhara Stream in relation to the Cheal C wellsite.

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

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

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

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

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very

abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.

Results and discussion

At the time of this early morning survey, water temperatures in the unnamed tributary of the Mangawharawhara Stream ranged from 10.5°C to 11.7°C. A low to very low flow of clear, uncoloured water was present at all three sites. Substrate comprised of silt and wood/root at all sites, although sand was present at site 2. Macrophytes were recorded growing on the edges of the stream at site 1 and site 3 and on the edges of the stream and on the streambed at site 2. Periphyton was not visible at site 2 and site 3; however patchy mats were visible at site 1. Site 3 was completed by overhanging vegetation, whereas site 1 and site 2 were only partially shaded.

Macroinvertebrate communities

Table 2 summarises the results of this macroinvertebrate survey performed prior to hydraulic fracturing of the Cheal C wellsite. Comparative data for sites in similar streams are presented in Table 3. The macroinvertebrate fauna recorded by the current survey are presented in Table 4.

Table 2: Number of taxa, MCI, and $SQMCI_s$ in the unnamed tributary of the Mangawharawhara Stream, sampled on 07 March 2014 prior to hydraulic fracturing of Cheal C wellsite.

Site No.	No taxa	MCI value	$SQMCI_s$ value
1	10	64	1.8
2	16	80	4.9
3	10	76	1.8

Table 3: Range and median number of taxa, MCI values and $SQMCI_s$ scores for ring plain streams rising outside of the National Park at altitudes 300-349 m asl ((TRC, 1999 (updated 2013)).

	No. of taxa	MCI value	$SQMCI_s$ value
No. Samples	44	44	25
Range	9-34	76-129	1.5-7.4
Median	23	100	4

Table 4: Macroinvertebrate fauna of the unnamed tributary of the Mangawharawhara Stream in relation to the Cheal C pre hydraulic fracturing survey sampled 07 March 2014.

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3
	Site Code		MWW000217	MWW000219	MWW000221
	Sample Number		FWB14177	FWB14178	FWB14179
COELENTERATA	Coelenterata	3	-	-	R
NEMATODA	Nematoda	3	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	VA	R	VA
MOLLUSCA	*Gyraulus*	3	-	R	-
	Sphaeriidae	3	R	-	-
CRUSTACEA	Copepoda	5	-	-	R
	Ostracoda	1	A	-	A
	Isopoda	5	-	R	-
	Paracalliope	5	A	XA	A
	Talitridae	5	-	R	-
	Paranephrops	5	-	R	R
EPHEMEROPTERA (MAYFLIES)	*Zephlebia group*	7	-	A	C
ODONATA (DRAGONFLIES)	*Xanthocnemis*	4	-	R	-
HEMIPTERA (BUGS)	*Microvelia*	3	-	R	-
TRICHOPTERA (CADDISFLIES)	*Polyplectropus*	6	-	C	-
	Triplectides	5	C	R	-
DIPTERA (TRUE FLIES)	*Paralimnophila*	6	R	-	R
	Chironomus	1	R	-	-
	Orthocladiinae	2	C	A	R
	Polypedilum	3	-	R	-
	Tanypodinae	5	C	-	-
	Culicidae	3	-	R	-
	Paradixa	4	-	A	-
	Empididae	3	-	R	-
	Sciomyzidae	3	R	-	-
	No of taxa		10	16	10
	MCI		64	80	76
	SQMCIs		1.8	4.9	1.8
	EPT (taxa)		1	3	1
	%EPT (taxa)		10	19	10

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

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

Site 1- 25 m upstream of Cheal C wellsite discharge

A moderately low community richness of ten taxa was found at site 1, thirteen taxa less than the median richness found at similar sites elsewhere in the region (Table 2 and Table 3). The macroinvertebrate community comprised proportions of both 'sensitive' (60%) and 'tolerant' (40%) taxa which was reflected in the MCI score of 64 units. This MCI score was a significant 36 units less than the median MCI score for 'control' sites in similar streams at comparative altitudes (Stark, 1998) (Table 3). The moderately low taxa richness and MCI score recorded in this survey are reflective of the habitat which was limited by very low and slow flows.

The community at this site was characterised by two 'tolerant' taxa, (oligochaete worms and seed shrimp (Ostracoda)), and one 'sensitive' taxon, (amphipod (*Paracalliope*)).

The numerical dominance of two 'tolerant' taxa resulted in a $SQMCI_S$ score of 1.8 units which was significantly lower (2.2 units) than the median score for 'control' sites in similar streams at a similar altitude (Stark, 1998) (Table 3).

Site 2- 50 m downstream of Cheal C wellsite discharge

A moderate community richness of sixteen taxa was found at site 2 (Table 2 and Table 4), six taxa more than what was found at site 1 and seven taxa less than the median richness found at similar sites in the region (Table 3). The macroinvertebrate community comprised proportions of both 'tolerant' (56%) and 'sensitive' (44%) taxa which was reflected in the MCI score of 80 units. This was 16 units greater than what was recorded at site 1 and a significant 20 units less than the median MCI score for 'control' sites in similar streams at comparative altitudes (Stark, 1998) (Table 3).

The community at this site was characterised by two 'sensitive' taxa (amphipod (*Paracalliope*) and mayfly (*Zephlebia group*)), and two 'tolerant' taxa (orthoclad midges and midge larvae (*Paradixa*)).

The numerical dominance of 'sensitive' taxa resulted in a $SQMCI_S$ score of 4.9 units, which was a significant 0.9 unit greater than the median $SQMCI_S$ score for 'control' sites in similar streams at this altitude (Table 3). It was also a significant 3.1 units greater than the $SQMCI_S$ score recorded at site 1.

Site 3- 100 m downstream of Cheal C wellsite discharge

A moderately low community richness of ten taxa was found at site 3 (Table 2 and Table 4), the same number of taxa recorded at the upstream control site and thirteen taxa less than the median richness found at similar sites elsewhere in the region (Table 3). The macroinvertebrate community comprised of equal proportions of 'tolerant' and 'sensitive' taxa, which was reflected in the MCI score of 76 units, 12 units more than what was recorded at the upstream control site and a significant twenty four units less than the median MCI score for 'control' sites in similar streams at comparative altitudes (Stark, 1998) (Table 3). Similarly to the upstream control site, the moderately low taxa richness and MCI score recorded were reflective of the habitat which was limited by very low and slow flows.

The community at this site was characterised by two 'tolerant' taxa (oligochaete worms and seed shrimp (Ostracoda)), and one 'sensitive' taxon, (amphipod (*Paracalliope*)).

A numerical dominance of 'tolerant' taxa resulted in the $SQMCI_S$ score of 1.8 units which was the same as what was recorded at site 1. This $SQMCI_S$ score was significantly fewer (by 2.2 units), than the median score for 'control' sites in similar streams elsewhere in the region (Stark, 1998) (Table 3).

Summary and Conclusions

The Councils 'vegetation sweep' sampling technique was used at three sites to collect streambed macroinvertebrates from the unnamed tributary of the Mangawharawhara Stream. This has provided baseline data for any future assessment of consented discharge effects from the Cheal C 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 March 2014 survey of three sites upstream and downstream of the skimmer pit discharge to land near the stream, was undertaken prior to hydraulic fracturing of the Cheal C wellsite.

The three sites surveyed were relatively similar in macroinvertebrate community composition with low to moderate taxonomic richnesses (number of taxa). A total of 25 taxa was found through the reach of the stream surveyed, with 3 of these taxa (12%) found at all three sites and 5 taxa (20%) found at any two of these sites. One 'sensitive' taxon was abundant at all three sites. $SQMCI_S$ scores recorded at site 1 and site 3 were significantly lower than the medians recorded from other ring plain streams arising outside of the National Park at similar altitudes, whereas site 2 was significantly higher (TRC, 1999 (updated 2013)).The MCI score recorded at site 1 was significantly lower than those recorded at site 2 and site 3, similarly the MCI score recorded at site 3 was significantly less than that recorded at site 2. In addition, MCI scores for all sites were significantly less than the median MCI scores for comparable streams within the region. The moderately low taxa richness and MCI scores recorded in this survey are reflective of the habitat which was limited by very low and slow flows. The MCI scores indicated that the stream macroinvertebrate communities were of 'poor' to 'fair' health (TRC, 2014).

A further survey will be conducted following the completion of hydraulic fracturing activities at the Cheal C wellsite, to determine whether any discharges to land, near the unnamed tributary of the Mangawharawhara Stream, have had any effects on the macroinvertebrate communities of this stream.

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