Cheal Petroleum Limited Deep Well Injection Monitoring Programme Annual Report 2016-2017

Technical Report 2017-21

ISSN: 1178-1467 (Online)
Document: 1850117 (Word)
Document: 1921233 (Pdf)

Taranaki Regional Council
Private Bag 713
STRATFORD

October 2017

Executive summary

Cheal Petroleum Limited (the Company) operates a number of wellsites within the Taranaki Region, most notably their Cheal wellsites located south of Stratford. Each wellsite contains varying numbers of producing wells and associated production infrastructure. This report for the period July 2016 to June 2017 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) in relation to the Company's deep well injection (DWI) activities. The report details the results of the monitoring undertaken, assesses the Company's environmental performance during the period under review and the environmental effects of their DWI activities.

The Company held five resource consents for DWI activities during the review period, which included a total of 80 conditions setting out the requirements that the Company must satisfy. Only three of the consents were exercised during the period being reported.

During the monitoring period the Company demonstrated an overall high level of environmental performance.

The Council's monitoring programme for the year under review included annual site inspections of all wellsites, two injectate samples and 11 groundwater samples collected for physicochemical analysis. The monitoring programme also included a significant data review component, with all injection data submitted by the company assessed for compliance on receipt.

The monitoring showed that the Company's DWI activities were being carried out in compliance with the conditions of the applicable resource consents. There is no evidence of any issues with any injection well currently in use, or the ability of the receiving formation to accept injected fluids. The results of groundwater quality monitoring undertaken show no adverse effects of the activity. Inspections undertaken during the monitoring year found sites being operated in a professional manner and there were no Unauthorised Incidents in relation to any of the Company's DWI consents.

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

For reference, in the 2016-2017 year, consent holders were found to achieve a high level of environmental performance and compliance for 74% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 21% of the consents, a good level of environmental performance and compliance was achieved.

In terms of overall environmental and compliance performance by the Company over the last several years, this report shows that the Company's performance remains at a high level.

This report includes recommendations to be implemented during the 2017–2018 monitoring period.

Table of contents

List of tables

List of figures

1. Introduction

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

1.1.1. Introduction

This report is for the period July 2016 to June 2017 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Cheal Petroleum Limited (the Company) for deep well injection (DWI) activities. During the period under review, the Company held five resource consents for the subsurface injection of fluids by DWI. The consents authorise discharges from three separate wellsites within the Company's Cheal oil and gas field located south of Stratford.

The resource consents held by the Company permit the discharge of a range of fluids by DWI, including produced water, contaminated stormwater, waste drilling fluids, hydraulic fracturing (HF) fluids, production sludges and compatible groundwater abstracted specifically for injection purposes. The consents include a number of special conditions which set out specific requirements the Company must satisfy.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the DWI consents held by the Company. This is the eighth report to be prepared by the Council to cover the Company's DWI discharges and their effects.

1.1.2. Structure of this report

Section 1 of this report is a background section. It sets out general information about:

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites though annual programmes;
- the resource consents held by the Company for DWI activities;
- the nature of the monitoring programme in place for the period under review; and
- a description of the activities and operations conducted by the Company.

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 2017-2018 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); and

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 Company, this report also assigns them a rating for their environmental and administrative performance during the period under review.

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 2016-2017 year, consent holders were found to achieve a high level of environmental performance and compliance for 74% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 21% of the consents, a good level of environmental performance and compliance was achieved.

1.2. Process description

The process of DWI involves injecting fluids deep underground into geological formations which are confined from overlying groundwater aquifers by low permeability strata. Injection wells are also designed and constructed to provide multi barrier protection against contaminant migration to groundwater systems.

The subsurface injection of fluids by DWI is often used as a method for disposing of waste fluids generated during oil and gas exploration and production activities. The greatest volume of waste fluids generated through these activities is saline water (brine) that is drawn to the surface with hydrocarbons through producing wells ('produced water'). The DWI consents currently held by the Company also authorise the injection of fluid types other the produced water. The range of fluid types authorised for injection varies by consent, but includes compatible groundwater, well workover fluids, well drilling fluids, HF fluids and HF return fluids.

In addition to providing a means to dispose of waste fluids, the subsurface injection of fluids by DWI is also an established oilfield technique for regulating reservoir pressure as a means of enhancing the rate of hydrocarbon recovery from a reservoir. This process, commonly referred to as water flooding, is often implemented when natural reservoir pressures become reduced due to ongoing production. Fluids can also be heated prior to injection to reduce the viscosity of the oil being produced, improving its flow toward a producing well and upward through the wellbore itself. During the reporting period one of the five consents (10254-1) held by the Company was being utilised for water flooding purposes.

A schematic representation of injection wells for both waste discharge and enhanced oil recovery is presented in Figure 1.

Further details regarding hydrocarbon exploration and production in Taranaki, the DWI process and its history within region can be found in previous compliance reports published by the Council (see Bibliography).

Further details regarding hydrocarbon exploration and production in Taranaki, the DWI process and its history within region can be found in previous compliance reports published by the Council (see Bibliography).

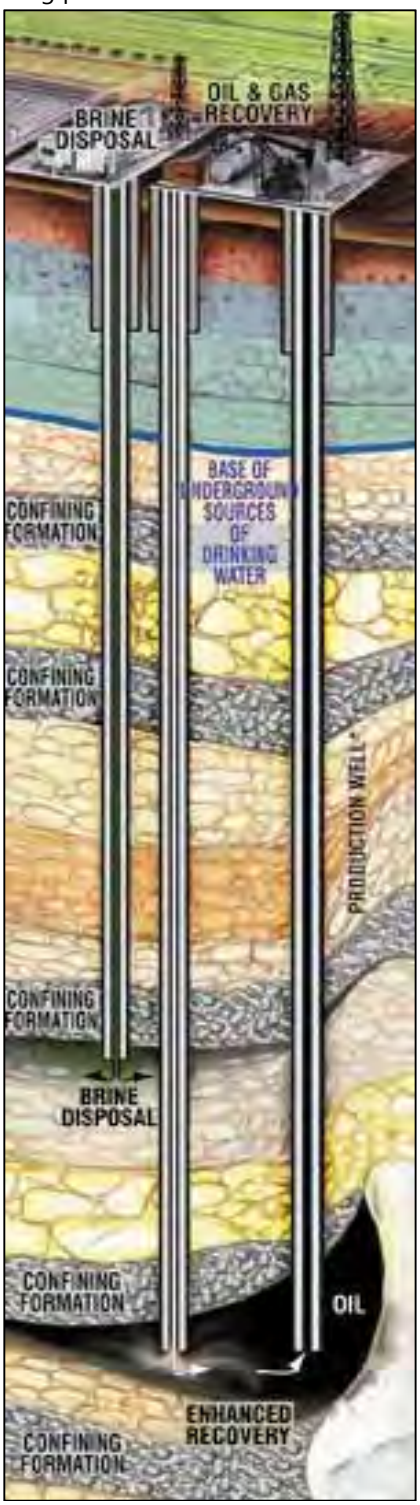

Figure 1 DWI schematic (www.epa.gov/uic)

1.3. Resource consents

1.3.1. Discharges of wastes to land

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

The Company held five discharge consents covering their DWI activities (Table 1). One of these consents (10354-1) was issued during the period under review.

Table 1 DWI consents held by the Company during the 2016-2017 monitoring year

Consent Number	Wellsite	Status	Injection Well(s)	Formation	Issued	Expiry
4728-2	Cheal-A	Not exercised	Cheal-A2	Mount Messenger	25/05/2012	01/06/2017
9545-2	Cheal-A	Active	Cheal-A4	Urenui	28/08/2015	01/06/2035
10254-1	Cheal-B	Active	Cheal-B3	Mount Messenger	11/04/2016	01/06/2034
10304-1	Cheal-E	Active	Cheal-E7	Mount Messenger	15/06/2016	01/06/2034
10354-1	Cheal-A	Not exercised	Cheal-A2	Mount Messenger	08/11/2016	01/06/2035

Consent **4728-2** was issued by the Council on 25 May 2012 under Section 87(e) of the RMA and expired on 1 June 2017. The consent authorises the discharge of saline groundwater from the Matemateaonga Formation into the Mount Messenger Formation for enhanced oil recovery purposes at the Cheal-A wellsite.

This consent was never exercised and was surrendered on 28 October 2016.

The surrendered consent had 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.

A detailed summary of the history of this consent can be found in previous compliance reports published by the Council (see Bibliography).

Consent **9545-2** was issued by the Council on 28 August 2015 under Section 87(e) of the RMA. It is due to expire on 1 June 2035. The consent authorises the discharge of produced water from hydrocarbon exploration and production operations reservoir compatible workover fluids and HF return fluids into the Urenui Formation by deep well injection at the Cheal-A wellsite.

The current consent has seventeen 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 2030;
- 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 m^3;
- 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.

A detailed summary of the history of this consent can be found in previous compliance reports published by the Council (see Bibliography).

Consent **10254-1** was issued by the Council on 11 April 2016 under Section 87(e) of the RMA. It is due to expire on 1 June 2034. The consent authorises the discharge of produced water, well drilling fluids, well work over fluids and HF fluids from hydrocarbon exploration and production operations in to the Mount Messenger Formation by deep well injection at the Cheal-B wellsite.

The current consent has seventeen 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 2029;
- Condition 4 requires the best practicable option to be adopted for fluid injection;
- Condition 5 limits the injection of fluids to the Mount Messenger Formation, below 1,600 m TVD;
- Condition 6 prohibits the discharge resulting in fracturing of the geological seals confining the injection zone;
- Condition 7 prohibits the discharge from resulting in any contaminants reaching any useable freshwater resources;
- Condition 8 limits the range of fluids that may be injected;
- Conditions 9, 10, 11 and 12 refer to process monitoring and data submission requirements;
- Conditions 13, 14 and 15 refer to local groundwater quality monitoring requirements;
- Condition 16 stipulates the annual reporting requirements; and
- Condition 17 is a review condition.

Consent **10304-1** was issued by the Council on 15 June 2016 under Section 87(e) of the RMA. It is due to expire on 1 June 2034. The consent authorises the discharge of produced water, well drilling fluids, well work over fluids and HF fluids from hydrocarbon exploration and production operations in to the Mount Messenger Formation by deep well injection at the Cheal-E wellsite.

The current consent has seventeen 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 2029;
- Condition 4 requires the best practicable option to be adopted for fluid injection;
- Condition 5 limits the injection of fluids to the Mount Messenger Formation, below 1,700 m TVD;

- Condition 6 prohibits the discharge resulting in fracturing of the geological seals confining the injection zone;
- Condition 7 prohibits the discharge from resulting in any contaminants reaching any useable freshwater resources;
- Condition 8 limits the range of fluids that may be injected;
- Conditions 9, 10, 11 and 12 refer to process monitoring and data submission requirements;
- Conditions 13, 14 and 15 refer to local groundwater quality monitoring requirements;
- Condition 16 stipulates the annual reporting requirements; and
- Condition 17 is a review condition.

Consent **10354-1** was issued by the Council on 11 November 2016 under Section 87(e) of the RMA. It is due to expire on 1 June 2035. The consent authorises the discharge of produced water, well drilling fluids, well work over fluids and HF fluids from hydrocarbon exploration and production operations in to the Mount Messenger Formation by deep well injection at the Cheal-A wellsite.

The current consent has seventeen 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 2030;
- Condition 4 requires the best practicable option to be adopted for fluid injection;
- Condition 5 limits the injection of fluids to the Mount Messenger Formation, below 1,665 m TVD;
- Condition 6 prohibits the discharge resulting in fracturing of the geological seals confining the injection zone;
- Condition 7 prohibits the discharge from resulting in any contaminants reaching any useable freshwater resources;
- Condition 8 limits the range of fluids that may be injected;
- Conditions 9, 10, 11 and 12 refer to process monitoring and data submission requirements;
- Conditions 13, 14 and 15 refer to local groundwater quality monitoring requirements;
- Condition 16 stipulates the annual reporting requirements; and
- Condition 17 is a review condition.

Figure 2 shows the location of the DWI consents held by the Company during the period under review.

This summary of consent conditions may not reflect the full requirements of each condition. The consent conditions in full can be found in the resource consents which are appended to this report (Appendix I).

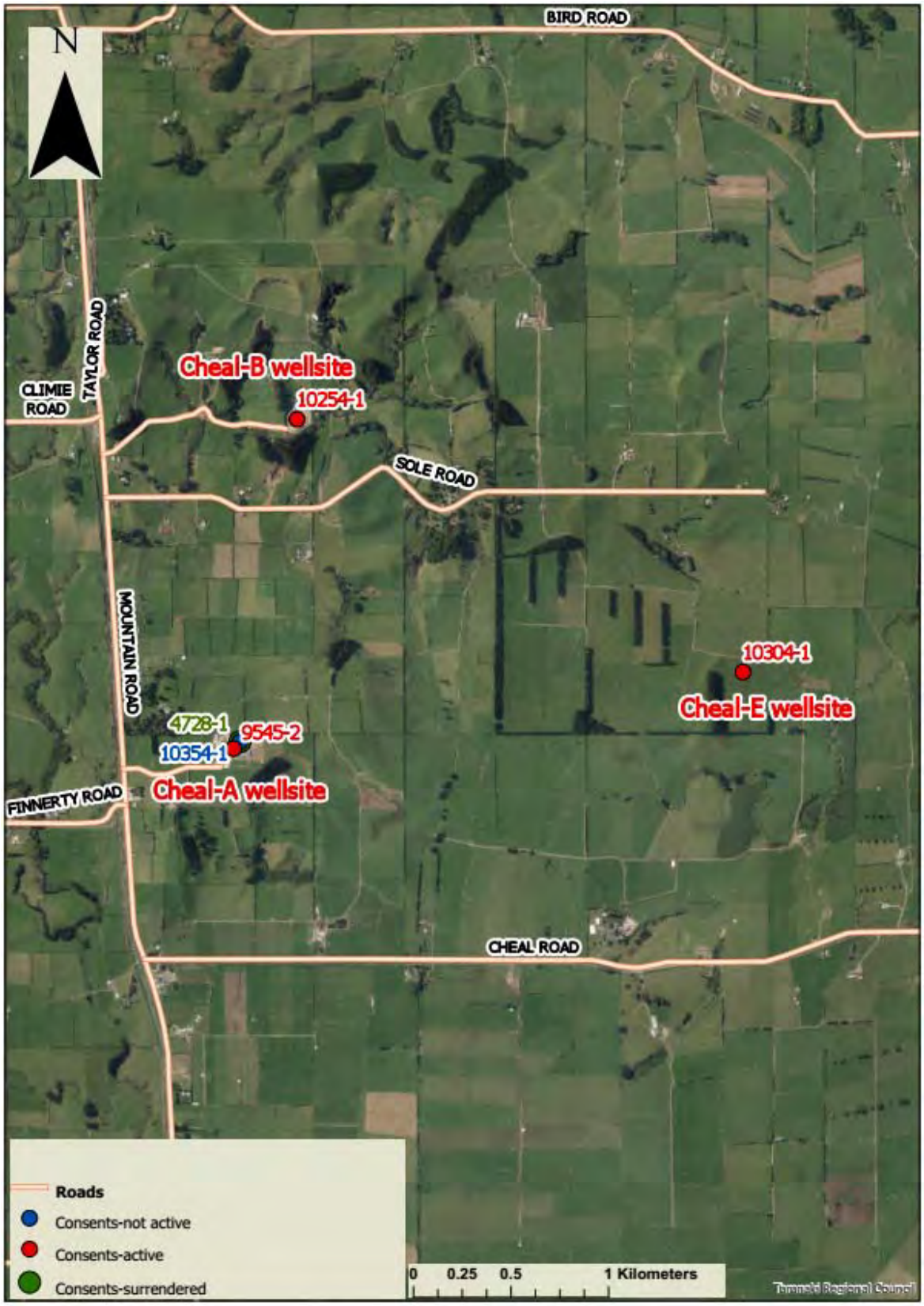

Figure 2 Cheal wellsites and associated consents

1.4. Monitoring Programme

1.4.1. Introduction

Section 35 of the RMA sets obligations upon the Council to gather information, monitor and conduct research on the exercise of resource consents within the Taranaki region. The Council is also required to assess the effects arising from the exercising of these consents and report upon them.

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 the DWI sites consisted of five primary components.

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 consent reviews, renewals or new consent applications;
- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

1.4.3. Site inspections

The Company's Cheal-B and Cheal-E wellsites were visited once and the Company's Cheal-A wellsite, which is also a production station, was visited six times during the monitoring period. With regard to consents for DWI activities, the main points of interest are general housekeeping and any processes with potential or actual discharges, including any surface water runoff, and their receiving environments.

An additional two visits to the Company's Cheal-A wellsite were undertaken by Council Officer's for injectate sampling purposes, as outlined in Section 1.4.4.

1.4.4. Injectate sampling

Injectate samples were obtained for analysis in the Council's IANZ accredited laboratory on two occasions during the monitoring period. 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.

Injectate samples were collected from the bulk storage tanks at the Cheal-A wellsite, identified on-site as tanks T-0504 and T-0505 and displayed in Figure 3.

The injectate samples were analysed for the following parameters:

- pH;
- conductivity;
- alkalinity;
- chlorides; and
- total petroleum hydrocarbons.

1.4.5. Groundwater sampling

Groundwater samples were also obtained on two occasions during the monitoring period. This sampling is a continuation of the groundwater monitoring component of this programme which was initiated during the 2012-2013 monitoring period.

Previous groundwater sampling carried out has been limited to monitoring sites in the vicinity of the Cheal-A wellsite (GND1139 and GND0492). Injection commenced at the Cheal-B and Cheal-E wellsites during the reporting period and the purpose built monitoring bores GND2592 and GND2571 have now been added to the monitoring programme.

Details of the sites currently included in the monitoring programme are listed below in Table 2. The location of the groundwater sites in relation to the injection well being monitored is illustrated in Figure 3.

Table 2 Location of groundwater sampling sites

Site code	Wellsite	Distance from injection well (m)	Cased depth (m)	Screened interval (m)	Total depth (m)	Groundwater level (m BMP)	Aquifer
GND1139	Cheal-A	415	0-36.0	36.0-54.0	54.0	6.1	Volcanics
GND0492	Cheal-A	357	0-19.5	Open hole	30.5	7.0	Volcanics
GND2543	Cheal-B	<50	0-14.1	14.1-32.1	32.1	1.1	Volcanics
GND2592	Cheal-E	<50	0-30.7	18.7-30.7	30.7	0.2	Volcanics

Groundwater samples are analysed in the Council's IANZ accredited laboratory for a basic range of chemical parameters as follows:

- pH;
- conductivity;
- chlorides; and
- total petroleum hydrocarbons.

The parameters above are deemed sufficient to enable identification of any significant changes in groundwater quality related to DWI activities.

In addition, baseline samples have been collected and analysed by Hill Laboratories Limited (Hills) for general ion chemistry, BTEX and dissolved gas concentrations. These more detailed analyses will allow a more in depth assessment of variations in groundwater composition should the need arise in the future.

1.4.6. Assessment of data submitted by the Company

A significant component of the monitoring programme is the assessment of consent holder submitted data. The Company is required to submit a wide range of data under the conditions of their respective DWI consents.

As required by the conditions of their consents, the Company has submitted an Injection Operation Management Plan for each active injection well. 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 actions 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 Company is also required to maintain continuous records of injection volumes, rates and pressures, and to characterise the chemical characteristics of all waste types being discharged. This data is submitted to the Council on a monthly basis where it is assessed for compliance against the relevant consent conditions.

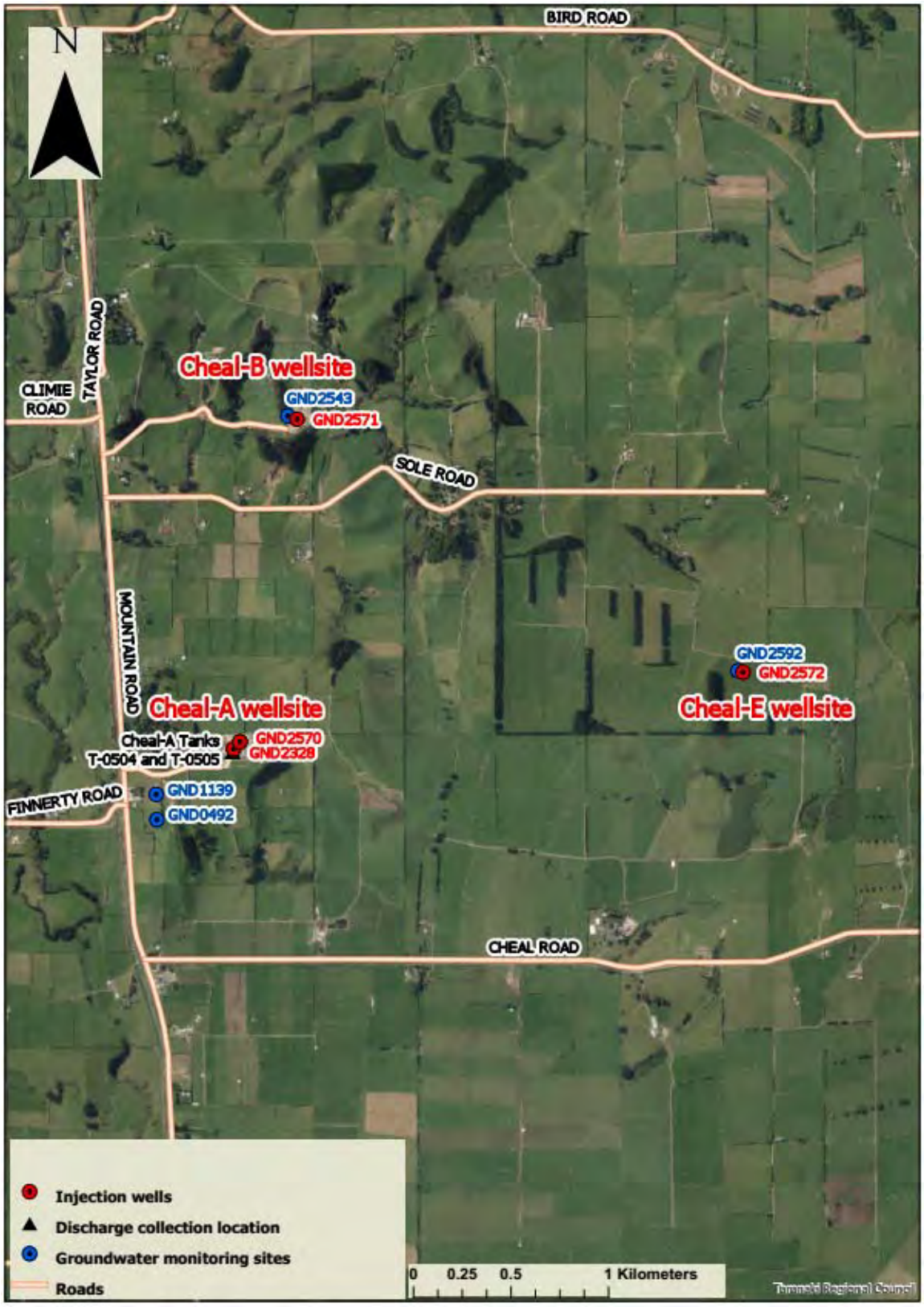

Figure 3 Location of groundwater sampling sites in relation to injection wells being monitored

2. Results

2.1. Inspections

Annual routine inspections of the Company's wellsites were conducted during the period under review. Routine inspections included undertaking a general visual assessment of the operational equipment, storage facilities and associated equipment. The inspecting officer concluded that the wellsites were in good condition and being well managed. There were no issues noted specific to any of the Company's DWI consents.

The site was also visited by Council officers on two occasions during the monitoring year for the purpose of injectate sampling. This involved accessing the Company's bulk liquid storage tanks at the Cheal-A wellsite. No issues were noted by staff during these visits.

2.2. Injectate sampling

Samples of injectate were obtained from the Company's storage tanks at the Cheal Production Station, located at the Cheal-A wellsite, on 18 October 2016 and 2 May 2017. The samples were submitted to the Council's laboratory on the same day for physicochemical analysis.

The results of the sample analyses are included below in Table 3. The range of results for each analyte over previous monitoring periods is also presented for comparison.

The Company also collects samples for analysis monthly at each site prior to injection. The range of the results of this analysis is presented in Table 4, Table 5 and Table 6.

The concentrations of each analyte measured over the 2016-2017 period are within the expected range for produced water samples at these sites.

Table 3 Results of the Councils injectate sampling in 2016-2017 in comparison to previous results

Sample details	Units	Cheal Production Station Tanks T0504 and T0505			
		Minimum	Maximum	-	-
Date	-	1-Jul-2013 to 30-Jun-2016		18-Oct-2016	2-May-2017
Time	NZST	-	-	9:15	9:30
TRC sample number	-	-	-	TRC163446	TRC171559
pH	pH units	6.0	8.0	8.0	7.8
Electrical conductivity	mS/m@20°C	3,760	4,140	1,100	3,020
Chloride	g/m^3	16,000	18,300	4,070	12,600
Total petroleum hydrocarbons	g/m^3	22	520	24	200

Table 4 Range of results of the Company's monthly injectate sampling at Cheal-A (2016-2017)

Sample details	Units	Cheal-A		
		Minimum	Maximum	Mean
Date	-	1-Jul-2016 to 30-Jun-2017		
pH	pH units	6.6	8.2	7.5
Electrical conductivity	mho/cm	0.0085	0.2632	0.0447
Suspended solids	g/m^3	29	494	123
Temperature	Deg°C	28	47	34
Salinity	TDS g/m^3	330	11,700	4,275
Chloride	mg/L	2,100	22,500	8,558
Total petroleum hydrocarbons	g/m^3	73	9,280	2,788

Table 5 Range of results of the Company's monthly injectate sampling at Cheal-B (2016-2017)

Sample details	Units	Cheal-B		
		Minimum	Maximum	Mean
Date	-	1-Jul-2016 to 30-Jun-2017		
pH	pH units	7.4	8.2	7.8
Electrical conductivity	mho/cm	0.0064	0.1232	0.0310
Suspended solids	g/m^3	9	120	43.9
Temperature	Deg°C	13	32	24
Salinity	TDS g/m^3	1,330	6,190	2,491
Chloride	mg/L	330	11,900	3,975
Total petroleum hydrocarbons	g/m^3	72	9,280	2,496

Table 6 Results of the Company's monthly injectate sampling at Cheal-E (2016-2017)

Sample details	Units	Cheal-E		
Date	-	Apr-2017	May-2017	Jun-2017
pH	pH units	7.6	7.8	7.9
Electrical conductivity	mho/cm	0.0158	0.0236	0.0094
Suspended solids	g/m^3	105	437	19
Temperature	Deg°C	23	24	13
Salinity	TDS g/m^3	3,350	4,160	1,625
Chloride	mg/L	6,200	7,700	2,500
Total petroleum hydrocarbons	g/m^3	72	110	72

2.3. Groundwater sampling

Groundwater samples were obtained from two sites located in the vicinity of the Cheal-A wellsite, (GND0492 and GND1139) and one site (GND2453) at the Cheal-B wellsite, on 11 October 2016 and 2 May 2017. Two baseline samples and one biannual sample (2 May 2017) were also obtained from GND2592, located at the Cheal-E wellsite, which was installed by the Company in anticipation of injection commencing during the review period.

All groundwater 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 results of groundwater sampling analyses carried out under the monitoring programme are set out below in Table 7 to Table 11.

The first baseline sample taken at GND2592 was taken on 9 December 2016, and the second on 9 February 2017. The initial sample indicated the presence of high levels of methane and a trace of toluene. These results initiated follow up sampling and the methane sample being sent to GNS for carbon isotope analysis. The repeat results confirmed the high methane and trace toluene concentrations.

The geology intersected during drilling the bore indicated the presence of immature hydrocarbons (peat deposits) at the site location. These types of deposits contain methane and can also contain traces of toluene (ESAA, 2017). A carbon-13 isotope analysis of dissolved methane in groundwater returned a result of -65.9 ‰ indicating a biogenic source and the lack of other contaminants which also occur if deep water hydrocarbons are present in groundwater indicate the methane and toluene are likely naturally occurring and not linked to activities at site.

The results show there have been no significant changes in groundwater composition at any site since monitoring commenced. This is demonstrated by the relatively narrow ranges between minimum and maximum analyte concentrations recorded since monitoring commenced. The subtle variation in analyte concentrations at each site are a result of natural seasonal fluctuation and sampling variability.

Table 7 Results of groundwater sampling undertaken by the Council at GND0492 (Cheal-A)

Sample details	Units	GND0492			
		Minimum	Maximum	-	-
Date	-	1-Jul-2011 to 30-Jun-2016		18-Oct-2016	2-May-2017
Time	NZST	-	-	14:53	14:17
TRC sample number	-	-	-	TRC163449	TRC171558
pH	pH units	6.6	8.1	6.8	7.1
Electrical conductivity	mS/m@20°C	11.1	21.5	16.9	14.4
Chloride	g/m^3	10.5	22.3	18.9	14.9
Total petroleum hydrocarbons	g/m^3	<0.5	<0.7	<0.5	<0.5

Table 8 Results of groundwater sampling undertaken by the Council at GND1139 (Cheal-A)

Sample details	Units	GND1139			
		Minimum	Maximum	-	-
Date	-	01-Jul-2012 to 30-Jun-2016		18-Oct-2016	2-May-2017
Time	NZST	-	-	11:56	14:50
TRC sample number	-	-	-	TRC163448	TRC171557
pH	pH units	6.7	7.1	6.9	7
Electrical conductivity	mS/m@20°C	14.5	20.6	18.9	18.5
Chloride	g/m^3	9.4	14.2	13.7	13.2
Total petroleum hydrocarbons	g/m^3	<0.5	1.4	<0.5	<0.5

Table 9 Results of groundwater sampling undertaken by the Council at GND2543 (Cheal-B)

Sample details	Units	GND2543		
Date	-	2-Jun-2016	18-Oct -2016	2-May-2017
Time	NZST	12:40	11:03	13:12
TRC sample number	-	TRC162242	TRC163447	TRC171556
pH	pH units	7.3	7.3	7.3
Electrical conductivity	mS/m@20°C	24.0	21.2	20.9
Chloride	g/m^3	16.9	16.4	16.3
Total petroleum hydrocarbons	g/m^3	<0.7	<0.5	<0.5

Table 10 Results of groundwater sampling undertaken by the Council at GND2592 (Cheal-E)

Sample details	Units	GND2592		
Date	-	09-Dec-16	09-Feb-17	02-May-17
Time	NZST	09:50	10:12	11:37
TRC sample number	-	TRC170179	TRC170783	TRC171555
pH	pH units	7.2	7.2	7.2
Electrical conductivity	mS/m@20°C	72.5	88.3	88.6
Chloride	g/m3	14.8	15.8	21.5
Total petroleum hydrocarbons	g/m3	< 0.7	< 0.7	1.7

Table 11 Results of baseline groundwater sampling undertaken by the Council at GND2592 (Cheal-E)

Sample details	Units	GND2592		Sample details	Units	GND2592	
Date	-	09-Dec-16	09-Feb-17	Date		09-Dec-16	09-Feb-17
Time	NZST	09:50	10:12	Time	NZST	09:50	10:12
TRC sample number	-	TRC170179	TRC170783	TRC sample number	-	TRC170179	TRC170783
Chloride	g/m³	14.8	15.8	Magnesium	g/m³	18.1	22.0
Electrical conductivity	mS/m	72.5	88.3	Dissolved bromine	g/m³	0.133	0.119
Dissolved oxygen	g/m³	0.44	1.08	Dissolved barium	g/m³	0.094	0.122
pH	pH units	7.2	7.2	Dissolved mercury	g/m³	< 0.00008	< 0.00008
Temperature	°C	17.9	15.2	Dissolved manganese	g/m³	0.35	0.89
Dissolved oxygen	%	4.8	11.0	Dissolved nickel	g/m³	0.0115	0.0030
Sulphates	g/m³	14.3	0.8	Dissolved zinc	g/m³	0.0099	0.0159
Alkalinity	g/m³ $CaCO_3$	370	470	Sum of cations	meq/L	7.2	8.7
Bicarbonate	g/m³ HCO_3	450	570	Methane	g/m³	38	33
Hardness	g/m³ $CaCO_3$	162	200	Toluene	g/m³	0.0017	0.0015
Total Nitrogen	g/m³ N	0.005	0.008	o-Xylene	g/m³	< 0.0010	< 0.0010
Nitrite	g/m³ N	0.004	0.003	m-Xylene	g/m³	< 0.002	< 0.002
Nitrate	g/m³ N	< 0.002	0.005	Benzene	g/m³	< 0.0010	< 0.0010
Sum of anions	meq/L	8.1	9.8	Ethylbenzene	g/m³	< 0.0010	< 0.0010
Calcium	g/m³	35	45	Ethane	g/m³	< 0.007	< 0.003
Potassium	g/m³	17.5	21.0	Ethylene	g/m³	< 0.010	< 0.004
Sodium	g/m³	77	94	Total hydrocarbons	g/m³	< 0.7	< 0.7
Dissolved iron	g/m³	5.50	1.77	Carbon 13	0/00	-	-65.9
Dissolved copper	g/m³	0.0097	0.0137	-	-	-	-

2.4. Provision of consent holder data

The Company provided records of their injection activities during 2016-2017 monitoring period, including daily injection volumes, pumping duration and injection pressure. No issues were found with data provide by the company.

Table 12 provides an overview of the Company's injection activities across all consents during the monitoring period. Consent 9545-2, was exercised during the entire period and consents 10254-1 and 10304-1 were utilised for the first time during the review period. Consent 4728-1 which provides for injection via the Cheal-A2 well was replaced by consent 10354-1, neither consent was exercised during the

review period. Table 13 provides a summary of injection at all sites since 2007 and indicates that the volume discharged during the review period was significantly higher than in previous years.

Table 12 Summary of injection activity during the 2016-2017 monitoring year

Consent	Wellsite	Injection well	Total volume discharged (m^3) 01/07/16 – 30/06/17	Discharge period		Well ID
				From	To	
4728-1	Cheal-A	Cheal-A2	0	N/A	N/A	GND2570
9545-1	Cheal-A	Cheal-A4	20,118.62	01/07/2016	30/06/2017	GND2328
10254-1	Cheal-B	Cheal-B3	34,005.75	01/07/2016	30/06/2017	GND2571
10304-1	Cheal-E	Cheal-E7	6,832.64	01/04/2017	30/06/2017	GND2572
10354-1	Cheal-A	Cheal-A2	0	N/A	N/A	GND2570
Total			**60,957.01**	-	-	-

Table 13 Summary of historical injection activity

Period	Total volume discharged (m^3)	Period	Total volume discharged (m^3)
2016-2017	60,957	2011-2012*	9,793
2015-2016	16,988	2010-2011*	9,792
2014-2015	17,630	2009-2010*	9,792
2013-2014	12,880	2007-2009	No injection
2012-2013	14,660	-	-

*Note *=volume was reported from 2009-2012 (29,377 m^3) so total has been averaged over the three year period.*

Table 14, Table 15 and Table 16 summarise the data for each active site during the review period.

At the Cheal-A wellsite the maximum injection pressure of 103.86 bar was recorded on 22 October 2016. The maximum daily volume of 129.32m^3 was recorded on 8 October 2016 and the maximum injection rate of 13.25 m^3/hr was recorded on 13 October 2016.

At the Cheal-B wellsite injection commenced on 20 September 2016. During the review period the maximum injection pressure of 97.18 bar was recorded 7 February 2017. The maximum daily volume of 267.58m^3 was recorded 12 October 2016 and the maximum injection rate of 65.62 m^3/hr was recorded on 27 December 2016. The high injection rate was an anomalous result with the second highest recorded rate of 18.20 m^3/hr recorded on 14 October 2016. The average injection rate over the monitoring period was 5.59 m^3/hr.

At the Cheal-E wellsite Injection commenced on 1 April 2016. During the review period the maximum injection pressure of 80.78 bar was recorded 20 May 2017 and the maximum daily volume of 197.89m^3 on 28 June 2017. The maximum injection rate of 11.84 m^3/hr was recorded 25 April 2017.

All submitted data was within consented limits.

Table 14 Summary of injection occurring under consent 9545-2 (2013-2017)

Deep well injection undertaken at Cheal-A wellsite via the Cheal-A4 injection well					
Year	Annual volume (m^3)	Max. injection volume (m^3/day)	Maximum injection rate (m^3/hr)	Max. injection pressure (bar)	Avg. injection pressure (bar)
Consent limit	-	200	-	276	-
2016-2017	20,119	129	13.3	104	74
2015-2016	16,988	123	5.3	104	53
2014-2015	14,705	117	13.4	140	69
2013-2014	12,880	142	12.0	209	58

Table 15 Summary of injection occurring under consent 10254-1 (2016-2017)

Deep well injection undertaken at Cheal-B wellsite via the Cheal-B3 injection well					
Year	Annual volume (m^3)	Max. injection volume (m^3/day)	Maximum injection rate (m^3/hr)	Max. injection pressure (bar)	Avg. injection pressure (bar)
2016-2017	34,006	268	65.6	97	63

Table 16 Summary of injection occurring under consent 10304-1 (2016-2017)

Deep well injection undertaken at Cheal-E wellsite via the Cheal-E7 injection well					
Year	Annual volume (m^3)	Max. injection volume (m^3/day)	Maximum injection rate (m^3/hr)	Max. injection pressure (bar)	Avg. injection pressure (bar)
2016-2017	6,833	198	11.8	81	33

Figure 4 to Figure 7 present the annual and historical injection data under consent 9454-2 at the Cheal-A wellsite graphically. A visual assessment of the data indicates wellhead pressures generally increase with higher volumes of injection. The volume of fluid injected via the Cheal-A4 well and the corresponding injection pressures have both increased steadily over time.

Figure 8 to Figure 11 presents the data for the review period under consents 10254-1 and 10304-1, at the Cheal-B and Cheal-E wellsites respectively. A visual assessment of the data indicates injection at the Cheal-B wellsite reduced once commencement of injection at the Cheal-E wellsite began. The decrease in injection volume corresponds to an increase in pressure indicating that fluid is not as easily accepted by the formation at the Cheal-B wellsite as it is at the other wellsites where increases in pressure relate to increases in volume. The increase is an indication of the success of the water flooding programme at this site which is designed specifically to increase pressure in the formation. Pressures will continue to be monitored closely across all sites.

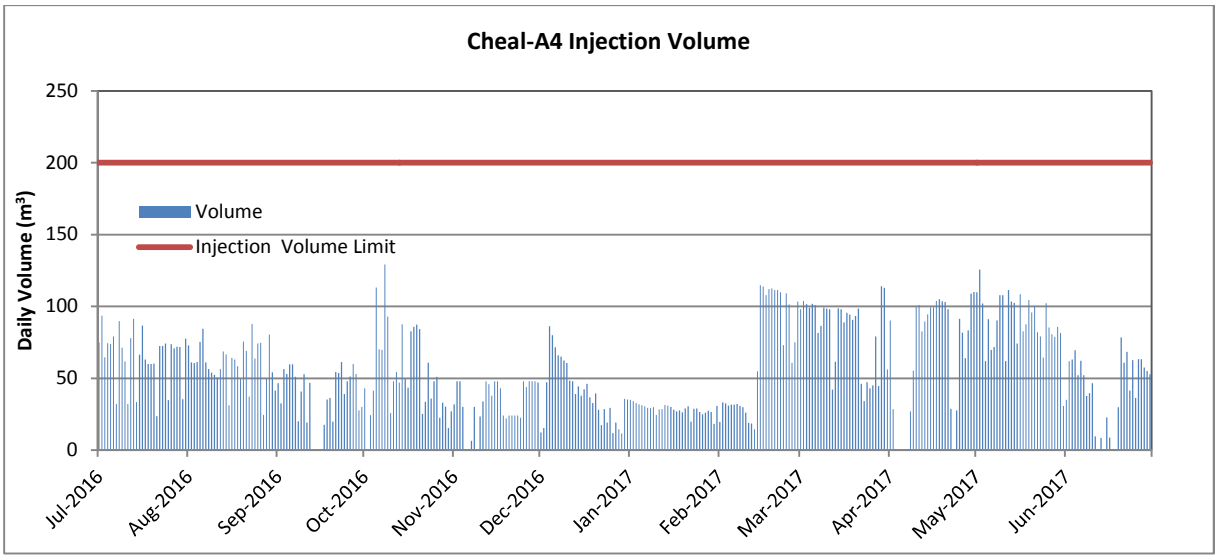

Figure 4 Cheal-A total daily injection volume (2016-2017)

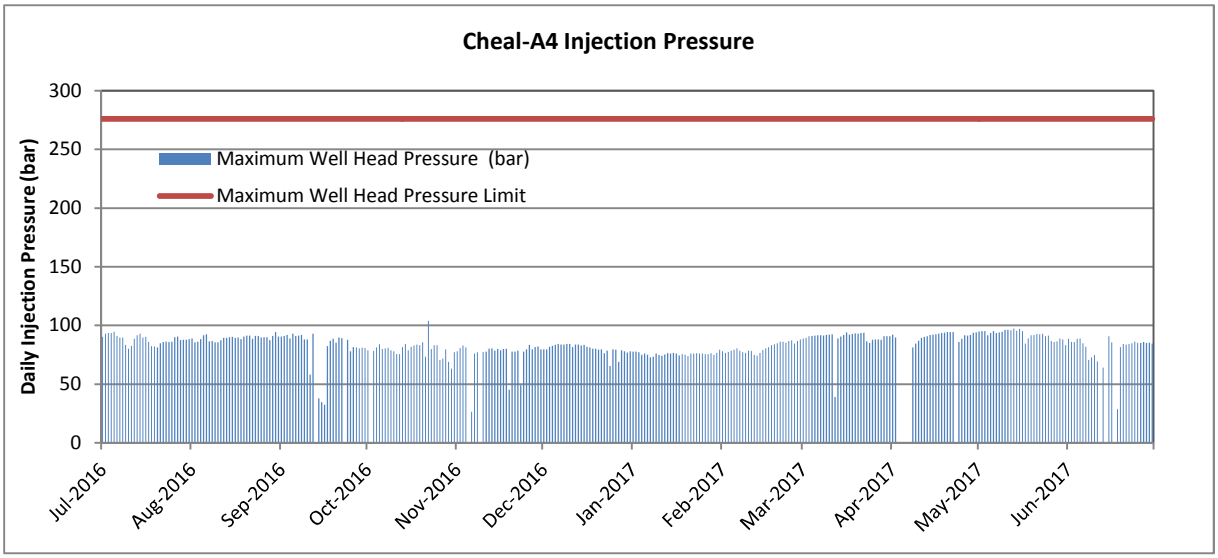

Figure 5 Cheal-A maximum daily injection pressure (2016-2017)

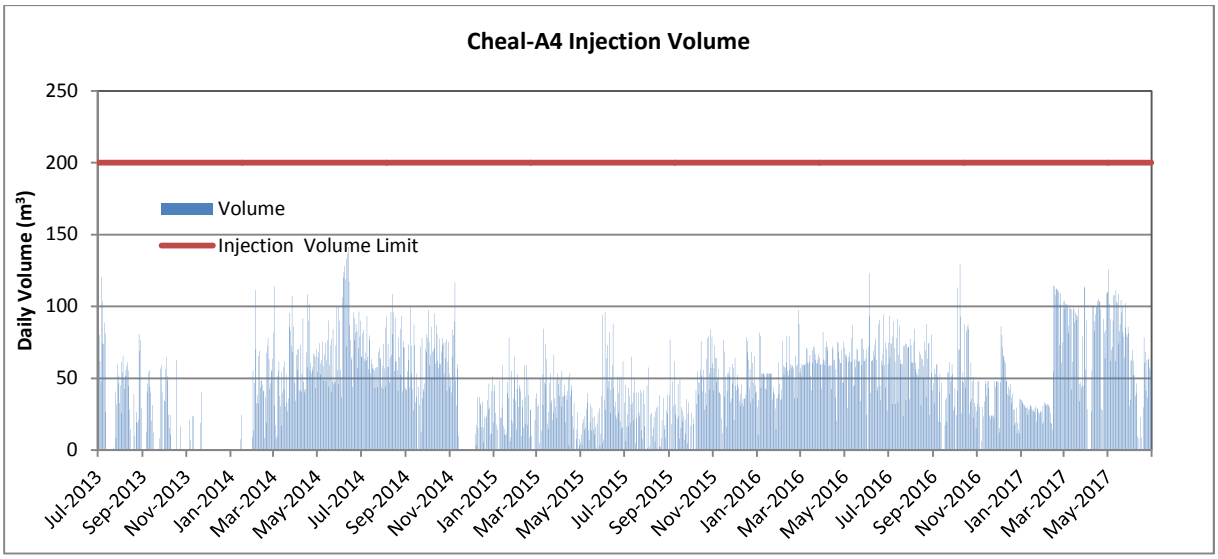

Figure 6 Cheal-A total daily injection volume (2013-2017)

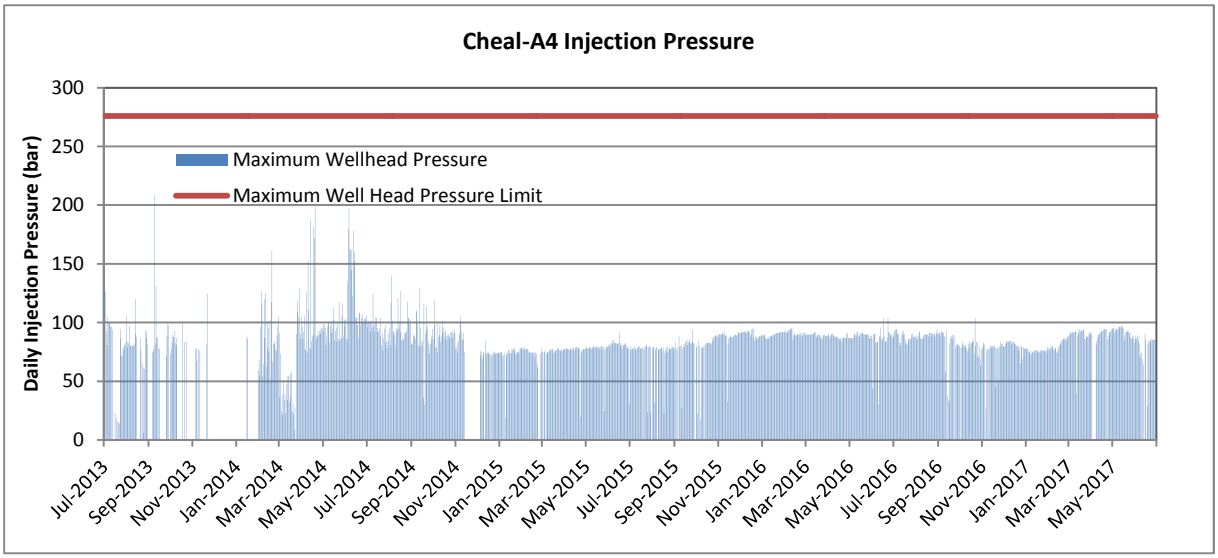

Figure 7 Cheal-A maximum daily injection pressure (2013-2017)

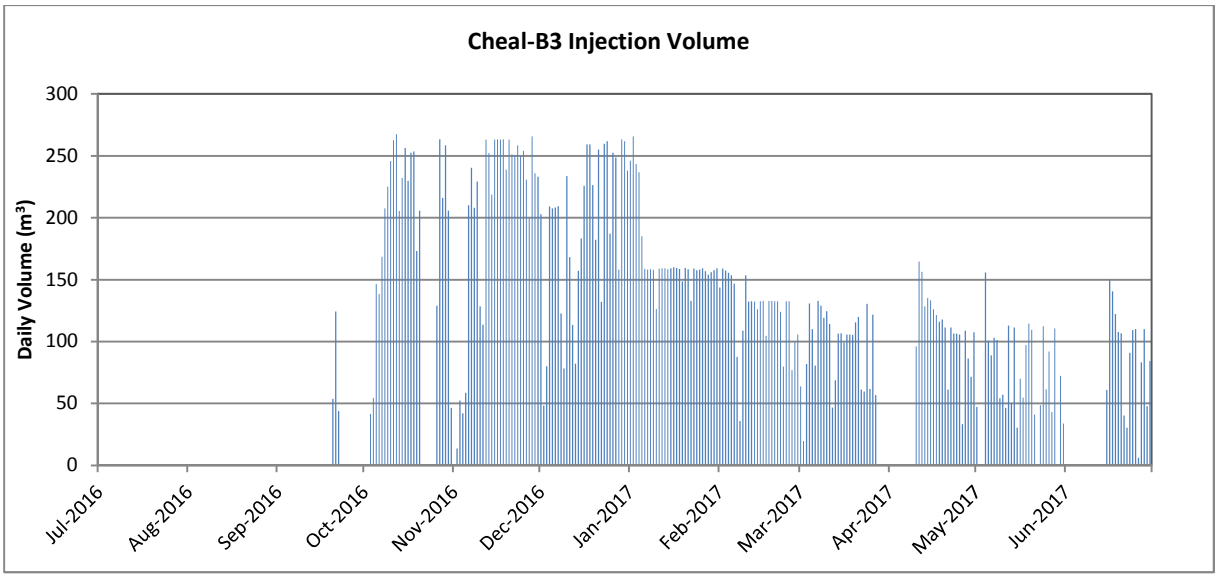

Figure 8 Cheal-B total daily injection volume (2016-2017)

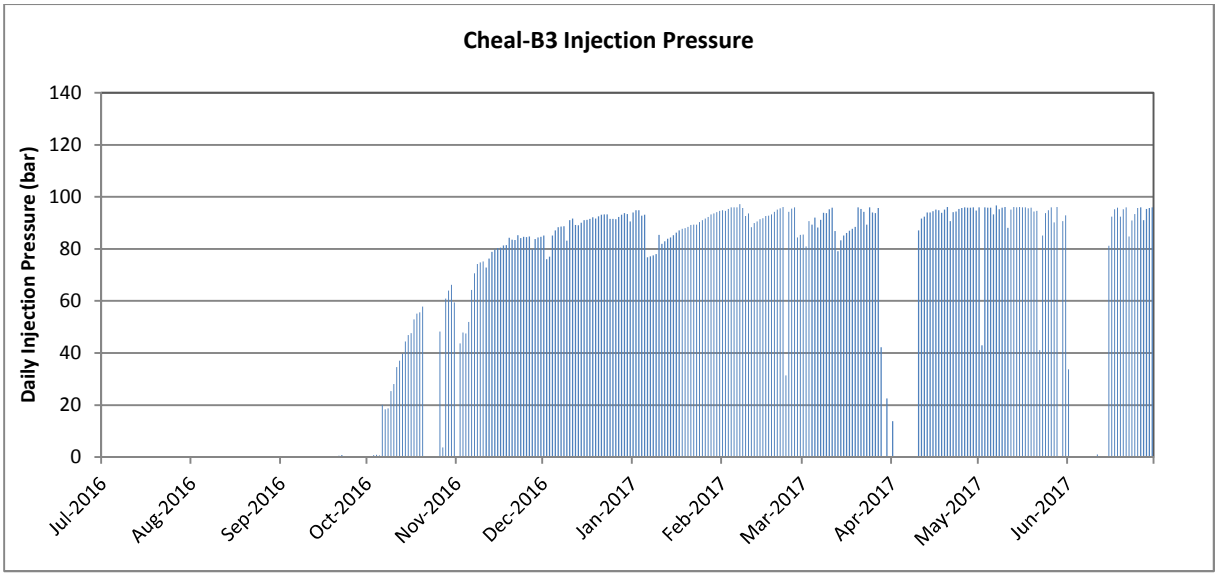

Figure 9 Cheal-B maximum daily injection pressure (2016-2017)

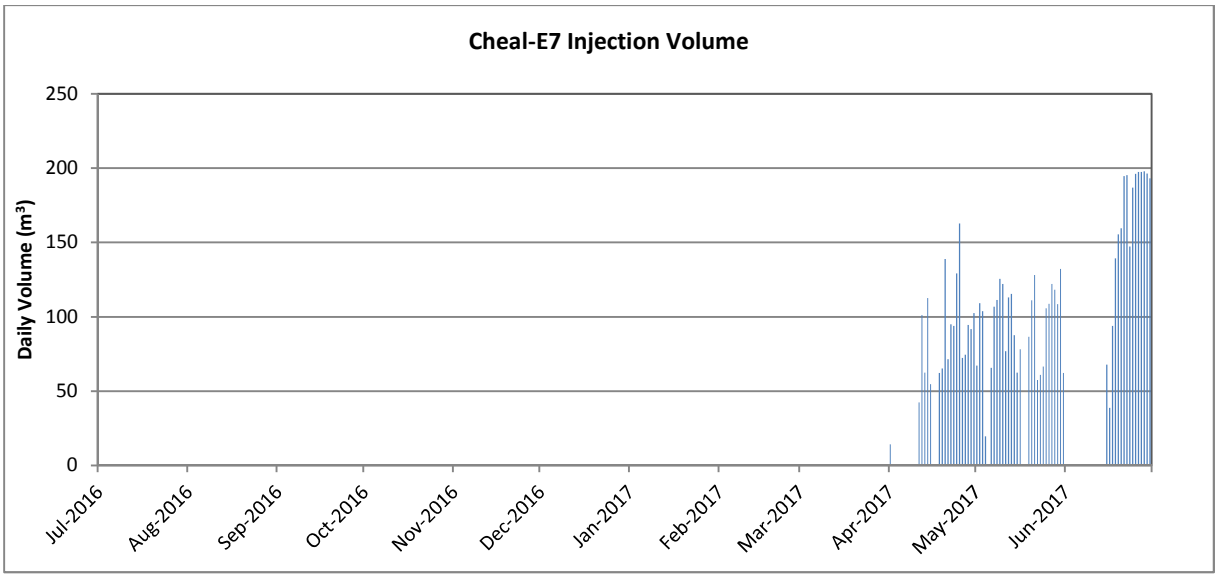

Figure 10 Cheal-E total daily injection volume (2016-2017)

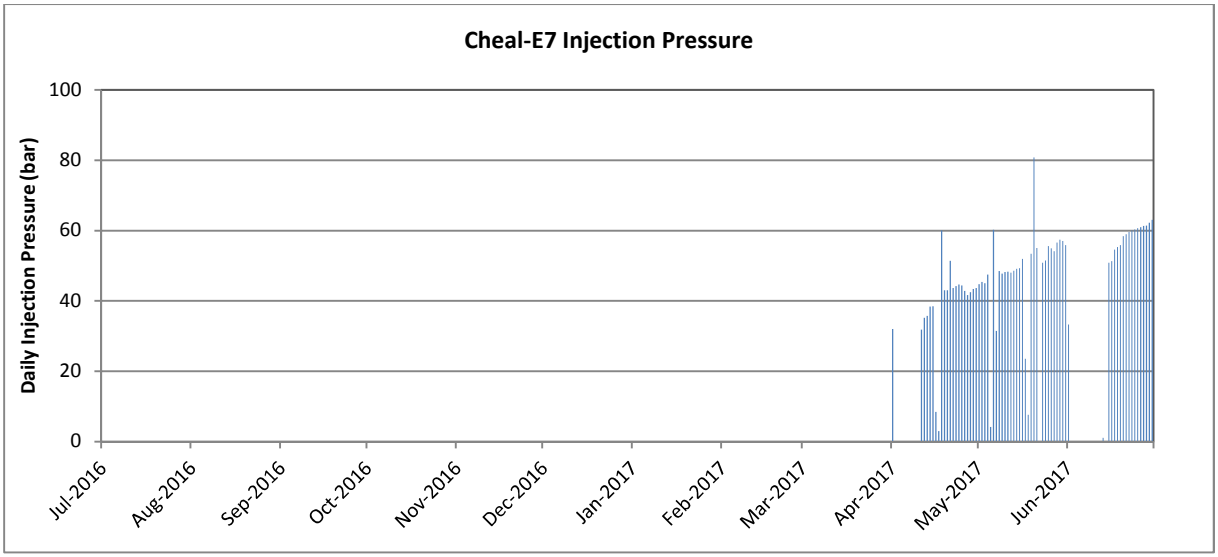

Figure 11 Cheal-E maximum daily injection pressure (2016-2017)

2.5. 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 Company. 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 causes 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 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).

All monitoring data was provided to the Council within acceptable timeframes and all submitted data was below consented limits during the 2016-2017 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

3.1. Discussion of site performance

During the period under review, the Company exercised three resource consents for the injection of fluids by DWI at three separate wellsites. The exercised consent 9545-2, authorises the injection of fluids into the Urenui Formation, at a depth in excess of 1,300 m TVD. Injection into this interval is via the Cheal-A4 well, located on the Cheal-A wellsite. The exercised consent 10254-1, authorises the injection of fluids into the Mount Messenger Formation, at a depth in excess of 1,600 m TVD. Injection into this interval is via the Cheal-B3 well, located on the Cheal-B wellsite. The exercised consent 10304-1, authorises the injection of fluids into the Mount Messenger Formation, at a depth in excess of 1,700 m TVD. Injection into this interval is via the Cheal-E7 well, located on the Cheal-E wellsite.

An Injection well is either converted from an existing production well or designed specifically for injection purposes and are fitted with engineering controls and in built safety systems to protect the wellbore against any process or subsurface related failures. In the event of any sudden pressure losses or increases, safety systems isolate the wellbore and shut down the injectate pumping system. It should also be noted that maximum pressure that can be generated by the injectate pumps are well below the safe operating pressures of the wellhead, casing and tubing and any unanticipated increases in wellhead, casing or tubing pressures initiate immediate shutdown of the well.

The operation of the injection well is monitored by Company staff, with automated systems recording the injection data required under the conditions of their consent. Throughout the monitoring period this data was submitted to the Council within an acceptable frequency and all data submitted fell below any consent condition limits.

A review of the 2016-2017 injection data provided by the Company shows a total of:

- 20,118.62 m3 of fluid was injected under consent 9545-2;
- 34,005.75 m3 of fluid was injected under 10254-1; and
- 6,832.54 m3 of fluid was injected under 10304-1.

The maximum daily volume of 129.32 m^3 injected via the Cheal-A4 well was recorded on 8 October 2016, via the Cheal-B3 well on 12 October2016 (267.58 m^3) and via the Cheal-E7 well on 28 June 2017 (197.89 m^3).

An assessment of the injection data record over the lifetime (2013-2017) of consent 9545-2 suggests that there may have been a slight increase in wellhead pressure over time. This increase is to be expected over time and also corresponds with an increase in volumes injected. In contrast, pressures at the Cheal-B wellsite have increased as volumes decrease indicating the formation does not accept fluids as easily and the success of the water flooding programme at this site.

Routine inspections of the Company's Cheal wellsites conducted during the period under review found them to be in good condition and being well managed. The Council was not required to enter any incidents in relation to the exercising of the Company's DWI consents during the review period, nor were any complaints received from the public in relation to these consents

3.2. Environmental effects of exercise of consents

To date, no adverse environmental effects have been recorded by the Council in relation to any DWI consent exercised by the Company.

The groundwater monitoring component of this programme continued during the period under review, with biannual samples being taken from active wellsites and baseline samples being taken from the Cheal-E wellsite. The results of the monitoring carried out show that the groundwater composition at each site has remained stable since the commencement of monitoring. Some very minor fluctuations in analyte concentrations are attributable to seasonal variations in water composition and standard sampling variability. There is no evidence to suggest that injection activities undertaken by the Company during the review period have had any adverse effect on local groundwater quality.

In order to monitor the effects of the Company's injection operations on groundwater resources, the groundwater monitoring component of this programme will be expanded as additional consents are exercised. During the review period one additional monitoring bore was installed prior to commencement of injection at the Cheal-E wellsite.

Compliance with the conditions of the Company's DWI consents exercised during the 2016-2017 monitoring period is summarised below in Section 3.3.

3.3. Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Tables 15, 16 and 17.

Table 17 Summary of performance for consent 9545-2

Purpose: ***To discharge produced water from hydrocarbon exploration and production operations into the Urenui Formation by deep well injection at the Cheal-A wellsite.***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. By 1 October 2015, the consent holder shall submit an "Injection Operation Management Plan."	Receipt of satisfactory "Injection Operation Management Plan," by 1 October 2015.	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 October 2015.	Yes
3. No injection permitted after 1 June 2030.	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, 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

Purpose: *To discharge produced water from hydrocarbon exploration and production operations into the Urenui Formation by deep well injection at the Cheal-A wellsite.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
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 an 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 15th 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

Purpose: *To discharge produced water from hydrocarbon exploration and production operations into the Urenui Formation by deep well injection at the Cheal-A wellsite.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
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 fist 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 administrative performance in respect of this consent		**High**

Table 18 Summary of performance for consent 10254-1

Purpose: *To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-B wellsite.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Before exercising, the consent holder shall submit an "Injection Operation Management Plan."	Receipt of satisfactory "Injection Operation Management Plan," before exercising the consent.	Yes

Purpose: *To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-B wellsite.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
2. Injection well, geological and operational data submission requirements. This information can be included in the "Injection Operation Management Plan."	Receipt of satisfactory information before exercising the consent.	Yes
3. No injection permitted after 1 June 2029.	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 mount Messenger Formation, deeper than 1,600 metres true vertical depth.	Review of "Water Flooding Operation Management Plan," well construction log and injection data.	Yes
6. The consent holder shall ensure that the exercise of this consent does not result in fracturing of geological seals.	Review and analysis of injection data.	Yes
7. 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
8. Limits the range of fluids that can be discharged under the consent.	Assessment of consent holder records and injectate sample analysis.	
9. Maintain records an undertake analysis to characterise each type of waste arriving on-site for discharge.	Receipt and assessment of injection data.	Yes
10. The consent holder will maintain daily injection data records.	Receipt of satisfactory data.	Yes
11. If not carried out by an IANZ accredited laboratory, analysis shall be carried out in accordance with QA plan which has been certified by the Chief Executive QA/QC	Inspection of QA plan	Yes

Purpose: *To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-B wellsite.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
12. The data required by conditions 9 & 10 above, for each calendar month, is required to be submitted by the 28th day of the following month.	Receipt of satisfactory data by the date specified	Yes
13. 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 exercising the consent,	Yes
14. 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
15. 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 fist round of sampling being undertaken	
16. 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
17. Consent review provision.	N/A	N/A

Purpose: *To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-B wellsite.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

Table 19 Summary of performance for consent 10304-1

Purpose: *To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-E wellsite.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Before exercising the consent holder shall submit an "Injection Operation Management Plan."	Receipt of satisfactory "Injection Operation Management Plan," before exercising the consent.	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 before exercising the consent.	Yes
3. No injection permitted after 1 June 2029.	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 mount Messenger Formation, deeper than 1,700 metres true vertical depth.	Review of "Water Flooding Operation Management Plan," well construction log and injection data.	Yes
6. The consent holder shall ensure that the exercise of this consent does not result in fracturing of geological seals.	Review and analysis of injection data.	Yes

Purpose: *To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-E wellsite.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
7. 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
8. Limits the range of fluids that can be discharged under the consent.	Assessment of consent holder records and injectate sample analysis.	
9. Maintain records and undertake analysis to characterise each type of waste arriving on-site for discharge.	Receipt and assessment of injection data.	Yes
10. The consent holder will maintain daily injection data records.	Receipt of satisfactory data.	Yes
11. If not carried out by an IANZ accredited laboratory, analysis shall be carried out in accordance with QA plan which has been certified by the Chief Executive QA/QC	Inspection of QA plan	Yes
12. The data required by conditions 9 & 10 above, for each calendar month, is required to be submitted by the 28th day of the following month.	Receipt of satisfactory data by the date specified	Yes
13. 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 exercising the consent,	Yes

Purpose: *To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-E wellsite.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
14. 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
15. 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 fist round of sampling being undertaken	
16. 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
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 administrative performance in respect of this consent		**High**

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

Table 20 Evaluation of environmental performance over time

Year	Consent number	High	Good	Improvement required	Poor
2015-2016	4728*				
	9545	1			
	10254*				
	10304*				
2014-2015	4728*				
	9545	1			
2013-2014	4728*				
	9545	1			
2012-2013	4728			1	
	9545	1			
2009-2012	4728			1	
2007-2009	4728	1			
Totals		5		2	

*Note *= not exercised during reporting period*

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

3.4. Recommendations from the 2015-2016 Annual Report

In the 2015-2016 Annual Report, it was recommended:

1. THAT the range of monitoring carried out during the 2015-2016 period be continued during the 2016-2017 monitoring period, noting that additional injectate and/or groundwater sampling will be required if injection from the Cheal-B and/or Cheal-E wellsites commences during the 2016-2017 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.

The recommendations above were implemented during the period under review.

3.5. Alterations to monitoring programmes for 2017-2018

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
- to 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 the range of monitoring carried out during the 2016-2017 period be continued during the 2017-2018 monitoring period.

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

3.6. Exercise of optional review of consent

The next optional review date for consents 9545-2;, 10254-1, 10304-1 and 10354-1 are provided for in June 2018. Conditions allow the Council to review each consent, if there are grounds that the conditions are not adequate to deal with any adverse effects on the environment arising from the exercise of the resource consent, which were either not foreseen at the time the application was considered or which was not appropriate to deal with at the time.

Based on the results of monitoring in the year under review, and in previous years as set out in earlier annual compliance monitoring reports, it is considered that there are no grounds that require a review to be pursued or grounds to exercise the review option.

4. Recommendations

1. THAT monitoring of consented activities in the 2017-2018 year continues at the same level as in the 2016-2017 monitoring period.
2. THAT 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.
BTEX	Benzene, toluene, ethylbenzene and xylene
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.
Fresh-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 ("fraccing").
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.
m BGL	Metres below ground level.
m BMP	Metres below measuring point
mS/m	Millisiemens per metre.
m TVD	Metres true vertical depth
m^3	Cubic metre.
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.
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).
UI	Unauthorised Incident.

Bibliography and references

Environmental Services Association of Alberta (2017), Where does toluene come from? Petrogenic families and biogenic loners, power point presentation for Watertech 2017, accessed on 19 September 2017 at http://www.esaa.org/wp-content/uploads/2017/04/2017-42.pdf

Heiden A.C. et al, (1999) Toluene emissions from plants, Geophysical Research Letters, Vol 26, Pages 1283-1286, 1 May 1999.

Taranaki Regional Council (2016). *Cheal Petroleum Limited Deep Well Injection Monitoring Programme Annual Report (2015-2016)*. Technical Report 2015-19. Document number 1719526.

Taranaki Regional Council (2015). *Cheal Petroleum Limited Deep Well Injection Monitoring Programme Annual Report (2014-2015)*. Technical Report 2015-19. Document number 1546589.

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

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 (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 Ltd Deep Well Injection Monitoring Programme Triennial Report (2009-2012)*. Technical Report 2012–67. Document number 1133945.

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

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

Appendix I

Resource consents held by Cheal Petroleum Limited

(For a copy of the signed resource consent please contact the TRC Consents department)

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 1407-1050 Burrard Street Vancouver BC CANADA V6Z 253
Change To Conditions Date:	8 September 2005 [Granted: 2 May 1995]

Conditions of Consent

Consent Granted:	To discharge up to 200 cubic metres per day of drilling mud wastes, waste drill water and produced water from hydrocarbon exploration and production operations by deepwell injection into the Mount Messenger Formation at or about (NZTM) 1712364E-5639488N
Expiry Date:	1 June 2011
Review Date(s):	June 1999, June 2005
Site Location:	Cheal-A wellsite, Mountain Road, Ngaere [Property owners: JR & RP Lightoller]
Legal Description:	Pt Sec 24 Blk VI Ngaere SD
Catchment:	Waingongoro
Tributary:	Mangawharawhara

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

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

Conditions 1 to 3 – changed

1. The consent holder shall monitor the injected wastes monthly for maximum and mean concentrations of suspended solids, total dissolved solids, salinity, chlorides, and total hydrocarbons and shall make the records available to the Taranaki Regional Council every two months.

2. The consent holder shall keep monthly records of the nature and amounts of all material injected, including injection pressure and rate, and shall make the records available to the Taranaki Regional Council on a three monthly basis, and when there has been a significant pressure change event.

3. Prior to the exercise of this consent for each individual well to be used for deep well injection, the consent holder shall submit, to the written satisfaction of the Chief Executive, Taranaki Regional Council, a log of the injection well, and an injection well operation management plan, to demonstrate that special condition 4 of this consent can be met. The report shall:

a) identify the injection zone, including a validated bore log and geophysical log,
b) detail the results of fluid sampled from the injection zone, and the proposed wastes to be injected for maximum and mean concentrations for pH, suspended solids, total dissolved solids, salinity, chlorides, and total hydrocarbons;
c) demonstrate the integrity of well casing; and
d) outline design and operational procedure to isolate the zone.

Condition 4 – unchanged

4. That the consent holder shall ensure that the discharge will not contaminate or endanger any actual or potential usable freshwater aquifer.

Condition 5 – additional

5. The consent holder shall provide to the Taranaki Regional Council during the month of May of each year, for the duration of the consent, a written report on all matters required under special conditions 1, 2, 3 and 4 above.

Condition 6 [previously condition 5] – unchanged

6. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during June 1999 and/or June 2005 and/or within three months following the first exercise of this consent, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects of the discharge on the receiving environment.

Transferred at Stratford on 28 October 2009

For and on behalf of
Taranaki Regional Council

_____

Director-Resource Management

Discharge Permit

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

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

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 PO Box 402 New Plymouth 4340
Decision Date:	11 April 2016
Commencement Date:	11 April 2016

Conditions of Consent

Consent Granted:	To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deep well injection at the Cheal-B wellsite
Expiry Date:	1 June 2034
Review Date(s):	June annually
Site Location:	Cheal-B wellsite, Taylor Road, Ngaere (Property owner: R & C Taylor)
Grid Reference (NZTM)	1712616E-5640740N
Catchment:	Patea
Tributary:	Ngaere

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. Before exercising the consent, 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. Before exercising the consent, 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 and its structural integrity;
   (c) an assessment of the suitability of the injection well for the proposed activity;
   (d) details of how the integrity of the injection well will be monitored and maintained;
   (e) confirmation of the depth to which fresh water resources, as defined in condition 7, are encountered below the site; and
   (f) a chemical assessment of the receiving formation water which confirms its Total Dissolved Solids (TDS) concentration, and also demonstrates that the mixing of formation and injection fluids will not result in any adverse effects on the receiving formation or the injection well.

   (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 2029.

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 Mount Messenger Formation, and be injected at a minimum depth of 1,600 metres true vertical depth below ground level.

6. The consent holder shall ensure that the discharge authorised by this consent does not result in the fracturing of the geological seals confining the injection zone.

7. 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.

8. Only the following types of fluid may be discharged:

   (a) produced water;
   (b) well drilling fluids;
   (c) well workover fluids, including hydraulic fracturing fluids; and
   (d) compatible groundwater.

   (Note: for the purpose of this condition compatible groundwater means groundwater of a similar salinity to the receiving formation, such that it doesn't cause stratification or fluid migration).

9. 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 (as listed in condition 8);
   (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 9(c) 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.

10. 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.

11. If the analysis required by condition 9(c) above is not carried out in an International Accreditation New Zealand (IANZ) accredited laboratory, it shall be undertaken in accordance with a "Quality Assurance (QA) Plan" that has been certified by the Chief Executive, Taranaki Regional Council, as meeting the requirements of condition 9. The Council may also, at its discretion, carry out an audit of the consent holder's sampling and analysis regime to assess adherence to the QA plan.

12. 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 28th day of the following month.

13. The consent holder shall undertake a programme of sampling and testing that monitors the effects of the exercise of this consent on fresh water resources within an Area of Review (AoR) to assess compliance with condition 7 (the 'Monitoring Programme'). The Monitoring Programme shall be submitted to the Chief Executive, Taranaki Regional Council, for certification before exercising the consent, 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 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.

14. 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 13 and 14, could be taken and analysed by the Council or other contracted party on behalf of the consent holder.

15. 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.

    Note: The Sampling and Analysis Plan may be combined with the Monitoring Programme required by condition 13.

16. 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 and an estimation of remaining storage capacity.

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 11 April 2016

For and on behalf of
Taranaki Regional Council

_____

A D McLay
Director - Resource Management

Discharge Permit

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

Name of Consent Holder:	Cheal Petroleum Limited PO Box 402 New Plymouth 4340
Decision Date:	15 June 2016
Commencement Date:	15 June 2016

Conditions of Consent

Consent Granted:	To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deepwell injection at the Cheal-E wellsite
Expiry Date:	01 June 2034
Review Date(s):	June annually
Site Location:	Cheal-E wellsite, Sole Road, Ngaere (Property Owner: J O'Neill)
Grid Reference (NZTM)	1714369E - 5639714N
Catchment:	Patea
Tributary:	Ngaere (Te Ngaere)

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. Before exercising the consent, 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. Before exercising the consent, 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 and its structural integrity;
   (c) an assessment of the suitability of the injection well for the proposed activity;
   (d) details of how the integrity of the injection well will be monitored and maintained;
   (e) confirmation of the depth to which fresh water resources, as defined in condition 7, are encountered below the site; and
   (f) a chemical assessment of the receiving formation water which confirms its Total Dissolved Solids (TDS) concentration, and also demonstrates that the mixing of formation and injection fluids will not result in any adverse effects on the receiving formation or the injection well.

   (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 2029.

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 Mount Messenger Formation, and be injected at a minimum depth of 1,700 metres true vertical depth below ground level.

6. The consent holder shall ensure that the discharge authorised by this consent does not result in the fracturing of the geological seals confining the injection zone.

7. 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.

8. Only the following types of fluid may be discharged:

   (a) produced water;
   (b) well drilling fluids;
   (c) well workover fluids, including hydraulic fracturing fluids; and
   (d) compatible groundwater.

   (Note: for the purpose of this condition compatible groundwater means groundwater of a similar salinity to the receiving formation, such that it doesn't cause stratification or fluid migration).

9. 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 (as listed in condition 8);
   (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 9(c) 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.

10. 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.

11. If the analysis required by condition 9(c) above is not carried out in an International Accreditation New Zealand (IANZ) accredited laboratory, it shall be undertaken in accordance with a "Quality Assurance (QA) Plan" that has been certified by the Chief Executive, Taranaki Regional Council, as meeting the requirements of condition 9. The Council may also, at its discretion, carry out an audit of the consent holder's sampling and analysis regime to assess adherence to the QA plan.

12. 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 28th day of the following month.

13. The consent holder shall undertake a programme of sampling and testing that monitors the effects of the exercise of this consent on fresh water resources within an Area of Review (AoR) to assess compliance with condition 7 (the 'Monitoring Programme'). The Monitoring Programme shall be submitted to the Chief Executive, Taranaki Regional Council, for certification before exercising the consent, 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 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.

14. 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 13 and 14, could be taken and analysed by the Council or other contracted party on behalf of the consent holder.

15. 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.

    Note: The Sampling and Analysis Plan may be combined with the Monitoring Programme required by condition 13.

16. 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 and an estimation of remaining storage capacity.

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 15 June 2016

For and on behalf of
Taranaki Regional Council

_____

A D McLay
Director - Resource Management

Discharge Permit

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

Name of Consent Holder:	Cheal Petroleum Limited PO Box 402 New Plymouth 4340
Decision Date:	8 November 2016
Commencement Date:	8 November 2016

Conditions of Consent

Consent Granted:	To discharge produced water, well drilling fluids, well work over fluids and hydraulic fracturing fluids from hydrocarbon exploration and production operations into the Mount Messenger Formation by deepwell injection at the Cheal-A wellsite
Expiry Date:	1 June 2035
Review Date(s):	June annually
Site Location:	Cheal-A wellsite, 4273 Mountain Road, Stratford
Grid Reference (NZTM)	1712371E-5639468N
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. Before exercising the consent, 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. Before exercising the consent, 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 and its structural integrity;
   (c) an assessment of the suitability of the injection well for the proposed activity;
   (d) details of how the integrity of the injection well will be monitored and maintained;
   (e) confirmation of the depth to which fresh water resources, as defined in condition 7, are encountered below the site; and
   (f) a chemical assessment of the receiving formation water which confirms its Total Dissolved Solids (TDS) concentration, and also demonstrates that the mixing of formation and injection fluids will not result in any adverse effects on the receiving formation or the injection well.

   (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 2030.

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 Mount Messenger Formation, and be injected at a minimum depth of 1,665 metres true vertical depth below ground level.

6. The consent holder shall ensure that the discharge authorised by this consent does not result in the fracturing of the geological seals confining the injection zone.

7. 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.

8. Only the following types of fluid may be discharged:

   (a) produced water;
   (b) well drilling fluids;
   (c) well workover fluids, including hydraulic fracturing fluids; and
   (d) compatible groundwater.

   (Note: for the purpose of this condition compatible groundwater means groundwater of a similar salinity to the receiving formation, such that it doesn't cause stratification or fluid migration).

9. 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 (as listed in condition 8);
   (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 9(c) 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.

10. 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.

11. If the analysis required by condition 9(c) above is not carried out in an International Accreditation New Zealand (IANZ) accredited laboratory, it shall be undertaken in accordance with a "Quality Assurance (QA) Plan" that has been certified by the Chief Executive, Taranaki Regional Council, as meeting the requirements of condition 9. The Council may also, at its discretion, carry out an audit of the consent holder's sampling and analysis regime to assess adherence to the QA plan.

12. 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 28th day of the following month.

13. The consent holder shall undertake a programme of sampling and testing that monitors the effects of the exercise of this consent on fresh water resources within an Area of Review (AoR) to assess compliance with condition 7 (the 'Monitoring Programme'). The Monitoring Programme shall be submitted to the Chief Executive, Taranaki Regional Council, for certification before exercising the consent, 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 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.

14. 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 13 and 14, could be taken and analysed by the Council or other contracted party on behalf of the consent holder.

15. 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.

    Note: The Sampling and Analysis Plan may be combined with the Monitoring Programme required by condition 13.

16. 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 and an estimation of remaining storage capacity.

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 8 November 2016

For and on behalf of
Taranaki Regional Council

_____

A D McLay
Director - Resource Management