

**TAG Oil (NZ) Limited  
Southern Cross Wellsite  
Monitoring Programme Report  
2013-2014**

**Technical Report 2014-52**

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## **Executive summary**

TAG Oil (NZ) Limited established a hydrocarbon exploration site located along Cross Road, within the Stratford district, in the Waitara catchment. The site is called Southern Cross wellsite. This report covers the period from February 2014 to July 2014. During this period, a wellsite was established with one well drilled, side-tracked, 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 Southern Cross wellsite during the period under review, and the results and environmental effects of TAG Oil (NZ) Limited's activities.

**During the monitoring period, the Company demonstrated an overall high level of both environmental and administrative performance and compliance with the resource consents.**

TAG Oil (NZ) Limited holds five resource consents for the activities at the Southern Cross wellsite, which include a total of 63 consent conditions setting out the requirements that TAG Oil (NZ) Limited must satisfy. TAG Oil (NZ) Limited holds consent 9715-1 to discharge contaminants to air from hydrocarbon exploration (not exercised); consent 9716-1 to discharge emissions to air associated with hydrocarbon producing wells (not exercised); consent 9717-1 to discharge treated stormwater and produced water from hydrocarbon exploration and production operations at the Southern Cross wellsite, onto land where it may enter an unnamed tributary of the Makara Stream; consent 9718-1 to take groundwater; and consent 9719-1 to discharge stormwater and sediment, deriving from soil disturbance undertaken for the purpose of constructing the Southern Cross wellsite.

The Council's monitoring programme for the period under review included 11 inspections of the site and surrounding environment, at approximately fortnightly intervals. Six stormwater samples were obtained for analysis. Furthermore, biomonitoring surveys were conducted prior to the commencement of drilling activities, and another following the completion of drilling activities at the Southern Cross wellsite.

Analysis showed that all of the samples obtained were compliant. In addition, it appears that drilling activities at the Southern Cross wellsite did not cause any impacts on the macroinvertebrate communities within an unnamed tributary of the Makara Stream, as there was no change detected between the pre-drill and post-drill biomonitoring surveys performed.

TAG Oil (NZ) Limited did not need to notify the Council of its intention to combust gas, as gas combustion activities were not undertaken at the Southern Cross wellsite or in association with this wellsite. No offensive or objectionable odours, smoke or dust associated with activities at the wellsite were observed. The drilling fluids and cuttings were disposed of at a consented off-site facility.

During the monitoring period the Council received one incident investigation report from TAG Oil (NZ) Limited. On 26 March 2014 approximately 1,000 litres of hydraulic oil spilled at the Southern Cross wellsite as a result of a hydraulic pump failure. The clean up operation was supervised by Spill Control New Zealand. The area was quickly and

effectively bunded with a small sump dug to collect the oil, which was then pumped into drums for removal from the site. An on-site crane was used to remove the container which housed the hydraulic pump system and placed into/onto a liner. A second sump was dug and also lined with an impermeable liner. The container was subsequently cleaned over the liner in which all material was directed to the lined sump and again pumped into temporary storage prior to removal from the site. The contaminated gravel was also removed from site and disposed of at an appropriate licensed facility. Inspection found no evidence of contaminants having tracked away from the spill location. The spill was cleaned up in an immediate, professional and thorough manner. Given the unforeseen nature of this event, and the Company's prompt and comprehensive report, this event was not actionable by the Council.

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

During the monitoring period, TAG Oil (NZ) Limited demonstrated both a high level of environmental and administrative performance and compliance with the resource consents.

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

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## 1. Introduction

### 1.1 Compliance monitoring programme reports and the Resource Management Act 1991

#### 1.1.1 Introduction

This report is for the period February 2014 to July 2014 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by TAG Oil (NZ) Limited. During this period, a wellsite was established with one well drilled, side-tracked, 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 Southern Cross wellsite located off Cross Road in the Stratford District.

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

#### 1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the RMA and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consent held by TAG Oil (NZ) Limited in the Waitara 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 Southern Cross wellsite during exploration activities.

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

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

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

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

#### 1.1.3 The Resource Management Act (1991) and monitoring

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

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

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

#### **1.1.4 Evaluation of environmental and consent performance**

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

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

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

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

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

##### **Environmental Performance**

- **High** No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment .The Council did not record any verified unauthorised incidents involving

significant environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.

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

For example:

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

### **Administrative compliance**

- **High** The administrative requirements of the resource consents were met, or any failure to do this had trivial consequences and were addressed promptly and co-operatively.
- **Good** Perhaps some administrative requirements of the resource consents were not met at a particular time, however this was addressed without repeated interventions from the Council staff. Alternatively adequate reason was provided for matters such as the no or late provision of information, interpretation of ‘best practical option’ for avoiding potential effects, etc.
- **Improvement required** Repeated interventions to meet the administrative requirements of the resource consents were made by Council staff. These matters took some time to resolve, or remained unresolved at the end of the

period under review. The Council may have issued an abatement notice to attain compliance.

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

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

## 1.2 Process description

### **Site description**

TAG Oil (NZ) Limited holds the five year Petroleum Mining Permit No. 54876 to prospect, explore, and mine for condensate, gas, LPG, oil and petroleum within an area of 15.84 Km<sup>2</sup>. The Southern Cross wellsite is one of many sites within this area that have been established in order to explore, evaluate and produce hydrocarbons.

The Southern Cross wellsite is located approximately 2 km along Cross Road and approximately 3 km from Wharehuia, as per Figure 1. The Southern Cross wellsite was established in 2014 and involved the removal of topsoil to create a firm level foundation on which to erect a drilling rig and house associated equipment. Site establishment also involved the installation of:

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

The nearest residence is approximately 655 m away from the wellsite. Bunding, earthworks and good site location helped minimise any potential for off-site effects for the neighbours.



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

### Well development

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

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

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

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

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

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

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

### **Management of stormwater, wastewater and solid drilling waste**

The Southern Cross wellsite is located approximately 84 m to the North west of the nearest waterbody which is an unnamed tributary of the Makara Stream.

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

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

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

### **Flaring from exploration activities**

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

- Well testing and clean-up;

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

## 1.3 Resource consents

### 1.3.1 Background

TAG Oil (NZ) Limited holds five resource consents related to exploration activities at the Southern Cross wellsite site, as follows:

- Discharge Permit 9715-1; granted 23 October 2013,
- Discharge Permit 9716-1; granted 23 October 2013,
- Discharge Permit 9717-1; granted 23 October 2013,
- Water Permit 9718-1; granted 23 October 2013 and
- Discharge Permit 9719-1; granted 23 October 2013,

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

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

### 1.3.2 Air discharge permit (exploration activities)

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

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

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

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

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

TAG Oil (NZ) Limited holds air discharge permit 9715-1 to discharge contaminants to air from hydrocarbon exploration at the Southern Cross 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.

This permit was issued by the Council on 23 October 2013 under Section 87(e) of the RMA. It is due to expire on 1 June 2033.

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 2, Section 3.3.

### **1.3.3 Air discharge permit (production activities)**

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

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

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

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

TAG Oil (NZ) Limited holds air discharge permit 9716-1 to discharge emissions to air associated with hydrocarbon producing wells at the Southern Cross wellsite.

This permit was issued by the Council on 23 October 2013 under Section 87(e) of the RMA. It is due to expire on 1 June 2033.

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 3, Section 3.3.

### **1.3.4 Water discharge permit (treated stormwater and treated produced water)**

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

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

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

TAG Oil (NZ) Limited holds water discharge permit 9717-1 to discharge treated stormwater and produced water from hydrocarbon exploration and production operations at the Southern Cross wellsite, onto land where it may enter an unnamed tributary of the Makara Stream.

This permit was issued by the Council on 23 October 2013 under Section 87(e) of the RMA. It is due to expire on 1 June 2033.

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 4, Section 3.3.

### **1.3.5 Water abstraction permit (groundwater)**

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

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

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

Any produced water would be from reserves far below that which is used for domestic or farm purposes. Shallow groundwater (which does not have any saltwater content) was protected by casing within the bore hole. Given these factors, the abstraction would not cause the above effects.

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

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

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

- Duration of consent; and
- Review of the conditions of consent and the timing and purpose of the review.

TAG Oil (NZ) Limited holds water permit 9718-1 to take groundwater as ‘produced water’, during hydrocarbon exploration and production activities at the Southern Cross wellsite.

This permit was issued by the Council on 23 October 2013 under Section 87(d) of the RMA. It is due to expire on 1 June 2033.

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 5, Section 3.3.

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

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

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

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

TAG Oil (NZ) Limited supplied a site erosion and sediment control management plan in support of the application.

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

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

TAG Oil (NZ) Limited holds water discharge permit 9719-1 to discharge stormwater and sediment, deriving from soil disturbance undertaken for the purpose of

constructing the Southern Cross wellsite, onto land where it may enter an unnamed tributary of the Makara Stream.

This permit was issued by the Council on 23 October 2013 under Section 87(e) of the RMA. 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.

## **1.4 Monitoring programme**

### **1.4.1 Introduction**

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

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

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

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

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

### **1.4.2 Programme liaison and management**

There is generally a significant investment of time and resources by the Council in ongoing liaison with resource consent holders over consent conditions and their interpretation and application, in discussion over monitoring requirements, preparation for any reviews, renewals, or new consents, advice on the Council's environmental management strategies and the content of regional plans, and consultation on associated matters.

### **1.4.3 Site inspections**

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

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

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

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

During each inspection the following are checked:

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

### **1.4.4 Chemical sampling**

The Council may undertake sampling of discharges from site and from sites upstream and downstream of the discharge point to ensure that resource consent

special conditions are complied with and to determine whether site activities were having any effects within the receiving environment.

#### **1.4.5 Solid wastes**

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

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

#### **1.4.6 Air quality monitoring**

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

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

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

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

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

If hydraulic fracturing activities are undertaken at site, sampling and analysis of the hydraulic fracturing, return flow fluids and nearby bores are carried out. These inspections of the site and surrounding land and water are carried out to ensure that no observable effects have occurred as a result of the discharge to land. Pre and post hydraulic fracturing reports are submitted by the consent holder detailing among other things, the effectiveness of the mitigation measures put in place to protect the environment.

#### **1.4.8 Biomonitoring surveys**

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

## 2. Results

### 2.1 Water

#### 2.1.1 Inspections

The Southern Cross wellsite, adjacent land and streams were inspected 11 times during this monitoring period. Below is a copy of the comments that were noted on the day of each inspection.

#### **17 February 2014**

Site construction of the Southern Cross wellsite had begun. Some topsoil stripping of the site had taken place. Silt fencing and silt ponds had been placed about the perimeter of the drill pad in preparation of site development. Silt ponds were constructed at the base of full areas. Silt and sediment treatment on the access track was yet to be installed however no earthworks had begun on the track. It was outlined to site staff to ensure that the fill areas were free of any rubbish and debris. Also to inspect silt and sediment controls during rainfall events to ensure that they were working appropriately.

#### **27 February 2014**

Inspection was carried out during an extended period of dry weather. Earthworks were being undertaken on-site with works on both the access track and drilling pad underway. No metal had yet been imported to the site, however it was anticipated that metal would be brought onto site within the next week. The first culvert on the access track was installed earlier in the day with earthworks continuing about the ends of the piping. The rock rip-rap was to be placed about the entry and exit of the culvert before the end of the day. Following the placement of the rocks further silt treatment devices were to be placed in the general area to treat track run-off prior to entry into the receiving waters. The streams about the site were inspected visually and found to be running clean and clear. Silt and sediment controls were in place about the pad area. The sediment controls appeared to be appropriate at this stage however were to be continually assessed during periods of wet weather.

#### **7 March 2014**

Inspection found that metal had been imported and placed on the access track. The initial portion of the access track had been sealed. The final level of the pad had been obtained and it was anticipated that metal would be imported onto the pad in coming days. Final ring drains were being installed at the time of inspection and the skimmer pits had been marked out. Silt and sediment controls remained in place about the site and appeared to be adequate for the size and scope of the operation. However it was outlined that it was still important to inspect the controls prior to and during any anticipated rainfall events. The first culvert on the access track was installed with rock rip-rap in place about the entry and exit of the pipe. The rock rip-rap was considered appropriate for the size of the culvert and the water flow anticipated for this culvert. The larger culvert on the access track had been installed. Although some rock rip-rap had been put in place further rock rip-rap was required to be installed in the stream bed on the upstream side of the culvert for a distance of 3 metres. Further rock rip-rap was also required to be placed downstream of the culvert to ensure that it extended 1.5 metres past the scour hole.

### **18 March 2014**

Site inspection carried out during a period of light rain to ensure silt and sediment controls were appropriate for the nature and scale of the operation. Inspection found that site development had been completed and the exposed areas had been hydro-seeded. Ring drains were in place directing all stormwater to the skimmer pits. Skimmer pits were lined with a shut off valve in place at the exit pipe. At the time of the inspection the first pit was filling rapidly, however it had not yet flowed over into the second pit. There was limited free board in the second pit due to the position of the emergency spill way. Discussions were held with on-site staff and it was agreed to raise the swale slightly to increase the freeboard available within the pits. It was also outlined to inspect the pits when full to ensure that the pipe between the first and second pits was sitting either lower or at the same level as the discharge pipe. Silt and sediment controls were working well at the time of inspection, however stormwater appeared to be beginning to flow under the silt cloth near the first culvert on the access track. This was brought to the attention of staff on-site. Drilling of two conductors was taking place on-site. The drilling equipment was bunded to prevent any spills from entering the ring drain.

### **28 March 2014**

Inspection was carried out following a spill on-site. The Nova rig was on-site and drilling had begun. Drilling was continuing to 200m at the time of inspection. TVD was 2100 m. Water was being taken from the nearby stream under the permitted activity rule. Incident investigation report was received by Council in regards to an on-site spill. At 1300 hrs on 26/03/2014 approximately 1000 litres of hydraulic oil was spilled on-site at the wells site. The spill was a result of a hydraulic pump failure. As a result of the spill, the area was quickly bunded with a small hole dug to collect the oil. The oil was then pumped from the hole/sump into drums for removal from site. Once the majority of the spill was cleaned up an on-site crane was used to remove the container which contained the hydraulic pump system and placed into / onto a liner. A second sump was dug in this location and also lined with the impermeable liner. The container was subsequently cleaned over the liner in which all material was directed to the lined sump and then again pumped into temporary storage prior to removal from site. The clean up operation was supervised by Spill Control New Zealand. The contaminated gravel was then removed from site and disposed of at an appropriate licensed facility. At the time of inspection there was no sign of contaminants having tracked away from the spill location. A stormwater sample was taken from the skimmer pits to ensure that no contaminants had entered the ring drain / skimmer pit system. Inspection found that efforts to clean up the spill were appropriate for the size and nature of the spill. All indications were that the spill was cleaned up in an immediate, professional and thorough manner. Steps had been taken to install steel plates at the entrances of the containers, hence providing a 200mm internal bund within each of the two containers containing the hydraulic pumping equipment. Given the unforeseen nature of the event, the prompt and comprehensive response by the Company, and the lack of any environmental effects, this event was not actionable by the Council.

### **9 April 2014**

At the time of inspection the weather was overcast and a very light rain was beginning to fall. Drilling was continuing with the target depth likely to be obtained in the coming days. Casing was on-site ready to case the bottom hole should the well log provide good shows. Inspection found that the mud tanks and cuttings area were

in a clean and tidy order. A shovel and wheel barrow were stored in the general area to enable minor spills to be cleaned up quickly and efficiently. The non-hazardous chemical store was clean and tidy with all liquid material stored on an impermeable liner and bunded to prevent spills entering the ring drain system.

All liquid chemicals were stored within appropriate containers with lids on. Dry chemicals were stored within containers on-site. Skimmer pits were inspected. The second pit was empty while the first pit was full. A visual inspection found that the first skimmer pit was clean and clear. Due to dilution that would be obtained prior to discharge no samples were taken. The receiving stream was inspected and found to be clean, clear and flowing freely. Water was being taken under the permitted activity rule. Inspection of records found that the water take for April was well below the daily allowable limit of 50 m<sup>3</sup>/day. The hydro-seeding sprayed about the site and access track was beginning to take, resulting in the exposed soil beginning to stabilise. Silt and sediment controls about the wellsite remained in place and appeared to be working well. The silt and sediment controls about the access track required maintenance. It was outlined to site staff to ensure that the silt cloth was buried 200 mm below the surface, and the damaged sections were to be repaired and/or replaced.

#### **22 April 2014**

At the time of inspection the site was engaged in side-tracking the recently completed well. The site appeared clean and tidy with no signs of recent spills. On-site chemicals were stored in a lined and bunded area, as were cement tanks and equipment. The skimmer pits were at a level where a discharge would occur, however the shut off valve was found to be in the closed position. A visual inspection of the receiving waters showed no impact from recent discharges. A sample was retrieved from the second skimmer pit for analysis. Due to recent rainfall some sections of the ring drain had suffered various degrees of soil slip; until stabilisation had been achieved silt controls were advised to be installed near the entry point to the skimmer pits to minimise suspended solids from entering the system.

#### **8 May 2014**

At the time of inspection the site was engaged with maintenance. No water takes had been recently exercised. Sediment had been removed from the perimeter drain where surface water entry to skimmer pits was located. Contractors were on-site conducting water quality sampling of the skimmer system. Skimmer pits were not discharging at time of inspection. A sample was retrieved from the second skimmer pit near the outfall. A visual inspection of the receiving environment was carried out and no areas of concern were observed. Consents were compliant at the time of inspection.

#### **9 July 2014**

The wellsite had been plugged and all equipment had been removed. The site was not due to be reinstated or consents surrendered as future drilling may occur. Site was clean and tidy. A small area of the perimeter drain at the site entry required a bund wall built up to ensure surface water was directed to the skimmer pits. A sample was retrieved from the second skimmer pit, as no discharges were occurring during inspection. Visual inspection of the down stream receiving environment showed no impact from any recent discharges.

### 17 July 2014

The well had been plugged and buried sub-surface, no equipment was on-site. Skimmer pits were not discharging at the time of inspection. A sample was retrieved from the second skimmer near the outfall. Inspection of receiving waters showed no visual effects from any recent discharges.

It was outlined to site staff that the site entrance required attention to ensure surface water was directed to the skimmer pits to ensure consent compliance.

### 23 July 2014

Contractors were on-site carrying out works to the site entrance to ensure compliance with resource consent conditions, as outlined in the previous inspection. A bund was being constructed ensuring surface water was directed to the perimeter drains to flow to the skimmer pits for treatment. Skimmer pits were not discharging during the inspection. A sample was retrieved from the second skimmer pit near the outfall. Inspection of the receiving waters showed no visual impacts from any recent discharges. Consents were compliant at the time of inspection.

#### 2.1.2 Results of abstraction and discharge monitoring

During the period under review a total of six stormwater samples were obtained for analysis. Stormwater was not observed discharging from the wellsite skimmer pits during inspections. However, five samples were obtained from the second skimmer pit and one from the first skimmer pit to ensure compliance with consent conditions in anticipation of potential discharges.

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

**Table 1** Results of stormwater samples obtained from the Southern Cross wells site during the monitoring period

Date	Chloride g/m <sup>3</sup>	Hydrocarbons g/m <sup>3</sup>	pH pH	Suspended Solids g/m <sup>3</sup>	Sampling location
28 Mar 2014	7.4	<0.5	8.4	8	First skimmer pit
22 Apr 2014	9.9	0.8	7.1	42	Second skimmer pit
08 May 2014	8.8	7.5	7.0	77	Second skimmer pit
09 Jul 2014	2.0	<0.5	6.8	18	Second skimmer pit
17 Jul 2014	2.6	<0.5	6.9	8	Second skimmer pit
23 Jul 2014	2.7	<0.5	7.3	2	Second skimmer pit

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

#### 2.1.3 Results of receiving environment monitoring

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

## **2.2 Air**

### **2.2.1 Inspections**

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

### **2.2.2 Results of discharge monitoring**

Although a flare stack was deployed at the wellsite in anticipation of potential flaring, TAG Oil (NZ) Limited did not undertake gas combustion at the Southern Cross wellsite during the period under review.

Furthermore, from observations during routine inspections, no offensive or objectionable odours, smoke or dust associated with activities at the Southern Cross wellsite were observed.

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

No chemical monitoring of air quality was undertaken during the period under review of the Southern Cross wellsite as gas combustion activities were not undertaken during the period under review. In addition, operations undertaken by TAG Oil (NZ) Limited did not give rise to any concerns with regard to air quality.

### **2.2.4 Other ambient monitoring**

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

## **2.3 Land**

### **2.3.1 Inspections**

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

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

TAG Oil (NZ) Limited notified the Council of its intention to commence construction of the Southern Cross wellsite on 10 February 2014. Controls implemented during the earthworks phase of the construction of the Southern Cross wellsite did not give rise to any concerns. Silt and sediment retention methods proved successful (with minor adjustments following advice from Council staff on occasion), and no significant adverse effects were observed. From observations during site inspections, it appeared that special conditions relating to the control of discharges originating from soil disturbance for the purposes of constructing the wellsite were complied with.

### 2.3.3 Land status

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

## 2.4 Biomonitoring surveys

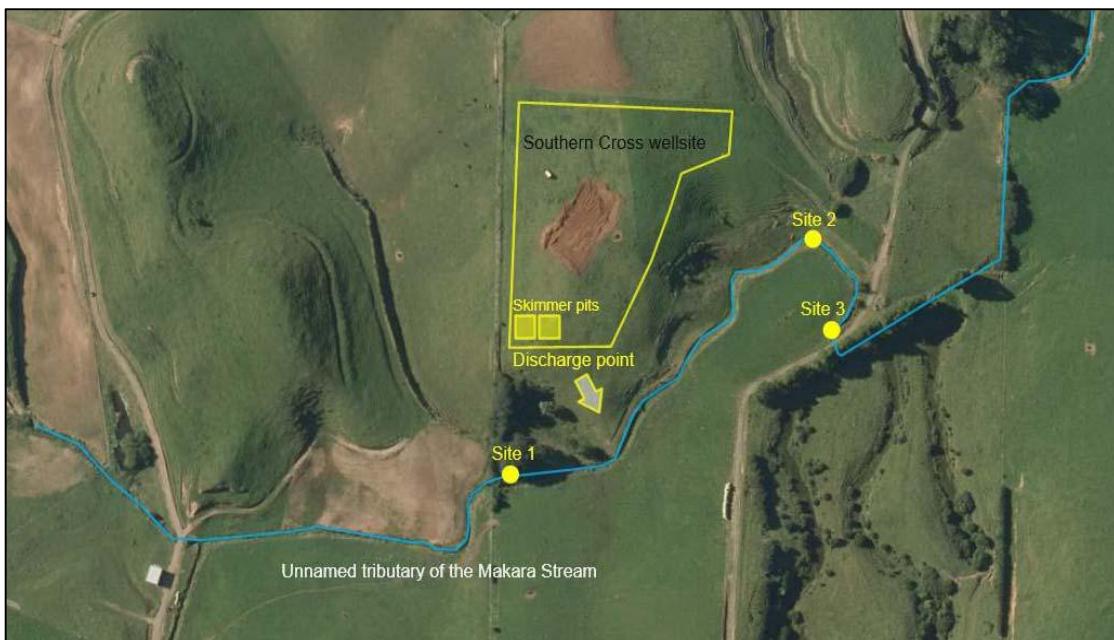
Biomonitoring surveys were performed prior to the commencement of drilling activities on 21 February 2014, and following the completion of drilling activities on 16 April 2014 at the Southern Cross wellsite to determine whether or not consented discharges into and near the unnamed tributary of the Makara Stream have had a detrimental effect upon the macroinvertebrate communities of this stream.

Both the pre and post drilling biomonitoring surveys were undertaken at three established sites; upstream of the Southern Cross wellsite discharge directly below boundary fence (site 1), 20 m downstream of the Southern Cross wellsite discharge (site 2), and 75 m downstream of the Southern Cross wellsite discharge (site 3), as seen in Figure 2.

The Councils' 'vegetation sweep' sampling technique was used at the three sites to collect streambed macroinvertebrates from the unnamed tributary of the Makara Stream. This has provided baseline data for any future assessment of consented discharge effects from the Southern Cross wellsite on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCIs scores for each site.

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

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



**Figure 2** Biomonitoring sites in an unnamed tributary of the Makara Stream in relation to the Southern Cross wellsite

### 21 February 2014

This February 2014 survey of three sites upstream and downstream of the skimmer pit discharge to land near the stream, was undertaken prior to the drilling of the Southern Cross 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 27 taxa was found through the reach of the stream surveyed, with 13 of these taxa (48%) found at all three sites and 5 taxa (19%) found at any two of these sites. Two 'sensitive' taxa were abundant at all three sites. SQMCI<sub>S</sub> scores recorded at site 1 and site 3 were significantly higher than the medians recorded from other small lowland hill country streams at similar altitudes (TRC, 1999 (updated 2014)). There were no significant differences in MCI scores between the three sites surveyed, nor were there significant differences between these MCI scores and median MCI scores for comparable streams within the region. The MCI scores indicated that the stream macroinvertebrate communities were of 'poor' to 'fair' health (TRC, 2014).

### 16 April 2014

This April 2014 survey of three sites upstream and downstream of the skimmer pit discharge to land near the stream, was undertaken following drilling at the Southern Cross wellsite but unfortunately also following stream excavation works at sites 1 and 2 undertaken by the landowner. These excavation works resulted in a significant loss of macrophyte habitat, and all three sites suffered severe sedimentation. In addition, there was a loss of shading from bankside vegetation. In places, the silt was knee deep. Of concern is that these works have caused such extensive disturbance, that they had the potential to mask any impacts associated with the recent drilling activities at the Southern Cross wellsite.

The three sites surveyed were relatively similar in macroinvertebrate community composition with moderate taxonomic richnesses (number of taxa). A total of 17 taxa

was found through the reach of the stream surveyed, with 9 of these taxa (53%) found at all three sites and 2 taxa (12%) found at any two of these sites. One 'sensitive' taxon was abundant at all three sites. SQMCIs scores recorded at site 1 and site 2 were similar to the median recorded from other small lowland hill country streams at similar altitudes (TRC, 1999 (updated 2014)), but site 3 recorded a score significantly less. In addition, all three sites recorded a reduction in SQMCIs score from that recorded in the pre-drill survey, although this reduction was only statistically significant for site 3. 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 'poor' to 'fair' health (TRC, 2014).

Overall, it appears that the drilling activities at the Southern Cross wellsite did not cause any impacts on the macroinvertebrate communities, as there was no change between the pre-drill and post-drill surveys, which could not be attributed to the stream excavation works. In addition there was no physical evidence of impacts, with no hydrocarbon odour observed during sampling, and no obvious discharge of contaminants at the discharge point.

## **2.5 Contingency plan**

TAG Oil (NZ) Limited has provided a general contingency plan, as required by Condition 4 of resource consent 9717-1 with site specific maps. The contingency plan has been reviewed and approved by officers of the Council.

## **2.6 Investigations, interventions and incidents**

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

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

In the monitoring period under review, the Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with TAG Oil (NZ) Limited's conditions in resource consents or provisions in Regional Plans.

During the monitoring period the Council received one incident investigation report from TAG Oil (NZ) Limited. On 26 March 2014 approximately 1,000 litres of hydraulic oil spilled at the Southern Cross wellsite as a result of a hydraulic pump failure. The clean up operation was supervised by Spill Control New Zealand. The area was quickly and effectively banded with a small sump dug to collect the oil, which was then pumped into drums for removal from the site. An on-site crane was

used to remove the container which housed the hydraulic pump system and placed into/onto a liner. A second sump was dug and also lined with an impermeable liner. The container was subsequently cleaned over the liner in which all material was directed to the lined sump and again pumped into temporary storage prior to removal from the site. The contaminated gravel was also removed from site and disposed of at an appropriate licensed facility. Inspection found no evidence of contaminants having tracked away from the spill location. The spill was cleaned up in an immediate, professional and thorough manner. As noted earlier, given the unforeseen nature of the event, the speed and scope of the Company's response, and the lack of environmental effects, this event was not actionable by the Council.

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 Officers were adhered to.

## **3. Discussion**

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

Of the five resource consents relating to the Southern Cross wellsite, consents 9717-1 (to discharge treated stormwater and produced water from hydrocarbon exploration and production operations at the Southern Cross wellsite, onto land where it may enter an unnamed tributary of the Makara Stream), 9718-1 (to take groundwater), and 9719-1 (to discharge stormwater and sediment, deriving from soil disturbance undertaken for the purpose of constructing the Southern Cross wellsite) were exercised and actively monitored.

The discharge of contaminants to air from hydrocarbon exploration as permitted by resource consent 9715-1, and the discharge of emissions to air associated with hydrocarbon producing wells at the Southern Cross wellsite as permitted by resource consent 9716-1 were not exercised during the period under review.

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

### **3.2 Environmental effects of exercise of consents**

#### **Stormwater**

The discharge of stormwater from earthworks has the potential for sediment and other contaminants to enter surface water where it may detrimentally affect instream flora and fauna. To mitigate these effects, 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.

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

Adverse effects on surface water quality can occur if contaminated water escapes through the stormwater system. Interceptor pits are designed to trap sediment and hydrocarbons through gravity separation. Any water that is unsuitable for release via the interceptor pits was directed to the drilling sums, 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). These procedures were exercised on one occasion, to good effect.

### **Groundwater**

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

### **Flaring**

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

The Council has previously undertaken field studies at two wells (one gas, and the other producing oil and heavier condensates); together with dispersion modelling at a third site<sup>1</sup>. More recently two studies have focused on field investigations and modelling of emissions from flares involving fracturing fluids.<sup>2</sup>

In brief, the previous studies found that measurements of carbon monoxide, carbon dioxide, and methane concentrations to be safe at all points downwind, including within 50 m of the flare pit. Measurements of suspended particulate matter found concentrations typical of background levels, and measurements of PM<sub>10</sub> found compliance with national standards even in close proximity to the flare. Beyond 120 m from the flare pit, concentrations of polycyclic aromatic hydrocarbons (PAH) approached background levels, as did levels of dioxins beyond 250 m from the flare.

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

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

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

The measures to be undertaken by TAG Oil (NZ) Limited to avoid or mitigate actual or potential adverse environmental impacts on air quality included:

- The use of a test separator to separate solids and fluids from the gas during all well clean-ups, and workover activities where necessary, thus reducing emissions to air. In particular, this would reduce the potential for heavy smoke incidents associated with elevated PAH and dioxin emissions;
- Records of flaring events are kept by TAG Oil (NZ) Limited and provided to the Council;
- Every endeavor was made by TAG Oil (NZ) Limited to minimise the total volume of gas flared while ensuring that adequate flow and pressure data was gathered to inform their investment decision; and
- Every endeavor was made by TAG Oil (NZ) Limited to minimise smoke emissions from the flare.

### **Odour and dust**

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

### **Hazardous substances**

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

TAG Oil (NZ) Limited was required to implement the following mitigation measures:

- All potentially hazardous material were used and stored in accordance with the relevant Hazardous Substances and New Organisms regulations;
- All areas containing hazardous chemicals were bunded;
- In the unlikely event of a spill escaping from bunded areas, the site perimeter drain and interceptor pit system would 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. The plan was exercised on one occasion to address a spill of hydraulic fracture fluid.

### **Summary**

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

### 3.3 Evaluation of performance

A tabular summary of TAG Oil (NZ) Limited's compliance record for the period under review is set out in Tables 2 to 6.

**Table 2** Summary of performance for consent 9715-1 to discharge contaminants to air from hydrocarbon exploration at the Southern Cross 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

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 as directed by the Regional Air Quality Plan	Inspection	N/A
3. Flaring shall only occur over a contained area consisting of impermeable material	Inspection	N/A
4. Flaring and incineration shall only occur within 20 metres of the location NZTM 1712670E – 5651420N	Inspection	N/A
5. Consent shall not be exercised for more than an accumulated duration of 15 days per zone for up to 6 wells	Inspection of records	N/A
6. Council must be notified 24hrs prior to initial flaring of each zone	Notification	N/A
7. Occupants of dwellings within 200 m of the wellsite shall be provided with notification at least 24 hrs prior to flaring, when practicable	Notification	N/A
8. No material to be flared or incinerated, other than those derived from or entrained in the well stream	Inspection of flare stack	N/A
9. All gas flared must first be treated by effective liquid and solid separation and recovery	Inspection of flare stack	N/A
10. If effective separation could not be achieved, the consent holder shall reinstate effective separation as soon as possible; if separation could not be achieved within 3 hours, combustion must cease	Inspection of flare stack and company records	N/A
11. If effective liquid and solid separation could not be achieved, the consent holder shall provide to the Council a report	Inspection of flare stack and company records	N/A
12. Best practicable option to be adopted	Inspections, procedures and processes	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
13. No offensive or objectionable odour or smoke at or beyond the boundary	Inspection	N/A
14. Control of carbon monoxide, nitrogen dioxide, sulphur dioxide and fine particles	Inspection of company records	N/A
15. Control of other emissions	Inspection of company records	N/A
16. Analysis of typical gas and condensate stream from field to be made available to the Council	Available upon request	N/A
17. All permanent tanks used as hydrocarbon storage vessels fitted with vapour recovery systems	Inspection	N/A
18. Consent holder shall make available to the Council a flaring log detailing all flaring events including time, duration, zone, volumes flared and smoke events	Inspection of Company records	N/A
19. Consent shall lapse if not implemented	Lapse date 31 December 2018	N/A
20. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of environmental performance and compliance in respect of this consent		N/A – consent not exercised
Overall assessment of administrative performance in respect of this consent		N/A – consent not exercised

**Table 3** Summary of performance for consent 9716-1 to discharge emissions to air associated with hydrocarbon producing wells at the Southern Cross wellsite

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 as directed by the Regional Air Quality Plan	Inspection	N/A
3. Flaring shall only occur over a contained area consisting of impermeable material	Inspection	N/A
4. Flaring and incineration shall only occur within 20 metres of the location NZTM 1713670E – 5651420N	Inspection	N/A
5. Council must be notified 24hrs prior to continuous flaring or incineration expected to occur for more than five minutes	Notification	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
6. Occupants of dwellings within 200 m of the wellsite shall be provided with notification at least 24 hrs prior to flaring, when practicable	Notification	N/A
7. No material to be flared or incinerated, other than those derived from or entrained in the well stream	Inspection	N/A
8. All gas flared must first be treated by effective liquid and solid separation and recovery	Inspection	N/A
9. Best practicable option to be adopted	Inspections, procedures and processes	N/A
10. No offensive or objectionable odour or smoke at or beyond the boundary	Inspection	N/A
11. All permanent tanks used as hydrocarbon storage vessels fitted with vapour recovery systems	Inspection	N/A
12. Control of carbon monoxide, nitrogen dioxide, sulphur dioxide and fine particles	Inspection of company records	N/A
13. Control of other emissions	Inspection of company records	N/A
14. Analysis of typical gas and condensate stream from field to be made available to the Council	Available upon request	N/A
15. Consent holder shall make available to the Council a flaring log detailing all flaring events including time, duration, zone, volumes flared and smoke events	Inspection of Company records	N/A
16. Consent shall lapse if not implemented	Lapse date 31 December 2018	N/A
17. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of environmental performance and compliance in respect of this consent		N/A – consent not exercised
Overall assessment of administrative performance in respect of this consent		N/A – consent not exercised

**Table 4** Summary of performance for consent 9717-1 to discharge treated stormwater and produced water from hydrocarbon exploration and production operations at the Southern Cross wellsite, onto land where it may enter an unnamed tributary of the Makara Stream

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Inspection of site, procedures & processes	Yes
2. Maximum stormwater catchment area shall be no more than 0.8 Ha	Plans, procedures and processes	Yes
3. 5 days written notice provided to the Council prior to site works and drilling	Notification received	Yes
4. Council to approve prepared contingency plan in relation to the wellsite prior to exercise of consent	Contingency plan approved	Yes
5. The stormwater system shall be designed, managed and maintained in accordance with information submitted	Comparative inspections in accordance with information submitted	Yes
6. All discharges from the site shall flow to a perimeter drain and skimmer pit	Inspection	Yes
7. Skimmer pits shall have a combined capacity of no less than 174 m <sup>3</sup> and retain hydrocarbons	Inspection and physicochemical sampling	Yes
8. All stormwater pits shall be lined with impervious material	Inspection	Yes
9. Perimeter drains and skimmer pits to be installed prior to the commencement of works at the site	Inspection	Yes
10. Constituents in discharges shall meet the following standards: <ol style="list-style-type: none"> <li>pH 6.0 – 9.0</li> <li>Suspended solids &lt;100 g/m<sup>3</sup></li> <li>Hydrocarbon &lt;15 g/m<sup>3</sup></li> <li>Chloride 50 g/m<sup>3</sup></li> </ol>	Physicochemical sampling	Yes
11. Following a mixing zone of 25 m , discharges shall not give rise to an increase in temperature of more than 2°C	Physicochemical sampling	Yes
12. Following the mixing zone, the discharge shall not give rise to adverse effects in the receiving waters	Inspection	Yes
13. The Council shall be advised in writing 48 hrs prior to reinstatement	Notification	N/A

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

**Table 5** Summary of performance for consent 9718-1 to take groundwater as 'produced water', during hydrocarbon exploration and production activities at the Southern Cross 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	Sampling adjacent bores pre/post drilling	N/A
2. The abstraction does not cause the intrusion of salt water into any freshwater aquifer	Sampling adjacent bores pre/post drilling	N/A
3. A well log to 1,000 m must be submitted to the Council	Well log to 1,000 m submitted	N/A
4. Consent shall lapse if not implemented by date specified	Consent exercised	N/A
5. Notice of Council to review consent	Notice of intention not served	N/A
Overall assessment of environmental performance and compliance in respect of this consent		N/A – consent not exercised
Overall assessment of administrative performance in respect of this consent		N/A – consent not exercised

**Table 6** Summary of performance for consent 9719-1 to discharge stormwater and sediment, deriving from soil disturbance undertaken for the purpose of constructing the Southern Cross wellsite, onto land where it may enter an unnamed tributary of the Makara Stream

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. The discharge of stormwater from land shall not exceed more than 1.9 ha	Inspections and plans	Yes
2. Consent holder to adopt best practicable option at all times	Inspections, procedures and processes	Yes
3. 7 days written notice prior to site earthworks commencing	Notification received	Yes
4. All run off from any exposed soil shall pass through settlement ponds or sediment traps or other sediment control measure of equal standard	Inspections	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
5. Condition 4 shall cease to apply, and sediment control measures removed when the area is stabilised	Inspections	Yes
6. All earth worked areas shall be stabilised as soon as practicable	Inspection	Yes
Overall assessment of environmental performance and compliance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

During the monitoring period, TAG Oil (NZ) Limited demonstrated a high level of both environmental performance and administrative compliance with the resource consents. 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 2015.

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

### 3.5 Alterations to monitoring programmes

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

The Council has routinely monitored wellsight 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 wellsight and associated activities. Furthermore, with regard to hydraulic fracturing activities, baseline groundwater monitoring samples have demonstrated that hydraulic fracturing discharges have not given rise to any significant adverse effects on groundwater aquifers within the region. However, the Council had for a time not routinely required the imposition of additional targeted physicochemical and

biological monitoring unless a site-specific precautionary approach indicated this would be warranted for certainty and clarity around site effects.

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

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

## 4. Recommendations

1. THAT this report be forwarded to the Company, and to any interested parties upon request;
2. THAT the monitoring of future consented activities at Southern Cross wellsite continue to include biomonitoring surveys;
3. THAT the monitoring of future consented activities include sampling and extensive analysis of both groundwater and surface waters in the general vicinity of the wellsite if hydraulic fracturing is to commence or additional drilling is to be undertaken at the Southern Cross wellsite;
4. THAT, subject to the findings of monitoring of any further activities at the Southern Cross wellsite consents 9715-1, 9716-1, 9717-1 and 9718-1 shall not be reviewed in 2015.

## Glossary of common terms and abbreviations

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

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

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

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

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



## **Appendix I**

### **Resource consents**



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

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

Decision Date: 23 October 2013

Commencement Date: 23 October 2013

**Conditions of Consent**

Consent Granted: To discharge stormwater and sediment, deriving from soil disturbance undertaken for the purpose of constructing the Southern Cross wellsite, onto land where it may enter an unnamed tributary of the Makara Stream

Expiry Date: 1 June 2018

Site Location: Southern Cross wellsite, Cross Road, Midhirst  
(Property owner: FC & JA Perrett)

Legal Description: Lot 2 DP 392389 (Discharge source & site)

Grid Reference (NZTM) 1713689E-5651390N

Catchment: Waitara

Tributary: Makino  
Makara

*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 1.9 ha of land where earthworks is being undertaken for the purpose of establishing the Southern Cross 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](mailto: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.*

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 23 October 2013

For and on behalf of  
Taranaki Regional Council



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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 October 2013

Commencement Date: 23 October 2013

**Conditions of Consent**

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

Expiry Date: 1 June 2033

Review Date(s): June 2021, June 2027

Site Location: Southern Cross wellsite, Cross Road, Midhirst  
(Property owner: FC & JA Perrett)

Legal Description: Lot 2 DP 392389 (Site of take & use)

Grid Reference (NZTM) 1713689E-5651390N

Catchment: Waitara

Tributary: Makino  
Makara

*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 31 December 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 2021 and/or June 2027 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 October 2013

For and on behalf of  
Taranaki Regional Council



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Director-Resource Management

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

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

Decision Date: 23 October 2013

Commencement Date: 23 October 2013

**Conditions of Consent**

Consent Granted: To discharge treated stormwater and produced water from hydrocarbon exploration and production operations at the Southern Cross wellsite, onto land where it may enter an unnamed tributary of the Makara Stream

Expiry Date: 1 June 2033

Review Date(s): June 2021, June 2027

Site Location: Southern Cross wellsite, Cross Road, Midhirst  
(Property owner: FC & JA Perrett)

Legal Description: Lot 2 DP 392389 (Discharge source & site)

Grid Reference (NZTM) 1713676E-5651279N

Catchment: Waitara

Tributary: Makino  
Makara

*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 0.8 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](mailto: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 7600.
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 174 m<sup>3</sup>, 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.

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

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](mailto:worknotification@trc.govt.nz).
14. This consent shall lapse on 31 December 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 9717-1

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 2021 and/or June 2027 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 October 2013

For and on behalf of  
Taranaki Regional Council



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Director-Resource Management

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

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

Decision Date: 23 October 2013

Commencement Date: 23 October 2013

**Conditions of Consent**

Consent Granted: To discharge emissions to air associated with hydrocarbon producing wells at the Southern Cross wellsite

Expiry Date: 1 June 2033

Review Date(s): June 2021, June 2027

Site Location: Southern Cross wellsite, Cross Road, Midhirst  
(Property owner: FC & JA Perrett)

Legal Description: Lot 2 DP 392389 (Discharge source & site)

Grid Reference (NZTM) 1713670E-5651420N

*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. 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, lined with 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 1713670E-5651420N.
5. Other than in emergencies, the consent holder shall notify the Chief Executive, Taranaki Regional Council, whenever the continuous flaring or incineration of hydrocarbons (other than purge gas) is expected to occur for more than five minutes in duration. Notification shall be no less than 24 hours before the flaring or incineration commences. Notification shall include the consent number and be emailed to [worknotification@trc.govt.nz](mailto:worknotification@trc.govt.nz).
6. At least 24 hours before any flaring or incineration, other than in emergencies, the consent holder shall provide notification to 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.
7. No material shall be flared or incinerated, other than those derived from or entrained in the well stream.
8. To the greatest extent possible, all gas that is flared or incinerated must first be treated by effective liquid and solid separation and recovery.

9. 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).
10. 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.
11. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.
12. 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.
13. The consent holder shall control all emissions of contaminants to the atmosphere from the site, other than those expressly provided for under special condition 12, 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.
14. 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.
15. 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'.
16. This consent shall lapse on 31 December 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.

17. 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 2021 and/or June 2027, for any of the following purposes:
- (a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or
  - (b) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or
  - (c) to alter, add or delete limits on mass discharge quantities or discharge or ambient concentrations of any contaminant.

Signed at Stratford on 23 October 2013

For and on behalf of  
Taranaki Regional Council



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**Director-Resource Management**

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

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

Decision Date: 23 October 2013

Commencement Date: 23 October 2013

**Conditions of Consent**

Consent Granted: To discharge contaminants to air from hydrocarbon exploration at the Southern Cross 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 2033

Review Date(s): June 2021 and/or June 2027 and in accordance with special condition 20

Site Location: Southern Cross wellsite, Cross Road, Midhirst  
(Property owner: FC & JA Perrett)

Legal Description: Lot 2 DP 392389 (Discharge source & site)

Grid Reference (NZTM) 1713670E-5651420N

*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. 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 1712670E-5651420N.
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 4 zones per well and 6 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](mailto: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 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.
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.
17. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.

Consent 9715-1

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 31 December 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 2021 and/or June 2027; 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 23 October 2013

For and on behalf of  
Taranaki Regional Council



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M. McLean  
Director-Resource Management

## **Appendix II**

### **Biomonitoring surveys**



To Job Manager; Callum MacKenzie  
From Scientific Officer, Bart Jansma  
Report No BJ230  
Document 1354863  
Date 29 May 2014

## **Biomonitoring of an unnamed tributary of the Makara Stream following drilling by Cheal Petroleum Ltd at Southern Cross wellsite, April 2014**

### **Introduction**

This biological survey was performed following drilling of the Southern Cross well, to determine whether or not treated stormwater and treated produced water discharges onto land in the vicinity of the Makara 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**

Southern Cross wellsite stormwater and site production water has been consented for discharge on to land near the unnamed tributary of the Makara Stream (Figure 1). This post-drill survey was undertaken on 16 April 2014 at three newly established sites; upstream of the Southern Cross wellsite discharge (directly below the boundary fence) (site 1), 20 m downstream of the Southern Cross wellsite discharge (site 2) and 75 m downstream of the Southern Cross wellsite discharge (site 3) (Table 1)(Figure 1).

The Council's standard 'vegetation sweep' sampling technique was used at all three sites to collect streambed macroinvertebrates from the unnamed tributary of the Makara Stream upstream and downstream of the proposed discharges from the Southern Cross wellsite. The 'vegetation sweep' sampling technique is very similar to Protocol C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Table 1: Biomonitoring sites and sampling methods used in the unnamed tributary of the Makara Stream related to the Southern Cross wellsite.

Site no.	Site code	Grid reference (NZTM)	Location	Sampling method	Altitude m asl
1	MKA000080	1713652E-5651229N	U/s of Southern Cross wellsite discharge directly below boundary fence	Vegetation sweep	280
2	MKA000081	1713811E-5651353N	20m d/s of Southern Cross wellsite discharge	Vegetation sweep	280
3	MKA000083	1713821E-5651307N	75m d/s of Southern Cross wellsite discharge	Vegetation sweep	280



Figure 1 Biomonitoring sites in the unnamed tributary of the Makara Stream in relation to the Southern Cross wells.

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 ( $\text{SQMCI}_s$ ) 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  $\text{SQMCI}_s$  is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower.

## Results and discussion

At the time of this early morning survey, water temperatures in the unnamed tributary of the Makara Stream ranged from 11.2°C to 11.3°C. A moderate flow of uncoloured, clear water was present at all three sites. Substrate comprised of silt, sand and a minor amount of fine gravel at all sites. Macrophytes were recorded growing on the edges of the stream at sites 1 and 2, while they were also present on the bed at site 3.

Of note was that the stream at sites 1 and 2 had been excavated since the pre-drill survey, with the vast majority of instream habitat excavated and placed on the banks. As a result, there was a significant loss of macrophyte habitat, and all three sites suffered severe sedimentation. In addition, there was a loss of shading from bankside vegetation. In places, the silt was knee deep. The impacts of these works can be seen in photos 1 & 2. Of concern is that these works have caused such disturbance, that if there had been impacts from the drilling activities at the Southern Cross wellsite, the evidence would be severely compromised.



**Photo 1** The habitat present in the unnamed tributary during the pre-drill survey, note the abundant aquatic plant growth and bank side vegetation.



**Photo 2** The habitat present in the unnamed tributary during the post-drill survey, note the lack of aquatic plant growth and bank side vegetation.

## Macroinvertebrate communities

Table 2 summarises the results of the macroinvertebrate surveys performed prior to and following drilling of the Southern Cross 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 SQMCIs in the unnamed tributary of the Makara Stream, prior to and following drilling of Southern Cross wellsite.

Site No.	No of taxa		MCI value		SQMCIs value	
	Pre-drill	Post-drill	Pre-drill	Post-drill	Pre-drill	Post-drill
1	16	13	83	80	5.0	4.3
2	20	12	83	78	4.8	4.4
3	22	12	75	83	5.1	3.0

Table 3: Range and median number of taxa, MCI values and SQMCIs scores for smaller (lowland) hill country streams at altitudes 200-299 m asl ((TRC, 1999 (updated 2014))).

	No. of taxa	MCI value	SQMCIs value
No. Samples	178	178	178
Range	5-33	52-108	1.5-6.5
Median	18	79	4.1

Table 4 Macroinvertebrate fauna of the unnamed tributary of the Makara Stream in relation to the Southern Cross post-drill survey sampled 16 April 2014.

Taxa List	Site Number Site Code Sample Number	1	2	3
		MKA000080	MKA000081	MKA000083
		FWB14211	FWB14212	FWB14213
NEMERTEA	Nemertea	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	A	A
MOLLUSCA	Lymnaeidae	3	-	R
	<i>Potamopyrgus</i>	4	R	VA
CRUSTACEA	Copepoda	5	-	-
	Ostracoda	1	C	C
	<i>Paracalliope</i>	5	VA	VA
	<i>Paranephrops</i>	5	R	R
EPHEMEROPTERA (MAYFLIES)	<i>Zephlebia</i> group	7	C	A
ODONATA (DRAGONFLIES)	<i>Xanthocnemis</i>	4	C	C
HEMIPTERA (BUGS)	<i>Sigara</i>	3	R	-
TRICHOPTERA (CADDISFLIES)	<i>Polyplectropus</i>	6	C	C
	<i>Psilochorema</i>	6	-	-
DIPTERA (TRUE FLIES)	<i>Polypedilum</i>	3	-	R
	Tanypodinae	5	R	C
	<i>Austrosimulium</i>	3	C	R
ACARINA (MITES)	Acarina	5	R	-
No of taxa		13	12	12
MCI		80	78	83
SQMCIs		4.3	4.4	3.0
EPT (taxa)		2	2	3
%EPT (taxa)		15	17	25
'Tolerant' taxa		'Moderately sensitive' taxa		
		'Highly sensitive' taxa		

R = Rare

C = Common

A = Abundant

VA = Very Abundant

XA = Extremely Abundant

### **Site 1- Upstream of Southern Cross wellsite discharge, directly below boundary fence**

A moderately low community richness of thirteen taxa was found at site 1, five taxa less than the median richness found at similar sites elsewhere in the region (Table 2 and Table 3). The macroinvertebrate community comprised similar proportions of ‘sensitive’ and ‘tolerant’ taxa which was reflected in the MCI score of 80 units. This MCI score was an insignificant 1 unit greater than the median MCI score for ‘control’ sites in similar streams at comparative altitudes, and three units less than that recorded in the pre-drill survey (Table 2, Table 3).

During the pre-drill survey, the community at this site was characterised by two ‘sensitive’ taxa, amphipod (*Paracalliope*), and caddisfly (*Polyplectropus*). *Paracalliope* were also recorded in abundance during the post-drill survey, as were ‘tolerant’ oligochaete worms.

The numerical dominance of the ‘sensitive’ amphipod resulted in a SQMCI<sub>S</sub> score of 4.3 units which was similar to the median score for ‘control’ sites in similar streams at a similar altitude (Table 3), but 0.7 unit less than that recorded in the pre-drill survey (Table 2).

### **Site 2- 20 m downstream of Southern Cross wellsite discharge**

A moderately low community richness of twelve taxa was found at site 2 (Table 2 and Table 4), one taxon less than what was found at site 1 and eight taxa less than that recorded in the pre-drill survey (Table 2). As with site 1, the macroinvertebrate community comprised similar proportions of ‘sensitive’ taxa and ‘tolerant’ taxa which was reflected in the MCI score of 78 units. This was similar to that recorded at site 1 and the median MCI score for ‘control’ sites in similar streams at comparative altitudes (Table 3), and only five units less than that recorded in the pre-drill survey (Table 2).

The community at this site was characterised by two ‘sensitive’ taxa (amphipod (*Paracalliope*) and mayfly (*Zephlebia group*)), and two ‘tolerant’ taxa (oligochaete worms and snail (*Potamopyrgus*)). This constitutes a reduced abundance of two ‘sensitive’ taxa and one ‘tolerant’ taxon from that recorded in the previous survey, and is a direct reflection of the loss of macrophyte habitat caused by the stream bed excavation.

The shared numerical dominance of ‘sensitive’ and ‘tolerant’ taxa resulted in a SQMCI<sub>S</sub> score of 4.4 units, which was an insignificant 0.1 unit higher than the SQMCI<sub>S</sub> score recorded at site 1 and an insignificant 0.3 unit higher than the median score for ‘control’ sites in similar streams at this altitude (Table 3). It also constituted little change from that recorded in the previous survey (Table 2).

### **Site 3- 75 m downstream of Southern Cross wellsite discharge**

A moderately low community richness of twelve taxa was also found at site 3 (Table 2 and Table 4), similar to what was recorded at the upstream control site and six taxa fewer than the median richness found at similar sites elsewhere in the region (Table 3). However, this richness was ten taxa fewer than that recorded in the pre-drill survey, reflecting loss caused by the excavation of the stream bed upstream, and the resultant release of sediment. The macroinvertebrate community comprised an equal proportion of ‘tolerant’ and ‘sensitive’ taxa which was reflected in the MCI score of 83 units, slightly higher than what was recorded at the two upstream sites and the median MCI score for ‘control’ sites in similar streams at comparative altitudes (Stark, 1998) (Table 3). This result is also eight units higher than that recorded in the previous survey (Table 2).

The community at this site was characterised by one ‘sensitive’ taxon (amphipod (*Paracalliope*)), and two ‘tolerant’ taxa (oligochaete worms and ostracod seed shrimps). Similar to that recorded at sites 1 and 2, this is a reduction in the number of taxa recorded in abundance.

A numerical dominance of ‘tolerant’ taxa resulted in the SQMCI<sub>S</sub> score of 3.0 units which was significantly less than what was recorded at site 1 and site 2, and also that recorded at this site in the previous survey (Table 2). It is also 1.1 units less than the median score for ‘control’ sites in similar streams elsewhere in the region (Stark, 1998) (Table 3).

## Summary and Conclusions

The Councils ‘vegetation sweep’ sampling technique was used at three sites to collect streambed macroinvertebrates from the unnamed tributary of the Makara Stream, to assess whether discharges from the Southern Cross 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<sub>S</sub> scores for each site.

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

This April 2014 survey of three sites upstream and downstream of the skimmer pit discharge to land near the stream, was undertaken following drilling at the Southern Cross wellsite but unfortunately also following stream excavation works at sites 1 and 2 undertaken by the landowner. These excavation works resulted in a significant loss of macrophyte habitat, and all three sites suffered severe sedimentation. In addition, there was a loss of shading from bankside vegetation. In places, the silt was knee deep. Of concern is that these works have caused such extensive disturbance, that they had the potential to mask any impacts associated with the recent drilling activities at the Southern Cross wellsite.

The three sites surveyed were relatively similar in macroinvertebrate community composition with moderate taxonomic richnesses (number of taxa). A total of 17 taxa was found through the reach of the stream surveyed, with 9 of these taxa (53%) found at all three sites and 2 taxa (12%) found at any two of these sites. One ‘sensitive’ taxon was abundant at all three sites. SQMCI<sub>S</sub> scores recorded at site 1 and site 2 were similar to the median recorded from other small lowland hill country streams at similar altitudes (TRC, 1999 (updated 2014)), but site 3 recorded a score significantly less. In addition, all three sites recorded a reduction in SQMCI<sub>S</sub> score from that recorded in the pre-drill survey, although this reduction was only statistically significant for site 3. 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 ‘poor’ to ‘fair’ health (TRC, 2014).

Overall, it appears that the drilling activities at the Southern Cross wellsite did not cause any impacts on the macroinvertebrate communities, as there was no change between the pre-drill and post-drill surveys, which could not be attributed to the stream excavation works. In addition there was no physical evidence of impacts, with no hydrocarbon odour observed during sampling, and no obvious discharge of contaminants at the discharge point.

## References

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- 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, BR, 2013: Biomonitoring of an unnamed tributary of the Makara Stream prior to drilling by Cheal Petroleum Ltd at Southern Cross wellsite, February 2014. Report No. BT014.
- 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 May 2014). 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 BT014  
Document 1352717  
Date 27 May 2014

## **Biomonitoring of an unnamed tributary of the Makara Stream prior to drilling by Cheal Petroleum Ltd at Southern Cross wellsite, February 2014**

### **Introduction**

This biological survey was performed prior to drilling of the Southern Cross well, but after site preparation earthworks to provide baseline data on the macroinvertebrate community of the unnamed tributary of the Makara 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 unnamed tributary of the Makara Stream have had a detrimental effect upon the macroinvertebrate communities of this stream.

### **Methods**

Southern Cross wellsite stormwater and site production water has been consented for discharge on to land near the unnamed tributary of the Makara Stream (Figure 1). This pre-drill survey was undertaken on 21 February 2014 at three newly established sites; upstream of the Southern Cross wellsite discharge (directly below the boundary fence) (site 1), 20 m downstream of the Southern Cross wellsite discharge (site 2) and 75 m downstream of the Southern Cross wellsite discharge (site 3) (Table 1)(Figure 1).

The Council's standard 'vegetation sweep' sampling technique was used at all three sites to collect streambed macroinvertebrates from the unnamed tributary of the Makara Stream upstream and downstream of the proposed discharges from the Southern Cross wellsite. The 'vegetation sweep' sampling technique is very similar to Protocol C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Table 1: Biomonitoring sites and sampling methods used in the unnamed tributary of the Makara Stream related to the Southern Cross wellsite.

Site no.	Site code	Grid reference (NZTM)	Location	Sampling method	Altitude m asl
1	MKA000080	1713652E-5651229N	U/s of Southern Cross wellsite discharge directly below boundary fence	Vegetation sweep	280
2	MKA000081	1713811E-5651353N	20m d/s of Southern Cross wellsite discharge	Vegetation sweep	280
3	MKA000083	1713821E-5651307N	75m d/s of Southern Cross wellsite discharge	Vegetation sweep	280



Figure 1 Biomonitoring sites in the unnamed tributary of the Makara Stream in relation to the Southern Cross wells site.

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 mid morning survey, water temperatures in the unnamed tributary of the Makara Stream ranged from 17.1°C to 17.4°C. A low flow of uncoloured, cloudy water was present at all three sites. Substrate comprised of silt at all sites, although wood and roots were also present at site 1. Macrophytes were recorded growing on the edges of the stream and on the streambed at all three sites. No periphyton was visible at any of the sites. 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 Southern Cross 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<sub>S</sub> in the unnamed tributary of the Makara Stream, sampled on 21 February 2014 prior to drilling of Southern Cross wellsite.

Site No.	No taxa	MCI value	SQMCI <sub>S</sub> value
1	16	83	5.0
2	20	83	4.8
3	22	75	5.1

Table 3: Range and median number of taxa, MCI values and SQMCI<sub>S</sub> scores for smaller (lowland) hill country streams at altitudes 200-299 m asl ((TRC, 1999 (updated 2014)).

	No. of taxa	MCI value	SQMCI <sub>S</sub> value
No. Samples	178	178	178
Range	5-33	52-108	1.5-6.5
Median	18	79	4.1

Table 4: Macroinvertebrate fauna of the unnamed tributary of the Makara Stream in relation to the Southern Cross pre-drill survey sampled 21 February 2014.

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3
	Site Code		MKA000080	MKA000081	MKA000083
	Sample Number		FWB14141	FWB14142	FWB14143
PLATYHELMINTHES (FLATWORMS)	<i>Cura</i>	3	-	R	R
NEMERTEA	Nemertea	3	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	R	C	C
MOLLUSCA	<i>Potamopyrgus</i>	4	-	VA	A
CRUSTACEA	Ostracoda	1	-	-	R
	<i>Paracalliope</i>	5	VA	XA	XA
	<i>Paranephrops</i>	5	R	-	-
EPHEMEROPTERA (MAYFLIES)	<i>Zephlebia group</i>	7	C	A	A
ODONATA (DRAGONFLIES)	<i>Xanthocnemis</i>	4	C	A	C
	<i>Antipodochlora</i>	5	-	R	-
HEMIPTERA (BUGS)	<i>Microvelia</i>	3	R	R	C
	<i>Saldula</i>	5	-	R	-
COLEOPTERA (BEETLES)	Dytiscidae	5	R	R	R
TRICHOPTERA (CADDISFLIES)	<i>Polyplectropus</i>	6	A	A	VA
	<i>Psilochorema</i>	6	-	R	R
	Oeconesidae	5	-	-	R
	<i>Oxyethira</i>	2	R	R	R
	<i>Triplectides</i>	5	R	R	-
DIPTERA (TRUE FLIES)	<i>Paralimnophila</i>	6	R	-	R
	Orthocladiinae	2	R	R	R
	<i>Polypedilum</i>	3	C	R	R
	Tanypodinae	5	R	A	C
	<i>Paradixa</i>	4	C	C	A
	Empididae	3	R	C	R
	Psychodidae	1	-	-	R
	<i>Austrosimilium</i>	3	-	-	R
ACARINA (MITES)	Acarina	5	-	R	-
No of taxa			16	20	22
MCI			83	83	75
SQMCIs			5.0	4.8	5.1
EPT (taxa)			3	4	4
%EPT (taxa)			19	20	18
'Tolerant' taxa		'Moderately sensitive' taxa		'Highly sensitive' taxa	

R = Rare

C = Common

A = Abundant

VA = Very Abundant

XA = Extremely Abundant

### **Site 1- Upstream of Southern Cross wellsite discharge, directly below boundary fence**

A moderate community richness of sixteen taxa was found at site 1, two taxa less than the median richness found at similar sites elsewhere in the region (Table 2 and Table 3). The macroinvertebrate community comprised equal proportions of 'sensitive' and 'tolerant' taxa which was reflected in the MCI score of 83 units. This MCI score was an insignificant 4 units greater than the median MCI score for 'control' sites in similar streams at comparative altitudes (Stark, 1998) (Table 3).

The community at this site was characterised by two 'sensitive' taxa, amphipod (*Paracalliope*), and caddisfly (*Polyplectropus*).

The numerical dominance of two 'sensitive' taxa resulted in a SQMCI<sub>S</sub> score of 5.0 units which was significantly higher (0.9 unit) than the median score for 'control' sites in similar streams at a similar altitude (Stark, 1998) (Table 3).

### **Site 2- 20 m downstream of Southern Cross wellsite discharge**

A moderate community richness of twenty taxa was found at site 2 (Table 2 and Table 4), four taxa more 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 comprised equal proportions of 'sensitive' taxa and 'tolerant' taxa which was reflected in the MCI score of 83 units. This was equal to that recorded at site 1 and an insignificant 4 units greater 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 four 'sensitive' taxa (amphipod (*Paracalliope*), mayfly (*Zephlebia group*), caddisfly (*Polyplectropus*) and true fly larvae (Tanypodinae)), and two 'tolerant' taxa (damselfly larvae (*Xanthocnemis*) and snail (*Potamopyrgus*)).

The numerical dominance of 'sensitive' taxa resulted in a SQMCI<sub>S</sub> score of 4.8 units, which was an insignificant 0.2 unit less than the SQMCI<sub>S</sub> score recorded at site 1 and an insignificant 0.7 unit greater than the median score for 'control' sites in similar streams at this altitude (Table 3).

### **Site 3- 75 m downstream of Southern Cross wellsite discharge**

A moderate community richness of twenty two taxa was found at site 3 (Table 2 and Table 4), six taxa more than what was recorded at the upstream control site and four taxa more than the median richness found at similar sites elsewhere in the region (Table 3). The macroinvertebrate community comprised a significant proportion of 'tolerant' taxa (64%), which was reflected in the MCI score of 75 units, 8 units less than what was recorded at the two upstream sites and an insignificant four 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 three 'sensitive' taxa (amphipod (*Paracalliope*), mayfly (*Zephlebia group*), and caddisfly (*Polyplectropus*)), and two 'tolerant' taxa (snail (*Potamopyrgus*) and true fly larvae (*Paradixa*)).

A numerical dominance of 'sensitive' taxa resulted in the SQMCI<sub>S</sub> score of 5.1 units which was insignificantly greater (by 0.1 unit) than what was recorded at site 1 but significantly greater

(by 1 unit), than the median score for ‘control’ sites in similar streams elsewhere in the region (Stark, 1998) (Table 3).

## Summary and Conclusions

The Councils ‘vegetation sweep’ sampling technique was used at three sites to collect streambed macroinvertebrates from the unnamed tributary of the Makara Stream. This has provided baseline data for any future assessment of consented discharge effects from the Southern Cross wellsite on the macroinvertebrate communities of this stream. Samples were processed to provide number of taxa (richness), MCI, and SQMCIs scores for each site.

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

This February 2014 survey of three sites upstream and downstream of the skimmer pit discharge to land near the stream, was undertaken prior to the drilling of the Southern Cross 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 27 taxa was found through the reach of the stream surveyed, with 13 of these taxa (48%) found at all three sites and 5 taxa (19%) found at any two of these sites. Two ‘sensitive’ taxa were abundant at all three sites. SQMCIs scores recorded at site 1 and site 3 were significantly higher than the medians recorded from other small lowland hill country streams at similar altitudes (TRC, 1999 (updated 2014)). There were no significant differences in MCI scores between the three sites surveyed, nor were there significant differences between these MCI scores and median MCI scores for comparable streams within the region. The MCI scores indicated that the stream macroinvertebrate communities were of ‘poor’ to ‘fair’ health (TRC, 2014).

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

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