

Cheal Petroleum Limited
Deep Well Injection
Monitoring Programme
Annual Report
2014-2015

Technical Report 2015-19

ISSN: 1178-1467 (Online)
Document: 1546589 (Word)
Document: 1549648 (Pdf)

Taranaki Regional Council
Private Bag 713
STRATFORD
September 2015

Executive summary

The following Annual Report by the Taranaki Regional Council (the Council) encompasses the monitoring period 1 July 2014 – 30 June 2015. The report provides details of the deep well injection (DWI) consents held by Cheal Petroleum Limited (the Company) during the period under review. The report also outlines the Company's DWI activities during this period, discusses the monitoring programme implemented by the Council and its results, and also provides an assessment of Company performance with regard to consent compliance.

During the period under review, the Company held two resource consents for the injection of fluids by DWI at their Cheal-A wellsite, Mountain Road, Ngaere. Consent 4728-2 permits the discharge of saline groundwater from the Mateamateonga Formation into the Mount Messenger Formation. Consent 9545-1 permits the discharge of produced water from hydrocarbon exploration and production operations into the Urenui Formation. The consents include a number of special conditions which set out specific requirements with which the Company must comply.

During the monitoring period, Cheal Petroleum Limited demonstrated an overall high level of environmental performance.

During the period under review, the Council carried out two routine DWI inspection visits. Inspection visits included liaising with on-site staff, identification of the active injection well(s), viewing of the injection well monitoring equipment and injection logs, and the spot sampling of the injectate. In addition to the DWI inspection visits, the Cheal-A wellsite was visited by Council staff on six separate occasions in the 2014-2015 monitoring period for inspections relating to other consents held by the Company for various activities at the site.

As required by the special conditions of the DWI consents held by the Company, process monitoring data and injection records were supplied to the Council during the 2014-2015 monitoring period. In total 17,630 cubic metres of fluids were discharged under consent 9545-1. Consent 4728-2 was not exercised during the 2014-2015 monitoring period. An assessment of process data provided by the consent holder and data gathered during Council inspections do not indicate any potential issues with the integrity of the injection well or the injection zone.

Groundwater monitoring carried out by the Council in the vicinity of the Cheal-A wellsite does not indicate any contamination of shallow aquifers as a result of injection activities, further supporting the conclusion that the injection wells and injection zone remain secure.

The information gathered during inspection visits and the data supplied by the consent holder have been used in compiling this report.

The Council did not receive any complaints or register any unauthorised incidents associated with any of the Company's DWI activities during the 2014-2015 monitoring period.

During the year, the Company demonstrated a high level of environmental and administrative performance with the resource consents.

For reference, in the 2014-2015 year, 75% 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 22% demonstrated a good level of environmental performance and compliance with their consents.

This report includes recommendations for the 2015-2016 year.

Table of contents

| | Page |
|--|-------------|
| 1. Introduction | 1 |
| 1.1 Compliance monitoring programme reports and the Resource Management Act 1991 | 1 |
| 1.1.1 Introduction | 1 |
| 1.1.2 Structure of this report | 1 |
| 1.1.3 The Resource Management Act 1991 and monitoring | 1 |
| 1.1.4 Evaluation of environmental and administrative performance | 2 |
| 1.2 Process description | 4 |
| 1.2.1 Background | 4 |
| 1.2.2 Deep Well Injection (DWI) | 4 |
| 1.3 Potential environmental effects of exercising a DWI consent | 7 |
| 1.4 Resource consents | 8 |
| 1.5 Monitoring programme | 11 |
| 1.5.1 Introduction | 11 |
| 1.5.2 Programme liaison and management | 11 |
| 1.5.3 Site inspections | 11 |
| 1.5.4 Assessment of data submitted by consent holder | 12 |
| 1.5.5 Groundwater Quality Monitoring | 13 |
| 2. Results | 14 |
| 2.1 Site inspections and injectate sampling | 14 |
| 2.2 Assessment of data provided by the consent holder | 14 |
| 2.3 Groundwater Quality Monitoring | 18 |
| 2.4 Investigations, interventions, and incidents | 18 |
| 3. Discussion | 20 |
| 3.1 Evaluation of performance | 21 |
| 3.2 Recommendations from the 2014-2015 Annual Report | 22 |
| 3.3 Alterations to monitoring programmes for 2015-2016 | 23 |
| 3.4 Exercise of optional review of consent | 23 |
| 4. Recommendations | 24 |
| Glossary of common terms and abbreviations | 25 |
| Bibliography and references | 27 |
| Appendix I DWI consents exercised in 2014-2015 period | |

List of tables

| | | |
|----------------|---|----|
| Table 1 | Summary of DWI consents held by the Company during the 2014-2015 period | 8 |
| Table 2 | Location of injectate sampling sites | 12 |
| Table 3 | Location of groundwater sampling sites | 13 |
| Table 4 | Results of injectate sampling undertaken by the Council (2014-2015) | 14 |
| Table 5 | Summary of DWI activities during the period under review (2014-2015) | 14 |
| Table 6 | Summary of the Company's 2014-2015 injection data | 15 |
| Table 7 | Range of contaminants in injectate sampled in 2014-2015 | 16 |
| Table 8 | Results of groundwater sampling undertaken by the Council (2014-2015) | 18 |

List of figures

| | | |
|-----------------|---|----|
| Figure 1 | DWI schematic representative of Taranaki sites | 7 |
| Figure 2 | Aerial view of Cheal-A wellsite, Mountain Road, Ngaere | 10 |
| Figure 3 | 2014-2015 fluid injection volumes – consent 9545-1 | 15 |
| Figure 4 | 2014-2015 daily injection volumes and pressure – consent 9545-1 | 16 |
| Figure 5 | 2010-2015 daily injection volumes and pressure – consent 9545-1 | 17 |
| Figure 6 | 2010-2015 annual injection volumes | 17 |

1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

The following Annual Report covers the monitoring period 1 July 2014–30 June 2015. During the period under review, Cheal Petroleum Limited (the Company) held two resource consents for the disposal of wastes by deep well injection (DWI) at their Cheal-A wellsite, Mountain Road, Ngaere. The resource consents held by the Company permit the discharge of produced water and saline groundwater into the Urenui and Mount Messenger Formations, respectively. The consents include a number of special conditions, setting out specific requirements with which the Company must comply.

The following report provides details of the DWI consents held by the Company during the period under review, and outlines their DWI activities during this period. The report also outlines the compliance monitoring programme implemented by the Taranaki Regional Council (the Council) with regard to these activities, discusses its results, and provides an assessment of the Company's performance with regard to consent compliance. The report concludes with recommendations regarding the future monitoring of the Company's DWI activities.

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 consents held by the Company in the Patea catchment, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted in the Company's site/catchment.

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

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

Section 4 presents recommendations to be implemented in the 2015-2016 monitoring year.

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 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 an activity, and may include cultural and social-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 (for example 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 Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each activity. 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 RMA, the Council undertakes compliance monitoring for consents and rules in regional plans, and maintains an overview of the performance of resource users and consent holders. Compliance monitoring, including both activity and impact monitoring, enables the Council to continually re-evaluate its approach and that of consent holders to resource management and, ultimately, through the refinement of methods and considered responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and administrative 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 (that is 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 performance

- **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 2014-2015 year, 75% 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 22% demonstrated a good level of environmental performance and compliance with their consents.

1.2 Process description

1.2.1 Background

The Taranaki Basin occupies an area of approximately 100,000 square kilometres and is the most explored and commercially successful hydrocarbon producing area in New Zealand. Oil and gas exploration and development has been on-going in the region for nearly 150 years. Since the first well in 1865, over 600 exploration and production wells have been drilled. While the majority of the basin is offshore, the majority of the producing wells are onshore. The geology of the basin is derived from diverse episodes of tectonic activity. The Cretaceous to Quaternary basin fill is up to 9,000 m thick in places.

The modern era of exploration began in New Zealand in 1955 when a Shell-BP-Todd consortium explored a large part of the Taranaki region. The groups first well (Kapuni-1), discovered gas-condensate in Late Eocene Kapuni Group strata, and marked the beginning of New Zealand's natural gas industry. The Kapuni Field commenced commercial production in 1970. The next major discovery was the off-shore Maui field in 1969, which was in full production by 1979. Maui is New Zealand's largest hydrocarbon field to date. Many smaller fields were discovered between 1979 and 1999, including the McKee, Mangahewa, Ngatoro, Kaimiro and Rimu fields. More recent discoveries include the Pohokura gas field in 2001.

Overall, the Taranaki Basin remains relatively under-explored compared to many comparable rift complex basins of its size and potential.

1.2.2 Deep Well Injection (DWI)

DWI is often utilised as liquid waste disposal technology and provides an alternative to the surface disposal of such material. The DWI process utilises specially designed injection wells to pump liquid waste into deep geological formations, hydrocarbon reservoirs or confined saline aquifers. The receiving formations generally contain water that is too saline to be of any potential use. Impermeable geological seals overlying the injection intervals restrict any potential vertical migration of injected wastes into shallow freshwater aquifers.

A typical injection well consists of concentric casing, cemented into the surrounding rock, which extend into permeable saline formations, at depths far below the base of potentially useable freshwater aquifers. Waste is then injected into the receiving formation by pressure generated by surface pumps. International standards (adopted in the Taranaki Region) for the construction of disposal wells emphasise the

importance of surface casing extending to depths below the base of the freshwater zones and that it is cemented back to surface. The standards also highlight the requirement for internal casing strings to be cemented back up the hole to seal off and isolate the disposal interval from the overlying freshwater zones, providing a multi-barrier approach to the protection of freshwater resources. As part of the resource consent application procedure for DWI activities, applicants are required to submit information that details both the design and construction specifications of the injection well(s) and illustrates well integrity and the isolation of the well bore from surrounding formations.

In Taranaki, contaminants disposed of by DWI are generally limited to produced water, saline groundwater, contaminated stormwater, waste drilling fluids, hydraulic fracturing fluids, and production sludges. The Council has approved, on specific occasions, the discharge of small volumes of other specified contaminants by DWI. Any application to discharge waste material not specifically licenced by the relevant resource consent is assessed by the Council on a case by case basis. The Council will assess the composition of the waste for consistency with those specifically approved for disposal. In some cases, a new consent may be required.

Produced water makes up the greatest volume of waste fluids generated by oil and gas exploration and production activities. Produced water is water that is present in a hydrocarbon bearing reservoir, brought to the surface as crude oil or natural gas is extracted from it. The composition of this produced fluid is dependent on whether crude oil or natural gas is being produced and generally includes a mixture of either liquid or gaseous hydrocarbons, formation water, dissolved or suspended solids, produced solids such as sand or silt, and injected fluids and additives that may have been placed in the formation as a result of exploration, hydraulic fracturing, and/or production activities. Produced waters may contain, in addition to salts, hydrocarbon residues and free oil, and traces of process additives including anti-scaling agents, anti-corrosion agents and biocides. Proportionally, higher quantities of water are produced from a hydrocarbon field as more oil or gas is extracted and the productive life of the field diminishes. The volume of produced water requiring disposal is therefore expected to increase as many producing fields approach the end of their lives, and as more fields are discovered and developed.

Produced water and drilling fluid wastes are typically highly saline and contain hydrocarbon residues and system additives. Without treatment to an acceptable standard, the surface disposal of large volumes of produced water is not a suitable disposal option, particularly where the discharge can enter surface or groundwater systems. The salts and other contaminants contained within the discharge can adversely affect soil or freshwater biological systems and the quality of water resources used for supply purposes. Although there are methods to treat produced waters to a suitable standard for surface disposal, such as gas/steam stripping, biological and chemical adsorption, and activated carbon, they are generally not practical or economically viable. The injection of produced waters into deep geological formations by DWI is presently the most cost-effective option for the disposal of this type of waste, and more importantly, is an environmentally sound disposal option.

Produced waters have been disposed of by DWI in Taranaki since the development of the Kapuni Field in 1970. The collection, handling, treatment and disposal of produced water from a producing field are major undertakings and, if not appropriately

managed, can have lasting adverse environmental effects. However, under appropriate geological and operational conditions, the disposal of produced waters by DWI should have no more than negligible environmental effects.

The injection of fluids into hydrocarbon bearing reservoirs is also an established oilfield technique for regulating reservoir pressure and/or as a means of enhancing the rate of oil recovery from a reservoir. This process is often referred to as water flooding. Water flooding is a secondary recovery process that is often implemented when natural reservoir pressures decline due to the removal of reservoir fluids during production. The injection of produced fluids back into the reservoir can increase reservoir pressure and stimulate production by driving reserves toward a production well. In certain cases, injected water is heated and injected through a well annulus to reduce oil viscosity, improving oil deliverability through the wellbore. Typically, either produced waters or freshwater, or a combination of the two, are used for water flooding.

Regional councils are responsible for monitoring environmental effects from hydrocarbon exploration and development activities under the RMA. Sections 15 and 30 of the RMA give regional councils the responsibility for regulating the discharge of contaminants into the environment. The discharge of contaminants onto or into land that may result in water contamination may not take place unless expressly allowed by a rule in a regional plan, resource consent or other relevant regulations. The control of DWI activities through the resource consenting process and subsequent compliance monitoring is an appropriate regulatory regime. In the Taranaki region, the discharge of contaminants by DWI requires resource consent from the Council. The activity falls under Rule 51 of the Regional Freshwater Plan for Taranaki and is classified as a discretionary activity. The application may be non-notified if no parties are deemed to be adversely affected by the proposed activity.

At the time of writing, there were a total of 19 current resource consents for DWI in Taranaki. However, several resource consents have been issued for relatively short-term activities during exploration phase drilling, and several others have not been, and may never be exercised.

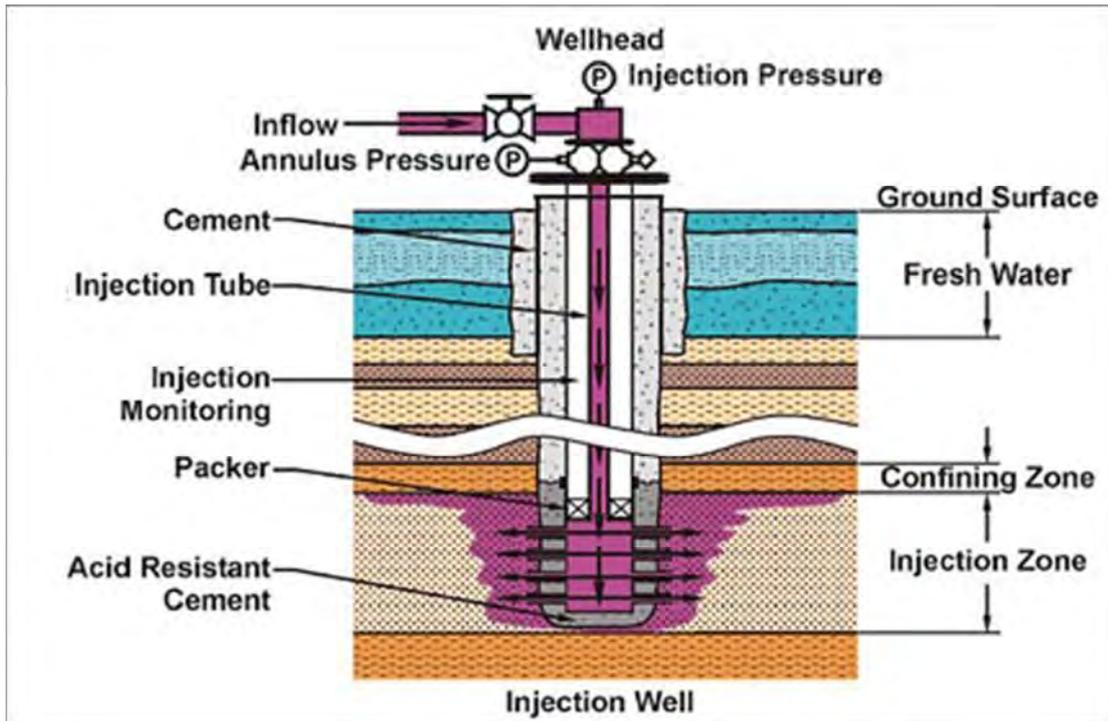


Figure 1 DWI schematic representative of Taranaki sites¹

1.3 Potential environmental effects of exercising a DWI consent

The most significant adverse environmental effect of discharging waste fluids by DWI is the contamination of freshwater aquifers during or following the discharge. Potential pathways for contamination of a freshwater aquifer can be created by the rupture of geological seal confining the injection interval, or failure of the grout seal in either the disposal well or any other well that penetrates the disposal interval. There is also potential for fluids to be forced upward from the injection interval through transmissive faults or fractures in the geological formations overlying the injection interval. Faults or fractures may have formed naturally prior to injection, or may be created by the waste dissolving the rocks of the confining zone. Artificial fractures may also be created by injecting wastewater at excessive pressures or by thermal processes.

There is also the potential for shallow groundwater to be contaminated by surface activities associated with DWI operations, particularly the handling, storage and transport of waste fluids. In all cases, the risk of contamination by spillage or unintended discharge of fluids being managed can be adequately mitigated by ensuring wastes are stored and transported in appropriately constructed and tested storage vessels and pipelines.

In each of the scenarios outlined above, the potential risk can be adequately mitigated by appropriate assessment, design, operation and monitoring of DWI activities. Appropriately engineered technology, regional and local geologic characterisation, and site specific modelling are typically combined at the planning stage of a disposal well to ensure that fluids discharged by DWI will be contained within the intended disposal

¹ <https://upstrm.wordpress.com/tag/injection-wells/>

interval. The assessment of resource consent applications and setting of appropriate conditions address these issues.

1.4 Resource consents

The protection of groundwater quality is of primary concern to the Council when processing resource consent applications for DWI activities. Section 15(1)(b) of the RMA stipulates that no person may discharge any contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant originated as a result of natural processes from that contaminant) entering water, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or national regulations.

Table 1 lists the consents held by the Company during the period under review, the wellsites to which the consents relate and the disposal wells in use at each site. All of the resource consents were issued by the Council under Section 87(e) of the RMA.

Table 1 Summary of DWI consents held by the Company during the 2014-2015 period

| Consent number | Wellsite | Injection well(s) | Formation |
|----------------|----------|-------------------|-----------------|
| 4728-2 | Cheal-A | Cheal A2 | Mount Messenger |
| 9545-1 | Cheal-A | Cheal A4 | Urenui |

A summary of each consent held by the Company for DWI activities during the 2014-2015 monitoring period is included below.

Resource consent: 4728-2

“To discharge saline groundwater from the Mateamateonga Formation into the Mount Messenger Formation by water flooding for enhanced oil recovery purposes”

Background

The Company lodged an application to renew consent 4728-1 on 26 November 2010. The application sought to change the purpose and conditions of the existing consent to reflect a change in the injection activities being carried out on-site. The application submitted by the Company proposed a reduction in scope with regard to the injection of power fluid into the Urenui Formation. Consent 4728-2 permits the applicant to inject fluids into the Mount Messenger Formation only, for enhanced oil recovery purposes. The point of discharge is approximately 400 m deeper than the previously carried out Urenui Formation water flood. The consent permits only the injection of saline groundwater abstracted from the lower section of the Mateamateonga Formation. It is proposed that saline groundwater will be abstracted via the Cheal-A4 well, under water take consent 9211-1. The abstracted groundwater will be injected into the Mount Messenger Formation via the previously suspended Cheal-A2 well, at a depth of approximately 1,800 m TVD below ground level. It is intended that the injection of fluids into the Cheal-A2 well will drive oil reserves within the Mt. Messenger Formation toward the Cheal-BH1 production well.

Consent 4728-2 was granted to Cheal Petroleum Limited on 25 May 2012.

Consequential changes to the conditions of the revised consent included an increase in the maximum permitted daily injection volume from 200 m³ to 800 m³ and increased

monitoring and reporting frequency requirements. As of 30 June 2014, the consent had not been exercised.

The current consent has twelve special conditions, as summarised below:

- Condition 1 requires the consent holder to submit a “Water Flooding Operation Management Plan” prior to exercising the consent;
- Condition 2 refers to injection well and subsurface information required for submission;
- Condition 3 limits the injection of fluids to the Mount Messenger Formation, below 1,600 m (below ground level);
- Condition 4 stipulates a maximum daily injection volume of 800 m³;
- Condition 5 limits the injection pressure below which would be required to fracture the receiving formation;
- **Condition 6 requires the best practicable option to be adopted for fluid injection;**
- Conditions 7 and 8, refer to process monitoring and data submission requirements;
- Condition 9 stipulates the annual reporting requirements;
- Condition 10 is a notification requirement;
- **Condition 11 prohibits the discharge from endangering or contaminating any freshwater resources; and**
- Condition 12 is a review condition.

The consent conditions provide the Council with an option to review the conditions of the consent at specified intervals. Optional reviews are provided for on an annual basis. The consent is due to expire on 1 June 2017.

Resource consent: 9545-1

“To discharge produced water from hydrocarbon exploration and production operations into the Urenui Formation by deepwell injection at the Cheal-A wellsite”

Background

Consent 9545-1, which permits the discharge of waste fluids by DWI at the Cheal-A wellsite, Mountain Road, Ngaere, was granted on 17 April 2013.

Waste fluids are heated and injected through the Cheal-A4 well into the Urenui Formation below 1,300 m TVD. The fluid is injected into the reservoir to improve oil flow and to physically push the oil toward an adjacent production well. The Company has utilised their Cheal-A4 well to inject fluids into the Urenui Formation since December 2009. The activity was permitted previously under consent 4728-1.

The consent was first exercised on 22 April 2013.

The current consent has twelve special conditions, as summarised below:

- Condition 1 requires the consent holder to submit a “Injection Operation Management Plan” prior to exercising the consent;
- Condition 2 refers to injection well and subsurface information required for submission;
- Condition 3 stipulates that there shall be no injection after 1 June 2016;

- Condition 4 requires the best practicable option to be adopted for fluid injection;
- Condition 5 limits the injection of fluids to the Urenui Formation, below 1,300 m TVD;
- Condition 6 stipulates a maximum daily injection volume of 200 m³;
- Condition 7 limits the injection pressure to below 4,000 psi (276 bars);
- Condition 8 prohibits the discharge from resulting in any contaminants reaching any useable freshwater resources;
- Conditions 9, 10, and 11 refer to process monitoring and data submission requirements;
- Conditions 12, 13, and 14 refer to local groundwater quality monitoring requirements;
- Condition 15 stipulates the annual reporting requirements;
- Condition 16 is a notification requirement; and
- Condition 17 is a review condition.

The consent conditions provide the Council with an option to review the conditions of the consent at specified intervals. Optional reviews are provided for on an annual basis. The consent is due to expire on 1 June 2018.

Figure 2 shows the location of the DWI consents held by the Company during the period under review. Copies of the consent certificates of exercised consents only are attached in Appendix I.



Figure 2 Aerial view of Cheal-A wellsite, Mountain Road, Ngaere

1.5 Monitoring programme

1.5.1 Introduction

Section 35 of the RMA sets out obligations upon the Council to gather information, monitor, and conduct research on the exercise of resource consents, and the effects arising, within the Taranaki region and report upon these.

To perform its statutory obligations, the Council may be required to take 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 implemented by the Council in relation to the Company's DWI activities consisted of four main components:

- Programme design, liaison and management;
- Site inspections and injectate sampling;
- Assessment of data submitted by the consent holder; and
- Groundwater quality monitoring.

Each component of the monitoring programme is discussed in further detail below.

1.5.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council during annual reviews of existing monitoring programmes, and the scoping and design of future monitoring requirements. Significant time is spent managing compliance monitoring programmes throughout the monitoring year, and liaising with resource consent holders over consent conditions, their interpretation and application. The Council also undertakes discussion during preparation for any consent reviews, renewals, or new consent applications, and provides advice on environmental management strategies, the content of regional plans and various other associated matters.

1.5.3 Site inspections

The monitoring programme provides for physical inspections to be undertaken at all active DWI sites operated by the Company. The inspections include an examination of the injection wellhead, viewing the monitoring equipment, and the spot sampling of the injectate for laboratory analysis. The sampling of injectate is carried out in order to characterise the general chemical nature of the discharge and also the variation in its chemical composition across the monitoring period. During the period under review samples of the injectate were obtained from storage tanks T-0504 and T-0505 located at the Cheal-A wellsite.

The injectate samples collected were submitted to Council's IANZ accredited laboratory for the following analyses:

- pH;
- Conductivity;
- Alkalinity;
- Chlorides; and
- Total petroleum hydrocarbons.

Table 2 Location of injectate sampling sites

| Consent | Wellsite | Injection well | Site code | Sample point |
|---------|----------|----------------|-----------|-----------------------|
| 9545-1 | Cheal-A | Cheal-A4 | GND2328 | Tanks T-0504 & T-0505 |

1.5.4 Assessment of data submitted by consent holder

The resource consents held by the Company for DWI include conditions which require the Company to submit injection data and supporting information to the Council within specified timeframes. The injection data submitted by the consent holder forms the basis for assessing consent compliance. The major information requirements are as follows:

1. Information on the disposal well and injection zone

For each well used for DWI, the consent holder was required to provide an "Injection Operation Management Plan." The plans are required to include the operational details of the injection activities and to identify the conditions that would trigger concerns about the integrity of the injection well, the receiving formation or overlying geological seals. The plans are also required to detail the action(s) to be taken by the consent holder if trigger conditions are reached. The Company was also required to submit well construction details, an assessment of the local geological environment, results of well integrity testing and details of the proposed monitoring plan for the injection well. The information requested is required to demonstrate that the exercise of the consent will not contaminate or endanger any actual or potentially useable freshwater aquifer.

The Council holds a significant volume of information regarding the Company's wells and the underlying geology in the Cheal area. Data has been gathered where submitted as part of resource consent applications, during specific site investigations, and as part of various compliance monitoring programmes.

2. Discharge records

For each well used for DWI during the period under review, the consent holder was required to provide discharge records. The data required by the conditions of the consents exercised by the Company included the following:

- Injection volumes;
- Injection rate;
- Injection pressures; and
- Results of injectate analysis

The Company provided adequate injection records for the 2014-2015 monitoring year. The data submitted met the requirements stipulated in the DWI consents exercised during this period.

3. Annual reporting

The Company was required to submit annual reports to the Council providing a summary of all injection data gathered over the previous 1 July to 30 June period. The level of detail required in the annual reports varies depending on the conditions of the consents exercised. Additional reporting requirements may also include requirements to provide an assessment of monitoring data and the implications for consent compliance, and/or updated injection modelling reports.

The Company supplied the required annual reports to the Council within the timeframes specified in the relevant consents.

1.5.5 Groundwater Quality Monitoring

A programme of groundwater monitoring in the vicinity of the Company's active injection sites was initiated during the 2012-2013 period, and was continued in the 2013-2014 and 2014-2015 periods, with some sites removed, and some additional sites added. The monitoring programme provides for biannual sampling of groundwater from selected groundwater sites.

In order to select suitable sampling sites for inclusion in the monitoring programme, the Council carried out a survey of groundwater abstractions within 1 km radius of the Company's active injection wellsite. Initially, a desktop review of data held by the Council was conducted, including a search of the Council 'wells' database. The desktop review indicated that the Council held records of a limited number of groundwater abstractions in the areas of investigation.

Following the desktop review, a field survey was undertaken to confirm the location of known abstraction sites, to assess their suitability for sampling, and to identify any additional groundwater abstraction sites that may not have been registered with the Council.

Following the field survey, two private groundwater abstraction sites were selected for inclusion in the groundwater monitoring programme. The criteria used in assessing the suitability of each site for inclusion in the programme were the proximity of the site to the Cheal-A wellsite, the depth to which the bore has been drilled, the construction specification of the bore, and its susceptibility to contamination by surface runoff.

Details of the site selected for inclusion in the monitoring programme are listed below in Table 3.

Table 3 Location of groundwater sampling sites

| Site code | Type | Distance from injection wellhead (m) | Casing depth (m) | Total depth (m) | High static water level (m) | Aquifer | Comment |
|-----------|------|--------------------------------------|------------------|-----------------|-----------------------------|-----------|--------------------------|
| GND0492 | Bore | 415 | 19.5 | 30.5 | 6.1 | Volcanics | Downgradient of wellsite |
| GND1139 | Bore | 357 | 36 | 54 | 7.0 | Volcanics | Downgradient of wellsite |

2. Results

2.1 Site inspections and injectate sampling

During the period under review, the Council carried out two routine DWI inspections at the Cheal-A wellsite. In addition, a total of six separate inspections were carried out by Council staff in relation to various activities at the Cheal-A wellsite during the 2014-2015 monitoring year.

Routine DWI inspections included undertaking a general visual assessment of the operational equipment, storage facilities and associated equipment. No operational issues were identified during the inspections and all equipment appeared in good condition. Company personnel were able to assist by detailing the status of injection equipment, outlining the injection operations being carried out by the Company at that time, and also providing real-time monitoring data on request.

As part of the monitoring programme, spot samples of the injectate were obtained from active injection sites, typically during site inspection visits. The sampling of injectate was carried out on 7 October 2014 and 30 April 2015. The injectate samples were submitted to the Council's IANZ accredited laboratory for physicochemical analysis. The results of the analyses are included below in Table 4. The concentrations of each analyte are within the expected range for produced water samples.

Table 4 Results of injectate sampling undertaken by the Council (2014-2015)

| Parameter | Unit | Site GND2328 | |
|------------------------------|------------------|--------------|------------|
| | | 7/10/2014 | 30/04/2015 |
| Time | NZST | 11:15 | 13:40 |
| TRC sample number | - | TRC1411396 | TRC151588 |
| pH | pH Units | 6.5 | 6.3 |
| Conductivity @ 20°C | mS/m @ 20°C | 4,040 | 4,140 |
| Chloride | g/m ³ | 16,900 | 18,300 |
| Total petroleum hydrocarbons | g/m ³ | 60 | 260 |

2.2 Assessment of data provided by the consent holder

The Company provided full records of injection activities carried out during the 2014-2015 monitoring period, including injection hours, volumes, rate, and pressure data.

Table 5 outlines the Company's injection activities during the period under review. The injection data provided by the Company is summarised in Table 6.

Table 5 Summary of DWI activities during the period under review (2014-2015)

| Consent | Wellsite | Injection wells | Total volume discharged (m ³) 01/07/14 – 30/06/15 | Discharge period | | TRC well ID |
|---------|----------|-----------------|--|------------------|----------|-------------|
| | | | | From | To | |
| 9545-1 | Cheal-A | Cheal-A4 | 17,630 | 01/07/14 | 30/06/15 | GND2328 |

Table 6 Summary of the Company's 2014-2015 injection data

| | 9545-1 | | |
|---------------|-----------------------------------|--------------------------|-------------------------------------|
| | Volume injected (m ³) | Injection pressure (bar) | Injection rate (m ³ /hr) |
| Total | 14,705 | - | - |
| Daily maximum | 117 | 140 | 13 |
| Daily average | 32 | 69 | 3 |

The injection volume and pressure data provided by the Company for injection carried out under consent 9545-1 is presented graphically in Figures 3 and 4.

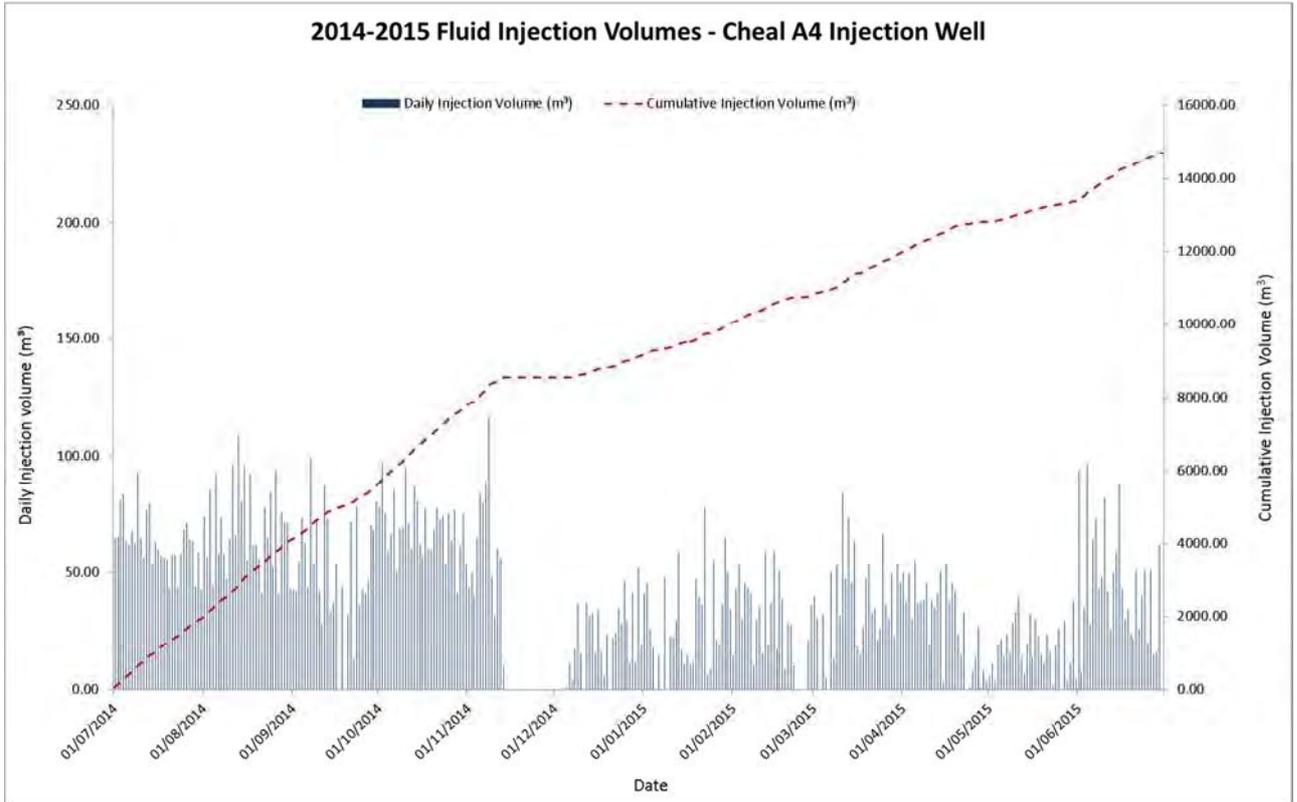


Figure 3 2014-2015 fluid injection volumes – consent 9545-1

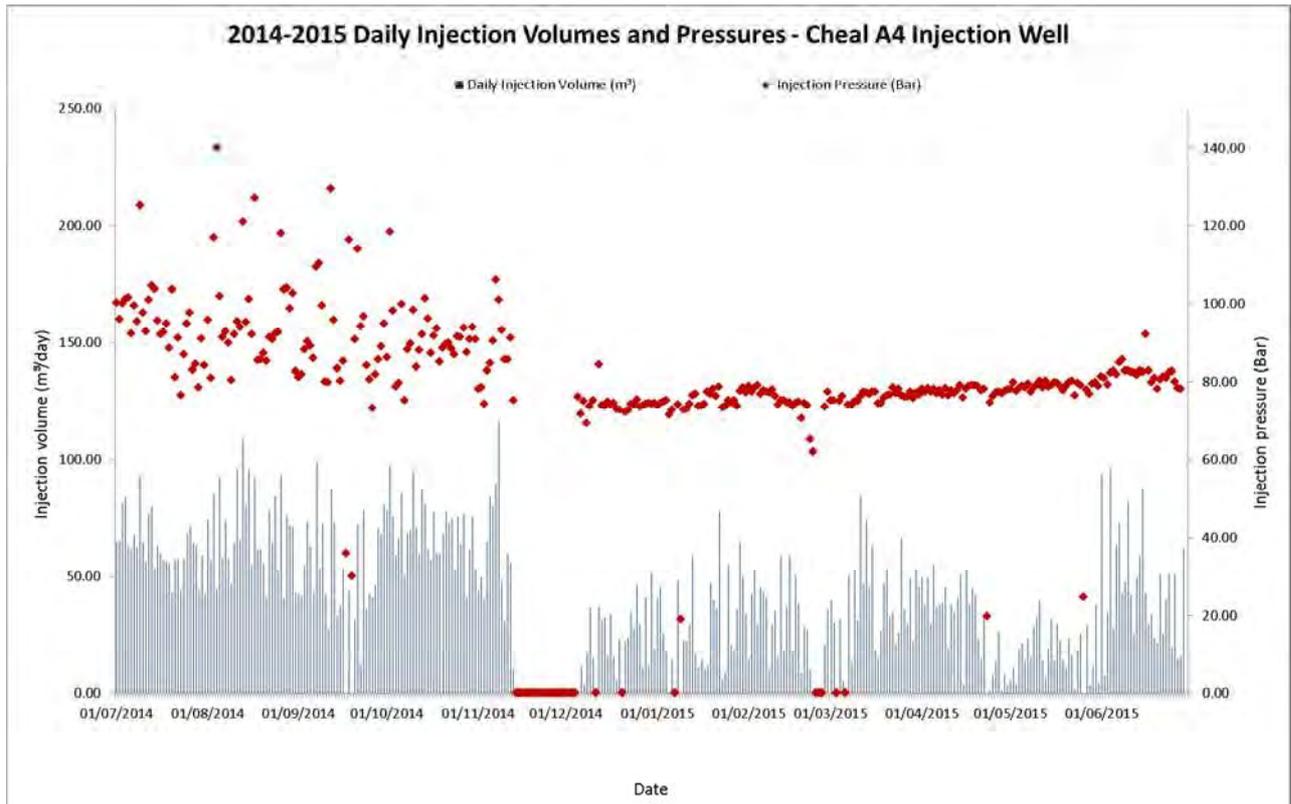


Figure 4 2014-2015 daily injection volumes and pressure – consent 9545-1

The injection volume and pressure data provided by the Company for injection carried out via the Cheal-A4 well between July 2010 and June 2015 is presented graphically in Figure 5. The total annual injection volumes for the Cheal-A4 injection well between the 2010-11 and 2014-15 monitoring periods are shown in Figure 6.

In addition to the Council's injectate sampling (Section 2.1), the Company also provided analytical results for samples of produced water injected via the Cheal-A4 well. As presented in Table 7, the maximum and mean values associated with the results of these analyses illustrate the variability in the composition of injectate across the monitoring period. The composition of the injectate varies depending on the origin and volume of fluids transferred from each individual source at the time of injection. The primary sources of produced water being injected at the Cheal-A wellsite are production wells at the Cheal-A, Cheal-B and Sidewinder wellsites.

Table 7 Range of contaminants in injectate sampled in 2014-2015

| Parameter | Unit | Number of samples | Maximum value | Minimum value | Mean value |
|------------------------------|------------------|-------------------|---------------|---------------|------------|
| Temperature | °C | 12 | 24 | 19 | 22 |
| pH | pH units | 12 | 7.5 | 6.5 | 6.9 |
| Conductivity | uS/cm | 12 | 42,800 | 29,000 | 35,675 |
| Salinity | ppt | 12 | 31.6 | 18.3 | 24.3 |
| Chloride | g/m ³ | 12 | 27,150 | 10,595 | 14,427 |
| Suspended solids | g/m ³ | 12 | 178 | 10 | 76 |
| Total petroleum hydrocarbons | ppm | 12 | 1,091 | 19 | 268 |

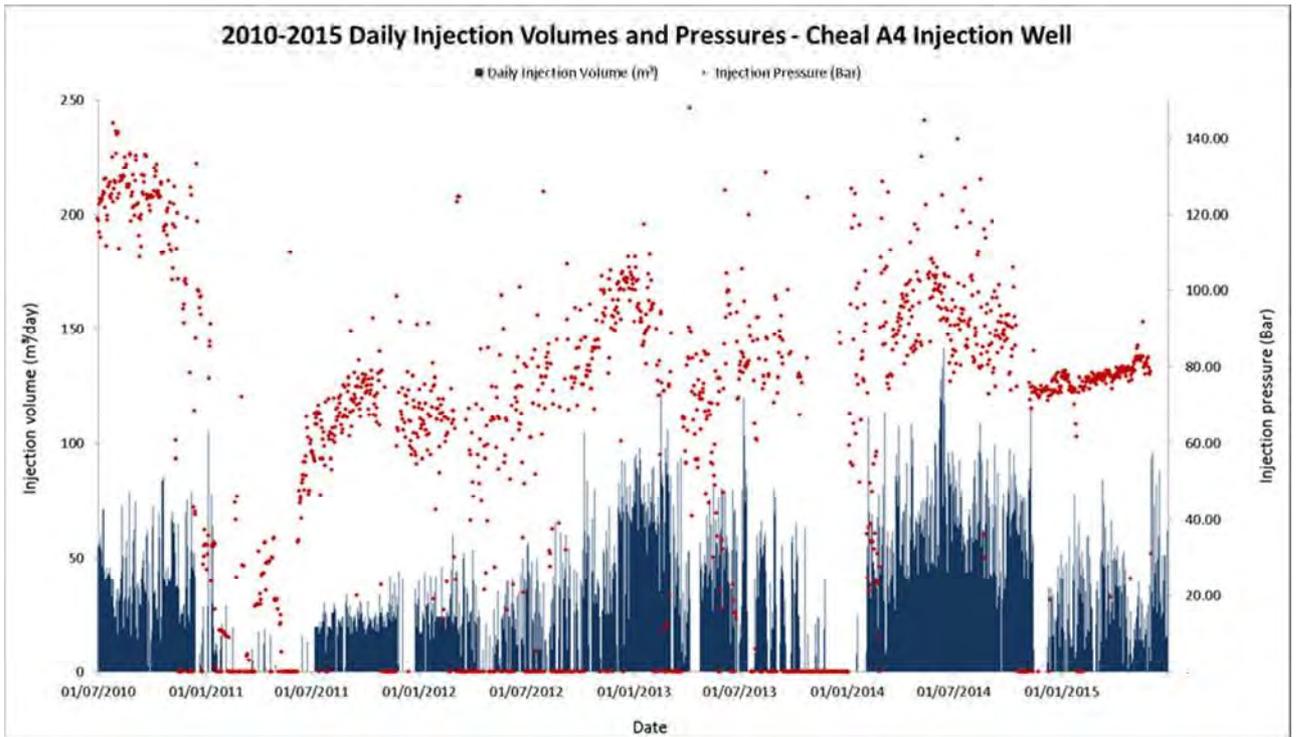


Figure 5 2010-2015 daily injection volumes and pressure – consent 9545-1

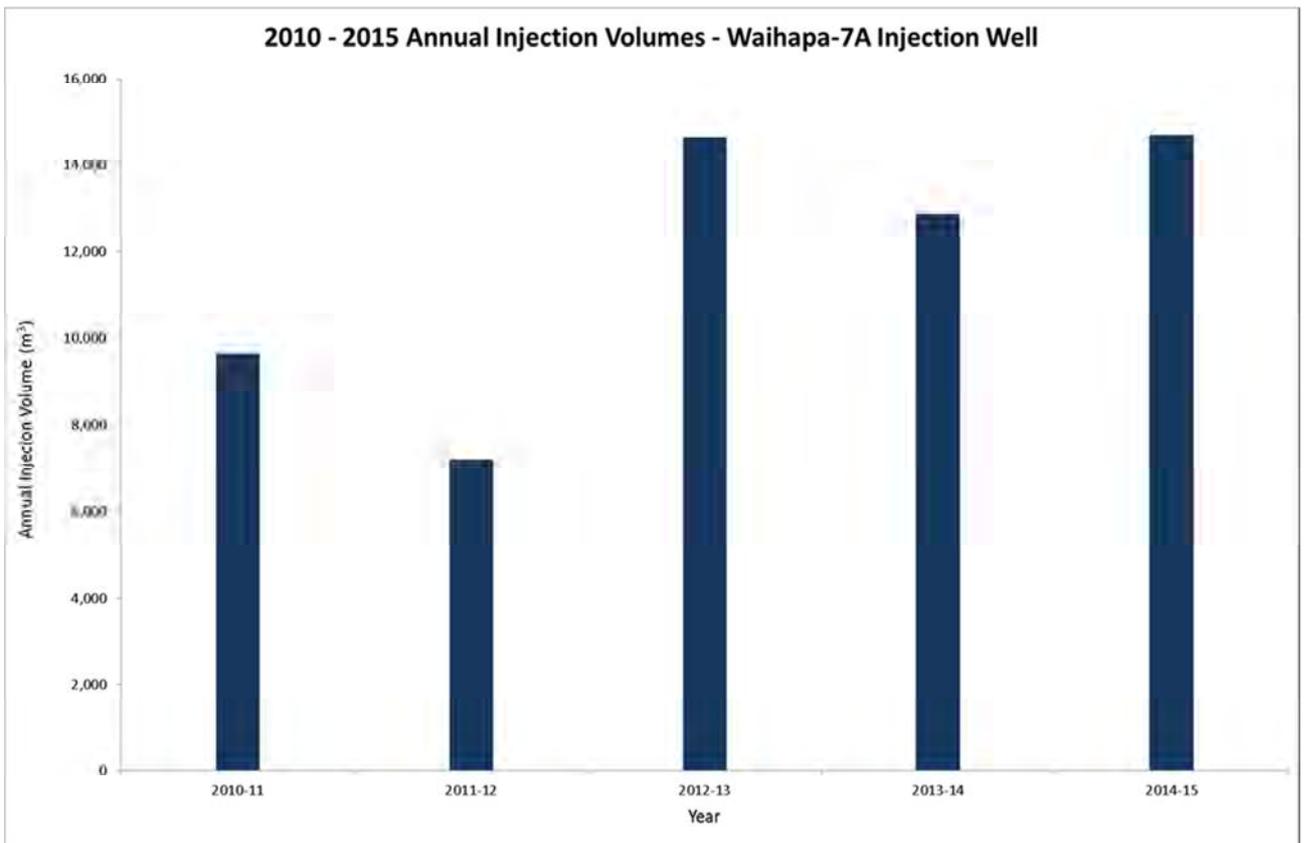


Figure 6 2010-2015 annual injection volumes

2.3 Groundwater Quality Monitoring

As part of the groundwater monitoring programme implemented in the vicinity of the Cheal-A wellsite, groundwater samples were obtained from GND0492 on 18 November 2014 and 20 May 2015 and GND1139 on 7 October 2014 and 1 May 2015. The samples were collected following standard groundwater sampling methodologies and generally in accordance with the National Protocol for State of the Environment Groundwater Sampling in New Zealand (2006). The samples were analysed in the Council's IANZ accredited laboratory for a basic range of parameters, sufficient to characterise local groundwater quality, and to assess for potential contamination due to injection activities. The results of analyses carried out on samples obtained are set out below in Table 8. Low levels of hydrocarbons were detected during the October 2014 sampling of GND1139. No hydrocarbons were detected during the May 2015 sampling event from the same well. It is not suspected that the hydrocarbons detected were caused by injected fluids migrating to freshwater aquifers. It is thought that either cross-contamination from an injectate sample collected earlier the same day or a laboratory error resulted in the detection of hydrocarbons. The results of previous sampling carried out in the vicinity of the Cheal wellsites was reported in the Cheal Petroleum Limited Deep Well Injection Monitoring Programme Report 2014-2015, Cheal Petroleum DWI Monitoring Programme Report (2009-2012), Cheal Petroleum DWI Monitoring Programme Report (2012-2013) and the TAG Oil Groundwater Monitoring Programme Compliance Report (Technical Report 2012-80).

Table 8 Results of groundwater sampling undertaken by the Council (2014-2015)

| Sample details | Units | GND0492 | | GND1139 | |
|--------------------|------------------|------------|------------|------------|-----------|
| TRC sample number | - | TRC1411944 | TRC151778 | TRC1411397 | TRC151591 |
| Sample date | - | 18/11/2014 | 20/05/2015 | 7/10/2014 | 1/05/2015 |
| Sample time | NZST | 12:38 | 12:53 | 11:30 | 11:27 |
| Analyte | Units | | | | |
| Static water level | m | 5.91 | 5.58 | - | - |
| Temperature | °C | 14.2 | 13.5 | 11.4 | 13.7 |
| pH | pH Units | 6.72 | 6.42 | 6.44 | 6.89 |
| Conductivity (EC) | mS/m@20°C | 18.79 | 23.58 | 15 | 24.3 |
| Chloride | g/m ³ | 22.3 | 18.7 | 13.2 | 13.8 |
| Total hydrocarbons | g/m ³ | <0.5 | <0.5 | 1.4 | <0.5 |

2.4 Investigations, interventions, and incidents

The monitoring programme for the year was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the consent holder. During the year matters may arise which require additional activity by the Council, for example provision of advice and information, or investigation of potential or actual courses of non-compliance or failure to maintain good practices. A pro-active approach that in the first instance avoids issues occurring is favoured.

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 Incident Register (IR) includes events where the Company concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

Complaints may be alleged to be associated with a particular site. If there is potentially 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 2014-2015 period, the Council *was not* required to undertake significant additional investigations and interventions, or record incidents, in association with the Company's conditions in resource consents or provisions in Regional Plans.

3. Discussion

During the period under review, the Company exercised one DWI consent at its Cheal-A wellsite; 9545-1. This consent authorises the discharge of produced water into the Urenui Formation.

Consent 9545-1 was exercised between 1 July 2014 and 30 June 2015. During this period, 17,630 m³ of fluid was injected, at an average rate of 3 m³/hr. The average injection pressure was 76 bar. Production water from the Company's production wells at the Cheal-A, Cheal-B and Sidewinder wellsites was the main source of fluids for injection.

The special conditions of Consent 9545-1 specify a maximum daily injection volume of 200 m³/day, and a maximum authorised injection pressure of 276 bar. A review of the injection data provided by the Company indicates the maximum daily volume injected was 117 m³, on 8 November 2014. The maximum daily injection volume was within the limits specified in the consent. The maximum injection pressure reached during the period under review was 140 bar, which occurred on 4 August 2014. The maximum injection pressure was within the limits specified in the consent.

Daily injection volumes and pressures over the 2010-2011 to 2014-2015 monitoring periods show that injection pressures only increase when large volumes of fluid are being injected. When lower volumes are being injected, the pressure decreases accordingly, indicating that capacity remains within the formation for further injection. Annual injection volume data shows that the volumes of fluid injected via the Cheal-A4 well has increased over last five years, from 9,646 m³ in 2010-2011 to 14,705 m³ in 2014-2015 monitoring periods.

The Company has provided sufficient information regarding well construction and the injection interval to satisfy the relevant consent conditions and monitoring programme information requirements. However, if deemed necessary, the Council may request further information from the consent holder that illustrates that the injection wells and the receiving formation remain secure.

During the 2014-2015 monitoring period, consent holder performance was assessed on compliance with consent conditions. There is a particular emphasis on record keeping requirements, data provision, and the analysis data provided. Compliance with the conditions of the DWI consents exercised during the 2014-2015 monitoring period is summarised below in Section 3.1.

The consent holder is required to ensure that the discharge does not result in any contamination of actual or potentially useable freshwater aquifer. Compliance with this condition is based on the assessment of consent holder submitted data, and the sampling and analysis of local groundwater abstractions.

During the period under review, groundwater sampling sites in the vicinity of the Cheal-A wellsite were sampled. The results of the analyses carried out do not indicate any form of contamination of local groundwater as a result of injection activities.

No complaints were received from the public with regard to any of the Company's DWI activities during the period under review, and no incidents were recorded by the Council.

3.1 Evaluation of performance

During the period under review, the Company exercised DWI consent 9545-1. A summary of the Company's level of compliance with the special conditions attached to consent 9545-1 is provided in Table 9.

Table 9 Summary of Company performance with regard to consent 9545-1

| Purpose: To discharge produced water from from hydrocarbon exploration and production operations into the Urenui Formation by deepwell injection at the Cheal-A wellsite | | |
|--|---|----------------------|
| Condition requirement | Means of monitoring during period under review | Compliance achieved? |
| 1. By 1 June 2013, the consent holder shall submit an "Injection Operation Management Plan." | Receipt of satisfactory "Injection Operation Management Plan," by 1 June 2013. | Yes |
| 2. Injection well, geological and operational data submission requirements. This information can be included in the "Injection Operation Management Plan." | Receipt of satisfactory information by 1 June 2013. | Yes |
| 3. No injection permitted after 1 June 2016. | Assessment of injection records and site inspection notices. | N/A* |
| 4. The consent holder shall at all times adopt the best practicable option. | Assessment of consent holder records and site inspection notices. | Yes |
| 5. The injection of fluids shall be confined to the Urenui Formation only, deeper than 1,300 metres true vertical depth. | Review of "Water Flooding Operation Management Plan," well construction log and injection data. | Yes |
| 6. The volume of fluid injected shall not exceed 200 cubic metres per day. | Review and analysis of injection data. | Yes |
| 7. The injection pressure at the wellhead shall not exceed 4,000 psi (276 bars). | Review and analysis of injection data. | Yes |
| 8. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water). | Assessment of injection records and results of groundwater sampling and analysis programme. | Yes |
| 9. Maintain full records of injection data. | Receipt and assessment of injection data. | Yes |
| 10. Maintain records and undertake analysis to characterise each type of waste arriving on-site for discharge. | Receipt and assessment of injection data. | Yes |

| | | |
|---|---|-------------|
| 11. The data required by conditions 9 & 10 above, for each calendar month, is required to be submitted by the 15 th day of the following month. | Receipt of satisfactory data by the date specified. | Yes |
| 12. The consent holder shall undertake a programme of sampling and testing (the 'Monitoring Programme') that monitors the effects of the exercise of this consent on fresh water resources. | Monitoring Programme submitted to the Chief Executive, Taranaki Regional Council, for certification before 1 June 2013, | Yes |
| 13. All groundwater samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for: a. pH; b. conductivity; c. chloride; and d. total petroleum hydrocarbons. | Implementation of Groundwater Monitoring Programme and assessment of results. | Yes |
| 14. All groundwater sampling and analysis shall be undertaken in accordance with a Sampling and Analysis Plan, which shall be submitted to the Chief Executive, Taranaki Regional Council for review and certification before the first sampling is undertaken. | Receipt of Sampling and Analysis Plan prior to first round of sampling being undertaken | Yes |
| 15. The consent holder shall provide to the Council, before 31 August each year, a summary of all data collected and a report detailing compliance with consent conditions over the previous 1 July to 30 June period. | Receipt of satisfactory report by 31 August each year. | Yes |
| 16. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 5 days prior to the first exercise of this consent. | Notification received by Council. | Yes |
| 17. Consent review provision. | N/A | N/A* |
| Overall assessment of consent compliance and environmental performance in respect of this consent | | High |
| Overall assessment of consent compliance and administrative performance in respect of this consent | | High |

*N/A = Not Applicable

During the year, the Company demonstrated a high level of environmental and administrative performance with the resource consents as defined in Section 1.1.4.

3.2 Recommendations from the 2013-2014 Annual Report

In the 2013-2014 Annual Report, it was recommended:

1. THAT the range of monitoring carried out during the 2013-2014 period in relation to the Company's DWI activities be continued during the 2014-2015 monitoring period.

The recommendation was implemented in the 2014-2015 period.

2. That the Council notes there is no requirement at this time for a consent review to be pursued or grounds to exercise review options

There was no review of any DWI consent held by the Company during the 2014-2015 period as it was deemed that the conditions of each consent were adequate to deal with the potential adverse effects of the activity.

3.3 Alterations to monitoring programmes for 2015-2016

In designing and implementing the monitoring programmes for air/water discharges in the region, the Council has taken into account the extent of information made available by previous authorities, its relevance under the RMA, its obligations to monitor emissions/ discharges and effects under the RMA, and report to the regional community. The Council also takes into account the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki emitting to the atmosphere/ discharging to the environment.

It is proposed that the range of monitoring carried out during the 2014-2015 period in relation to the Company's DWI activities be continued during the 2015-2016 monitoring period.

Recommendations to this effect are included in Section 4 of this report.

3.4 Exercise of optional review of consent

The next optional review dates for consents 9545-1, and 4728-2 are provided for in June 2016.

The Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent. A review may be required 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.

Based on the results of monitoring carried out in the period under review, and in previous years as set out in earlier annual compliance monitoring reports, it is considered that there are no grounds to require a consent review to be pursued or grounds to exercise the review options. A recommendation to this effect is presented in Section 4 of this report.

4. Recommendations

1. THAT the range of monitoring carried out during the 2014-2015 period in relation to the Company's DWI activities be continued during the 2015-2016 monitoring period.
2. THAT the Council notes there is no requirement at this time for a consent review to be pursued or grounds to exercise the review options.

Glossary of common terms and abbreviations

The following abbreviations and terms may be used within this report:

| | |
|-----------------------------------|---|
| Aquifer (freshwater) | A formation, or group or part of a formation that contains sufficient saturated permeable media to yield exploitable quantities of fresh water. |
| Bcf | Billion cubic feet. |
| Conductivity | A measure of the level of dissolved salts in a sample. Usually measured at 20°C and expressed as millisiemens per metre (mS/m) or as Total Dissolved Solids (g/m ³). |
| Confining layer | A geological layer or rock unit that is impermeable to fluids. |
| Deep well injection (DWI) | Injection of fluids at depth for disposal or enhanced recovery. |
| Fracture gradient | A measure of how the pressure required to fracture rock in the earths crust changes with depth. It is usually measured in units of "pounds per square inch per foot" (psi/ft) and varies with the type of rock and the strain of the rock. |
| Freshwater-saline-water interface | The depth in a well at which fresh water becomes saline. The interface may be a gradational or sharp transition, depending on geology. The FW-SW transition is demonstrated by down-hole geophysical logging. |
| g/m ³ | Grams per cubic metre. A measure of concentration which is equivalent to milligrams per litre (mg/l), or parts per million (ppm). |
| Hydraulic fracturing (HF) | The process of increasing reservoir permeability by injecting fluids at pressures sufficient to fracture rock within the reservoir ("fracking"). |
| Injectate | Fluid disposed of by deep well injection. |
| 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. |
| IR | 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. |
| L/s | Litres per second. |
| mbgl | Metres below ground level. |
| m TVD | Metres true vertical depth |
| m ³ | Cubic metre. |
| Packer | A down hole device used to isolate the annulus from the production conduit, enabling controlled production, injection or treatment. |

| | |
|------------------|--|
| pH | Numerical system for measuring acidity in solutions, with 7 as neutral. Values lower than 7 are acidic and higher than 7 are 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. |
| Power fluid | Pressurized fluids used to transmit and control energy into oil/gas wells. Cheal power fluid is a heated combination of fresh and produced water. |
| Produced water | Water associated with oil and gas reservoirs that is produced along with the oil and gas. Typically highly saline with salt concentrations similar to seawater and containing low levels of hydrocarbons. |
| Resource consent | Refer Section 87 of the RMA. Resource consents 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). |
| TRC | Taranaki Regional Council (the Council). |
| UI | Unauthorised Incident. |
| Water flooding | A method of thermal recovery in which hot water is injected into a reservoir through specially distributed injection wells. Hot water flooding reduces the viscosity of the crude oil, allowing it to move more easily toward production wells. |

Bibliography and references

Environmental Protection Agency, United States. An introduction to the technology of subsurface wastewater injection. Environmental Protection Technology Series (EPA-600/2-77-240).

Ministry for the Environment (2006). A National Protocol for State of the Environment Groundwater Sampling in New Zealand. Ref. ME781.

Stevens G. 2001. Taranaki : *In*: Groundwaters of New Zealand, M.R. Rosen and P.A. White (eds). New Zealand Hydrological Society Inc., Wellington. P381-386.

Taranaki Regional Council (2010). Cheal Petroleum Limited Deep Well Injection Monitoring Programme Biennial Report (2007-2009). Technical Report 2009-92. Document number 717351.

Taranaki Regional Council (2012). Officer Report. Cheal Petroleum Limited - Cheal DWI Consent Renewal (Consent 4728-2). Document number 1013643.

Taranaki Regional Council (2013). TAG Oil (NZ) Ltd Company Groundwater Monitoring Programme Compliance Report (2011-2012). Technical Report 2012-80. Document number 1160304.

Taranaki Regional Council (2013). Cheal Petroleum Limited Deep Well Injection Monitoring Programme Annual Report (2012-2013). Technical Report 2013-34. Document number 1233811.

Taranaki Regional Council (2015). Cheal Petroleum Limited Deep Well Injection Monitoring Programme Annual Report (2013-2014). Technical Report 2014-93. Document number 1468596.

Appendix I

DWI consents exercised in 2014-2015 period

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: 17 April 2013

Commencement Date: 17 April 2013

Conditions of Consent

Consent Granted: To discharge produced water from hydrocarbon exploration
 and production operations into the Urenui Formation by
 deepwell injection at the Cheal-A wellsite

Expiry Date: 1 June 2018

Review Date(s): June 2014, June 2015, June 2016, June 2017

Site Location: Cheal-A wellsite, 4273 Mountain Road, Ngaere
 (Property owner: J & R Lightoller)

Legal Description: Pt Sec 24 Blk VI Ngaere SD (Discharge source & site)

Grid Reference (NZTM) 1712361E-5639489N

Catchment: Waingongoro

Tributary: Mangawharawhara

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

General condition

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

Special conditions

1. By 1 June 2013, the consent holder shall submit an "Injection Operation Management Plan." The plan shall include the operational details of the injection activities and identify the conditions that would trigger concerns about the integrity of the injection well, the receiving formation or overlying geological seals. The plan shall also detail the action(s) to be taken by the consent holder if trigger conditions are reached.
2. By 1 June 2013, the consent holder shall provide to the Chief Executive, Taranaki Regional Council:
 - (a) a geological assessment of the environment in which the well is located, including the injection zone, the geological seals confining the injection zone and any associated faulting;
 - (b) details of the injection well design, construction its structural integrity, including an up to date well construction diagram;
 - (c) an assessment of the suitability of the injection well for the proposed activity; and
 - (d) details of how the integrity of the injection well will be monitored and maintained;

(Note: The information required by condition 2 may be included within the "Injection Operation Management Plan" required by condition 1).

3. There shall be no injection of any fluids after 1 June 2016.
4. 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.
5. The injection of fluids shall be confined to the Urenui Formation, deeper than 1,300 metres true vertical depth.
6. The volume discharged shall not exceed 200 cubic metres per day.
7. The injection pressure at the wellhead shall not exceed 4,000 psi (276 bars). If exceeded, the injection operation shall be ceased immediately and the Chief Executive of the Taranaki Regional Council informed immediately.
8. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water). Useable fresh groundwater is defined as any groundwater having a TDS concentration of less than 1,000 mg/l.
9. Once the consent is exercised, the consent holder shall keep daily records of the:
 - (a) injection hours;
 - (b) volume of fluid discharged; and
 - (c) maximum and average injection pressure.

10. For each waste stream arriving on site for discharge, the consent holder shall characterise the fluids by recording the following information:
- (a) type of fluid;
 - (b) source of fluid (site name and company);
 - (c) an analysis of a representative sample of the fluid for:
 - (i) pH;
 - (ii) conductivity
 - (iii) suspended solids concentration;
 - (iv) temperature;
 - (v) salinity;
 - (vi) chloride concentration; and
 - (vii) total hydrocarbon concentration.

The analysis required by condition 10 above is not necessary if a sample of the same type of fluid, from the same source, has been taken, analysed and provided to the Chief Executive, Taranaki Regional Council within the previous 6 months.

11. The information required by conditions 9 and 10 above, for each calendar month, shall be provided to the Chief Executive, Taranaki Regional Council before the 15th day of the following month.
12. The consent holder shall undertake a programme of sampling and testing (the 'Monitoring Programme') that monitors the effects of the exercise of this consent on fresh water resources within an Area of Review (AoR), to assess compliance with condition 8. The Monitoring Programme shall be designed to characterise local groundwater quality, and be submitted to the Chief Executive, Taranaki Regional Council, for certification before 1 June 2013, and shall include:
- (a) the location of sampling sites;
 - (b) well/bore construction details; and
 - (c) sampling frequency.

The AoR shall extend 1,000 metres radially from the point of injection. It is a requirement that at least one suitable monitoring bore be located within 500 metres of the well head. If no suitable existing bores are available, it will be necessary for the Monitoring Programme to include installation of, and sampling from, a suitable bore. The bore would be of a depth, location and design determined after consultation with the Chief Executive, Taranaki Regional Council and installed in accordance with NZS 4411:2001.

13. All groundwater samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for:
- (a) pH;
 - (b) conductivity;
 - (c) chloride; and
 - (d) total petroleum hydrocarbons.

Note: The samples required, under conditions 12 and 13, could be taken and analysed by the Council or other contracted party on behalf of the consent holder.

14. All groundwater sampling and analysis shall be undertaken in accordance with a Sampling and Analysis Plan, which shall be submitted to the Chief Executive, Taranaki Regional Council for review and certification before the first sampling is undertaken. This plan shall specify the use of standard protocols recognised to constitute good professional practice including quality control and assurance. An IANZ accredited laboratory shall be used for all sample analysis. Results shall be provided to the Chief Executive, Taranaki Regional Council within 30 days of sampling and shall include supporting quality control and assurance information. These results will be used to assess compliance with condition 8.

Note: The Sampling and Analysis Plan may be combined with the Monitoring Programme required by condition 12.

15. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, before 31 August each year, a summary of all data collected and a report detailing compliance with consent conditions over the previous 1 July to 30 June period. Based on the data provided, the report shall also provide:
- a) an assessment of injection well performance;
 - b) an assessment of the on-going integrity and isolation of the wellbore;
 - c) an assessment of the on-going integrity and isolation of the receiving formation; and
 - d) an updated injection modeling report, demonstrating the ability of the receiving formation to continue to accept additional waste fluids.
16. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 5 days prior to the first exercise of this consent. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
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 each year, 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 17 April 2013

For and on behalf of
Taranaki Regional Council

Chief Executive

