

Origin Energy Resources New Zealand Limited
Deep Well Injection
Monitoring Programme
Annual Report
2013-2014

Technical Report 2014-94

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Executive summary

The following Annual Report by the Taranaki Regional Council (the Council) encompasses the monitoring period 1 July 2013 – 30 June 2014. The report details the deep well injection (DWI) consents held by Origin Energy Resources New Zealand Limited (the Company) during the period under review, outlines the Company's DWI activities during this period, discusses the monitoring programme implemented by the Council and its results, and also provides an assessment of Company performance with regard to consent compliance.

During the period under review, the Company held a total of five resource consents for the injection of fluids by DWI, permitting discharges from five separate sites in the South and Central Taranaki area. The consents permit the discharge of a range of fluids, including produced water, heated water, contaminated stormwater, water based drilling fluids, and hydraulic fracturing fluids including return fluids. The consents include a number of special conditions which set out specific requirements with which the Company must comply.

During the year under review Origin Energy Resources New Zealand Limited demonstrated a high level of environmental performance.

During the 2013-2014 monitoring period, the Company exercised DWI consents 4094-2 and 7905-1. Consent 4094-2 permits the discharge produced water, contaminated stormwater, water based drilling fluids and hydraulic fracturing fluids, including return fluids, by deep well injection at the Waihapa Production Station, Bird Road, Stratford. On 1 November 2013, consent 4094-2 was transferred from the Company to New Zealand Energy Corp (NZEC). Consent 7905-1 permits the discharge of heated water, including produced water, at the Manutahi-D wellsite, Lower Ball Road, Kakaramea. As required by the special conditions of the DWI consents held by the Company, process monitoring data and injection records have been supplied to the Council, and were reviewed on submission.

In total 18,788 cubic metres (m³) of fluids were discharged under consent 4094-2, and 20,827m³ under consent 7905-1. The volume of fluid discharged and the pressure at which it was injected into the receiving formations were within the limits specified in the respective resource consents.

The Council carried out a total of three inspections of the Company's active DWI sites during the period under review. Inspection visits included liaising with on-site staff, identification of the active injection well, viewing the injection well monitoring equipment and injection logs, and spot sampling of the injectate. In addition to the DWI inspection visits, active injection sites were visited by Council staff on four separate occasions in the 2013- 2014 monitoring period for inspections relating to other consents held by the Company for various activities at these sites.

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

During the year under review Origin Energy Resources New Zealand Limited demonstrated a high level of environmental performance and a high level of administrative performance and compliance with the resource consents. The Council did not receive any complaints or register any unauthorised incidents associated with any of the Company's DWI activities during the 2013-2014 monitoring period.

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

This report includes recommendations to be implemented during the 2014-2015 monitoring period.

Table of contents

	Page
1. Introduction	1
1.1 Compliance monitoring programme reports and the Resource Management Act 1991	1
1.1.1 Introduction	1
1.1.2 Structure of this report	1
1.1.3 The <i>Resource Management Act (1991)</i> and monitoring	2
1.1.4 Evaluation of environmental performance	2
1.2 Process description	4
1.2.1 Background	4
1.2.2 Deep well injection (DWI)	4
1.3 Potential environmental effects of exercising a DWI consent	7
1.4 Resource consents	8
1.5 Monitoring programme	15
1.5.1 Introduction	15
1.5.2 Programme liaison and management	15
1.5.3 Site inspections and injectate sampling	15
1.5.4 Consent holder data submission requirements	16
1.5.5 Groundwater quality monitoring	17
2. Results	18
2.1 Site inspections and injectate sampling	18
2.2 Assessment of data provided by the consent holder	18
2.3 Groundwater quality monitoring	23
3. Investigations, interventions and incidents	25
4. Discussion	26
4.1 Discussion of site performance	27
4.2 Environmental effects of exercise of discharge permit	29
4.3 Recommendations from the previous monitoring report	30
4.4 Alterations to the monitoring programme for 2014-2015	31
4.5 Exercise of optional review of consents	31
5. Recommendations	32
Glossary of common terms and abbreviations	33
Bibliography	35
Appendix I DWI consents exercised in 2013-2014 period	

List of tables

Table 1	Summary of DWI consents held by the Company during the 2013-2014 period	8
Table 2	Location of sample points for active DWI sites	16
Table 3	Details of groundwater sampling sites	17
Table 4	Results of injectate sampling undertaken by the Council (2013-2014)	18
Table 5	Summary of DWI activities during the period under review (2013-2014)	19
Table 6	Summary of the Company's 2013-2014 injection data	19
Table 7	Range of contaminants in Waihapa-7A injectate samples (2013-2014)	23
Table 8	Range of contaminants in Manutahi-D injectate samples (2013-2014)	23
Table 9	Results of groundwater sampling undertaken by the Council (2013-2014)	24
Table 10	Summary of Company performance with regard to consent 4094-2 (2013-2014)	27
Table 11	Summary of Company performance with regard to consent 7905-1 (2013-2014)	28

List of figures

Figure 1	DWI schematic representative of Taranaki sites	7
Figure 2	Resource consents for DWI held by the Company during the period under review	14
Figure 3	2013-2014 fluid injection volumes – Waihapa-7A injection well (4094-2)	20
Figure 4	2013-2014 daily injection volumes and pressure – Waihapa-7A injection well (4094-2)	20
Figure 5	2013-2014 fluid injection volumes –Manutahi D-2H injection well (7905-1)	21
Figure 6	2013-2014 daily injection volumes and pressure –Manutahi D-2H injection well (7905-1)	21
Figure 7	2013-2014 fluid injection volumes –Manutahi D-4H ST2 injection well (7905-1)	22
Figure 8	2013-2014 daily injection volumes and pressure - Manutahi D-4H ST2 injection well (7905-1)	22

List of photos

Photo 1	Waihapa-D wellsite and Waihapa-5 disposal wellsite (3688-2)	9
Photo 2	Waihapa production station and Waihapa-7A disposal well (4094-2)	11
Photo 3	Manutahi-D wellsite and disposal wells D-2H, D-3H and D-4H ST2 (7905-1)	13

1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

The following Annual Report covers the monitoring period 1 July 2013–30 June 2014. During the period under review, Origin Energy Resources New Zealand Limited (the Company) held five resource consents for the disposal of wastes by deep well injection (DWI) from five separate wellsites in the South Taranaki region. The consents held by the Company permit the discharge of a range of fluids by DWI, including produced water, heated water, contaminated stormwater, water based drilling fluids and hydraulic fracturing fluids, including return fluids. The consents include a number of special conditions which set out specific requirements with which the Company must comply.

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

1.1.2 Structure of this report

The following report comprises five sections as follows:

- Section 1 of this report is a background section. It sets out general information about compliance monitoring under the relevant legislation and the Council's obligations and general approach to monitoring sites through dedicated monitoring programmes. Also covered in this section are the details of the individual resource consents held by the Company, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted on the Company's well sites;
- Section 2 presents the results of monitoring during the period under review, including technical data;
- Section 3 outlines any incidents, interventions and incidents that occurred during period under review;
- Section 4 discusses the results, their interpretation, and their significance for the environment; and
- Section 5 presents recommendations to be implemented in the 2014 - 2015 monitoring period.

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

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

The *Resource Management Act (1991)* (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 a discharger, and may include cultural and socio-economic effects;
- (b) physical effects on the locality, including landscape, amenity and visual effects;
- (c) ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;
- (d) natural and physical resources having special significance (e.g., recreational, cultural, or aesthetic); 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 discharge source. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the RMA to assess the effects of the exercise of consents. In accordance with section 35 of the RMA, the Council undertakes compliance monitoring for consents and rules in regional plans; and maintains an overview of performance of resource users against regional plans and consents. Compliance monitoring, (covering both activity and impact), also enables the Council to continuously assess its own performance in resource management as well as that of resource users, particularly consent holders. It also enables the Council to continually re-evaluate its approach to resource management, and ultimately, through the refinement of methods, and considered responsible resource utilisation, to move closer to achieving sustainable development of the regions resources.

1.1.4 Evaluation of environmental performance

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

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

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

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

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

Environmental Performance

- **High** No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment. The Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.
- **Good** Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self reports, or in response to unauthorised incident reports, but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and quickly. The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

For example:

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

Administrative Performance

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

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

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

1.2 Process description

1.2.1 Background

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

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

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

1.2.2 Deep well injection (DWI)

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

overlying the injection intervals restrict any potential vertical migration of injected wastes into shallow freshwater aquifers.

A typical injection well consists of concentric casing, cemented into the surrounding rock, which extend into permeable saline formations, at depths far below the base of potentially useable freshwater aquifers. Waste is then injected into the receiving formation by pressure generated by surface pumps. International standards (adopted in the Taranaki Region) for the construction of disposal wells emphasise the importance of surface casing extending to depths below the base of the freshwater zones and that it is cemented back to surface. The standards also highlight the requirement for internal casing strings to be cemented back up the hole to seal off and isolate the disposal interval from the overlying freshwater zones, providing a multi-barrier approach to the protection of freshwater resources. As part of the resource consent application procedure for DWI activities, applicants are required to submit information that details both the design and construction specifications of the injection well(s) and illustrates well integrity and the isolation of the well bore from surrounding formations.

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

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

Produced water and drilling fluid wastes are typically highly saline and contain hydrocarbon residues and system additives. Without treatment to an acceptable standard, the surface disposal of large volumes of produced water is not a suitable disposal option, particularly where the discharge can enter surface or groundwater systems. The salts and other contaminants contained within the discharge can adversely affect soil or freshwater biological systems and the quality of water resources used for supply purposes. Although there are methods to treat produced waters to a suitable standard for surface disposal, such as gas/steam stripping,

biological and chemical adsorption, and activated carbon, they are generally not practical or economically viable. The injection of produced waters into deep geological formations by DWI is presently the most cost-effective option for the disposal of this type of waste, and more importantly, is an environmentally sound disposal option.

Produced waters have been disposed of by DWI in Taranaki since the development of the Kapuni Field in 1970. The collection, handling, treatment and disposal of produced water from a producing field are major undertakings and, if not appropriately managed, can have lasting adverse environmental effects. However, under appropriate geological and operational conditions, the disposal of produced waters by DWI should have no more than negligible environmental effects.

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

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

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

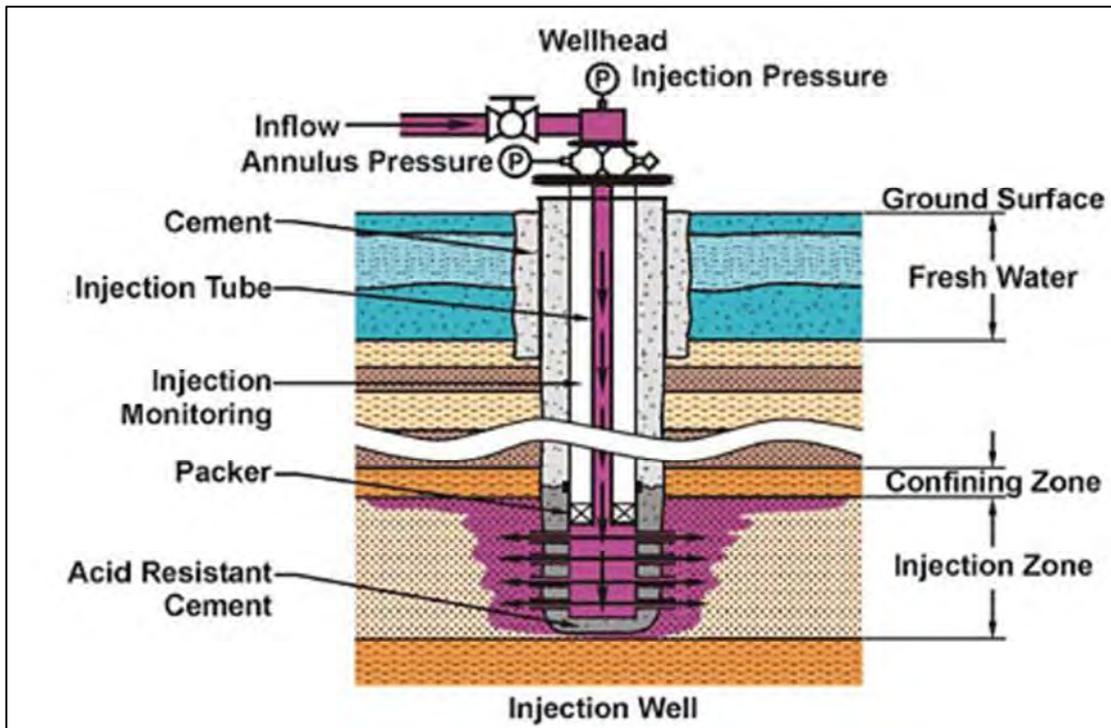


Figure 1 DWI schematic representative of Taranaki sites¹

1.3 Potential environmental effects of exercising a DWI consent

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

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

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

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

within the intended disposal interval. The assessment of resource consent applications and setting of appropriate conditions address these issues.

1.4 Resource consents

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

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

Table 1 Summary of DWI consents held by the Company during the 2013-2014 period

Consent Number	Wellsite	Injection Well(s)	Formation
3688-2	Waihapa-D	Waihapa-5	Tikorangi
4094-2	Waihapa Production Station	Waihapa-7A	Mateamateaonga
5503-1 ⁽¹⁾	Rimu-A	<i>none identified</i>	<i>none identified</i>
6544-1*	Kupe Production Station	<i>none identified</i>	<i>none identified</i>
7905-1	Manutahi-D	D-2H, D-3H and D-4H ST2	Manutahi

* The consent issued for this activity requires details of proposed injection well(s) to be submitted prior to commencement of any injection. No injection activities have commenced at this site and hence details of the intended injection well(s) have not been submitted to the Council.

⁽¹⁾ This consent was deemed to have lapsed as of 31 March 2014 as per condition 5 of the consent.

A summary of each consent held by the Company for DWI activities during the 2013-2014 monitoring period is included below.

Resource Consent: 3688-2

“To discharge waste drilling fluids, produced water and stormwater from hydrocarbon exploration and production operations by deep well injection at the Waihapa-D wellsite”

Background:

Consent 3688 authorises the discharge of waste fluids by DWI at the Waihapa-D wellsite, Cheal Road, Stratford (Photo 1). The consent was originally granted to Petrocorp Exploration Ltd. (Petrocorp) on 20 June 1990.

The original consent authorised the discharge of drilling fluids and wastes generated by the drilling site via any well drilled on the named well-site. On 26 May 1992, an application was received to increase the permitted discharge volume to 250 m³/day. The application was subsequently granted on 27 July 1992.

On 27 November 2002, the consent was transferred to Swift Energy New Zealand Ltd. (Swift). The consent was renewed by Swift on 23 June 2003 and then varied on 2 November 2006. Consent 3688 was transferred to Origin Energy Resources New

Zealand (SPV2) Ltd. on 11 April 2008 and to Origin Energy Resources New Zealand (TAWN) Ltd., on 1 December 2008. The consent was transferred to New Zealand Energy Corp. (NZEC) on 1 November 2013.

The consent provides for reviews in June 2016, June 2022 and June 2028 and is due to expire on 1 June 2034. Disposal at the site is via the Waihapa-5 injection well.

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

- Special conditions 1, 3 and 4 refer to the Company's process monitoring and data submission requirements;
- Special condition 2 prohibits the discharge from endangering or contaminating any freshwater aquifer;
- Special condition 5 requires injection pressure to remain below that required to fracture the injection interval;
- Special condition 6 is a lapse clause; and
- Special condition 7 is a consent review provision.

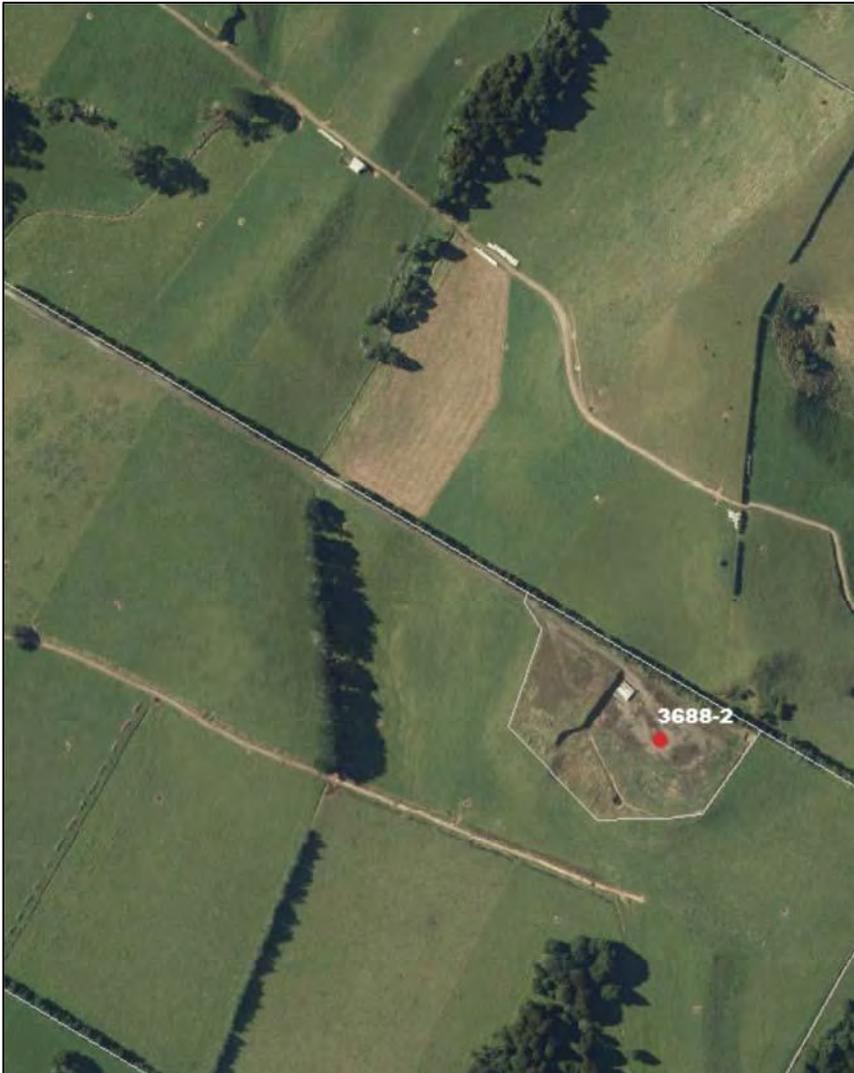


Photo 1 Waihapa-D wellsite and Waihapa-5 disposal wellsite (3688-2)

Resource Consent: 4094-2

"To discharge produced water, contaminated stormwater, and water based drilling fluids by deepwell injection into the Matemateonga formation"

Background:

Consent 4094-2 authorises the discharge of waste fluids via the Waihapa-7A well at the Waihapa Production Station, Bird Road, Stratford (Photo 2). The consent was originally granted to Petrocorp on 17 June 1992.

On 7 February 2002, the consent was transferred to Swift. On 16 April 2002, an application was received to alter the consent to allow for the discharge of wastes from producing wells other than those at the Waihapa Production Station. A revised consent was subsequently granted on 24 April 2002.

Consent 4094 was transferred to Origin Energy Resources New Zealand (SPV2) Ltd. on 11 April 2008 and to Origin Energy Resources New Zealand (TAWN) Ltd., on 1 December 2008. A consent renewal was applied for in late 2009 and consent 4094-2 was granted on 10 September 2010, permitting the discharge of produced water, contaminated stormwater, and water based drilling fluids by DWI via the Waihapa-7A well. A variation to the consent was granted on 3 September 2013 to include hydraulic fracturing fluids, including return fluids, in the list of fluids that could be discharged by the Waihapa-7A well. The consent was transferred to NZEC on 1 November 2013. The consent provides for reviews in June 2016 and June 2022 and expires on 1 June 2028.

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

- Special condition 1 states that the well shall operate in accordance with the "Origin Energy Resource NZ Limited – Deep Well Injection Management Plan;"
- Special condition 2 sets a maximum allowable injection pressure of 85 bar (1,232 psi);
- Special condition 3 requires the company adopt the best practicable option as defined in section 2 of the RMA;
- Special conditions 4 and 5 refer to the Company's process monitoring and data submission requirements; and
- Special condition 6 is a review provision.



Photo 2 Waihapa Production Station and Waihapa-7A injection well (4094-2)

Resource Consent: 5503-1

“To discharge waste drilling fluids from hydrocarbon exploration operations by deepwell injection into the Matemateaonga Formation at the Rimu-A wellsite”

Background:

Consent 5503-1, which permits the discharge of waste fluids by DWI at the Rimu-A wellsite, Old South Road, Mokoia, was originally granted to Swift on 23 June 1999.

On 29 September 2000, an application was received to change the consent conditions by removing the reference to the discharge volume. A revised consent was granted on 25 October 2000. On 5 December 2002, a further application was received to extend the lapse period for the consent. A revised consent was granted on 9 January 2003.

Consent 5503 was transferred to Origin Energy Resources New Zealand (SPV2) Ltd. on 11 April 2008 and to the current consent holder, Origin Energy Resources New Zealand (Rimu) Ltd., on 1 December 2008.

The Council waived its option to review this consent in June 2004 and June 2010 as the consent conditions were deemed adequate to deal with the potential effects of the activity. The consent is due to expire on 1 June 2016.

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

- Special conditions 1 and 3 refer to the Company's process monitoring and data submission requirements;
- Special condition 2 prohibits the discharge from endangering or contaminating any freshwater aquifer;
- Special condition 4 is a review provision; and
- Special condition 5 is a lapse clause.

It is noted that there is no record of consent 5503-1 having been exercised to date and therefore no well has been designated for disposal at the site. Therefore, on 31 March 2014, this consent lapsed, as per condition 5 in the consent.

Resource Consent: 6544-1

"To discharge produced water from hydrocarbon production operations by deepwell injection at the Kupe Production Station site"

Background:

Consent 6544, which permits the discharge of waste fluids by DWI at the Kupe Production Station, Inaha, Manaia, was granted to Origin Energy New Zealand (Kupe) Ltd, on 21 June 2005. The consent was varied in June 2010 to extend the lapse date of the consent until 30 June 2015. The consent provides for reviews in June 2017, June 2023, June 2029 and June 2034 and is due to expire on 1 June 2039.

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

- Special condition 1 states how the activity must be undertaken;
- Special condition 2 refers to best practicable option;
- Special conditions 3, 5 and 7 refer to the Company's process monitoring and data submission requirements;
- Special condition 4 prohibits the discharge from endangering or contaminating any freshwater aquifer;
- Special condition 6 requires injection pressure to remain below that required to fracture the injection interval;
- Special condition 8 is a lapse clause; and
- Special condition 9 is a review provision.

It is noted that the consent has not been exercised to date (as at 30 June 2014). Unless exercised prior or a consent variation application received by the Council, the consent will lapse on 30 June 2015.

Resource Consent: 7905-1

"To discharge heated water, including produced water to ground at the Manutahi-D wellsite for water flooding purposes"

Background:

Consent 7905 permits the discharge of fluids for water flooding purposes at the Manutahi-D wellsite, Lower Ball Road, Kakaramea (Photo 3). The consent was granted to Origin Energy New Zealand (Rimu) Ltd., on 16 September 2011. A

waterflood trial was carried out in September 2011, which resulted in the injection of 113 m³ of heated fluids into the Manutahi Formation. The water flooding programme commenced in August 2012.

The current consent has 11 special conditions, as summarised below:

- Special condition 1 states that prior to exercising the consent, the consent holder shall submit an updated “Injection Operation Management Plan.”
- Special condition 2 refers to the injection well and receiving formation information requirements;
- Special condition 3 limits the injection pressure;
- Special condition 4 limits the volume of waste that can be injected;
- Special condition 5 requires the consent holder to adopt best practicable option;
- Special conditions 6 and 7 relate to the monitoring of injected wastes and provision of data;
- Special condition 8 requires the consent holder to notify the Council prior to the first exercising of the consent;
- Special condition 9 prohibits the discharge from endangering or contaminating any freshwater aquifer;
- Special condition 10 is a lapse clause; and
- Special condition 11 is a review provision.

Consent 7905-1 provides for reviews in June 2016 and June 2022 and is due to expire in June 2028.

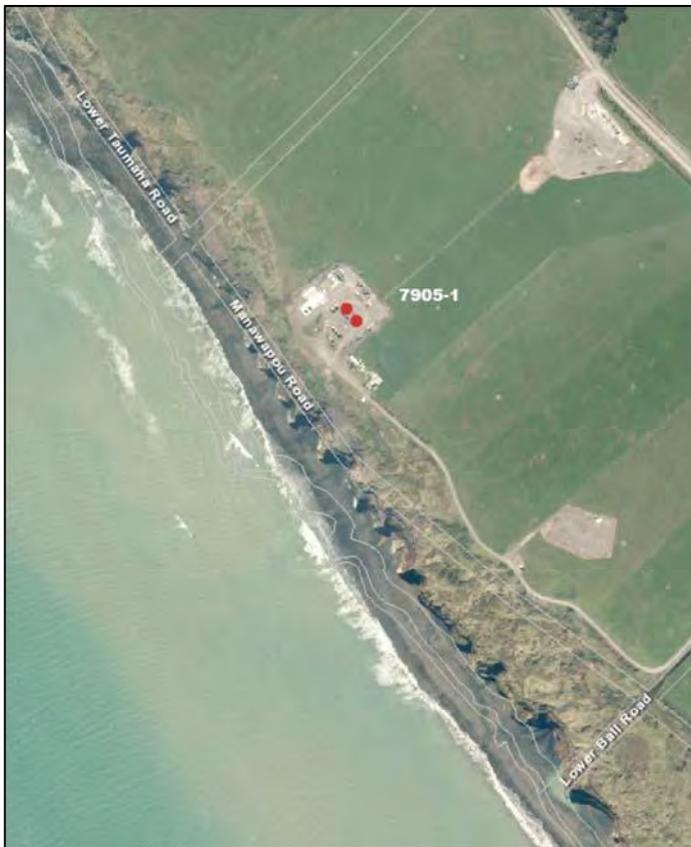


Photo 3 Manutahi-D wellsite and disposal wells D-2H, D-3H and D-4H ST2 (7905-1)

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

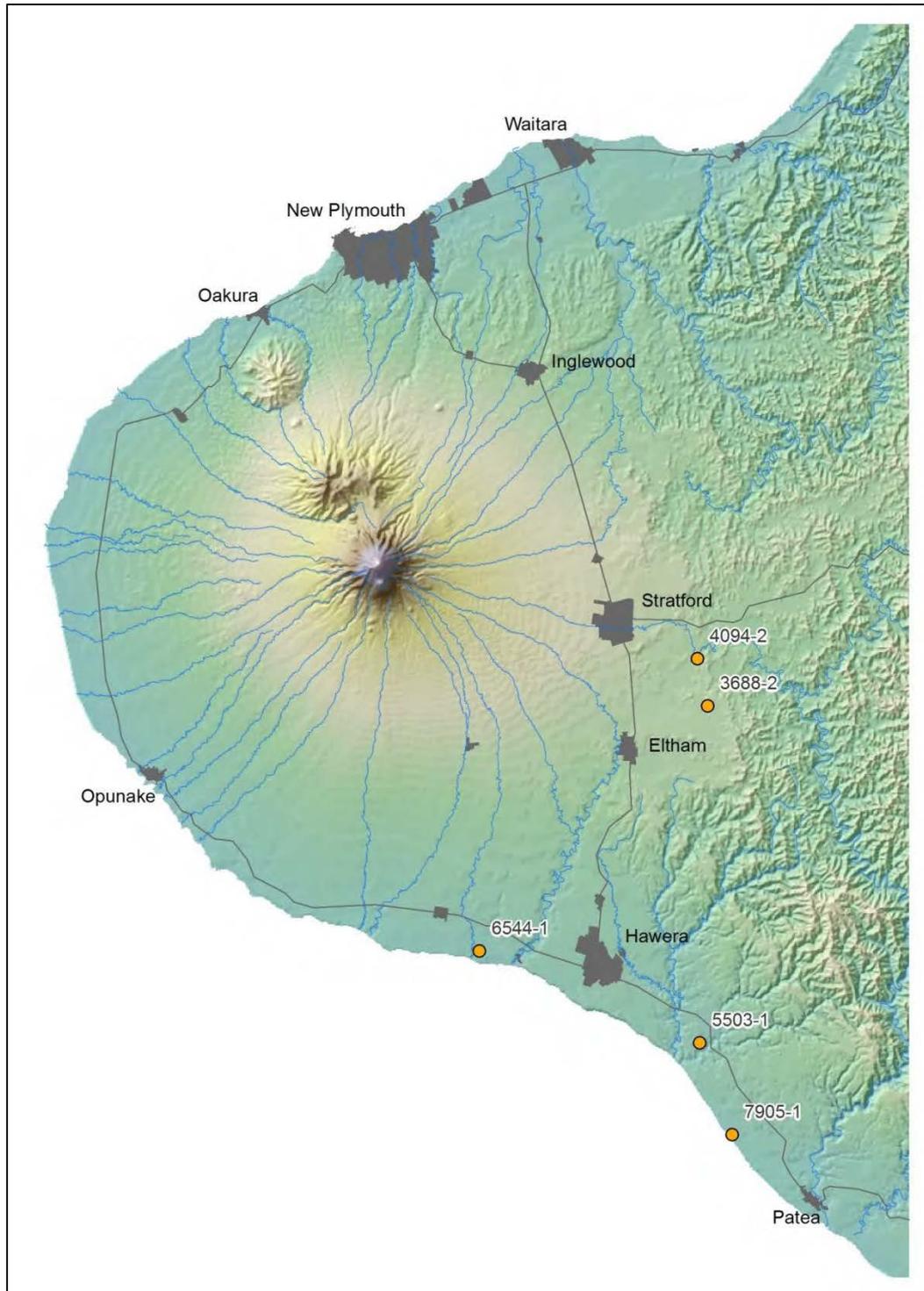


Figure 2 Resource consents for DWI held by the Company during the period under review

1.5 Monitoring programme

1.5.1 Introduction

Section 35 of the RMA sets obligations upon the Council to gather information, monitor, and conduct research on the effects arising from consented activities within the Taranaki region and report upon these.

To perform its statutory obligations, the Council may be required to take and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations and seek information from consent holders. The monitoring programme implemented by the Council in relation to the Company's DWI activities consisted of four main components:

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

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

1.5.2 Programme liaison and management

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

1.5.3 Site inspections and injectate sampling

The monitoring programme provides for physical inspections to be undertaken at all active DWI sites operated by the Company. The inspections include an examination of the injection wellhead, viewing the monitoring equipment and the spot sampling of the injectate for laboratory analysis. The sampling of injectate is carried out in order to characterise the general chemical nature of the discharge and also the variation in its chemical composition across the monitoring period. Samples of the injectate were collected from the injection line linking the produced water tanks to the disposal wells.

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

- pH;
- Suspended solids concentration;
- temperature;
- salinity;

- Chlorides; and
- Total petroleum hydrocarbons.

Table 2 Location of sample points for active DWI sites

Consent	Wellsite	Injection well	Site code	Sample point
4094-2	Waihapa Production Station	Waihapa-7A	GND1634	Tank T206
7905-1	Manutahi-D	D-2H, D-4H ST2	GND2307	Tank 041

1.5.4 Consent holder data submission requirements

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

1. Information on the disposal well and injection zone

The conditions of the resource consents exercised by the Company required them to submit management plans for the operation of each injection well(s). The plans were required to include the operational details of the injection activities and to identify the conditions that would trigger concerns about the integrity of the injection well, the receiving formation or overlying geological seals. The plans are also required to detail the action(s) to be taken by the consent holder if trigger conditions are reached. The information requested is required to demonstrate that the exercise of the consent will not contaminate or endanger any actual or potentially useable freshwater aquifers.

2. Discharge records

For each well used for DWI during the period under review, the consent holder was required to provide discharge records. Specific data requirements included the following:

- Injection volumes;
- Injection pressures;
- Injection rate; and
- Analytical results for injectate samples.

The Company provided adequate injection records for the 2013-2014 monitoring year. The data submitted met the requirements stipulated in the DWI consents exercised during this period.

3. Annual reporting

The Company was required to submit annual written reports to the Council providing a summary of all injection data gathered over the previous 1 July to 30 June period. Annual reports also require the Company to detail how compliance has been achieved with the special conditions of consents exercised during the monitoring period. The Company's annual written report for the 2013-2014 period was received by the Council on 22 May 2014.

1.5.5 Groundwater quality monitoring

A programme of groundwater monitoring in the vicinity of the Company's active injection sites was initiated during the 2012-2013 period and was continued in the 2013-2014 period. The programme provides for biannual sampling of groundwater from selected groundwater abstraction sites during each monitoring year.

In order to select suitable sampling sites for inclusion in the monitoring programme, surveys of water abstraction sites within a 1 km radius of the Waihapa Production Station and Manutahi-D wellsite were carried out. Initially, a desktop review of data held by the Council was conducted, including a search of the Council groundwater sites database. The desktop review indicated that the Council held records of a limited number of groundwater abstractions in the areas of investigation.

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

During the initial field survey during the 2012-2013 monitoring period, one private groundwater abstraction site in the vicinity of the Waihapa Production Station was selected for inclusion in the groundwater monitoring programme (GND1031). There was no groundwater monitoring site identified for the Manutahi-D wellsite during the 2012-2013 survey. However, on 31 October 2014, a groundwater monitoring well (GND2372) was drilled for the purpose of monitoring shallow groundwater in relation to DWI activities at the wellsite. The criteria used in assessing the suitability of a site for inclusion in the monitoring programme is the proximity of the site to the injection well in use, the depth to which the bore has been drilled, its construction of specification, and its susceptibility to contamination by surface runoff.

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

Table 3 Details of groundwater sampling sites

Site Code	Classification	Distance from injection wellhead (m)	Casing depth (m)	Total depth (m)	High static water level (m)	Aquifer	Comment
GND1031	Bore	748	220	303.8	26	Matemateaonga	Downgradient of Waihapa Production Station
GND2372	Bore	71	15	24	7	Volcanics	Downgradient of Manutahi-D wellsite

2. Results

2.1 Site inspections and injectate sampling

During the period under review, the Council carried out three routine DWI inspections at the Company's active DWI sites. In addition, a total of four separate inspections were carried out by Council staff in relation to various activities at these sites during the 2013-2014 monitoring year.

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

As part of the monitoring programme, spot samples of the injectate were obtained from active injection sites during inspection visits. No sampling of injectate was carried out at the Waihapa Production Station before it was taken over by NZEC. A sample was obtained from the Manutahi-D wellsite on 29 October 2013 and 11 April 2014. The injectate samples were submitted to the Council's IANZ accredited laboratory for physicochemical analysis. The results of the analysis are included below in Table 4. The concentrations of each analyte are within the expected range for produced water samples.

Table 4 Results of injectate sampling undertaken by the Council (2013-2014)

Parameter	Unit	Site GND2307	
		29/10/13	11/04/14
Time	NZST	11:10	13:50
TRC sample number	-	TRC137440	TRC149765
pH	pH units	7.0	7.0
Conductivity @ 20°C	mS/m @ 20°C	1,400	924
Alkalinity	g/m ³ CaCO ₃	239	166
Chloride	g/m ³	5,380	3,380
Total petroleum hydrocarbons	g/m ³	1	780

2.2 Assessment of data provided by the consent holder

The Company provided a record of injection data for the 2013-2014 monitoring period, including the injection volumes, rates and pressure data.

The total volume of fluids discharged at the Waihapa Production Station includes a proportion of produced water generated by the following third parties:

- Cheal Petroleum Limited;
- New Zealand Energy Corp; and
- Shell Todd Oil Services Limited.

The disposal of wastes generated at sites other than those operated by the consent holder is permitted under the conditions of the consent 4094-2.

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

Table 5 Summary of DWI activities during the period under review (2013-2014)

Consent	Wellsite	Injection wells	Total volume discharged (m ³) 01/07/13 – 30/06/14	Discharge period		TRC well ID
				From	To	
4094-2	Waihapa Production Station	Waihapa-7A	18,788	01/07/13	28/10/14	GND1634
7905-1	Manutahi-D	D-2H and D-4H ST2	20,827	01/07/13	30/04/13	GND2307
Total			39,615	01/07/12	30/06/13	-

Table 6 Summary of the Company's 2013-2014 injection data

	4094-2 – Waihapa-7A injection well		
	Volume injected (m ³)	Injection pressure (bar)	Injection Rate (m ³ /hr)
Total	18,788	-	-
Daily Maximum	626	45	89
Daily Average	125	20	45
	7905-1 – D-2H injection well		
	Volume injected (m ³)	Injection pressure (bar)	Injection Rate (m ³ /day)
Total	5,907	-	-
Daily Maximum	48	40	48
Daily Average	19	31	19
	7905-1 – D-4H ST2 injection well		
	Volume injected (m ³)	Injection pressure (bar)	Injection Rate (m ³ /day)
Total	14,920	-	-
Daily Maximum	146	39	146
Daily Average	49	31	49

The injection volume and pressure data provided by the Company for injection carried out under consent 4094-2 is presented graphically in Figures 3 and 4. The injection data for consent 7905-1 is presented in Figures 5, 6, 7 and 8.

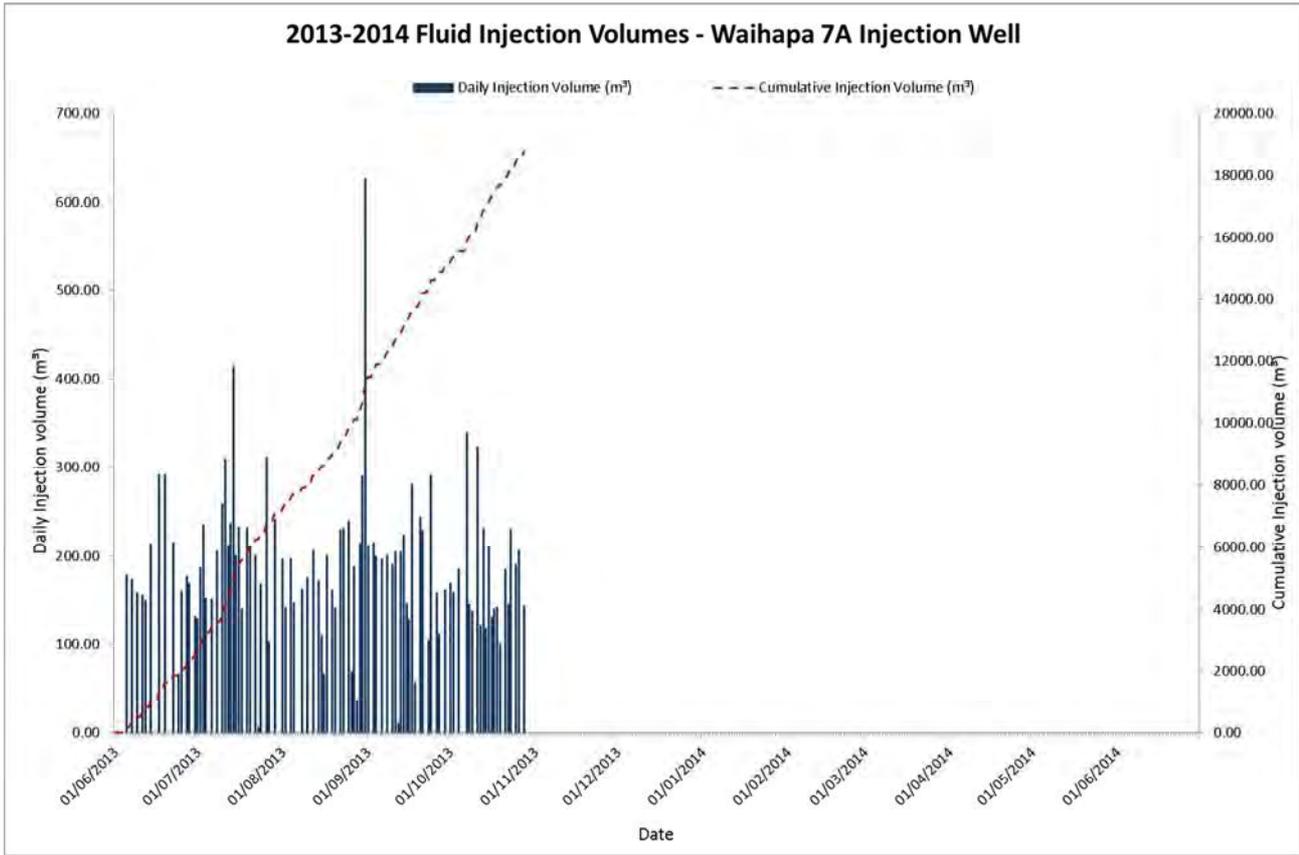


Figure 3 2013-2014 fluid injection volumes – Waihapa-7A injection well (4094-2)

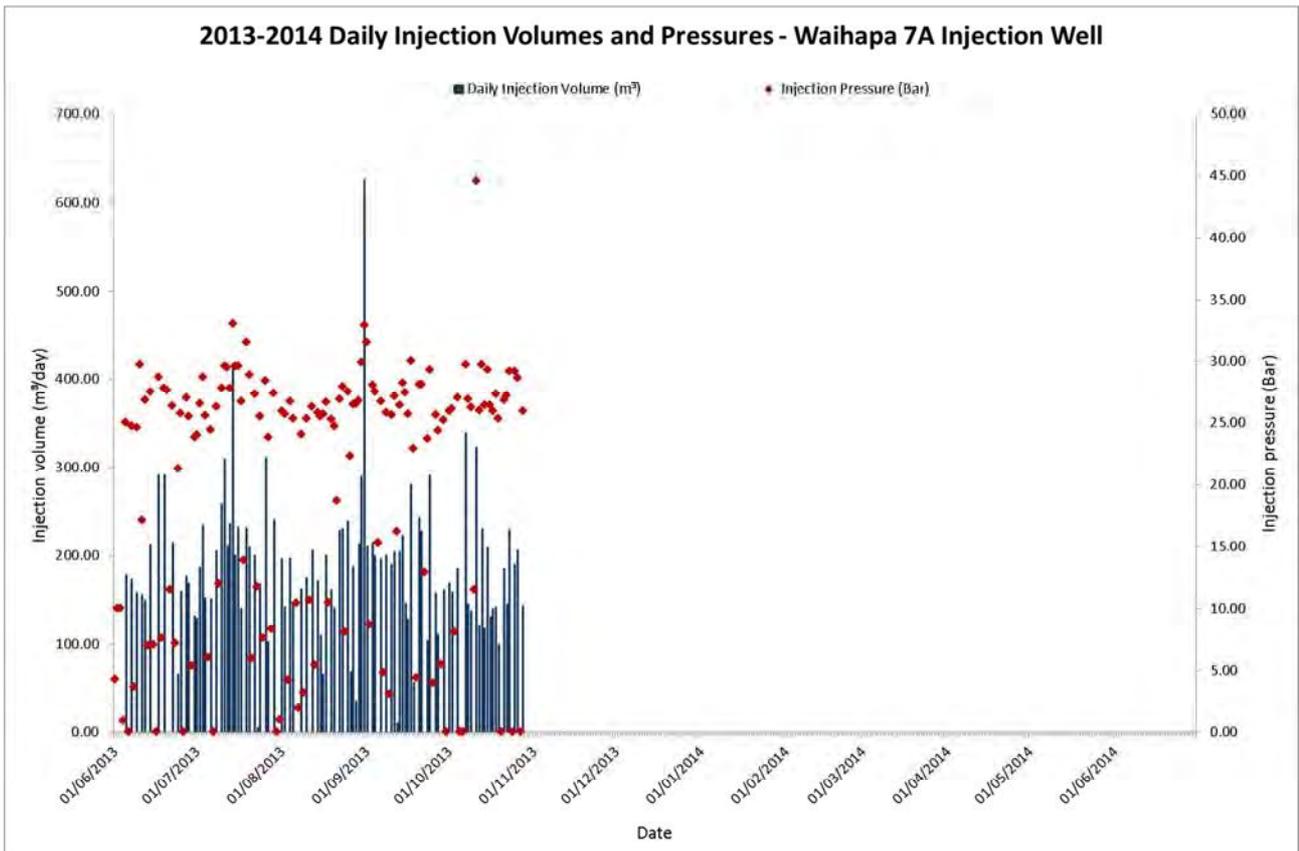


Figure 4 2013-2014 daily injection volumes and pressure – Waihapa-7A injection well (4094-2)

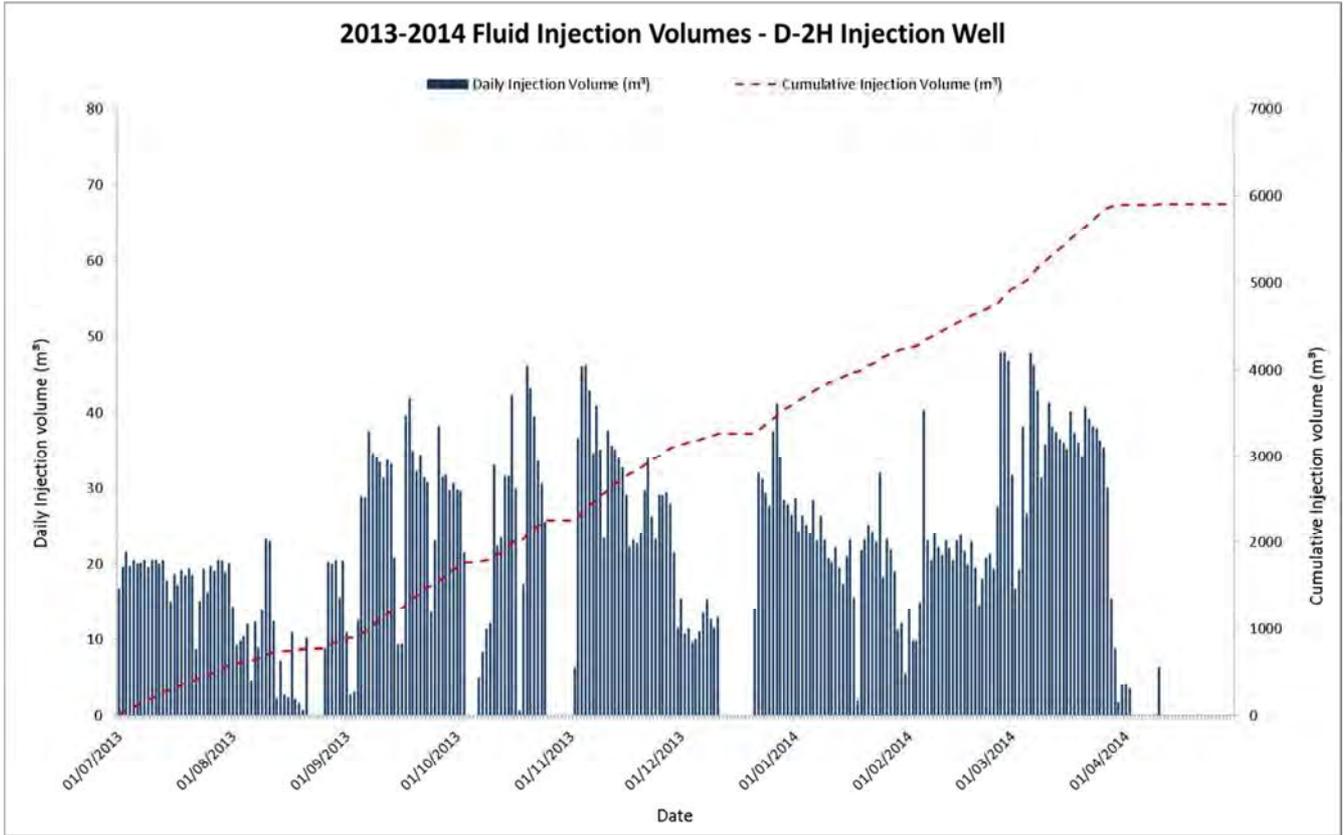


Figure 5 2013-2014 fluid injection volumes –Manutahi D-2H injection well (7905-1)

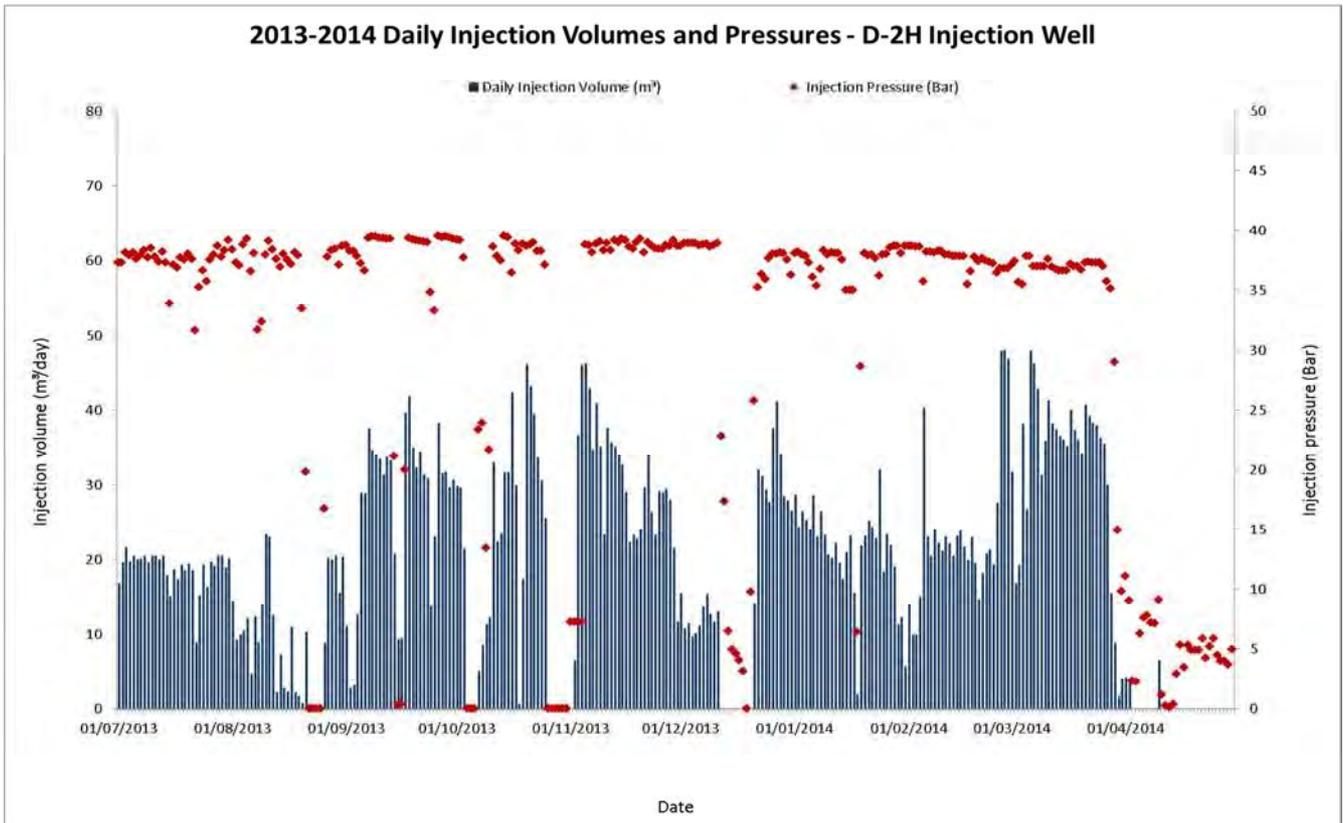


Figure 6 2013-2014 daily injection volumes and pressure –Manutahi D-2H injection well (7905-1)

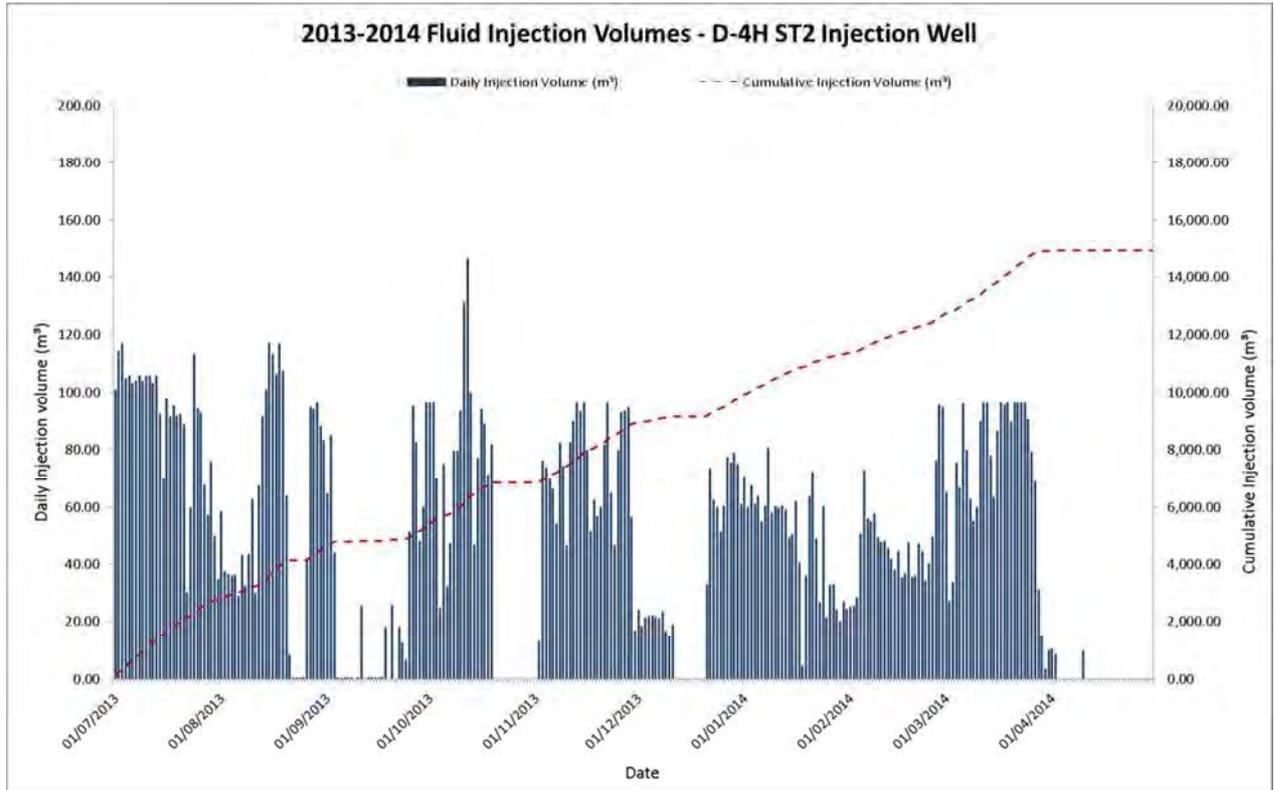


Figure 7 2013-2014 fluid injection volumes –Manutahi D-4H ST2 injection well (7905-1)

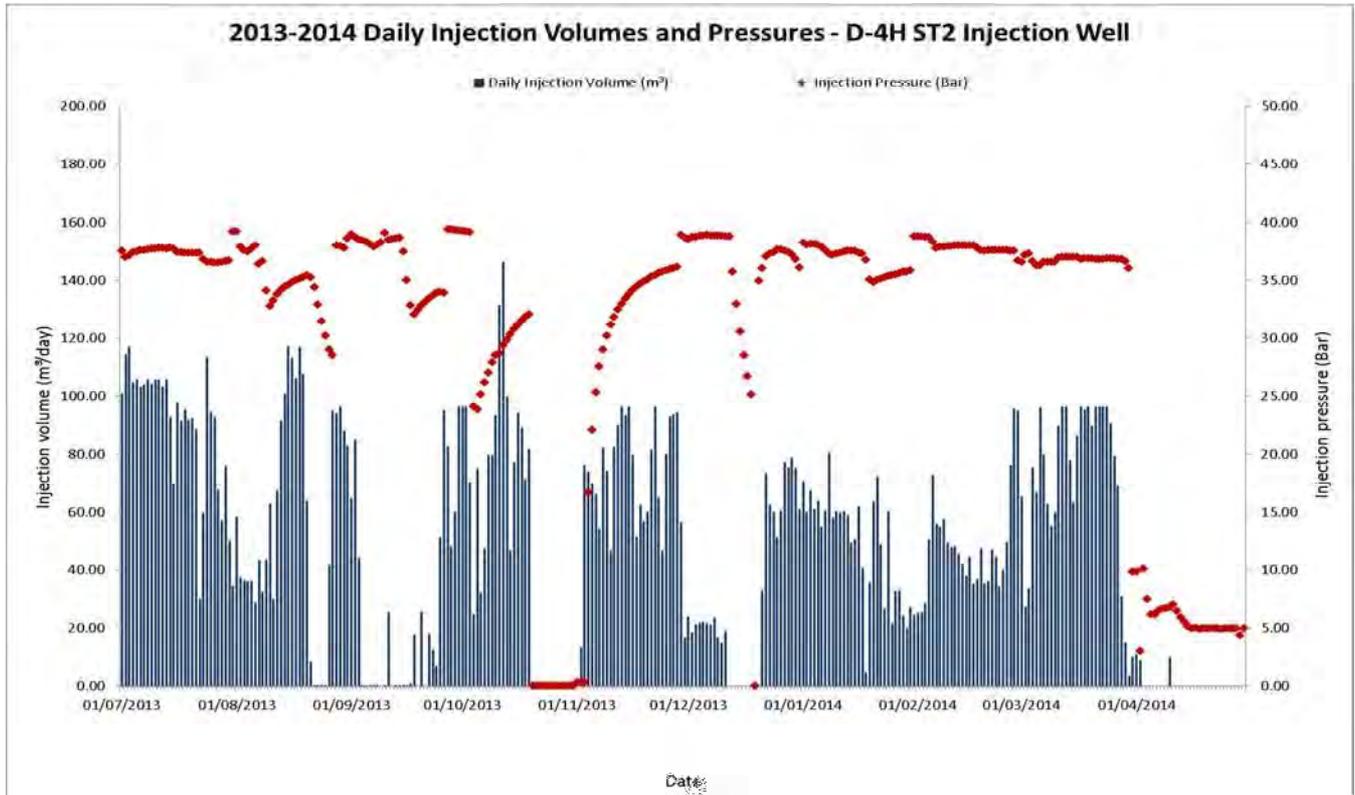


Figure 8 2013-2014 daily injection volumes and pressure - Manutahi D-4H ST2 injection well (7905-1)

In addition to the Council’s injectate sampling (Section 2.1), the Company also provided analytical results for samples of produced water injected via the Waihapa-7A and Manutahi-D injection wells. As presented in Table 7 and Table 8 below, the

maximum and mean values associated with the results of these analyses illustrate the variability in the composition of injectate across the monitoring period. The composition of the injectate varies depending on the origin and volume of fluids transferred from each individual waste source at the time of injection.

Table 7 Range of contaminants in Waihapa-7A injectate samples (2013-2014)

Parameter	Unit	Number of samples	Maximum value	Minimum value	Mean value
Temperature	°C	6	22	20	21
pH	pH units	6	7.2	6.5	6.7
Salinity	ppt	6	28	11	19
Chloride	g/m ³	6	19,258	6,228	13,927
Suspended solids	g/m ³	6	274	23	115
Total petroleum hydrocarbons	g/m ³	6	498	16	192

Table 8 Range of contaminants in Manutahi-D injectate samples (2013-2014)

Parameter	Unit	Number of samples	Maximum value	Minimum value	Mean value
pH	pH units	6	7.3	6.4	6.9
Conductivity	uS/cm	4	20,000	9,090	13,590
Chloride	g/m ³	4	4,114	<3	2,063
Suspended solids	g/m ³	5	255	7	76
Total petroleum hydrocarbons	g/m ³	3	18	1	6

2.3 Groundwater quality monitoring

As part of the groundwater monitoring programme implemented in the vicinity of the Manutahi-D wellsite, groundwater samples were obtained from GND2372 on 12 November 2013 and 11 April 2014. The samples were collected following standard groundwater sampling methodologies, and generally in accordance with the National Protocol for State of the Environment Groundwater Sampling in New Zealand (2006). The sample collected on 12 November 2013 was analysed in the IANZ accredited Hill Laboratories in Hamilton. The sample collected on 11 April 2014 was analysed in the Council's IANZ accredited laboratory. Samples were analysed for a basic range of parameters, sufficient to characterise local groundwater quality, and to assess for potential contamination due to injection activities. The results of the analyses performed on the samples collected are outlined in Table 9. The results give no indication of any potential contamination by injected fluids. No groundwater monitoring was carried out in the vicinity of the Waihapa Production Station before it was taken over by NZEC.

Table 9 Results of groundwater sampling undertaken by the Council (2013-2014)

Sample Details	Units	GND2372	GND2372
TRC Sample Number	-	TRC137833	TRC149766
Sample Date	-	12/11/13	11/04/14
Sample Time	NZST	11:15	13:35
Analyte	Units		
Static Water Level	m	21.8	20.8
Temperature	°C	16.1	15.5
pH	pH Units	7.1	7.2
Conductivity (EC)	mS/m@20°C	52.5	44.8
Total Alkalinity	g/m ³ as CaCO ₃	153	-
Chloride	g/m ³	75	63
Total Hydrocarbons	g/m ³	<0.7	<0.5

3. Investigations, interventions and incidents

The monitoring programme for the period was based on what was considered to be an appropriate level of monitoring, review of data and liaison with the consent holder. During the monitoring period, matters may arise which require additional activity by the Council e.g. provision of advice and information, investigation of potential or actual causes of non-compliance or failure to maintain best 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 and reported or 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).

There were no incidents recorded by the Council associated with any of the Company's DWI consents during the 2013-2014 monitoring period.

4. Discussion

During the period under review, the Company exercised two resource consents for the injection of fluids by DWI. These consents authorised discharges of various forms of fluid into the Mateamateonga Formation, via the Waihapa-7A well, and Manutahi Formation via the Manutahi D-2H and Manutahi D-4H ST2 wells. Produced water from the Company's producing fields was the main source of fluid for injection.

Consent 4094-2 permits the discharge of produced water, contaminated stormwater, and water based drilling fluids by deep well injection into the Mateamateonga formation at the Waihapa Production Station. The Company utilised the consent for the disposal of produced water between 1 July and 29 October 2013. The consent was taken over by NZEC on 1 November 2013. Injection was via the Waihapa-7A well, at a depth between 1,126 and 1,176 m TVD (below ground level). During the period under review, a total of 18,788 m³ of fluid was injected under the consent, at an average of 125 m³/day. The average injection pressure was 20 bar, with a maximum pressure of 45 bar.

Consent 4094-2 does not specify any limits on daily discharge volumes. Condition 2 of the consent requires that the maximum injection pressure does not exceed 85 bar. Based on the data provided, the maximum injection pressure reached was 45 bar, on 11 October 2013, well within the maximum injection pressure limit stipulated in the consent.

Consent 7905-1 permits the discharge of heated water, including produced water to ground at the Manutahi-D wellsite. The Company injects the water for enhanced oil recovery purposes within its Manutahi Field. Injection was carried out under the consent between 1 July 2013 and 30 April 2014. A plant shutdown commenced in early May until the end of the monitoring period for its first year of operation inspections. The injection was via two separate wells, Manutahi D-2H and D-4H ST2. The Manutahi D-2H and Manutahi D-4H ST2 wells discharge into a confined oil reservoir within the Manutahi Formation. Injection via Manutahi D-2H occurs between 1114.3 -1114.9m TVD (below ground level), and injection via Manutahi D-4H ST2 occurs between 1112.8 -1125.5m TVD (below ground level). During the period under review, a total of 20,827 m³ was injected under consent 7905-1. A total of 5,907 m³ was injected via the D-2H well, at an average of 19 m³/day, and 14,920 m³ was injected via the D-4H ST2 well, at an average of 49 m³/day. The maximum injection pressure reached within the D-2H and D-4H ST2 wells were 40 bar and 39 bar, respectively.

Special condition 4 of consent 7905-1 specifies a maximum daily injection volume of 318 m³. Based on the data provided by the Company, the highest volume of daily injection occurred on 12 October 2013, when 146 m³ was injected via the D-4H ST2 well. Special condition 3 requires that the maximum injection pressure is to remain below 50 bar. Based on the data provided by the Company, the maximum injection pressure reached was 40 bar (D-2H well). Both the maximum daily discharge volume and maximum injection pressure were within the consented limits.

For each of the wells used for DWI during the monitoring period, the consent holder has provided sufficient information regarding well construction and the injection zone to satisfy the relevant consent and monitoring programme information

requirements. However, if deemed necessary, the Council may request further information from the consent holder that illustrates that the wells being used for the injection and the receiving formation remain secure.

During the 2013-2014 period, consent holder performance was assessed on compliance with consent conditions, with a particular emphasis on record keeping requirements and information provision, and the analysis of the information and data provided. Compliance with the conditions of the DWI consents exercised during the 2013-2014 year is summarised below in Section 4.1.

The consent holder is required to ensure that the discharge does not result in any contamination of any actual or potential useable freshwater aquifer. Compliance with this condition is based on the assessment of consent holder submitted data, and the sampling and analysis of local groundwater abstractions. There is no evidence to suggest that the injection of fluids by DWI at either of the Company's active injection sites has resulted in the vertical migration of contaminants outside of the intended injection interval. During the period under review, a groundwater sampling site was identified in the vicinity of the Manutahi-D wellsite and sampled. The results of the analyses carried out do not indicate any form of contamination of local groundwater due to injection activities at the Manutahi-D wellsite. No groundwater sampling was carried out in the vicinity of the Waihapa Production Station before it was taken over by NZEC.

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

4.1 Discussion of site performance

During the period under review, the Company exercised DWI consents, 4094-2 and 7905-1. A summary of the Company's level of compliance with the special conditions attached to consent 4094-2 is provided in Table 10, and for consent 7905-1 in Table 11.

Table 10 Summary of Company performance with regard to consent 4094-2 (2013-2014)

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder must operate in accordance in Injection Operation Management Plan.	Receipt of satisfactory information	Yes
2. Injection pressure must not exceed 85 Bar (1232 PSI)	Assessment of consent holder records	Yes
3. Consent holder shall at all times adopt best practicable option (BPO to prevent and/or minimise environmental impact)	Assessment of consent holder records and site inspection results	Yes
4. Provision of records for discharge volumes, rates, and pressures	Receipt of well discharge data	Yes
5. Chemical analysis of discharge	Receipt of discharge analysis results	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
6. Review provision	N/A	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of consent compliance and administrative performance in respect of this consent		High

Table 11 Summary of Company performance with regard to consent 7905-1 (2013-2014)

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder must submit an Injection Operation Management Plan.	Receipt of satisfactory Injection Operation Management plan	Yes
2. Provision of well and injection zone information.	Receipt of satisfactory information	Yes
3. Injection pressure must not exceed 50 Bar (721 PSI)	Assessment of consent holder records	Yes
4. Daily volume of fluid injected must not exceed 318 cubic metres.	Assessment of consent holder records	Yes
5. The consent holder shall at all times adopt the best practicable option	Assessment of consent holder records and site inspection notices.	Yes
6. Provision of records for discharge volumes, rates, and pressures	Receipt of well discharge data	Yes
7. Provision of records of chemical analysis of discharge	Receipt of discharge analytical results	Yes
8. Notification provision	Received 5 working days prior to consent exercise	Yes
9. No contamination of freshwater aquifers	Assessment of consent holder records	Yes*
10. Lapse clause	Receive notice of exercise of consent	Yes
11. Review provision	N/A	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of consent compliance and administrative performance in respect of this consent		High

* no evidence to suggest any contamination of freshwater aquifers has occurred due to injection activities

Overall, in 2013-2014, the Company achieved a **'High'** standard of environmental performance and a **'High'** level of administrative performance with respect to consents 4094-2 and 7905-1. The criteria associated with a 'high' level of environmental performance are outlined in Section 1.1.4 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.

Administrative Performance

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

4.2 Environmental effects of exercise of discharge permit

The most significant potential adverse environmental effect arising as a result of fluid injection is the contamination of freshwater aquifers. The protection of groundwater is fundamental to the protection of surface water and consequently, groundwater should be protected to the greatest extent practicable from serious or irreversible damage arising from human activity.

Well engineering technology, regional and local geologic characterisation, and site specific mathematical modelling are typically combined at the planning stage of an injection well to ensure that injected fluids are contained within the intended disposal interval. This information is typically supplied to the Council when an application for consent to discharge fluids by DWI is lodged, and used to assess the potential for adverse environmental effects resulting from the proposed activity.

The DWI consents exercised during the period under review permit discharges into the Mateamateonga Formation via the Waihapa-7A well, and into the Manutahi Formation via the Manutahi D-2H and Manutahi D-4H ST2 wells.

The discharge from Waihapa-7A occurs into a confined saline aquifer in the Mateamateonga Formation, between 1,126 and 1,176 m TVD (below ground level). The freshwater-saline water interface below the site is approximately 809 m TVD (below ground level). The formation into which the injection is made contains highly saline water, as proven by resistivity logs of nearby wells and samples taken during the drilling of the well. The aquifer is separated from the shallower freshwater aquifers by a massive mudstone (thick impermeable rock) layer which vertically isolates the formation, thereby containing the injected fluids. This seal is characterised by the sudden increase in salinity below the mudstone and is well-suited for the containment of near-wellbore pressure increases due to injection.

The Manutahi D-2H and Manutahi D-4H ST2 wells discharge into a confined oil reservoir in the Manutahi Formation. Injection via Manutahi D-2H occurs between 1114.3 -1114.9 m TVD (below ground level), and injection via Manutahi D-4H ST2 occurs between 1112.8 -1125.5 m TVD (below ground level). The freshwater-saline water interface in both wells is approximately 895 m TVD (below ground level). The

local water table is located at approximately 2 m below ground level, and deep confined aquifers exist at depths between 50–400 m below ground level. The well logs supplied by the Company show a number of geological seals (thick layers of claystones and mudstones) between the injection interval and the freshwater aquifers located in the Marine Terraces and Whenuakura Formations. The geological confinement of the reservoir is proven by the containment of oil.

The natural geological characteristics of the strata confining the injection zones, the engineering of the injection wells, the planning and monitoring of injection activities and their regulation all contribute to minimise the potential for any adverse environmental effects emanating as a result of DWI activities.

4.3 Recommendations from the previous monitoring report

In the 2012-2013 Annual Report, it was recommended:

1. THAT the range of monitoring carried out during the 2012-2013 period in relation to the Company's DWI activities be continued during the 2013-2014 monitoring period.

The recommendation was implemented in the 2013-2014 period.

2. THAT the Company ensures that injectate analysis is carried out for the full range of parameters, and at the required frequencies, as stipulated in the resource consents for active injection sites;

The recommendation was implemented in the 2013-2014 period.

3. THAT the Company installs a suitable groundwater monitoring well in the vicinity of active injection wells where there are no suitable existing groundwater monitoring sites available.

A suitable groundwater monitoring well (GND2372) was installed in the vicinity of the Manutahi-D wellsite on 30 October 2013.

4. THAT sampling of shallow groundwater in the vicinity of active injection wells be carried out on a biannual basis.

Biannual groundwater sampling was carried out at GND2372 during the 2013-2014 monitoring period. No groundwater sampling was carried out in the vicinity of the Waihapa Production Station as the consent was transferred to NZEC before the first round of sampling took place.

5. 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.

There was no review of any DWI consent held by the Company during the 2013-2014 period as it was deemed that the conditions of each consent were adequate to deal with the potential adverse effects of the activity.

4.4 Alterations to the monitoring programme for 2014-2015

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, the obligations of the RMA in terms of monitoring emissions/discharges and effects, and subsequently reporting to the regional community, the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki emitting to the atmosphere/discharging to the environment.

It is proposed that the range of monitoring carried out in the 2013-2014 period be continued in the 2014-20145 period.

4.5 Exercise of optional review of consents

The next optional review dates for consents 3688-2, 4094-2 and 7905-1 are provided for in June 2016. The next optional review date for consent 6544-1 is June 2017, however the consent will lapse if not exercised prior to 21 June 2015. Consent 5503-1 lapsed on 31 March 2014 due to the consent not being exercised, as per condition 5 in the consent.

The Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent. A review may be required for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

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

5. Recommendations

1. THAT the range of monitoring carried out during the 2013-2014 period in relation to the Company's DWI activities be continued during the 2014-2015 monitoring period.
2. THAT sampling of shallow groundwater in the vicinity of active injection wells be carried out on a biannual basis.
3. THAT the Council notes there is no requirement at this time for a consent review to be pursued or grounds to exercise the review options.

Glossary of common terms and abbreviations

The following abbreviations and terms are used within this report:

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

pH	Numerical system for measuring acidity in solutions, with 7 as neutral. Values lower than 7 are acidic and higher than 7 are alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Power fluid	Pressurized fluids used to transmit and control energy into oil/gas wells. Cheal power fluid is a heated combination of fresh and produced water.
ppt	Parts per thousand.
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).
The Act	Resource Management Act 1991 and subsequent amendments.
TRC	Taranaki Regional Council (the Council).
TVDSS	True vertical depth sub sea. Given as metres below sea level.
UI	Unauthorised Incident.
UIR	Unauthorised Incident Register – contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
Water flooding	A method of thermal recovery in which hot water is injected into a reservoir through specially distributed injection wells. Hot water flooding reduces the viscosity of the crude oil, allowing it to move more easily toward production wells.

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Appendix I

DWI consents exercised in 2013-2014 period

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

Name of
Consent Holder: Origin Energy Resources NZ [Rimu] Limited
Private Bag 2022
NEW PLYMOUTH

Change To 8 December 2008 [Granted: 23 June 1999]
Conditions Date:

Conditions of Consent

Consent Granted: To discharge waste drilling fluids from hydrocarbon
exploration operations by deepwell injection into the
Matemateaonga Formation at the Rimu-A wellsite at or
about (NZTM) 1717352E-5611071N

Expiry Date: 1 June 2016

Review Date(s): June 2010

Site Location: Rimu-A wellsite, Old South Road, Mokoia
[Property owner: M & P Hawken &
Tongahoe Farm Limited]

Legal Description: Lots 4 & 5 DP 9677 Blk XIV Hawera SD

Catchment: Manawapou

*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 4 [unchanged]

- 1. That prior to the exercise of this consent, the consent holder shall submit to the Taranaki Regional Council a log of the well, to the satisfaction of the Chief Executive, to demonstrate the conditions of consent can be met.
- 2. That the consent holder shall ensure that injection will not contaminate or endanger any actual or potential usable freshwater aquifer.
- 3. That the consent holder shall keep records of amounts of drilling fluids injected, including injection pressure and rate, and shall make the records available to the Taranaki Regional Council upon request.
- 4. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June 2004 and/or June 2010, 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 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.

Consent 5503-1

Condition 5 [new]

5. This consent shall lapse on 31 March 2014 unless the consent is given effect to before the end of that period, or the Taranaki Regional Council fixes a longer period pursuant to section 125 (b) of the Resource Management Act 1991.

Signed at Stratford on 8 December 2008

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: Origin Energy Resources (Kupe) Limited
Private Bag 2202
NEW PLYMOUTH 4342

Change To 21 June 2010 [Granted: 21 June 2005]
Conditions Date:

Conditions of Consent

Consent Granted: To discharge produced water from hydrocarbon production
operations by deepwell injection at the Kupe Production
Station site at or about (NZTM) 1699750E-5618461N

Expiry Date: 1 June 2039

Review Date(s): June 2011, June 2017, June 2023, June 2029, June 2034

Site Location: Kupe Production Station, west of Inaha Road, east of
Kapuni Road [being a paper road] and south of Siggs Road
[being a paper road], Inaha, Manaia

Legal Description: Secs 55 56 Pt Secs 53 54 Sbdn 1 of Pt Sec 53 Sbdn 1 of
Pt Sec 54 DP 2201 Blk VII Waimate SD Sec 17 Blk VIII
Waimate SD

Catchment: Kapuni

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

Consent 6544-1

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 7 [unchanged]

1. The exercise of this consent shall be undertaken in general accordance with the documentation submitted in support of application 3514. In the case of any contradiction between the documentation submitted in support of application 3514 and the conditions of this consent, the conditions of this consent shall prevail.
2. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent.
3. Prior to the exercise of this consent for each individual well to be used for deepwell 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.
4. The consent holder shall ensure that injection will not contaminate or endanger any actual or potential useable freshwater aquifer.
5. The consent holder shall keep daily records of the nature and amounts of all material injected, including injection pressure and rate, and mean concentrations of pH, suspended solids, total dissolved solids, salinity, chlorides, and total hydrocarbons. The consent holder shall make the records available to the Taranaki Regional Council on a 3 monthly basis, and when there has been a significant pressure change event.

Consent 6544-1

6. The consent holder shall inject fluids at pressures below the pressure that would be required to fracture the injection formation.
7. 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 3, 4, 5, and 6 above.

Condition 8 [changed]

8. This consent shall lapse on 30 June 2015, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

Condition 9 [unchanged]

9. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2011 and/or June 2017 and/or June 2023 and/or June 2029 and/or June 2034, 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 21 June 2010

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: Origin Energy Resources NZ [Rimu] Limited
Sustainability Manager
Private Bag 2022
NEW PLYMOUTH 4342

Decision Date: 16 September 2011

Commencement Date: 16 September 2011

Conditions of Consent

Consent Granted: To discharge heated water, including produced water to ground at the Manutahi-D wellsite for water flooding purposes at or about (NZTM) 1719971E-5603672N

Expiry Date: 1 June 2028

Review Date(s): June 2016, June 2022

Site Location: Manutahi-D wellsite, Lower Ball Road, Kakaramea
[Property Owner: NA Schrider & PW Campbell]

Legal Description: Lot 5 DP 14553 Blk I Carlyle SD [Discharge source & site]

Catchment: Mangaroa

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

General condition

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

Special conditions

1. Before this consent is exercised, except for an initial injection trial of up to 64 cubic metres of produced water per well, the consent holder shall submit an updated "Injection Operation Management Plan" which includes the details of this waterflooding pilot project and identifies the conditions that would trigger concerns about the integrity of the well, or the injection zone, and the action to be taken by the consent holder if trigger conditions are reached.
2. Before this consent is exercised the consent holder shall provide to the Chief Executive of the Taranaki Regional Council:
 - a) Subsurface construction details, including design of the exterior surface casing, the intermediate protective casing, and the innermost casing, tubing, and packer;
 - b) A log of the well, or a representative nearby well, from 0.0 mbgl to 1000 mbgl; clearly showing the freshwater/brine water interface zone;
 - c) Annular pressure; pressure testing which demonstrates well integrity [MIT];
 - d) Receiving Formation fracture pressure and geological seal fracture pressure;
 - e) A chemical analysis of the formation-water;
 - f) Cementing details.
3. The injection pressure at the wellhead shall not exceed a maximum injection pressure of 721 PSI [50 Bars].
4. The volume of liquid re-injected shall not exceed 318 cubic metres per day.
5. 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; in particular, ensuring that the injection material is contained within the injection zone.
6. The consent holder shall keep daily records of:
 - a) maximum injection pressure;
 - b) maximum and average rate of injection; and
 - c) volume of fluid injected;

during operation of the well. These records shall be provided to the Taranaki Regional Council at the end of each month.

7. The consent holder shall measure and record the following constituents of the discharge each month:
- a) pH;
 - b) suspended solids concentration;
 - c) temperature;
 - d) salinity;
 - e) chloride concentration; and
 - f) total hydrocarbon concentration.

The consent holder shall provide to Taranaki Regional Council, during the month of May of every year, a summary of all records collected in accordance with this condition.

8. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 5 working days prior to the first exercise of this consent, except for an initial injection trial of up to 64 cubic metres of produced water per well. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
9. The consent holder shall ensure that the exercise of this consent not contaminate or put at risk actual or potential usable freshwater aquifer.
10. This consent shall lapse on the 30 September 2016, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(b) of the Resource Management Act 1991.
11. 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 2016 and/or June 2022, 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 16 September 2011

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: Origin Energy Resources NZ (Tawn) Limited
Private Bag 2022
NEW PLYMOUTH 4342

Decision Date (Change): 3 September 2013

Commencement Date (Change): 3 September 2013 (Granted: 10 September 2010)

Conditions of Consent

Consent Granted: To discharge produced water, contaminated stormwater, water based drilling fluids and hydraulic fracturing fluids, including return fluids, by deepwell injection into the Matemateaonga Formation

Expiry Date: 1 June 2028

Review Date(s): June 2016, June 2022

Site Location: Waihapa-F wellsite, 7 Bird Road, Stratford

Legal Description: Sec 10 Blk III Ngaere SD (Discharge source & site)

Grid Reference (NZTM) 1717193E-5642014N

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. The consent holder shall operate the well in accordance with the "Origin Energy Resources NZ Limited - Deep Well Injection Management Plan" dated June 2010. In particular, Section 7 of the plan (page 11) which identifies the conditions that would trigger concerns about the integrity of the well, or the injection zone, and the action to be taken by the consent holder if trigger conditions are reached.
2. The injection pressure at the wellhead shall not exceed a maximum injection pressure of 85 bars (1,232 PSI).
3. 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; in particular, ensuring that the injection material is contained within the injection zone.
4. The consent holder shall keep daily records of:
 - a) maximum injection pressure;
 - b) maximum and average rate of injection; and
 - c) volume of fluid injected;

during operation of the well. These records shall be provided to the Taranaki Regional Council at the end of each month.

5. The consent holder shall measure and record the following constituents of the discharge at the end of each month:
 - a) pH;
 - b) suspended solids concentration;
 - c) temperature;
 - d) salinity;
 - e) chloride concentration; and
 - f) total hydrocarbon concentration.

The consent holder shall provide to Taranaki Regional Council, during the month of May of every year, a summary of all records collected in accordance with this condition. The consent holder must also provide any details on the major changes in characteristics or sources of injected fluid.

Consent 4094-2

6. 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 2016 and/or June 2022, 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 3 September 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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

Name of Consent Holder: Origin Energy Resources NZ (Tawn) Limited
Private Bag 2022
NEW PLYMOUTH 4342

Decision Date (Change): 3 September 2013

Commencement Date (Change): 3 September 2013 (Granted: 23 June 2003)

Conditions of Consent

Consent Granted: To discharge waste drilling fluids, produced water, hydraulic fracturing fluids, including return fluids, and stormwater from hydrocarbon exploration and production operations by deepwell injection at the Waihapa-D wellsite

Expiry Date: 1 June 2034

Review Date(s): June 2016, June 2022, June 2028

Site Location: Waihapa-D wellsite, Cheal Road, Ngaere, Stratford
(Property owner: A & J Moore)

Legal Description: Lot 1 DP 17294 Blk VII Ngaere SD (Discharge source & site)

Grid Reference (NZTM) 1718010E-5638199N

Catchment: Patea

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

General conditions

- a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.
- b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.
- c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:
 - i) the administration, monitoring and supervision of this consent; and
 - ii) charges authorised by regulations.

Special conditions

1. 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, a log of the injection well, and an injection well operation management plan, to demonstrate that special condition 2 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.
2. The resource consent holder shall ensure that injection will not contaminate or endanger any actual or potential useable freshwater aquifer.
3. The consent holder shall keep daily records of the amounts of all material injected, including injection pressure and rate, and shall make the records available to the Taranaki Regional Council on a 12 monthly basis, and when there has been a significant pressure change event.
4. The consent holder shall monitor the injected material monthly, and upon the request of the Taranaki Regional Council. Concentrations of suspended solids, total dissolved solids, salinity, chlorides, total hydrocarbons, and pH shall be monitored and the records made available to the Taranaki Regional Council on a 12 monthly basis.
5. The consent holder shall inject fluids at pressures below the pressure that would be required to fracture the stratigraphic seals of injection formation.

Consent 3688-2

6. This consent shall lapse on the expiry of five years after the date of commencement of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(b) of the Resource Management Act 1991.
7. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent, by giving notice of review during the month following receipt of information required under special conditions 3 and 4 above, and the month of June 2010 and/or June 2016 and/or June 2022 and/or June 2028 required for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 3 September 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management