

TAG Oil (NZ) Limited
Cheal-G Exploration Wellsite
Monitoring Programme Report
2013-2014

Technical Report 2014–02

ISSN: 0114-8184 (Print)
ISSN: 1178-1467 (Online)
Document: 1340365 (Word)
Document: 1348715 (Pdf)

Taranaki Regional Council
Private Bag 713
STRATFORD

June 2014

Executive summary

TAG Oil (NZ) Limited established a hydrocarbon exploration site located on Finnerty Road, Ngaere, within the Stratford district, in the Waingongoro catchment. The site is called Cheal-G wellsite. This report covers the period from December 2013 – April 2014. During this period, a wellsite was established, with one well drilled and tested, and another two drilled, plugged and abandoned.

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-G wellsite during the period under review, and the results and environmental effects of TAG Oil (NZ) Limited's activities.

TAG Oil (NZ) Limited holds a total of 4 resource consents for the activities at the Cheal-G wellsite, which include a total of 46 consent conditions setting out the requirements that TAG Oil (NZ) Limited must satisfy. TAG Oil (NZ) Limited holds consent 9616-1 to take groundwater; consent 9613-1 to discharge emissions to air associated with exploration activities; consent 9617-1 to discharge stormwater and sediment from earthworks during construction onto and into land; and consent 9615-1 to discharge treated stormwater and produced water associated with exploration activities to land.

The Council's monitoring programme for the period under review included 8 inspections of the site and surrounding environment, at approximately fortnightly intervals. Five stormwater samples were collected for analysis.

One abatement notice was issued in relation to untreated silt and sediment discharges leaving the site due to heavy rainfall inundating the capacity of the silt and sediment controls. Four samples were obtained and analysed in conjunction with this incident. Follow up inspections found the abatement notice had been adhered to. These discharges were deemed unlikely to have any significant adverse effect on receiving waters as discharges were temporary in nature and immediately addressed and rectified.

Two biomonitoring surveys were conducted during the monitoring period. One was conducted prior to the commencement of drilling activities, and another performed post drilling activities at the Cheal-G wellsite. The MCI scores indicated that the stream macroinvertebrate communities were of 'good' health and that the discharges from the wellsite have not had any detrimental effect on the macroinvertebrate communities of this stream.

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

Although flaring was anticipated in conjunction with well testing and development, no actual flaring activities occurred during the monitoring period at the wellsite. The drilling fluids and cuttings were disposed of off site.

During the monitoring period, TAG Oil (NZ) Limited demonstrated a good level of environmental performance and compliance with the resource consents. The only matter of note was inadequate control of earthworks sediment on one occasion of wet weather during access track preparation. The site was otherwise generally neat, tidy, and well maintained.

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

Table of contents

	Page
1. Introduction	1
1.1 Compliance monitoring programme reports and the Resource Management Act 1991	1
1.1.1 Introduction	1
1.1.2 Structure of this report	1
1.1.3 The Resource Management Act (1991) and monitoring	1
1.1.4 Evaluation of environmental and consent performance	2
1.2 Process description	3
1.3 Resource consents	5
1.3.1 Background	5
1.3.2 Water abstraction permit (groundwater)	6
1.3.3 Water discharge permit (treated stormwater and treated produced water)	7
1.3.4 Water discharge permit (stormwater and sediment – earthworks)	7
1.4 Monitoring programme	8
1.4.1 Introduction	8
1.4.2 Programme liaison and management	9
1.4.3 Site inspections	9
1.4.4 Chemical sampling	10
1.4.5 Air quality monitoring	10
1.4.6 Biomonitoring surveys	10
2. Results	11
2.1 Water	11
2.1.1 Inspections	11
2.1.2 Results of abstraction and discharge monitoring	13
2.1.3 Results of receiving environment monitoring	13
2.2 Air	14
2.2.1 Inspections	14
2.2.2 Results of discharge monitoring	14
2.2.3 Results of receiving environment monitoring	14
2.2.4 Other ambient monitoring	14
2.3 Land	15
2.3.1 Inspections	15
2.3.2 Land status	15
2.4 Biomonitoring surveys	15
2.5 Contingency plan	17
2.6 Investigations, interventions and incidents	17
3. Discussion	18
3.1 Discussion of consent exercise	18
3.2 Environmental effects of exercise of consents	18
3.3 Evaluation of performance	21
3.4 Exercise of optional review of consents	24

3.5	Change to any future monitoring programmes	24
4.	Recommendations	26
	Glossary of common terms and abbreviations	27
Appendix I	Resource consents	
Appendix II	Biomonitoring surveys	

List of tables

Table 1	Results of stormwater samples obtained from the second skimmer pit at the Cheal-G wellsite during the monitoring period	13
Table 2	Results of investigative samples obtained from the Cheal-G wellsite on 5 December 2013	13
Table 3	Summary of performance for 9616-1 to take groundwater as 'produced water', during hydrocarbon exploration and production activities at the Cheal-G wellsite	21
Table 4	Summary of performance for 9613-1 to discharge contaminants to air from hydrocarbon exploration at the Cheal-G wellsite, including combustion involving flaring or incineration of petroleum recovered natural deposits, in association with well development or redevelopment and testing or enhancement of well production flows	21
Table 5	Summary of performance for 9615-1 to discharge treated stormwater, treated surplus water and produced water from hydrocarbon exploration and production operations at the Cheal-G wellsite onto land where it may enter the Tuikonga Stream	23
Table 6	Summary of performance for 9617-1 to discharge stormwater and sediment, deriving from soil disturbance undertaken for the purpose of constructing the Cheal-G wellsite, onto land where it may enter the Tuikonga Stream	24

List of figures

Figure 1	Aerial view depicting the locality of the Cheal-G wellsite	5
Figure 2	Aerial photo displaying the biomonitoring sites in the Tuikonga Stream in relation to the Cheal-G wellsite	16

1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period December 2013 – April 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, a wellsite was established, with one well drilled and tested, and another two drilled, plugged and abandoned.

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

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

1.1.2 Structure of this report

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

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

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

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

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

1.1.3 The Resource Management Act (1991) and monitoring

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

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

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

1.1.4 Evaluation of environmental and consent performance

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

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

were matters that required urgent intervention, took some time to resolve, or remained unresolved at the end of the period under review, and/or, there were on-going issues around meeting resource consent conditions even in the absence of environmental effects. Abatement notices may have been issued.

- **poor performance (environmental) or poor performance (compliance)** indicates generally that the Council was obliged to record a verified unauthorised incident involving significant environmental impacts, or there were material failings to comply with resource consent conditions that required significant intervention by the Council even in the absence of environmental effects. Typically there were grounds for either a prosecution or an infringement notice.

1.2 Process description

Site description

TAG Oil (NZ) Limited holds a 10 year Petroleum Mining Permit No. 38156 to prospect, explore, and mine for condensate, gas, LPG, oil and petroleum within an area of 30.300 Km². The Cheal-G wellsite is one of many sites within this area that have been established in order to explore, evaluate and produce hydrocarbons.

The Cheal-G wellsite is located approximately 1.2 km along Finnerty Road, approximately 1.5 km from Ngaere.

The Cheal-G wellsite was established in 2013 and involved the removal of topsoil to create a firm level platform on which to erect a drilling rig and house associated equipment. Site establishment also involved the installation of:

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

The nearest residence is approximately 690 m away from the wellsite. Bunding, earthworks and good site location helped minimise any potential for off-site effects for the neighbours.

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 deviated.

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-G wellsite is located approximately 116 m to the east of the nearest waterbody which is Tuikonga Stream of the Waingongoro catchment.

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

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

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

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).

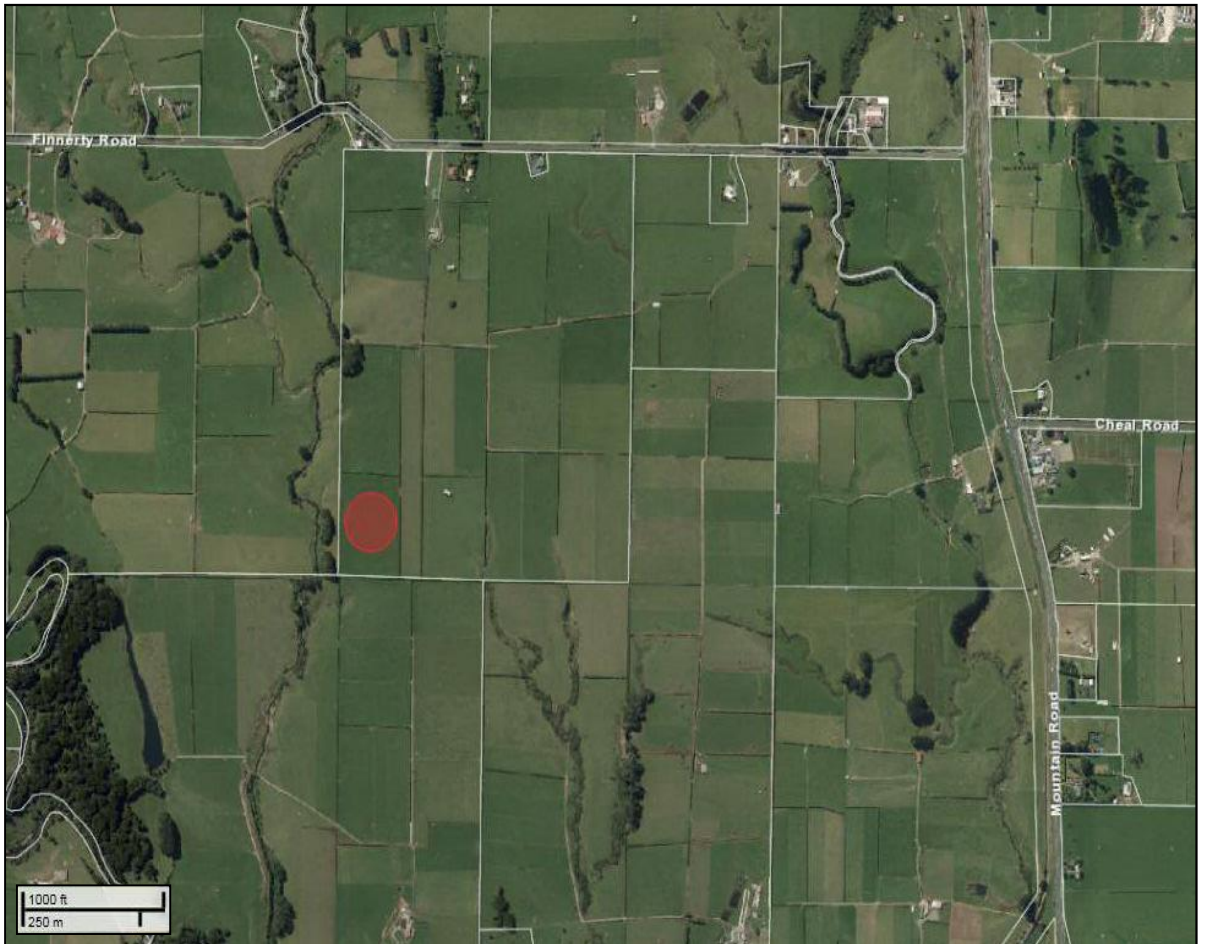


Figure 1 Aerial view depicting the locality of the Cheal-G wellsite

1.3 Resource consents

1.3.1 Background

TAG Oil (NZ) Limited holds 4 resource consents related to exploration activities at the Cheal-G wellsite site, as follows:

- Water Permit 9616-1; granted 23 August 2013,
- Discharge Permit 9613-1; granted 5 February 2014,
- Discharge Permit 9615-1; granted 23 August 2013 and
- Discharge Permit 9617-1; granted 13 August 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 and the Council reports describing the associated activities are contained within Appendix I of this report.

1.3.2 Water abstraction permit (groundwater)

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

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

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

TAG Oil (NZ) Limited holds water permit 9616-1 to take groundwater that may be encountered as produced water during exploration and production operations at the Cheal-G wellsite.

Any produced water will be from reserves far below that which is used for domestic or farm purposes. In addition, there are no known groundwater abstractions within a radial distance of 540 m from the wellsite. Shallow groundwater (which does not have any salt water content) was to be protected by casing within the bore hole. Given these factors, the abstraction would not cause the above effects.

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

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

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

This permit was issued by the Council on 23 August 2013 under Section 87(d) of the Act. It is due to expire on 1 June 2029.

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 3, Section 3.3.

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

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

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

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

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

TAG Oil (NZ) Limited holds water discharge permit 9615-1 to discharge treated stormwater and produced water from hydrocarbon exploration and production operations at the Cheal-G wellsite onto and into land.

This permit was issued by the Council on 23 August 2013 under Section 87(e) of the Act. It is due to expire on 1 June 2029.

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 5, Section 3.3.

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

1.3.4 Water discharge permit (stormwater and sediment – earthworks)

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

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

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

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 water body;
- 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 9617-1 to discharge stormwater and sediment from earthworks during construction of the Cheal-G wellsite onto and into land.

This permit was issued by the Council on 13 August 2013 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2018.

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 6, Section 3.3.

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

1.4 Monitoring programme

1.4.1 Introduction

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

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

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

- Programme liaison and management;
- Site inspections;
- Chemical sampling;
- Air quality monitoring; and
- Biomonitoring surveys.

The monitoring programme for the Cheal-G wellsite focused primarily on programme liaison and management, site inspections, and discharges to land. However, all five 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

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

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

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

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

During each inspection the following are checked:

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

- Surface waters in the vicinity for effects on colour and clarity, aquatic life and odour;
- Site records;
- General observations; and
- Odour (a marker for any hydrocarbon and hazardous chemical contamination).

1.4.4 Chemical sampling

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

1.4.5 Air quality monitoring

Air quality monitoring is carried out in association with the well testing and clean-up phase, when 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 staff onsite have regard to wind direction and speed at the time of flaring.

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

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

1.4.6 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-G wellsite, adjacent land and streams were inspected 8 times during the monitoring period.

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

2 December 2013

Site earthworks were observed to be progressing well. The site access track had been cut and metalled. Pad earthworks were underway with a large holding pond adjacent to the site boundary closest to the river. An earth bund had been established along the boundary where access to the pad was located. Silt controls had been established along the site access track and were satisfactory for weather conditions upon inspection. However it was noted that additional silt fencing and measures to slow water flow would be required during rain events to prevent erosion and silt overloading said control measures.

5 December 2013

Site earthworks were still underway at the time of inspection. The access track had been constructed and the drilling pad developed further. Site and sediment controls in place about the drill pad area were observed to be adequate, and as a result stormwater being discharged from the site was of reasonable quality. However, three 'low points' along the access track were found to have inadequate silt and sediment controls in place and as a result the storm water being discharged from site at these localities was of a poor quality. The first of the low points along the access track had a settling pond in place and no further silt controls were observed. The second of the low points had a single silt fence in place, which had become overloaded with sediment and was observed to be discharging around and over the fence, entering the receiving environment untreated. The third low point also had silt fencing in place. This silt fencing was observed to have a large gap in it and was constructed with two individual pieces of silt fence, allowing stormwater to pass between the two pieces of fencing without being treated. In addition, rilling, slumping and erosion was observed at a number of localities along the access track with no evidence of attempts made to prevent this from continuing. Samples were taken of the discharge and the receiving environment. An abatement notice (number 12162) was issued in relation to improving silt and sediment controls at the site.

13 December 2013

Inspection found that vast improvements had been made in relation to the silt and sediment controls on site and the previously issued abatement notice had been adhered to. Hay bales had been placed at various locations about the site in an attempt to direct and slow stormwater flow leaving the site. More silt fencing had been placed about the site as had a number of small sediment ponds. The newly established silt fences appeared to be well installed with the base of the fences buried sub-surface. Hydro-seeding had been undertaken on site adjacent to the access track, in anticipation that it would assist in controlling silt and sediment run off from the site. The pad area appeared to be well managed. Two skimmer pits had been dug; however stormwater drains were yet to be established. Aggregate had been placed over the majority of the site, and adequate short term silt and sediment controls had been established to treat stormwater until the skimmer pits were complete.

16 January 2014

At the time of inspection tanks were correctly bunded and the immediate area was clean and tidy. The chemical storage area was correctly lined and bunded, with chemicals covered and protected from exposure. Skimmer pits were not discharging at the time of inspection. A sample was obtained from the second skimmer pit to ensure compliance with consent conditions in anticipation of potential discharges.

5 February 2014

The site was found to be in a clean and tidy order. All liquid and dry chemicals were stored onsite in sealed containers. Empty drums were found to be stored upright with the lids replaced to prevent spillage. The area surrounding the drilling rig was observed to be clean and tidy. Tanks containing drilling mud and cuttings appeared to be free of spills. No flaring had occurred on site. The access track and exterior of the pad area were observed to be in good condition. Silt and sediment controls remained in place. Hydro-seeding was observed to have resulted in good grass growth on previously exposed areas. Records kept on site indicated compliance as water takes had not been exceeded. No adverse effects were observed within the receiving environment. Site staff were advised to monitor the ring drains during the next period of heavy rain, to ensure no pooling or ponding within the ring drain system. Skimmer pits were inspected and found not to be discharging at the time of inspection. A sample was obtained from the second skimmer pit.

19 February 2014

At the time of inspection, water was being obtained from the nearby stream. Inspection of records kept on site indicated compliance, as water take limits had not been exceeded. The site appeared to be clean and tidy. The non-hazardous chemical storage area was found to be free of spills, with liquid chemical drums stored upright with lids in place. Dry chemicals appeared to be stored in such a manner as to prevent them getting wet. Skimmer pits were inspected and found not to be discharging at the time of inspection. A sample was obtained from the second skimmer pit.

28 March 2014

At the time of inspection the drilling rig had been removed from the site and testing of the well was to commence. Flaring activities had not yet occurred at site, however was anticipated in conjunction with the well testing phase. Water obtained from the well was being stored appropriately on site for later disposal at a suitable external facility. Silt and sediment treatment systems remained in use around the wellsite. Skimmer pits appeared clean and clear and had plenty of freeboard still available.

10 April 2014

It was found during the inspection that all drilling and testing activities at site were complete. Although flaring was anticipated in conjunction with testing, no actual flaring activities had occurred. Ring drains were inspected and appeared to be in good order. The site was generally clean and tidy. Some tanks remained onsite; however they were empty and stored within an earth bunded area. The cellar had sufficient free board available to cope with additional rain. The access track was stabilised, therefore silt and sediment controls did not require any further active management. The skimmer pits were observed to be full following light rain over days prior to inspection. Skimmer pits were inspected and found not to be discharging at the time of inspection. A sample was obtained from the second skimmer pit.

2.1.2 Results of abstraction and discharge monitoring

During the period under review, stormwater was not observed discharging. There were 5 skimmer pit stormwater samples collected during the review period for this report and chemical analysis of the stormwater was carried out. All of the stormwater samples were collected from the second skimmer pit at the Cheal-G wellsite.

Review of company records conducted during inspections indicated compliance with water abstraction consent criteria.

Analysis of the samples obtained show that discharges would have been in compliance with resource consent conditions should a discharge have occurred. Results are detailed in Table 1.

Table 1 Results of stormwater samples obtained from the second skimmer pit at the Cheal-G wellsite during the monitoring period

Parameter	Unit	Consent limit	16 Jan 2014	05 Feb 2014	19 Feb 2014	13 Mar 2014	10 Apr 2014
Chloride	g/m ³	50	7.8	10.4	6.94	12.5	12.7
pH	pH	6-9	7.0	7.5	7.4	8.3	8.1
Suspended solids	g/m ³	100	4	3	<2	5	6
Hydrocarbons	g/m ³	15	<0.5	<0.5	<0.5	<0.5	<0.5

All sewage was directed for treatment through a septic tank system and removed by contractor to a licensed disposal facility. Inspections of the stormwater discharge found it to be mostly clear. No odours were found to be associated with the discharge.

2.1.3 Results of receiving environment monitoring

The receiving surface water body was inspected in conjunction with site inspections. No effects were observed in the receiving environment and the stream appeared clear with no visual change in colour or clarity. There was also no odour, oil, grease films, scum, foam or suspended solids observed in the stream during the monitoring period, with the exception of one inspection conducted on 5 December 2013.

Four samples were obtained in conjunction with said inspection conducted on 5 December 2013. These samples were in relation to untreated silt and sediment discharges leaving the site due to heavy rainfall inundating the capacity of the silt and sediment controls. The samples were obtained from the three untreated discharging localities along the access track, and one from the receiving environment. Samples were analysed for suspended solids and turbidity. The results are presented below in Table 2.

Table 2 Results of investigative samples obtained from the Cheal-G wellsite on 5 December 2013

Parameter	Unit	Sample 1	Sample 2	Sample 3	Sample 4
Suspended solids	g/m ³	33	7800	150	65
Turbidity	NTU	17	3000	64	33

One discharge sample (sample 2) returned elevated levels of suspended solids (7800 g/m³) and turbidity (3000 NTU); however, these discharges were temporary and

immediately addressed and rectified following abatement (notice number 12162). Therefore they were unlikely to have any significant or on-going adverse effect on receiving waters. A biological survey 11 days later found no evidence of any adverse ecological effect (see Section 2.4).

2.2 Air

2.2.1 Inspections

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

2.2.2 Results of discharge monitoring

Cheal-G wellsite notified the Council of its intention to test the well and flare gas intermittently between 2 December 2013 and 10 April 2014, yet no actual flaring activities occurred during this monitoring period. However, inspections were still conducted in relation to air discharges during the monitoring period.

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

It appeared that TAG Oil (NZ) Limited took all practicable steps to mitigate any potential effects of smoke, which included ensuring that plant equipment was working effectively and having regard to wind direction and speed. No offensive or objectionable smoke or odours were observed by Inspecting Officers.

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

From observations during site inspections, it appeared that special conditions relating to the control of emissions to air from the flaring of hydrocarbons were complied with.

2.2.3 Results of receiving environment monitoring

Monitoring inspections of the site found no offensive or objectionable odours, smoke or dust associated with activities at the Cheal-G wellsite, and inspections of the flare stack and surrounding area were carried out and no effects were observed.

No chemical monitoring of air quality was undertaken during the testing phase of the Cheal-G wellsite as 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 above for comments concerning site inspections.

2.3.2 Land status

The wellsite was constructed on a flat rural dairy farming area. Relatively minor earthworks were required to construct the site. The land had not been reinstated at the time of the last inspection (10 April 2014) as the site was still in use.

2.4 Biomonitoring surveys

A biological survey was performed prior to the commencement of drilling activities on 16 December 2013, and another post drilling activities on 11 April 2014 to monitor the health of the macroinvertebrate community of the Tuikonga Stream in relation to activities at the Cheal-G wellsite.

Both the pre and post drill surveys were undertaken at three established sites: 130 m upstream of the Cheal-G wellsite discharge (site 1), 80 m downstream of the Cheal-G wellsite discharge (site 2), and 150 m downstream of the Cheal-G wellsite discharge (site 3), as per Figure 2. The Councils 'kick-sampling' technique was used at the three sites to collect streambed macroinvertebrates from the Tuikonga Stream to assess whether activities at the Cheal-G wellsite had had any adverse effects on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCI_s scores for each site.

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



Figure 2 Aerial photo displaying the biomonitoring sites in the Tuikonga Stream in relation to the Cheal-G wellsite

16 December 2013

This biological survey was performed prior to drilling of the Cheal-G well, but after site preparation earthworks to provide baseline data on the macroinvertebrate community of the Tuikonga Stream.

The three sites surveyed were relatively similar in macroinvertebrate community composition with moderate taxonomic richnesses (number of taxa). A total of 30 taxa was found through the reach of the stream surveyed, with 18 of these taxa (60%) found at all three sites and 5 taxa (16.5%) found at any two of these sites. One 'tolerant' taxon, one 'highly sensitive' taxon and three 'moderately sensitive' were abundant at all three sites. SQMCI_s scores at all three sites were slightly above the medians recorded from other ring plain streams that rise outside of the national park at similar altitudes (TRC, 1999 (updated 2013)). There were no significant differences in MCI scores between the three sites surveyed. The MCI scores indicated that the stream macroinvertebrate communities were of 'good' health (TRC, 2014). Overall, the results indicated that reasonable water quality preceded this survey.

11 April 2014

This biological survey was performed following drilling of the Cheal-G well to determine whether or not treated stormwater, treated surplus drilling water and treated produced water discharges onto land in the vicinity of the Tuikonga Stream had had a detrimental effect upon the communities of the Tuikonga Stream.

This April 2014 survey of the three sites upstream and downstream of the skimmer pit discharge point to land near the stream, indicated that the discharges from the wellsite have not had any detrimental effect on the macroinvertebrate communities of this stream.

The three sites surveyed were relatively similar in macroinvertebrate community composition with relatively high taxonomic richnesses (number of taxa). A total of 38 taxa was found through the reach of the stream surveyed, with 24 of these taxa (63%) found at all three sites and 6 taxa (15.8%) found at any two of these sites. One

'tolerant' taxon, two 'highly sensitive' taxa and four 'moderately sensitive' were abundant at all three sites. SQMCI_s scores at all three sites were similar to or significantly higher than the medians recorded from other ring plain streams that rise outside of the national park at similar altitudes (TRC, 1999 (updated 2013)). There were no significant differences in MCI scores between the three sites surveyed, and neither did they differ significantly from their respective pre-drill survey scores. The MCI scores indicated that the stream macroinvertebrate communities were of 'fair' to 'good' health (TRC, 2014). Overall, the results indicated that reasonable water quality preceded this survey.

2.5 Contingency plan

TAG Oil (NZ) Limited has provided a general contingency plan, as required by Condition 4 of resource consent 9615-1 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 was one incident recorded by the Inspecting Officer during inspection.

On 5 December 2013 inspection found untreated silt and sediment discharges leaving the access track on the site due to heavy rainfall inundating the capacity of the silt and sediment controls. These discharges contravened special condition 2 of resource consent 9617-1 and section 15(1)(b) of the Resource Management Act 1991. Abatement notice 12162 was issued to TAG Oil (NZ) Limited requiring immediate action to remedy the discharges and inundated silt and sediment controls at site. A follow up inspection conducted on 13 December 2013 found abatement notice 12162 had been adhered to as vast improvements were observed in relation to the silt and sediment controls at site. There were no ongoing adverse ecological effects (Section 2.4).

Any minor actual 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 without delay.

3. Discussion

3.1 Discussion of consent exercise

Of the 4 resource consents relating to the Cheal-G wellsite, consents 9616-1 (take groundwater), 9613-1 (air discharge associated with exploration), 9615-1 (to discharge treated stormwater and produced water), and 9617-1 (to discharge stormwater and sediment from earthworks during construction) were exercised and actively monitored.

Drilling waste was transported off site to a consented facility. It is considered that all remaining resource consent conditions were complied with during the monitoring period, including the provision of various pieces of information (contingency plan, notifications etc.).

Monitoring has shown that the management on-site ensured that no significant 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, with the exception of the one reported incident upon inspection on 5 December 2013.

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:

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

Interceptor pits do not discharge directly to surface water, instead they discharge onto and into land where the discharge usually soaks into the soil before reaching any surface water. However, if high rainfall had resulted in the discharge reaching the surface water, significant dilution would have occurred.

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

Groundwater

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

Flaring

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

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

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

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

Although flaring was anticipated in conjunction with testing, no actual flaring activities occurred during the monitoring period.

Should flaring have occurred, measures to be undertaken by TAG Oil (NZ) Limited to avoid or mitigate actual or potential adverse environmental impacts on air quality would have included:

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

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

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.

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

- Records of flaring events are kept by TAG Oil (NZ) Limited and provided to the Council;
- TAG Oil (NZ) Limited endeavor to minimise the total volume of gas flared while ensuring that adequate flow and pressure data was gathered to inform their investment decision; and
- TAG Oil (NZ) Limited endeavor 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;
- Ignition sources were not permitted on any site;
- Sufficient separation of chemicals from the flare stack were maintained for safety reasons;
- In the unlikely event of a spill escaping from bunded areas, the site perimeter drain and interceptor pit system was implemented to provide secondary containment on-site; and
- A spill contingency plan was prepared that sets out emergency response procedures to be followed in the event of a spill.

Summary

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

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 3 to 6.

Table 3 Summary of performance for **9616-1** to take groundwater as 'produced water', during hydrocarbon exploration and production activities at the Cheal-G wellsite

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

Table 4 Summary of performance for **9613-1** to discharge contaminants to air from hydrocarbon exploration at the Cheal-G wellsite, including combustion involving flaring or incineration of petroleum recovered natural deposits, in association with well development or redevelopment and testing or enhancement of well production flows

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Definitions	-	N/A
2. Incineration shall only occur in a device with a minimum chimney height determined by Regional Air Quality Plans	Inspection	N/A
3. Flaring shall only occur over an impermeable pit / containment area	Inspection	N/A
4. Flaring and incineration shall only occur within 20 m of the location	Inspection	N/A
5. Flaring shall not occur for more than 15 days per zone, for up to four zones per well, for up to 12 wells	Inspection of records	N/A
6. 24hrs notice of flaring to the Council for initial flare of each zone	Notification received 24hrs prior to flaring	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
7. When possible the consent holder shall provide notification to occupants of dwellings and landowners within 300m and 200m respectively 24 hrs prior to the commencement of flaring	Inspection of company records	N/A
8. No material shall be flared or incinerated, other than those derived from or entrained in the well stream	Inspection of company records	N/A
9. Liquid and solid separation to occur before flaring to minimise smoke emissions	Inspection of flare stack and flare	N/A
10. Only gaseous hydrocarbons originating from well stream are to be flared or incinerated	Inspection of company records	N/A
11. Report to be prepared and submitted to the Council within 5 working days should combustions of liquid hydrogen should occur	-	N/A
12. Best practicable option adopted	Inspections, procedures & processes	N/A
13. No offensive odour or smoke beyond boundary	Assessment by investigating officer	N/A
14. Control of carbon monoxide	Inspections confirming chemical analysis not required	N/A
15. Control of other emissions	Inspections	N/A
16. Analysis of typical gas and crude oil stream from field to be made available to the Council	Available upon request	N/A
17. All storage tanks to have vapour recovery systems fitted.	Inspection	N/A
18. Log all flaring including time, duration, zone, volumes flared and smoke events	Inspection of Company records	N/A
19. Consent shall lapse if not implemented by date specified	Exercise of consent confirmed by inspection	Yes
20. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High

Table 5 Summary of performance for **9615-1** to discharge treated stormwater, treated surplus water and produced water from hydrocarbon exploration and production operations at the Cheal-G wellsite onto land where it may enter the Tuikonga Stream

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Inspections, procedures & processes	Yes
2. Max stormwater catchment area 2 Ha	Inspection of site and records	Yes
3. 5 days written notice prior to site works and drilling	Notification received	Yes
4. Maintain a contingency plan	Contingency plan received and approved	Yes
5. The stormwater system shall be designed, managed and maintained in accordance with information submitted	By comparing submitted & approved plans with the built site inspection	Yes
6. All discharges to be directed for treatment through skimmer pit.	Inspection of stormwater system	Yes
7. Skimmer pits to have a combined capacity of no less than 310 m ³	Submitted and approved plans	Yes
8. Stormwater pits to be impermeable	Inspection of stormwater system	Yes
9. Perimeter drains and skimmer pits to be installed prior to commencement of any site works	Inspection	Yes
10. Constituents in discharges shall meet the following standards: a) pH 6 – 9 b) Suspended solids <100 g/m ³ c) Hydrocarbon <15 g/m ³ d) Chloride <50 g/m ³	Physicochemical sampling	Yes
11. Effects not to occur in receiving waters beyond the established 25 m mixing zone	Physicochemical sampling of receiving waters	Yes
12. Discharge shall not have any significant adverse effects on receiving environment after the 25 m mixing zone	Physicochemical sampling and inspection	Yes
13. 48 hrs written notification to Council prior to reinstatement of site and reinstatement to minimise effects	Site inspections and liaison with consent holder	Yes
14. Consent shall lapse if not implemented by date specified	Exercise of consent confirmed by inspection	Yes – consent exercised
15. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High

Table 6 Summary of performance for **9617-1** to discharge stormwater and sediment, deriving from soil disturbance undertaken for the purpose of constructing the Cheal-G wellsite, onto land where it may enter the Tuikonga Stream

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Discharge of stormwater from no more than 3.1 hectares of land where earthworks is being undertaken	Inspection	Yes
2. Consent holder to adopt best practicable option at all times	Inspection, procedures & processes	Mostly – one breach, abatement issued
3. 7 days written notice prior to site earthworks	Notification received	Yes
4. All runoff shall pass through settlement ponds or traps with a minimum capacity of 100 m ³	Site erosion and sediment control plan submitted	Yes
5. Condition 4 will not apply when site is stabilised	Inspection	Yes
6. All earth worked areas shall be stabilised as soon as practicable	Inspection	Yes
Overall assessment of consent compliance and environmental performance in respect of this consent		Improvement Desired

During the monitoring period, TAG Oil (NZ) Limited demonstrated a good level of environmental performance and compliance with the resource consents. Overall, taking into account a lack of adequate stormwater control on one occasion during site preparation. The incident that occurred in respect of resource consent 9617-1 has been discussed in Section 2.5. The site was generally neat, tidy, and well maintained.

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 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 Change to any future 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. Accordingly the Council had for a time not routinely required the imposition of additional targeted physicochemical and biological monitoring unless a site-specific precautionary approach indicated this would be warranted for certainty and clarity around site effects. However, the Council has also noted a desire by some community members for a heightened level of information feedback and certainty around the results and outcomes of monitoring at wellsites to occur or has occurred. Notwithstanding the long track record of a demonstrable suitability of an inspection-based monitoring programme, the Council has therefore moved to extend the previous regime, to make the sampling and extensive analysis of treated stormwater discharge and biomonitoring of surface water ecosystems, an integral part of the basic monitoring programme for such activities. As noted in Section 2.4, this adjustment to the monitoring regime was implemented at Cheal-G, and be continued in the event of further site activity.

4. Recommendations

1. THAT this report be forwarded to the Company, and to any interested parties upon request;
2. THAT the Company be asked to inform the Council of the intention to either drill, test or undertake reinstatement;
3. THAT, subject to the findings of monitoring of any further activities at the Cheal-G wellsite consents 9613-1, 9615-1 and 9616-1 shall not be reviewed in June 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
<i>E.coli</i>	<i>Escherichia coli</i> , an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample
F	Fluoride
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample
Fresh g/m ³	elevated flow in a stream, such as after heavy rainfall grammes per cubic metre, and equivalent to milligrammes per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures
Incident	an event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred
Intervention	action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring
Investigation	action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident

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

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

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

Appendix I

Resource consents

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

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

Decision Date 5 February 2014
(Change):

Commencement Date 5 February 2014 (Granted: 29 July 2013)
(Change):

Conditions of Consent

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

Expiry Date: 1 June 2029

Review Date(s): June 2017, June 2023 and in accordance with special condition 20

Site Location: Cheal-G wellsite, Finnerty Road, Ngaere
(Property owner: B & N Hintz)

Legal Description: Sec 35 Blk V Ngaere SD (Discharge source and site)

Grid Reference (NZTM) 1710567E-5638308N

*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 to section 36 of the Resource Management Act 1991.

Special conditions

1. For the purposes of this consent:
 - (a) 'flaring' means the uncontrolled or partially controlled open air burning of hydrocarbons derived from or entrained in the well stream. 'Flare', as a verb, has the corresponding meaning and, as noun, means the flame produced by flaring.
 - (b) 'incineration' means the controlled, enclosed burning of formation hydrocarbons within a device designed for the purpose. 'Incinerate' has the corresponding meaning.
 - (c) 'Combustion' means burning generally and includes both flaring and incineration as well as other burning such as fuel in machinery.
2. Incineration shall only occur in a device with a minimum chimney height determined by the method detailed in Appendix VIII of the *Regional Air Quality Plan for Taranaki*.
3. Flaring shall only occur over a pit, or similar containment area, consisting of impermeable material that prevents any liquid from leaking through its base or sidewalls and discharging to land.
4. Flaring and incineration shall only occur within 20 metres of the location defined by NZTM 1710567E-5638308N.
5. Discharges to air from flaring or incineration shall not last longer than 15 days, cumulatively, inclusive of testing, clean-up, and completion stages of well development or work-over, per zone to be appraised, with a maximum of four zones per well and 12 wells.
6. The consent holder shall notify the Chief Executive, Taranaki Regional Council, at least 24 hours before the flaring or incineration from each zone commences. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
7. At least 24 hours before any flaring or incineration, other than in emergencies, the consent holder shall provide notification to the occupants of all dwellings within 300 metres of the wellsite and all landowners within 200 metres, of the commencement of flaring or incineration. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and complaints received in respect of any combustion activity.
8. No material shall be flared or incinerated, other than those derived from or entrained in the well stream.

Consent 9613-1.1

9. To the greatest extent possible, all gas that is flared or incinerated must first be treated by effective liquid and solid separation and recovery.
10. Only gaseous hydrocarbons originating from the well stream shall be flared or incinerated, except that if, for reasons beyond the control of the consent holder, effective separation can not be achieved and combustion of liquid hydrocarbon is unavoidable, the consent holder shall reinstate effective separation as soon as possible and if separation can not be achieved within 3 hours combustion must cease.
11. If liquid hydrocarbon is combusted in accordance with the exception provided for in condition 10 the consent holder shall prepare a report that details:
 - (a) the reasons that separation could not be achieved;
 - (b) the date and time that separation was lost and reinstated;
 - (c) what was done to attempt to reinstate separation and, if it the attempt was unsuccessful the reasons why.

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

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

Consent 9613-1.1

17. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.
18. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council, a 'combustion log' that includes:
 - (a) the date, time and duration of all flaring or incineration episodes;
 - (b) the zone from which flaring or incineration occurred;
 - (c) the volume of substances flared or incinerated;
 - (d) whether there was smoke at any time during the combustion episode and if there was, the time, duration and cause of each 'smoke event'.
19. This consent shall lapse on 30 September 2018, 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.
20. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review:
 - (a) during the month of June 2017 and/or June 2023; and/or
 - (b) within 1 month of receiving a report provided in accordance with condition 11;for any of the following purposes:
 - (i) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or
 - (ii) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or
 - (iii) to alter, add or delete limits on mass discharge quantities or ambient concentrations of any contaminant;
 - (iv) reducing emissions or environmental effects that may arise from any loss of separation.

Signed at Stratford on 5 February 2014

For and on behalf of
Taranaki Regional Council

A D McLay
Director-Resource Management

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

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

Decision Date: 23 August 2013

Commencement Date: 23 August 2013

Conditions of Consent

Consent Granted: To discharge treated stormwater, treated surplus drilling water and treated produced water from hydrocarbon exploration and production operations at the Cheal-G wellsite, onto land where it may enter the Tuikonga Stream

Expiry Date: 1 June 2029

Review Date(s): June 2017, June 2023

Site Location: Cheal-G wellsite, Finnerty Road, Stratford
(Property owner: B & N Hintz)

Legal Description: Sec 35 Blk V Ngaere SD (Discharge source & site)

Grid Reference (NZTM) 1710457E-5638483N

Catchment: Waingongoro

Tributary: Climie
 Tuikonga

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

General condition

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

Special conditions

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

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

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

4. The consent holder shall maintain a contingency plan that details measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not authorised by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge. The contingency plan shall be certified by the Chief Executive, Taranaki Regional Council prior to discharging from the site, and after any change to the Plan.
5. Subject to the other conditions of this consent the design, management and maintenance of the stormwater system shall be undertaken in accordance with the information submitted in support of the consent application 7499, in particular plans 13096-02.

6. All discharges from the site, including from any containment pit or hydrocarbon combustion facility (e.g. flare pit, thermal oxidiser), shall flow to a perimeter drain and skimmer pit. Perimeter drains shall be designed, including by having a positive grade and low permeability, to ensure that runoff flows directly to a skimmer pit without ponding.
7. Skimmer pits shall have a combined capacity of no less than 310 m³, and be designed to retain any hydrocarbons that enter them.
8. All skimmer pits and any other stormwater retention areas shall be lined with an impervious material to prevent seepage through the bed and sidewalls, and all skimmer pits shall have a valve that can be shut off to prevent any discharge from the site.
9. Perimeter drains and skimmer pits necessary to comply with the conditions of this consent shall be installed before any site works commences. Site works includes the introduction of a drilling rig, drilling equipment or any other associated equipment or facilities to the site for any purpose other than for the construction of the site.
10. Constituents in the discharge shall meet the standards shown in the following table.

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

11. After allowing for a mixing zone of 25 metres, the discharge shall not give rise to an increase in the temperature of the receiving waters of more than 2 degrees Celsius.
12. After allowing for a mixing zone of 25 metres, the discharge shall not give rise to any of the following effects in the receiving water:
 - a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
 - b) any conspicuous change in the colour or visual clarity;
 - c) any emission of objectionable odour;
 - d) the rendering of fresh water unsuitable for consumption by farm animals;
 - e) any significant adverse effects on aquatic life.
13. The consent holder shall advise the Chief Executive, Taranaki Regional Council, in writing at least 48 hours prior to the reinstatement of the site and the reinstatement shall be carried out so as to minimise adverse effects on stormwater quality. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
14. This consent shall lapse on 30 September 2018, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

Consent 9615-1

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 and/or June 2023, 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 23 August 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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

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

Decision Date: 23 August 2013

Commencement Date: 23 August 2013

Conditions of Consent

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

Expiry Date: 1 June 2029

Review Date(s): June 2017, June 2023

Site Location: Cheal-G wellsite, Finnerty Road, Stratford
(Property owner: B & N Hintz)

Legal Description: Sec 35 Blk V Ngaere SD (Site of take)

Grid Reference (NZTM) 1710513E-5638371N

Catchment: Waingongoro

Tributary: Climie
 Tuikonga

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

General condition

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

Special conditions

1. The consent holder shall ensure the abstraction does not cause more than a 10% lowering of static water-level by interference with any adjacent bore.
2. The consent holder shall ensure the abstraction does not cause the intrusion of salt water into any freshwater aquifer.
3. The consent holder shall submit a summary well log to a depth of 1000 metres within three months of completion of drilling. The report shall:
 - (a) include confirmation of the datum from which measurements are referenced;
 - (b) provide a log to show the true vertical depth to all geological formation tops intersected within the freshwater zone;
 - (c) identify the true vertical depth to, and thickness of, any freshwater aquifers intersected by the well;
 - (d) identify the true vertical depth to the freshwater- saline water interface in the well.
4. This consent shall lapse on 30 September 2018, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
5. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2017 and/or June 2023, 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 23 August 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 August 2013

Commencement Date: 13 August 2013

Conditions of Consent

Consent Granted: To discharge stormwater and sediment, deriving from soil disturbance undertaken for the purpose of constructing the Cheal-G wellsite, onto land where it may enter the Tuikonga Stream

Expiry Date: 1 June 2018

Site Location: Cheal-G wellsite, Finnerty Road, Stratford
(Property owner: B & N Hintz)

Legal Description: Sec 35 Blk V Ngaere SD (Discharge source & site)

Grid Reference (NZTM) 1710457E-5638483N

Catchment: Waingongoro

Tributary: Climie
 Tuikonga

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

General condition

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

Special conditions

1. This consent authorises the discharge of stormwater from no more than 3.1 hectares of land where earthworks is being undertaken for the purpose of establishing the Cheal-G wellsite.
2. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment associated with the discharge of contaminants from the site.
3. At least 7 working days before the commencement of earthworks for the purpose of wellsite construction and establishment, the consent holder shall notify the Taranaki Regional Council of the proposed start date for the earthworks. Notification shall include the consent number and a brief description of the activity consented and shall be emailed to worknotification@trc.govt.nz.
4. All run off from any area of exposed soil shall pass through settlement ponds or sediment traps with a minimum total capacity of:
 - a) 100 cubic metres for every hectare of exposed soil between 1 November to 30 April; and
 - b) 200 cubic metres for every hectare of exposed soil between 1 May to 31 October;

Unless other sediment control measures that achieve an equivalent standard are agreed to by the Chief Executive of the Taranaki Regional Council.

5. The sediment control measures necessary to comply with condition 4 above shall be constructed before soil is exposed for the construction of the wellsite and shall remain in place, in respect of any particular area, until that area is stabilised.

Note: For the purpose of conditions 5 and 6, "stabilised" in relation to any site or area means inherently resistant to erosion or rendered resistant, such as by using rock or by the application of basecourse, colluvium, grassing, mulch, or another method to the reasonable satisfaction of the Chief Executive, Taranaki Regional Council and as specified in the Taranaki Regional Council's Guidelines for Earthworks in the Taranaki Region, 2006. Where seeding or grassing is used on a surface that is not otherwise resistant to erosion, the surface is considered stabilised once, on reasonable visual inspection by an officer of the Taranaki Regional Council, an 80% vegetative cover has been established.

Consent 9617-1

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

Signed at Stratford on 13 August 2013

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
Report No BJ229
Document 1346906
Date 13 May 2014

Biomonitoring of the Tuikonga Stream following drilling by TAG Oil (NZ) Ltd at Cheal G wellsite, April 2014

Introduction

This biological survey was performed following drilling of the Cheal G well to determine whether or not treated stormwater, treated surplus drilling water and treated produced water discharges onto land in the vicinity of the Tuikonga Stream had had a detrimental effect upon the communities of the Tuikonga Stream. A survey was also conducted prior to drilling, but following site preparation earthworks to provide baseline data on the macroinvertebrate community of this stream (Thomas, 2014).

Methods

Cheal G wellsite stormwater and site production water has been consented for discharge on to land near the Tuikonga Stream (Figure 1). This post-drill survey was undertaken on 11 April 2014 at three established sites; 130 m upstream of the Cheal G wellsite discharge (site 1), 80 m downstream of the Cheal G wellsite discharge (site 2) and 150 m downstream of the Cheal G wellsite discharge (site 3) (Table 1).

The Council's standard 'kick-sampling' technique was used at all three sites to collect streambed macroinvertebrates from the Tuikonga Stream upstream and downstream of the proposed discharges from the Cheal G wellsite. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1: Biomonitoring sites and sampling methods used in the Tuikonga Stream related to the Cheal G wellsite.

Site no.	Site code	Grid reference (NZTM)	Location	Sampling method	Altitude (m asl)
1	TKG000170	1710361E-5638519N	130m u/s of Cheal G wellsite discharge	Streambed kick	240
2	TKG000172	1710388E-5638350N	80m d/s of Cheal G wellsite discharge	Streambed kick	240
3	TKG000175	1710380E-5638281N	150m d/s of Cheal G wellsite discharge	Streambed kick	240



Figure 1 Biomonitoring sites in the Tuikonga Stream in relation to the Cheal G 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 afternoon survey, water temperatures in the Tuikonga stream ranged from 15.8°C to 16.0°C. A moderate flow of brown cloudy water was present at all three sites. Substrate was similar at all sites and comprised predominantly of gravels and cobbles with some sand, silt and boulder also present. Macrophytes were recorded growing on the edges of the stream at all sites. Slippery films of periphyton were recorded at all sites and some patches of filamentous algae present at site 1. No shading was noted at the sites, as there was no overhanging vegetation.

Macroinvertebrate communities

Table 2 summarises the results of the macroinvertebrate surveys performed prior to and following drilling of the Cheal G 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 Tuikonga Stream, prior to and following drilling at the Cheal G wellsite.

Site No.	No of taxa		MCI value		SQMCI _s value	
	Pre-drill	Post-drill	Pre-drill	Post-drill	Pre-drill	Post-drill
1	23	32	107	104	6.7	5.7
2	22	29	103	99	7.0	7.1
3	26	31	107	101	6.8	6.0

Table 3 Range and median number of taxa, MCI values and SQMCI_s scores for ring plain sites rising outside of the National Park at altitudes >400 m asl ((TRC, 1999 (updated 2013)).

	No. of taxa	MCI value	SQMCI _s value
No. Samples	32	32	29
Range	8-33	87-127	2.3-7.5
Median	20	113	6.0

Table 4: Macroinvertebrate fauna of the Tuikonga Stream in relation to the Cheal-G post-drill survey sampled 11 April 2014.

Taxa List	Site Number	MCI score	1	2	3	
	Site Code		TKG000170	TKG000172	TKG000175	
	Sample Number		FWB14193	FWB14194	FWB14195	
NEMERTEA	Nemertea	3	-	-	R	
ANNELIDA (WORMS)	Oligochaeta	1	C	C	R	
MOLLUSCA	<i>Latia</i>	5	C	R	C	
	<i>Potamopyrgus</i>	4	VA	A	C	
CRUSTACEA	<i>Paracalliope</i>	5	R	R	-	
EPHEMEROPTERA (MAYFLIES)	<i>Austroclima</i>	7	C	C	R	
	<i>Coloburiscus</i>	7	A	A	VA	
	<i>Deleatidium</i>	8	VA	XA	XA	
	<i>Nesameletus</i>	9	C	R	R	
	<i>Zephlebia group</i>	7	R	-	-	
PLECOPTERA (STONEFLIES)	<i>Zelandobius</i>	5	C	R	C	
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	VA	
	Hydraenidae	8	-	-	R	
	Ptilodactylidae	8	R	R	R	
MEGALOPTERA (DOBSONFLIES)	<i>Archichauliodes</i>	7	A	A	A	
TRICHOPTERA (CADDISFLIES)	<i>Aoteapsyche</i>	4	A	A	XA	
	<i>Costachorema</i>	7	R	C	C	
	<i>Hydrobiosis</i>	5	A	A	A	
	<i>Neurochorema</i>	6	R	-	-	
	<i>Beraeoptera</i>	8	A	A	A	
	<i>Confluens</i>	5	R	R	C	
	<i>Oxyethira</i>	2	C	R	R	
	<i>Pycnocentria</i>	7	R	R	R	
	<i>Pycnocentroides</i>	5	A	A	C	
	DIPTERA (TRUE FLIES)	<i>Aphrophila</i>	5	R	R	R
		Eriopterini	5	C	C	R
		Hexatomini	5	R	-	R
		<i>Chironomus</i>	1	-	C	C
		<i>Maoridiamesa</i>	3	A	C	C
Orthocladiinae		2	C	C	C	
<i>Polypedilum</i>		3	R	-	-	
Tanytarsini		3	-	R	-	
Empididae		3	-	R	R	
Ephydriidae		4	R	-	-	
Muscidae		3	R	R	-	
<i>Austrosimulium</i>		3	C	R	R	
Tanyderidae		4	-	-	R	
ACARINA (MITES)		Acarina	5	R	-	R
No of taxa			32	29	31	
MCI			104	99	101	
SQMCI			5.7	7.1	6.0	
EPT (taxa)			14	12	12	
%EPT (taxa)			44	41	39	
'Tolerant' taxa		'Moderately sensitive' taxa		'Highly sensitive' taxa		

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

Site 1- 130 m upstream of Cheal G wellsite discharge

A high community richness of thirty-two taxa was found at site 1 (Table 2 and Table 4), twelve taxa more than the median richness found at similar sites elsewhere in the region (Table 3). The macroinvertebrate community was comprised of a relatively high proportion of 'sensitive' taxa (69%), which was reflected in the MCI score of 104 units. This MCI score was slightly lower (7 units) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 3), but similar to that recorded in the pre-drill survey (Table 2).

The community at this site was characterised by two 'highly sensitive' taxa (mayfly (*Deleatidium*) and caddisfly (*Beraeoptera*)), five 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmids beetles, dobsonfly (*Archichauliodes*), and caddisfly (*Hydrobiosis* and *Pycnocentroides*)), and three 'tolerant' taxa (*Potamopyrgus* snails, net-building caddis larvae *Aoteapsyche* and *Maoridiamesa* midge larvae) very similar to that recorded in the previous survey (Thomas, 2014).

The numerical dominance of many 'sensitive' taxa resulted in a SQMCI_s score of 5.7 units, which was slightly less (0.3 unit) than the median score for 'control' sites in similar streams at this altitude (Table 3) and 1.0 unit less than that recorded in the pre-drill survey (Table 2). This is likely to be a reflection of summer flow conditions present at the time of this survey.

Site 2- 80 m downstream of Cheal G wellsite discharge

A high community richness of twenty-nine taxa was found at site 2 (Table 2 and Table 4), three taxa less than what was found at site 1, but seven taxa more than that recorded in the pre-drill survey (Table 2) and nine taxa more than the median richness found at similar sites in the region (Table 3). The macroinvertebrate community was comprised of a similar proportion of 'sensitive' taxa (62%) as that recorded in the previous survey, and as a result, the MCI score was similar, being only four units less (Table 2). This is a statistically insignificant difference (Stark, 1998). Although this score was fourteen units fewer than the median MCI score for 'control' sites in similar streams at comparative altitudes (Stark, 1998) (Table 3), it was only five units less than that recorded at site 1.

The community at this site was characterised by two 'highly sensitive' taxa (mayfly (*Deleatidium*) and caddisfly (*Beraeoptera*)), five 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmids beetles, dobsonfly (*Archichauliodes*) and caddisfly (*Hydrobiosis* and *Pycnocentroides*)) and two 'tolerant' taxa (*Potamopyrgus* snails and net-building caddis larvae *Aoteapsyche*) (Table 4).

The extreme abundance of highly 'sensitive' *Deleatidium* mayfly resulted in a SQMCI_s score of 7.1 units, which was a significant 1.1 units greater than the median score for 'control' sites in similar streams at this altitude (Table 3), and 1.4 units higher than the upstream control site. Compared with that recorded in the previous survey, there was little difference (Table 2).

Site 3- 150 m downstream of Cheal G wellsite discharge

A high community richness of thirty-one taxa was found at site 3 (Table 2 and Table 4), one taxon less than the upstream control site, and eleven taxa more than the median richness found at similar sites elsewhere in the region (Table 3). This richness was also five units

higher than that recorded in the pre-drill survey (Table 2).). The macroinvertebrate community was comprised of a relatively high proportion of 'sensitive' taxa (65%), which was reflected in the MCI score of 101 units. This was similar to that recorded at sites 1 and 2, and an insignificant six units less than that recorded at this site in the previous survey (Table 2). Similar to that recorded at site 2, the MCI score recorded at site 3 in the current survey was statistically less than the median for 'control' sites in similar streams at comparative altitudes (Stark, 1998) (Table 3).

The community at this site was characterised by two 'highly sensitive' taxa (mayfly (*Deleatidium*) and caddisfly (*Beraeoptera*), four 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*) and caddisfly (*Hydrobiosis*) and one 'tolerant' taxon (net-building caddis larvae *Aoteapsyche*) (Table 4). This was very similar to those taxa recorded in abundance at sites 1 and 2.

This site recorded a significant increase in abundance of net-building caddis larvae *Aoteapsyche*, which reduced the SQMCI_s score to 6.0 units. Although this result is significantly less than that recorded at site 2 in the current survey (Stark, 1998), and 0.8 unit less than that recorded at this site in the previous survey, it was not significantly different to that recorded at site 1 (in the current survey) (Table 2). In addition, it was equal to the median score for 'control' sites in similar streams at this altitude elsewhere the region (Stark, 1998) (Table 3).

Summary and Conclusions

The Councils 'kick-sampling' technique was used at three sites to collect streambed macroinvertebrates from the Tuikonga Stream to assess whether discharges from the Cheal G well site had had any adverse effects on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCI_s scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The SQMCI_s takes into account taxa abundances as well as sensitivity to pollution. It may indicate subtle changes in communities, and therefore be the more relevant index if non-organic impacts are occurring. 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 April 2014 survey of three sites upstream and downstream of the skimmer pit discharge point to land near the stream, was undertaken following drilling at the Cheal G wellsite, and indicated that the discharges from the well site have not had any detrimental effect on the macroinvertebrate communities of this stream.

The three sites surveyed were relatively similar in macroinvertebrate community composition with relatively high taxonomic richnesses (number of taxa). A total of 38 taxa was found through the reach of the stream surveyed, with 24 of these taxa (63%) found at all three sites and 6 taxa (15.8%) found at any two of these sites. One 'tolerant' taxon, two 'highly sensitive' taxa and four 'moderately sensitive' were abundant at all three sites. SQMCI_s scores at all three sites were similar to or significantly higher than the medians recorded from other ring plain streams that rise outside of the national park at similar altitudes (TRC, 1999 (updated

2013)). There were no significant differences in MCI scores between the three sites surveyed, and neither did they differ significantly from their respective pre-drill survey scores. The MCI scores indicated that the stream macroinvertebrate communities were of 'fair' to 'good' health (TRC, 2014). Overall, the results indicated that reasonable water quality preceded this survey.

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 B, 2014: Biomonitoring of the Tuikonga Stream prior to drilling by TAG Oil (NZ) Ltd at Cheal G wellsite, December 2013. Report number BT012.

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 BT012
Document 1321802
Date 17 March 2014

Biomonitoring of the Tuikonga Stream prior to drilling by TAG Oil (NZ) Ltd at Cheal G wellsite, December 2013

Introduction

This biological survey was performed prior to drilling of the Cheal G well, but after site preparation earthworks to provide baseline data on the macroinvertebrate community of the Tuikonga Stream. A second survey will be performed following drilling of the well, to determine whether or not consented discharges of treated stormwater and uncontaminated site water and production water onto land near the Tuikonga Stream have had a detrimental effect upon the macroinvertebrate communities of this stream.

Methods

Cheal G wellsite stormwater and site production water has been consented for discharge on to land near the Tuikonga Stream (Figure 1). This pre-drill survey was undertaken on 16 December 2013 at three newly established sites; 130 m upstream of the Cheal G wellsite discharge (site 1), 80 m downstream of the Cheal G wellsite discharge (site 2) and 150 m downstream of the Cheal G wellsite discharge (site 3) (Table 1).

The Council's standard 'kick-sampling' technique was used at all three sites to collect streambed macroinvertebrates from the Tuikonga Stream upstream and downstream of the proposed discharges from the Cheal G wellsite. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1: Biomonitoring sites and sampling methods used in the Tuikonga Stream related to the Cheal G wellsite.

Site no.	Site code	Grid reference (NZTM)	Location	Sampling method	Altitude (m asl)
1	TKG000170	1710361E-5638519N	130m u/s of Cheal G wellsite discharge	Streambed kick	240
2	TKG000172	1710388E-5638350N	80m d/s of Cheal G wellsite discharge	Streambed kick	240
3	TKG000175	1710380E-5638281N	150m d/s of Cheal G wellsite discharge	Streambed kick	240



Figure 1 Biomonitoring sites in the Tuikonga Stream in relation to the Cheal G 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 afternoon survey, water temperatures in the Tuikonga stream ranged from 15.5°C to 16.0°C. A low flow of clear, cloudy water was present at all three sites. Substrate was similar at all sites and comprised predominantly of sand and cobbles with varying aggregates of gravel and boulders. Macrophytes were recorded growing on the edges of the stream at site 2 and site 3, and no macrophytes were recorded at site 1. Slippery films of periphyton were recorded at all sites and all sites were partially shaded by overhanging vegetation.

Macroinvertebrate communities

Table 2 summarises the results of this macroinvertebrate survey performed prior to drilling of the Cheal G 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 Tuikonga Stream, sampled on 16 December 2013 prior to drilling of Cheal G wellsite.

Site No.	No taxa	MCI value	SQMCI _s value
1	23	107	6.7
2	22	103	7.0
3	26	107	6.8

Table 3: Range and median number of taxa, MCI values and SQMCI_s scores for ring plain sites rising outside of the National Park at altitudes >400 m asl ((TRC, 1999 (updated 2013)).

	No. of taxa	MCI value	SQMCI _s value
No. Samples	32	32	29
Range	8-33	87-127	2.3-7.5
Median	20	113	6.0

Table 4: Macroinvertebrate fauna of the Tuikonga Stream in relation to the Cheal-G pre-drill survey sampled 16 December 2013.

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3	
	Site Code		TKG000170	TKG000172	TKG000175	
	Sample Number		FWB13379	FWB13380	FWB13381	
ANNELIDA (WORMS)	Oligochaeta	1	C	R	C	
MOLLUSCA	<i>Latia</i>	5	C	-	-	
	<i>Potamopyrgus</i>	4	C	C	C	
EPHEMEROPTERA (MAYFLIES)	<i>Austroclima</i>	7	C	R	C	
	<i>Coloburiscus</i>	7	A	C	A	
	<i>Deleatidium</i>	8	XA	XA	XA	
	<i>Nesameletus</i>	9	R	R	R	
PLECOPTERA (STONEFLIES)	<i>Zelandobius</i>	5	A	A	C	
COLEOPTERA (BEETLES)	Elmidae	6	XA	VA	VA	
	Ptilodactylidae	8	R	R	R	
MEGALOPTERA (DOBSONFLIES)	<i>Archichauliodes</i>	7	A	A	A	
TRICHOPTERA (CADDISFLIES)	<i>Aoteapsyche</i>	4	A	A	VA	
	<i>Costachorema</i>	7	C	R	C	
	<i>Hydrobiosis</i>	5	C	C	C	
	<i>Beraeoptera</i>	8	R	C	C	
	<i>Confluens</i>	5	-	R	-	
	<i>Olinga</i>	9	-	-	R	
	<i>Pycnocentria</i>	7	-	-	R	
	<i>Pycnocentroides</i>	5	VA	VA	VA	
	DIPTERA (TRUE FLIES)	<i>Aphrophila</i>	5	R	-	R
		Eriopterini	5	R	-	R
<i>Maoridiamesa</i>		3	-	R	R	
Orthocladiinae		2	R	C	R	
Tanytarsini		3	-	-	R	
Empididae		3	-	R	-	
Muscidae		3	-	R	R	
<i>Austrosimulium</i>		3	R	R	C	
Tabanidae	3	C	R	C		
	Tanyderidae	4	R	-	-	
ACARINA (MITES)	Acarina	5	R	-	R	
No of taxa			23	22	26	
MCI			107	103	107	
SQMCI			6.7	7.0	6.8	
EPT (taxa)			10	11	12	
%EPT (taxa)			43	50	46	
'Tolerant' taxa		'Moderately sensitive' taxa		'Highly sensitive' taxa		

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

Site 1- 130 m upstream of Cheal G wellsite discharge

A moderate community richness of twenty three taxa was found at site 1 (Table 2 and Table 4), three taxa more than the median richness found at similar sites elsewhere in the region (Table 3). The macroinvertebrate community was comprised of a significant proportion of 'sensitive' taxa (52%), which was reflected in the MCI score of 107 units. This MCI score was slightly lower (6 units) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 3).

The community at this site was characterised by one 'highly sensitive' taxon, mayfly (*Deleatidium*), one 'tolerant' taxon (net-building caddis larvae *Aoteapsyche*); and five 'moderately sensitive' taxa (dobsonfly (*Archichauloides*), stonefly (*Zelandobius*), mayfly (*Coloburiscus*), caddisfly (*Pycnocentroides*) and elmids beetles).

The numerical dominance of many 'sensitive' taxa resulted in a SQMCI₅ score of 6.7 units, which was slightly higher (0.7 unit) than the median score for 'control' sites in similar streams at this altitude (Table 3).

Site 2- 80 m downstream of Cheal G wellsite discharge

A moderate community richness of twenty two taxa was found at site 2 (Table 2 and Table 4), one taxa less than what was found at site 1, and two taxa more than the median richness found at similar sites in the region (Table 3). The macroinvertebrate community was comprised of equal proportions of 'sensitive' taxa (41%), and 'tolerant' taxa (41%), which was reflected in the MCI score of 103 units. This was an insignificant 4 units fewer than recorded at site 1 and an insignificant 10 units fewer 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 one 'highly sensitive' taxon, mayfly (*Deleatidium*), one 'tolerant' taxon (net-building caddis larvae *Aoteapsyche*); and four 'moderately sensitive' taxa (dobsonfly (*Archichauloides*), stonefly (*Zelandobius*), caddisfly (*Pycnocentroides*) and elmids beetles).

The numerical dominance of numerous 'sensitive' taxa resulted in a SQMCI₅ score of 7.0 units, which was a significant 1.0 unit greater than the median score for 'control' sites in similar streams at this altitude (Table 3), and an insignificant 0.3 unit higher than the upstream control site.

Site 3- 150 m downstream of Cheal G wellsite discharge

A moderate community richness of twenty six taxa was found at site 3 (Table 2 and Table 4), three units more than the upstream control site, and six taxa more than the median richness found at similar sites elsewhere in the region (Table 3). The macroinvertebrate community was comprised of a significant proportion of 'sensitive' taxa (46%), which was reflected in the MCI score of 107 units. This was the same MCI score as what was found at site 1. This MCI score was 4 units greater than what was found at site 2, and an insignificant six 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 one 'highly sensitive' taxon, mayfly (*Deleatidium*), one 'tolerant' taxon (net-building caddis larvae *Aoteapsyche*); and four 'moderately sensitive' taxa (dobsonfly (*Archichauloides*), mayfly (*Coloburiscus*), caddisfly (*Pycnocentroides*) and elmids beetles).

A numerical dominance of 'sensitive' taxa resulted in the SQMCI_s score of 6.8 units which was insignificantly greater (by 0.8 unit), than the median score for 'control' sites in similar streams at this altitude elsewhere the region (Stark, 1998) (Table 3), and insignificantly higher (by 0.1 unit) than what was recorded at site 1.

Summary and Conclusions

The Councils 'kick-sampling' technique was used at three sites to collect streambed macroinvertebrates from the Tuikonga Stream. This has provided baseline data for any future assessment of consented discharge effects from the Cheal G 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 December 2013 survey of three sites upstream and downstream of the skimmer pit discharge point to land near the stream, was undertaken prior to the drilling of the Cheal G wellsite but following site preparation earthworks.

The three sites surveyed were relatively similar in macroinvertebrate community composition with moderate taxonomic richnesses (number of taxa). A total of 30 taxa was found through the reach of the stream surveyed, with 18 of these taxa (60%) found at all three sites and 5 taxa (16.5%) found at any two of these sites. One 'tolerant' taxon, one 'highly sensitive' taxon and three 'moderately sensitive' were abundant at all three sites. SQMCI_s scores at all three sites were slightly above the medians recorded from other ring plain streams that rise outside of the national park at similar altitudes (TRC, 1999 (updated 2013)). There were no significant differences in MCI scores between the three sites surveyed. The MCI scores indicated that the stream macroinvertebrate communities were of 'good' health (TRC, 2014). Overall, the results indicated that reasonable water quality preceded this survey.

A further survey will be conducted following the completion of all drilling and well-testing activities at the Cheal G wellsite, to determine whether any discharges to land, near the Tuikonga Stream, have had any effects on the macroinvertebrate communities of this 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.
- 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.

