

Shell Todd Oil Services Ltd
Deep Well Injection
Monitoring Programme
Annual Report
2014-2015

Technical Report 2015-35

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Executive summary

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

During the period under review, the Company held two resource consents for the injection of fluids by DWI, at their KA1/7/19/20 wellsite, Palmer Road, Kapuni, and the KA9 wellsite, Lower Duthie Road, Kapuni. Consent 1336-3 permits the discharge of up to 2,000 cubic metres/day of produced water and approved contaminants by deep well injection into the Matemateaonga Formation via well KW-2 or into the Mangahewa Formation via contingency back-up wells KA-1 and KA-7. Consent 9970-1 permits the discharge of waste fluids associated with hydrocarbon exploration and production by deep well injection into the Matemateaonga Formation via the KW-2 well or into the Mangahewa Formation via wells KA-01 and KA-07. Consent 9970-1 replaced 1336-3 on 7 October 2014. The consents include a number of special conditions which set out specific requirements with which the Company must comply.

During the monitoring period, Shell Todd Oil Services Ltd demonstrated an overall high level of environmental performance.

During the period under review, injection was carried out exclusively via the KW-2 well, with the KA-1 and KA-7 wells providing contingency disposal options. The monitoring of the Company's DWI activities by the Council included undertaking inspections of injection operations, the review and assessment of injection data submitted by the Company, and groundwater monitoring in the vicinity of the active injection site.

The Council carried out two inspections of the Company's active DWI sites during the period under review. Inspection visits comprised liaison 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.

As required by the special conditions of consents 1336-3 and 9970-1, the Company supplied the Council with process monitoring data and injection records at the required intervals. Data supplied by the Company was reviewed by the Council on submission. In total, the Company discharged 43,014 cubic metres of fluids by DWI during the 2014-2015 monitoring period. The volumes of fluid discharged, and the pressure at which it was injected into the receiving formations, were within the limits specified in the resource consents.

During the period under review, groundwater monitoring sites in the vicinity of the KA9 wellsite were sampled by URS on behalf of the Company. The results of the analyses carried out on all samples collected do not indicate any form of contamination as a result of fluid injection via the KW-2 well.

The results of the analyses carried out do indicate the presence of dissolved methane gas within local groundwater. Further analysis of the isotopic signature of the gas indicates that it is biogenic in origin.

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

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

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

For reference, in the 2014-2015 year, 75% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 22% demonstrated a good level of environmental performance and compliance with their consents.

This report includes recommendations for the 2015-2016 year.

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

The following Annual Report covers the monitoring period 1 July 2014–30 June 2015. During the period under review, Shell Todd Oil Services Ltd (the Company) held two resource consents for the disposal of wastes by deep well injection (DWI), at their KA1/7/19/20 wellsite, Palmer Road, Kapuni, and the KA9 wellsite, Lower Duthie Road, Kapuni. The resource consents held by the Company permit the discharge of waste fluids associated with hydrocarbon exploration and production into the Matemateaonga or Mangahewa Formations. The consents include a number of special conditions, setting out specific requirements with which the Company must comply.

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

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the RMA and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consents held by the Company/companies in the Kapuni catchment, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted in the Company's site.

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

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

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

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

1.1.3 The Resource Management Act 1991 and monitoring

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

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

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each activity. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the RMA to assess the effects of the exercise of consents. In accordance with section 35 of the RMA, the Council undertakes compliance monitoring for consents and rules in regional plans, and maintains an overview of the performance of resource users and consent holders. Compliance monitoring, including both activity and impact monitoring, enables the Council to continually re-evaluate its approach and that of consent holders to resource management and, ultimately, through the refinement of methods and considered responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and administrative performance

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

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

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

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

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

Environmental Performance

- **High:** No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment. The Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.

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

For example:

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

Administrative performance

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

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

For reference, in the 2014-2015 year, 75% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 22% demonstrated a good level of environmental performance and compliance with their consents.

1.2 Process description

1.2.1 Background

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

The modern era of exploration began in New Zealand in 1955 when a Shell-BP-Todd consortium explored a large part of the Taranaki region. The group's 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 extends into permeable saline formations, at depths far below the base of potentially useable freshwater aquifers. Waste is then injected into the receiving formation by pressure generated by surface pumps. International standards (adopted in the Taranaki Region) for the construction of disposal wells emphasise the

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

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

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

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

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

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

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

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

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

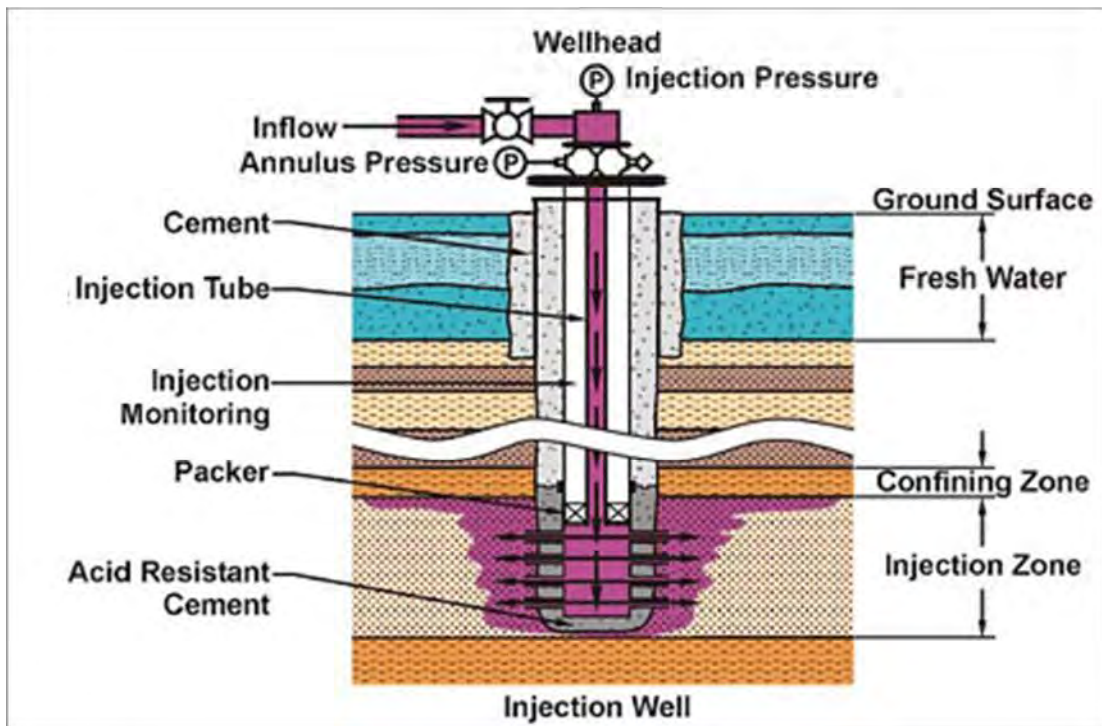


Figure 1 DWI schematic representative of Taranaki sites¹

1.3 Potential environmental effects of exercising a DWI consent

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

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

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

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

ensure that fluids discharged by DWI will be contained 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 disposal wells in use at each site. All of the resource consents were issued by the Council under Section 87(e) of the RMA.

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

Consent	Dates Exercised	Wellsite	Injection Well(s)	Formation
1336-3	1/7/2014 – 6/10/2014	KA9	KW-2	Matemateaonga
		KA1/7/19/20	KA-1	Mangahewa
		KA1/7/19/20	KA-7	Mangahewa
9970-1	7/10/2014 – 30/6/2015	KA9	KW-2	Matemateaonga
		KA1/7/19/20	KA-1	Mangahewa
		KA1/7/19/20	KA-7	Mangahewa

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

Resource Consent: 1336-3

“To discharge up to 2,000 cubic metres/day of produced water and approved contaminants by deep well injection into the Matemateaonga Formation via well KW-2 or into the Mangahewa Formation via contingency back-up wells KA-1 and KA-7.”

Background:

The first recorded discharges by DWI in the Kapuni field were carried out under water right 130. Records kept at the Council indicate that from 1973 to 1984, a total of 900,000 cubic metres (m³) of produced water was discharged at the Kapuni production station, via well KW-1. The discharge was into a freshwater aquifer in the Matemateaonga Formation at a depth of 502 to 538 m true vertical depth (TVD) below ground level. In 1981, when water right 130 was renewed, the Council required the consent holder to nominate a new injection well, and that discharges via the KW-1 well cease. KW-1 was retained for emergency disposal purposes, and periodic discharges of produced water occurred via the well until 1990. Water right 130 expired on 1 June 1991. No adverse environmental effects were reported, and KW-1 was plugged and abandoned in December 2000.

On 10 October 1984, consent TRK931336 was granted to Shell BP & Todd Oil Services Limited, covering DWI activities within the Kapuni field. The consent was subsequently transferred to Shell Todd Oil Services limited (STOS) on 24 January 1991. Consent TRK931336 permitted the discharge of up to 800 m³/day of produced water into the Matemateaonga Formation, via the KW-2 well, a non-producing gas well. On 26 September 1990, an application was received from the Company, seeking to increase the authorised discharge volume from 800 m³/day to 1,200 m³/day. This application was granted on 17 April 1991. On 7 August 1991, special dispensation was approved for a one-off disposal of up to 132 m³ of neutralised acids via KW-2.

A consent renewal application was received from the Company on 19 November 1992. The application also sought an increase in the authorised discharge volume to 2,000 m³/day. A revised consent (1336-2) was granted on 10 February 1993. On 19 December 2003, the consent conditions were varied to allow for discharge by DWI via two contingency wells, KA-1 and KA-7, at the KA1/7/19/20 wellsite.

The consent was reviewed again on 21 April 2005, and currently authorises the discharge of up to 2,000 m³/day of produced water into the Matemateaonga Formation via the KW-2 well, or into the Mangahewa Formation, via contingency wells KA-1 and KA-7.

On 31 July 2009, the Company applied for a further variation to consent 1336-3 in relation to the range of contaminants authorised for discharge. Due to continual changes in additive technology, and the evolving requirements of a mature field such as Kapuni, there are changes in the nature of additives that may enter the produced water system, and subsequently require disposal by DWI. Rather than requiring the Company to apply for a variation of consent with every change made to the range of additives being used, it was considered preferable that the Company sought prior approval from the Council for any changes to the additives being used on a case-by-case basis. This variation to the consent was approved on 5 October 2009. On 22 July 2013, the Company again applied for a variation to consent 1336-3. The application was to change the date when information is to be provided to the Council, from May annually, to August annually. This variation to the consent was approved on 9 August 2013.

On 7 October 2014, consent 1336-3 was replaced by consent 9970-1.

The consent had 11 special conditions, as summarised below:

- Special condition 1 requires the best practicable option to be adopted for the discharge;
- Special conditions 2, 3, 5, 6 and 8 refer to information and data submission requirements;
- Special condition 4 prohibits the discharge from endangering or contaminating any freshwater aquifer;
- Special condition 7 limits injection pressures to those which do not fracture the stratigraphic seals of the injection zone;
- Special condition 9 details the consent lapse and expiry dates;
- Special condition 10 contains review provisions; and
- Special condition 11 allows for the introduction of new chemicals to the produced water system, provided they can reasonably be expected to be used in

petrochemical well maintenance and development, and they will not have environmental effects that are more adverse than current chemicals in use.

Resource Consent: 9970-1

“To discharge waste fluids associated with hydrocarbon exploration and production by deep well injection into the Matemateaonga Formation via the KW-2 well or into the Mangahewa Formation via wells KA-01 and KA-07.”

Background:

Rather than seeking prior approval from the Council for any changes to the additives being used in the injection fluid on a case-by-case basis as per consent 1336-3, the Company decided to apply for a new consent which would cover a wider range of additives. Consent 9970-1 was applied for on 8 August 2014 and was granted on 7 October 2014.

The consent has 21 special conditions, as summarised below:

- Special condition 1 sets a maximum daily injection volume of 2,000 m³/day;
- Special condition 2 requires to consent holder to submit an “Injection Operation Management Plan” by 1 January 2015;
- Special condition 3 requires the consent holder to submit well completion information;
- Special condition 4 requires that no injection be made after 1 June 2024;
- Special condition 5 requires to BPO requirements;
- Special condition 6 sets a minimum injection depth of 1,200 mbgl;
- Special condition 7 requires the consent holder to submit an “Injection Operation Management Plan” prior to utilising either contingency back up wells;
- Special condition 8 prohibits the discharge from resulting in the fracturing of the geological seals confining the injection zone;
- Special condition 9 prohibits the discharge from endangering or contaminating any freshwater aquifer;
- Special condition 10 limits the type of fluid that may be discharged;
- Special condition 11 lists other fluids that may be discharged subject to a number of conditions;
- Special conditions 12, 13, 14 and 15 refer to process monitoring and data submission requirements;
- Special conditions 16, 17 and 18 relate to the requirement for the consent holder to implement a groundwater monitoring programme;
- Special condition 19 requires an annual report summarising data collected and compliance with consent conditions to be provided before 31 August each year;

- Special condition 20 is a lapse clause; and
- Special condition 21 is a review provision.

Figure 2 shows the location of the DWI consent held by the Company during the period under review. A copy of the consent certificate is attached in Appendix I of this report.



Figure 2 Location of consent 1336-3 and 9970-1 associated wellsites

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. During the period under review samples of the injectate were obtained from a storage tank located at the Kapuni Production Station (Table 2). The tanks are identified by the Company as tank T604.

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

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

Table 2 Location of injectate sampling sites

Consents	Wellsite	Injection well(s)	Site code	Sample point
1336-3 & 9970-1	KA9	KW-2	GND1412	Tank T604
	KA1/7/19/20	KA-1	GND1683	N/A - contingency well
	KA1/7/19/20	KA-7	GND1684	N/A - contingency well

1.5.4 Assessment of data submitted by the consent holder

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

1. Information on the disposal well and injection zone

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

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

2. Discharge records

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

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

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

3. Annual reporting

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

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

1.5.5 Groundwater quality monitoring

The Company carried out its own groundwater monitoring in the vicinity of the KA9 wellsite during the 2014-2015 monitoring period. The Company contracted URS New

Zealand Limited (URS) to carry out the sampling, as it had done for the previous monitoring period (2013-2014). URS obtained samples of groundwater from four existing groundwater abstractions on two separate occasions. Details of the sites sampled by URS are included in Table 3.

Table 3 Location of groundwater abstraction sampled by the Company (2014-2015)

URS reference	Site code	Type	Distance from wellsite (m)	Casing depth (m)	Total depth (m)	High static water level (m)	Aquifer
Site 1	GND1143	Bore	948	40	65	18	Volcanics
Site 2	GND1701	Bore	2,971	92	337	NR*	Matemateaonga
Site 3	GND2369	Bore	4,643	280	448	NR*	Matemateaonga
Site 4	GND1659	Bore	4,020	123	432	6	Matemateaonga

NR* Not Recorded: Design of the bore prevents static water level from being measured from the ground surface

2. Results

2.1 Site inspections and injectate sampling

During the period under review, the Council carried out two routine inspections in relation to the Company's DWI activities. Inspections were undertaken at the Kapuni Production Station on 1 October 2014 and 20 April 2015. The Kapuni Production Station serves as a central fluid collection and storage facility for waste fluids generated within the Kapuni field. All fluid injection is also controlled and monitored from the production station.

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

As part of the monitoring programme, spot samples of the injectate were obtained during the inspection visits. 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 injectate samples comprised predominantly of produced water.

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

Parameter	Unit	1/10/2014	20/4/2015
Time	NZST	13:30	14:30
TRC sample number	-	1411357	151495
pH	pH Units	7.2	8
Conductivity @ 20°C	mS/m @ 20°C	3,220	2,850
Alkalinity	g/m ³ CaCO ₃	7,500	9,530
Chloride	g/m ³	9,250	6,070
Total petroleum hydrocarbons	g/m ³	160	57

2.2 Assessment of data provided by the consent holder

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

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

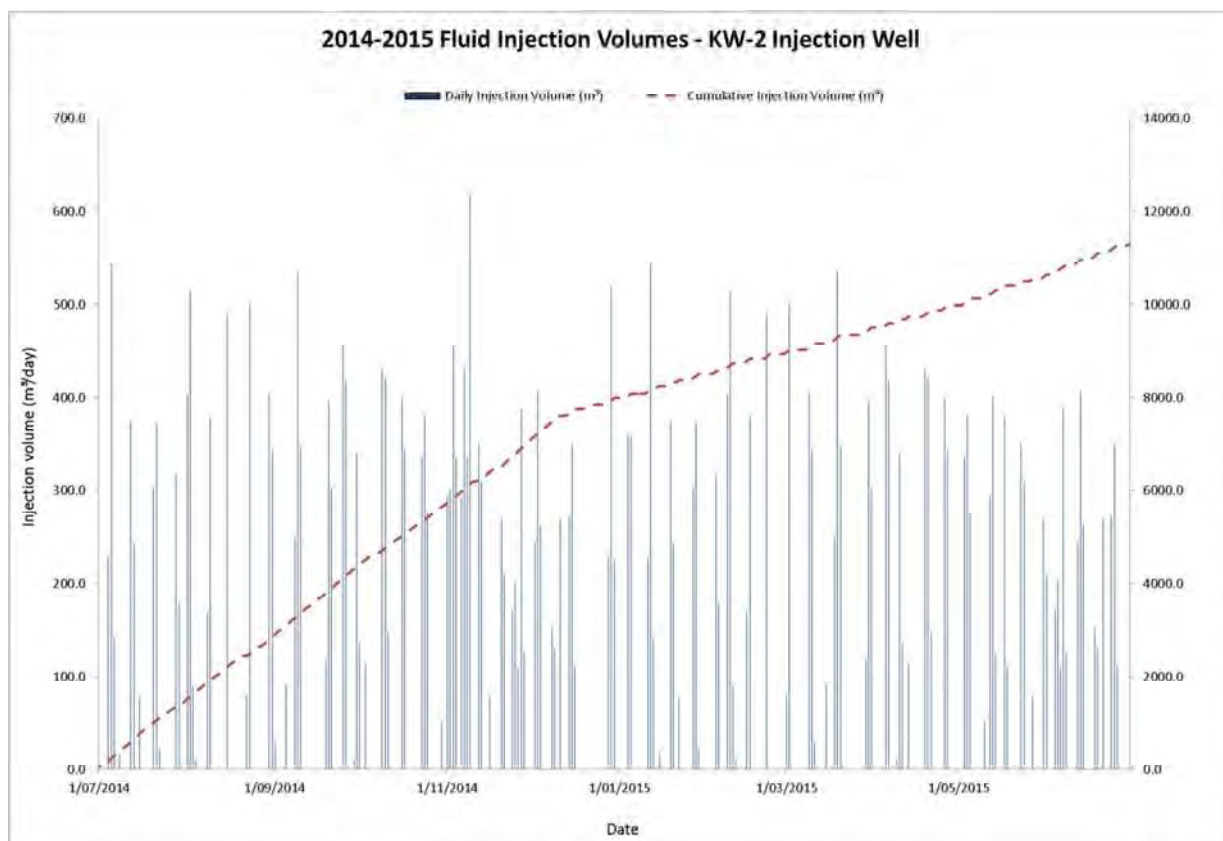
Table 5 Summary of DWI activities during the period under review (2014-2015)

Consents	Wellsite	Injection wells	Total volume discharged (m ³) 01/07/13 – 30/06/14	Discharge period		TRC well ID
				From	To	
1336-3 & 9970-1	KA9	KW-2	43,014	1/7/14	30/6/15	GND1412
	KA1/7/19/20	KA-1	0	-	-	GND1683
	KA1/7/19/20	KA-7	0	-	-	GND1684
Total			43,014	-	-	-

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

	4094-2		
	Volume injected (m ³)	Injection pressure (bar)	Injection rate (m ³ /hr)
Total	43,014	-	-
Daily maximum	617	60	10,250
Daily average	164	45	70

The injection volume and pressure data provided by the Company for injection carried out under consents 1336-3 and 9970-1 over the period being reported is presented graphically in Figures 2 and 3.

**Figure 3** 2014-2015 daily injection volumes – consent 1336-3 & 9970-1

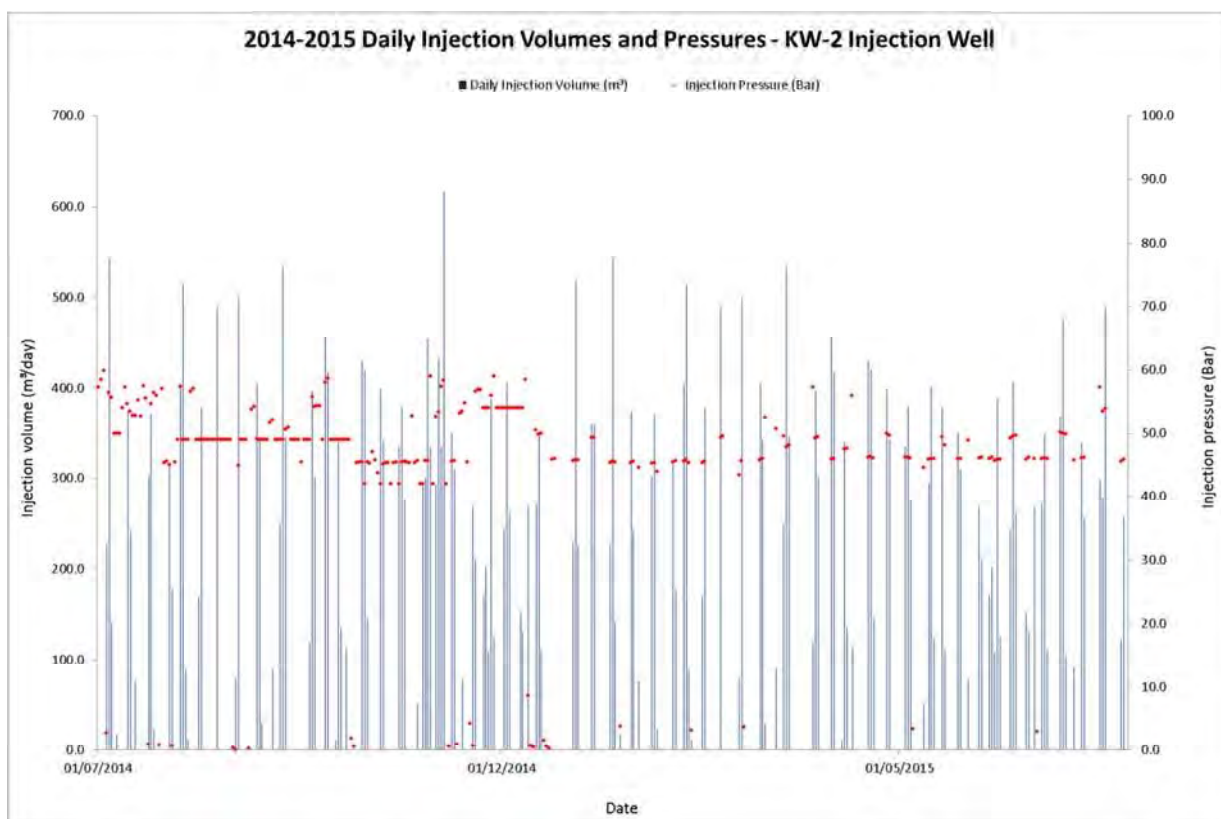


Figure 4 2014-2015 daily injection volumes and pressure – consent 1336-3 & 9970-1

The injection volume and pressure data provided by the Company for injection carried out via the KW-2 well between July 2010 and June 2015 is presented graphically in Figure 5. The total annual injection volumes for the KW-2 injection well between the 2010-11 and 2014-15 monitoring periods are shown in Figure 6.

In addition to the injectate sampling carried out by the Council (Section 2.1), the Company also provided results of their own analysis of KW-2 injectate samples. Injectate at KW-2 throughout the year was composed primarily of produced water. Small volumes of HF and flowback fluids were also discharged during the period under review. Separate physicochemical analysis of each waste stream was carried out. The results of the analyses are presented below in Table 7.

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

Parameter	Unit	Number of samples	Maximum value	Minimum value	Mean value
pH	pH units	46	7.6	6.7	7.2
Salinity	ppt	46	23,500	13,800	19,793
Chloride	g/m ³	45	10,432	75	7,447
Suspended solids	g/m ³	46	7,719	20	659
Total petroleum hydrocarbons	ppm	46	312	61	171

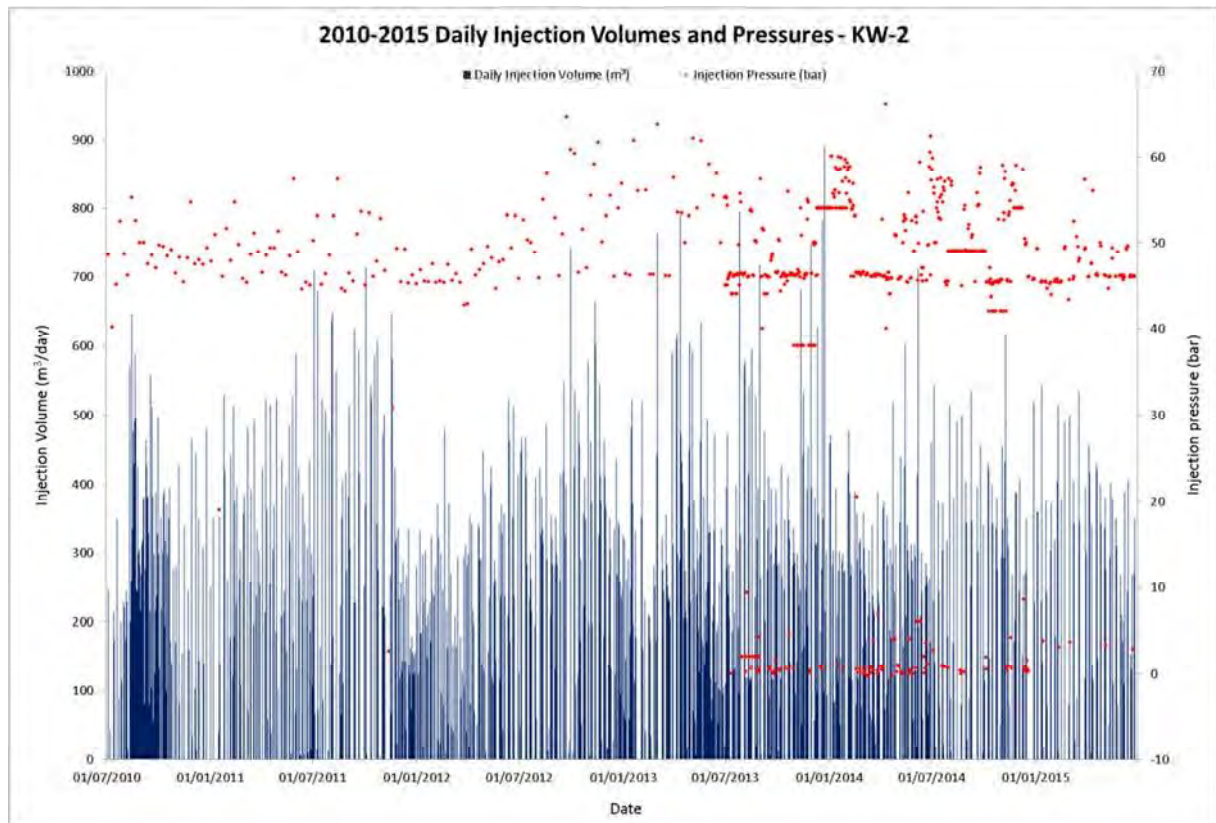


Figure 5 2010-2015 daily injection volumes and pressures – consent 1336-3 & 9970-1

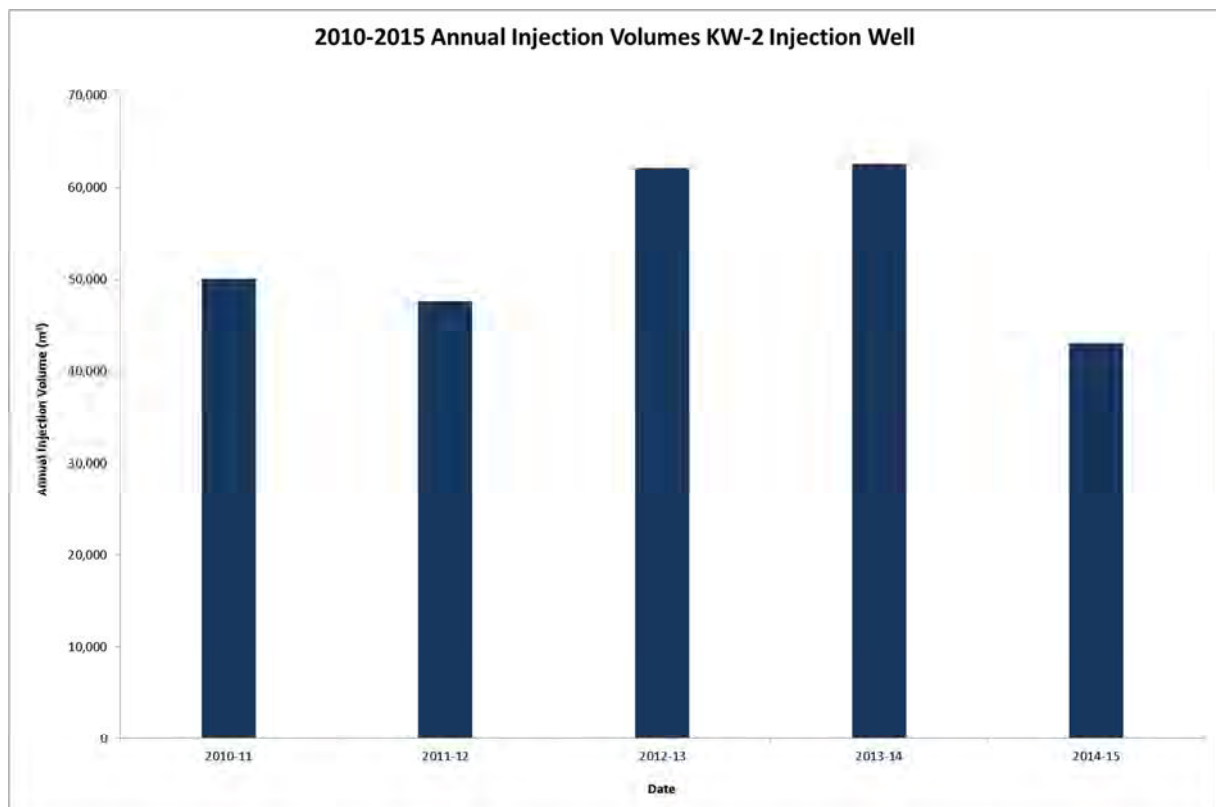


Figure 6 KW-2 total annual injection volumes (2010-2015) – consent 1336-3 & 9970-1

2.3 Groundwater quality monitoring

During the period under review, the Company conducted groundwater sampling at four sites in the vicinity of the KA9 wellsite. Sampling was conducted on 12 August 2014 and 23 March 2015. The samples were collected by URS following standard groundwater sampling methodologies. The samples were submitted to Hill Laboratories Limited for analysis. The results of the analyses are included in Appendix II.

The results give no indication of any potential contamination of shallow groundwater as a result of fluid injection via the KW-2 well. The results of the sampling were similar to those from the February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events at the same sites. The results are also generally consistent with the background groundwater quality for Taranaki.

The results of the analysis of groundwater samples for dissolved gases indicate the presence of methane gas within local groundwater. Dissolved methane gas is commonly found in groundwater across the Taranaki region, including in areas where no hydrocarbon exploration or production has occurred. The concentrations of dissolved methane gas are within the typical range for Taranaki groundwater.

As part of their assessment of dissolved gas concentrations, URS submitted samples of groundwater from each sampling site to GNS Science (GNS) for carbon isotope analysis. The analysis of carbon isotopes is used to determine the isotopic signature of methane gas, which can be used as an indicator of its origin. Shallow methane gas, derived from the breakdown of organic material close to the surface (e.g. swamps), is termed biogenic. Alternatively, thermogenic methane is normally produced in deeper formations, at greater heat and pressure.

Compositionally, shallow biogenic gas is easily recognisable from thermogenic gas, as the former is nearly 100% methane, while thermogenic methane usually occurs in the company of the related gases, ethane, propane, butane and pentane, derived from thermal decomposition (King, 2012). They can also be discriminated on the basis of their common stable (non-radioactive) carbon isotopes, ^{12}C (has 6 neutrons) and ^{13}C (has 7 neutrons). Biogenic methane contains more ^{12}C while thermogenic methane contains more of the ^{13}C carbon isotope. By analysing the relative concentration of ^{13}C carbon isotope ($\delta^{13}\text{C}$), it can be determined whether the methane present is biogenic or thermogenic in origin. Generally, a $\delta^{13}\text{C}$ value that exceeds -50‰ indicates biogenic methane, and a $\delta^{13}\text{C}$ value less than -50‰ indicates thermogenic methane. The higher or lower the $\delta^{13}\text{C}$ values, the stronger the isotopic signature. A $\delta^{13}\text{C}$ value in the vicinity of -50‰ can indicate a mixture of both biogenic and thermogenic methane.

In areas where the injection of fluids under pressure is occurring, i.e. within the vicinity of DWI sites, the presence of thermogenic methane may indicate the fracturing of the stratigraphic seals overlying the injection interval, or the presence of a conduit between the injection interval and the overlying freshwater aquifers.

The results of the $\delta^{13}\text{C}$ analysis carried out by the GNS are outlined below in Table 8. The results indicate that in all samples, the methane gas present is biogenic in origin and is likely to be present as a result of the biological breakdown of organic matter in

shallow subsurface and not related to the Company's injection activities, nor to natural gas seeps.

All results are similar to those obtained during the previous August 2014 sampling event

Table 8 Results of groundwater carbon isotope analysis undertaken by the Company (2014-2015)

URS reference	Sample date	$\delta^{13}\text{C}$ composition (‰)	Gas origin
Site 1	12 August 2014	-79.2	Biogenic
	23 March 2015	-76.74	
Site 2	12 August 2014	-81.3	Biogenic
	23 March 2015	-81.75	
Site 3	12 August 2014	-82.1	Biogenic
	23 March 2015	-80.78	
Site 4	12 August 2014	-81.7	Biogenic
	23 March 2015	-81.56	

2.4 Investigations, interventions, and incidents

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

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

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

In the 2014-2015 period, the Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with the Company's conditions in resource consents or provisions in Regional Plans.

3. Discussion of site performance

During the period under review, the Company exercised two consents for the injection of fluids by DWI; 1336-3 and 9970-1. The consents authorise the injection of produced water and other approved contaminants as well as waste fluids associated with hydrocarbon exploration and production into the Mateamateonga Formation via the KW-2 well, or into the Mangahewa Formation via contingency back-up wells KA-1 and KA-7.

During the period under review, the only well utilised for the injection of waste fluids was the KW-2 well, located at the Company's KA9 wellsite. Consent 1336-3 was exercised by the Company between 1 July 2014 and 6 October 2014. Consent 9970-1 was exercised between 7 October 2014 and 30 June 2015. During these periods, a total of 43,014 m³ of fluid was injected, at an average of 164 m³/day. The average injection pressure was 45 bar, with a maximum pressure of 60 bar.

Consents 1336-3 and 9970-1 specify a maximum daily injection volume of 2,000 m³. A review of the injection data provided by the Company indicates the daily maximum volume injected was 617 m³, on 9 November 2014. The maximum daily injection volume is well below the maximum daily volume authorised by the consents.

Daily injection volumes and pressures over the 2010-2011 to 2014-2015 monitoring periods show that injection pressures remained relatively consistent over the period, only increasing when large volumes of fluid are being injected. When lower volumes are being injected, the pressure decreases accordingly, indicating that capacity remains within the formation for further injection. Annual injection volume data shows that the volumes of fluid injected via the KW-2 well were at their highest during the 2012-2013 and 2013-2014 monitoring periods. The volume injected in the 2014-2015 monitoring period was the lowest volume in five years.

Consents 1336-3 and 9970-1 do not stipulate a maximum injection pressure, but requires fluids to be injected at pressures below that which would cause fracturing of the stratigraphic seals confining the injection interval. The maximum injection pressure reached during the period under review was 60 bar, which occurred on multiple occasions throughout the monitoring period. There is no evidence to suggest that the injection of fluids by DWI has resulted in any fracturing of the stratigraphic seals that confine the injection interval.

The consent holder has provided sufficient information for the KW-2 well regarding well construction, and the injection interval, to satisfy the relevant consent conditions and monitoring programme information requirements. However, if deemed necessary, the Council may request further information from the consent holder that illustrates that the wells being used for the injection and the receiving formation remain secure.

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

3.1 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 also 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.

The consent holder is required to ensure that the discharge does not result in any contamination of 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. During the period under review, groundwater monitoring sites in the vicinity of the KA9 wellsite were sampled by URS on behalf of the Company. The results of the monitoring undertaken do not indicate any form of contamination as a result of fluid injection via the KW-2 well.

The results of the analyses carried out do indicate the presence of dissolved methane gas within local groundwater. Further analysis of the isotopic signature of the gas indicates that it is biogenic in origin. Biogenic methane is commonly found in groundwater across the Taranaki region, including areas where no hydrocarbon exploration or production has occurred. The gas is present due to the biological breakdown of organic material within shallow subsurface formations. The concentrations of dissolved methane gas are within the typical range for Taranaki groundwater.

The results of groundwater monitoring undertaken during the period under review are consistent with the results of previous sampling events.

The DWI consents exercised by the Company during the period under review authorises the discharge of waste fluids into the Matemateaonga Formation, via the KW-2 well, or into the Mangahewa Formation via contingency back-up wells KA-7 and KA9. All discharges during the 2014-2015 monitoring period were via the KW-2 well, located at the KA9 wellsite.

Well integrity is critical in ensuring that the injection of waste fluids by DWI does not result in the release of contaminants outside of the intended injection interval. The Company carries out regular routine monitoring of well integrity by running time-lapse temperature surveys in the KW-2 well. Any loss of integrity and loss of contaminants outside the injection interval is indicated by spikes of increased temperature (in the shallow section of the well which is cooler than injected water) or reduced temperature (in the deeper part of the well). Injected water typically has a temperature of 16°C, whilst the undisturbed formation fluid temperature at 1,200 m TVD below ground level is approximately 26°C. The results of annual temperature surveys carried out by the company indicate the well bore remains isolated from the surrounding formation.

An increase in annulus pressure could also indicate a loss of integrity, and potential leakage outside of the well casing. The Company monitors annular pressure daily during injection. The assessment of the pressure data by the Company and the Council does not indicate any significant increases in well annular pressure, supporting the conclusion that the injection well remains secure.

The natural geological characteristics of the strata overlying the injection intervals, the engineering of the injection wells, the monitoring of injection activities, and their regulation, all contribute to minimise the potential for any adverse environmental effect resulting from DWI activities.

There is no evidence to suggest that the Company's DWI activities during the period under review have resulted in the vertical migration of contaminants outside of the intended injection interval.

3.2 Evaluation of performance

During the period under review, the Company exercised DWI consents 1336-3 and 9970-1. A summary of the Company's level of compliance with the special conditions attached to consents 1336-3 and 9970-1 are provided in Table 9 and Table 10, respectively.

Table 9 Summary of Company performance with regard to consent 1336-3

Purpose: <i>to discharge produced water, contaminated stormwater, water based drilling fluids and hydraulic fracturing fluids, including return fluids, by deep well injection into the Matemateonga Formation</i>		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Adopt best practice operations for DWI	Assessment of consent holder records and environmental performance	Yes
2. Exercise consent in accordance with consent application	Assessment of consent holder records	Yes
3. Provision of well and injection zone information	Receipt of satisfactory information	Yes
4. No contamination of freshwater aquifers	Assessment of consent holder records	Yes
5. Provision of records for discharge volumes, rates, and pressures	Receipt of well discharge data	Yes
6. Provision of records of chemical analysis of discharge	Receipt of discharge analytical results	Yes
7. No fracturing of stratigraphic seals of injection formation	Assessment of consent holder records	Yes
8. Provision of annual report on deep well injection activities	Receipt of annual report from consent holder	Yes
9. Lapse clause	Receive notice of exercise of consent	Yes
10. Consent review clause	N/A	N/A
11. Only approved chemicals to be discharged by DWI	Discharge of approved chemicals only	Yes
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

*N/A = Not Applicable

Table 10 Summary of Company performance with regard to consent 9970-1

Purpose: <i>to discharge waste fluids, associated with hydrocarbon exploration and production by deep well injection, into the Matemateaonga Formation</i>		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. The volume of fluid injected shall not exceed 200 cubic metres per day.	Review and analysis of injection data.	Yes
2. By 1 January 2015, the consent holder shall submit an "Injection Operation Management Plan."	Receipt of satisfactory "Injection Operation Management Plan," by 1 January 2015.	Yes
3. Injection well, geological and operational data submission requirements. This information can be included in the "Injection Operation Management Plan."	Receipt of satisfactory information by 1 January 2015.	Yes
4. No injection permitted after 1 June 2024	Assessment of injection records and site inspection notices.	N/A
5. The consent holder shall at all times adopt the best practicable option.	Assessment of consent holder records and site inspection notices.	Yes
6. No injection of fluids above 1,200 mbgl.	Review of "Water Flooding Operation Management Plan," well construction log and injection data.	Yes
7. Before Contingency wells are utilised, an "Injection Operation Management Plan" specific to the well being utilised must be provided to the Council	Receipt of satisfactory "Injection Operation Management Plan	N/A
8. The consent holder shall ensure that the exercise of this consent does not result in the fracturing of the geological seals confining the injection zone	Assessment of injection records and results of groundwater sampling and analysis programme.	Yes
9. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water).	Assessment of injection records and results of groundwater sampling and analysis programme.	Yes
10. Only the listed fluids may be discharged	Receipt and assessment of injection data.	Yes
11. These are the only other fluids that may be injected apart from those listed in condition 10	Receipt and assessment of injection data.	Yes
12. Consent holder shall keep daily injection records	Receipt and assessment of injection data.	Yes
13. Maintain records and undertake analysis to characterise each type of waste arriving on-site for discharge.	Receipt and assessment of injection data.	Yes
14. If analysis required by condition 13 is not carried out in an IANZ laboratory, it shall be undertaken in accordance with a Quality Assurance Plan certified by the Council	Receipt and assessment of injection data.	Yes
15. The data required by conditions 12 & 13 above, for each calendar month, is required to be submitted by the 28th day of the following month	Receipt of satisfactory data by the date specified.	Yes
16. The consent holder shall undertake a programme of sampling and testing (the 'Monitoring Programme') that monitors the effects of the exercise of this consent on fresh water resources.	Monitoring Programme submitted to the Chief Executive, Taranaki Regional Council, for certification before 1 June 2013,	Yes

Purpose: <i>to discharge waste fluids, associated with hydrocarbon exploration and production by deep well injection, into the Matemateonga Formation</i>		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
17. All groundwater samples taken for monitoring purposes shall be taken in accordance with recognised field procedures and analysed for: a. pH; b. conductivity; c. chloride; and d. total petroleum hydrocarbons.	Implementation of Groundwater Monitoring Programme and assessment of results.	Yes
18. All groundwater sampling and analysis shall be undertaken in accordance with a Sampling and Analysis Plan, which shall be submitted to the Chief Executive, Taranaki Regional Council for review and certification before the first sampling is undertaken.	Receipt of Sampling and Analysis Plan prior to first round of sampling being undertaken	Yes
19. The consent holder shall provide to the Council, before 31 August each year, a summary of all data collected and a report detailing compliance with consent conditions over the previous 1 July to 30 June period.	Receipt of satisfactory report by 31 August each year.	Yes
20. Lapse Clause	Receive notice of exercise of consent	Yes
21. Consent review clause	N/A	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

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

3.3 Recommendations from the 2013-2014 Annual Report

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

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

The recommendation was implemented in the 2014-2015 period.

2. THAT the Company maintain full daily records of all injection data required by the relevant resource consent, including the nature of material injected, injection volumes, pressures and rates.

The recommendation was implemented in the 2014-2015 period.

3. THAT, during the 2014-2015 monitoring period, the Company carries out biannual sampling of shallow groundwater, at the same sites sampled during the 2012-2013 baseline and 2013-2014 sampling round. Samples should be analysed for the same range of parameters as during previous sampling events.

The recommendation was implemented in the 2014-2015 period.

4. 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.

Consent 1336-3 was replaced by consent 9970-1 on 7 October 2014 so that prior approval from the Council for any changes to the additives being used in the injection fluid on a case-by-case basis would not be needed.

3.4 Alterations to monitoring programmes for 2015-2016

In designing and implementing the monitoring programmes for air/ water discharges in the region, the Council has taken into account the extent of information made available by previous authorities, its relevance under the RMA, 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 during the 2014-2015 period in relation to the Company's DWI activities be continued during the 2015-2016 monitoring period.

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

3.5 Exercise of optional review of consent

The next optional review date for consent 9970-1 is provided for in June 2016.

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

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

4. Recommendations

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

Glossary of common terms and abbreviations

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

Aquifer (freshwater)	A formation, or group or part of a formation that contains sufficient saturated permeable media to yield exploitable quantities of fresh water.
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.
Freshwater/saline water water interface	The depth in a well at which fresh water becomes saline. The interface may be a gradational or sharp transition, depending on geology. The FW-SW transition is demonstrated by down-hole geophysical logging.
g/m ³	Grams per cubic metre. A measure of concentration which is equivalent to milligrams per litre (mg/l), or parts per million (ppm).
Hydraulic fracturing (HF)	The process of increasing reservoir permeability by injecting fluids at pressures sufficient to fracture rock within the reservoir ("fracking").
Injectate	Fluid disposed of by deep well injection.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.
Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.
m ³	Cubic metre.
pH	Numerical system for measuring acidity in solutions, with 7 as neutral. Values lower than 7 are acidic and higher than 7 are alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Produced water	Water associated with oil and gas reservoirs that is produced along with the oil and gas. Typically highly saline with salt concentrations similar to seawater and containing low levels of hydrocarbons.
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).
RMA	Resource Management Act 1991 and subsequent amendments.

TRC	Taranaki Regional Council (the Council).
TVD	True vertical depth.
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 2014-2015 period

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

Name of Consent Holder:	Shell Todd Oil Services Ltd Private Bag 2035 NEW PLYMOUTH 4342
Decision Date (Change):	9 August 2013
Commencement Date (Change):	9 August 2013 [Granted: 21 April 2005]

Conditions of Consent

Consent Granted:	To discharge up to 2,000 cubic metres/day of produced water and approved contaminants by deepwell injection into the Matemateaonga Formation via well KW-2 or into the Mangahewa Formation via contingency back-up wells KA-01 and KA-07
Expiry Date:	1 June 2023
Review Date(s):	June 2017
Site Location:	KW-2 wellsite, Lower Duthie Road, Kapuni; KA-01 & KA-07 wellsites, Palmer Road, Kapuni
Legal Description:	Lot 1 DP 11291 Pt Sec 14 Blk XVI Kaupokonui SD [KW-2]; Lots 1 & 2 DP 11138 Blk XVI Kaupokonui SD [KA-01, KA-07]
Grid Reference (NZTM)	1702850E-5629709N, 1701107E-5630144N and 1701159E-5630128N
Catchment:	Kapuni Inaha

*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. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effects on the environment from the exercise of this consent.
- 2. The exercise of this consent shall be carried out in general accordance with the information submitted in support of application 3817. In the case of any contradiction between the documentation submitted in support of application 3817 and the conditions of this consent, the conditions of this consent shall prevail.
- 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, 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.
- 4. The resource consent holder shall ensure that injection will not contaminate or endanger any actual or potential useable freshwater aquifer.
- 5. The consent holder shall keep weekly records of the nature and amounts of all material injected, including injection pressure and rate, and shall make the records available to the Taranaki Regional Council on an annual basis, and when there has been a significant pressure change event.
- 6. The consent holder shall monitor the injected wastes weekly for maximum and mean concentrations for pH, suspended solids, total dissolved solids, salinity, chlorides, and total hydrocarbons and shall make the records available to the Taranaki Regional Council on an annual basis.

Consent 1336-3

7. The consent holder shall inject fluids at pressures below the pressure that would be required to fracture the stratigraphic seals of the injection formation.
8. The consent holder shall provide to the Taranaki Regional Council during the month of August of each year, for the duration of the consent, a written report on all matters required under special conditions 3, 4, 5, 6 and 7 above.
9. 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.
10. 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, 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.
11. The chemicals introduced to the produced water system and subsequently discharged by deepwell injection under this consent shall only be those listed in the product table on page 1 of the information submitted in support of application 6314, and other chemicals that:
 - a) can reasonably be expected to be used in petrochemical well maintenance and development in accordance with industry best practice;
 - b) have environmental effects that are no more adverse than those listed in the product table on page 1 of the information submitted in support of application 6314;
 - c) have been certified by the Chief Executive, Taranaki Regional Council as complying with a) and b) above; and
 - d) have been the subject of a specific request for certification in accordance with c) above that includes details of the concentration of the contaminant and an assessment of the effects of using the chemical in the manner proposed.

Signed at Stratford on 09 August 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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

Name of
Consent Holder: Shell Todd Oil Services Limited
Private Bag 2035
New Plymouth 4342

Decision Date: 07 October 2014

Commencement Date: 07 October 2014

Conditions of Consent

Consent Granted: To discharge waste fluids, associated with hydrocarbon exploration and production by deepwell injection, into the Matemateaonga Formation via the KW-2 well, or into the Mangaheua Formation via wells KA-01 and/or KA-07 as a contingency

Expiry Date: 01 June 2029

Review Date(s): June annually

Site Location: KW-2 wellbore at KA09 wellsite, 83 Lower Duthie Road, Kapuni
KA01/KA07 wellsite, 360 Palmer Road, Kapuni

Legal Description: Lot 1 DP 11291 Pt Sec 14 Blk XVI Kaupokonui SD
(Discharge source & site)(KA09)
Lots 1 & 2 DP 11138 Blk XVI Kaupokonui SD
(Discharge source & site)(KA01/KA07)

Grid Reference (NZTM) 1702850E - 5629709N (KA09)
1701152E - 5630141N (KA01/KA07)

Catchment: Inaha (KA09)
Kapuni (KA01/KA07)

*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 volume discharged into the wellbore shall not exceed 2,000 cubic metres per day.
2. By 1 January 2015, the consent holder shall submit an "Injection Operation Management Plan". The plan shall include the operational details of the injection activities and identify the conditions that would trigger concerns about the integrity of the injection well, the receiving formation or overlying geological seals. The plan shall also detail the action(s) to be taken by the consent holder if trigger conditions are reached.
3. Before exercising this consent, the consent holder shall provide to the Chief Executive, Taranaki Regional Council:
 - (a) a geological assessment of the environment in which the well is located, including the injection zone, the geological seals confining the injection zone and any associated faulting;
 - (b) details of the injection well design and its structural integrity;
 - (c) an assessment of the suitability of the injection well for the proposed activity;
 - (d) details of how the integrity of the injection well will be monitored and maintained; and
 - (e) confirmation of the depth to which fresh water resources, as defined in condition 9, are encountered below the site.

(Note: The information required by condition 3 may be included within the "Injection Operation Management Plan" required by condition 2).

4. There shall be no injection of any fluids after 1 June 2024.
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.
6. Fluids shall be injected at a minimum depth of 1,200 mbgl.
7. Before either contingency back-up wells (KA-01 and/or KA-07) are utilised for injection purposes, the consent holder must provide to the Chief Executive, Taranaki Regional Council an Injection Operation Management Plan specific to the well to be used, which includes all information required by condition 3.
8. The consent holder shall ensure that the discharge authorised by this consent does not result in the fracturing of the geological seals confining the injection zone.
9. The consent holder shall ensure that the exercise of this consent does not result in contaminants reaching any useable fresh water (groundwater or surface water). Useable fresh groundwater is defined as any groundwater having a TDS concentration of less than 1,000 mg/l.

10. Only the following types of fluid may be discharged:
 - (a) produced water;
 - (b) hydraulic fracturing and return fluids;
 - (c) well workover fluids;
 - (d) well servicing and intervention fluids;
 - (e) well drilling fluids;
 - (f) production chemicals
 - (g) production sludges;
 - (h) contaminated stormwater; and
 - (i) other fluids in accordance with condition 11 below.
11. The fluids discharged under this consent shall only be those listed in condition 10(a) to 10(h) above, and other fluids that:
 - (a) Can reasonably be expected to be used in petrochemical well maintenance and development in accordance with industry best practice;
 - (b) Have environmental effects that are no more adverse than those listed in 10(a)–10(h) above;
 - (c) Have been certified by the Chief Executive, Taranaki Regional Council as complying with 11(a) and 11(b) above; and
 - (d) Have been the subject of a specific request for certification, in accordance with 11(c) above, that includes details of the proposed contaminant.
12. Once the consent is exercised, the consent holder shall keep daily records of the:
 - (a) injection hours;
 - (b) volume of fluid discharged; and
 - (c) maximum and average injection pressure.
13. For each waste stream arriving on site for discharge, the consent holder shall characterise the fluids by recording the following information:
 - (a) type of fluid (as listed in condition 10);
 - (b) source of fluid (site name and company);
 - (c) an analysis of a representative sample of the fluid for:
 - (i) pH;
 - (ii) conductivity;
 - (iii) suspended solids concentration;
 - (iv) temperature;
 - (v) salinity;
 - (vi) chloride concentration; and
 - (vii) total hydrocarbon concentration.

(Note: The analysis required by condition 13 above is not necessary if a sample of the same type of fluid, from the same source, has been taken, analysed and provided to the Chief Executive, Taranaki Regional Council within the previous 6 months).

14. If the analysis required by condition 13 above is not carried out in an International Accreditation New Zealand (IANZ) accredited laboratory, it shall be undertaken in accordance with a “Quality Assurance (QA) Plan” that has been certified by the Chief Executive, Taranaki Regional Council, as meeting the requirements of condition 13. The Council may also, at its discretion, carry out an audit of the consent holder’s sampling and analysis regime to assess adherence to the QA plan.

15. The information required by conditions 12 and 13 above, for each calendar month, shall be provided to the Chief Executive, Taranaki Regional Council before the 28th day of the following month.
16. The consent holder shall undertake a programme of sampling and testing that monitors the effects of the exercise of this consent on fresh water resources within an Area of Review (AoR) to assess compliance with condition 9 (the 'Monitoring Programme'). The Monitoring Programme shall be designed to characterise local groundwater quality, and be submitted to the Chief Executive, Taranaki Regional Council, for certification before the exercising of this consent, and shall include:
- (a) the location of sampling sites;
 - (b) wellsite/wellbore construction details; and
 - (c) sampling frequency.

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

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

Note: The samples required, under conditions 16 and 17, could be taken and analysed by the Taranaki Regional Council or other contracted party on behalf of the consent holder.

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

Note: The Sampling and Analysis Plan may be combined with the Monitoring Programme required by condition 16.

19. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, before 31 August each year, a summary of all data collected and a report detailing compliance with consent conditions over the previous 1 July to 30 June period. Based on the data provided, the report shall also provide:
- a) A summary of injection activities over the period being reported;
 - b) an assessment of injection well performance;
 - c) an assessment of the on-going integrity and isolation of the wellbore; and
 - d) an assessment of the on-going integrity and isolation of the receiving formation.

Consent 9970-1.0

20. This consent shall lapse on 31 December 2019, 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.
21. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June each year, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 07 October 2014

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

Appendix II

Results of URS groundwater sampling

29 June 2015

Adam Wood
Environmental Advisor
Shell Todd Oil Services Limited
Private Bag 2035
New Plymouth 4342

Dear Adam

STOS Kapuni - Third Party Abstraction Wells - Groundwater Monitoring Event January and March 2015

1.0 Terms of Reference

This letter has been prepared for Shell Todd Oil Services Ltd (STOS) by AECOM Consulting Services (NZ) Ltd (AECOM) in accordance with the proposal dated 5 July 2012 and subsequent variations. It documents the findings of the seventh groundwater monitoring event (GME) completed at four, third party abstraction wells, located within the Kapuni area; it also presents the findings of a GME completed at the former emergency bore located at the STOS KA9 well site, which is the location of STOS produced water re-injection well, KW-2.

2.0 Objective and Background

The objective of the groundwater monitoring is to assess groundwater quality in deep abstraction wells located in the Kapuni area.

Six previous GMEs of the third party abstraction wells have been completed. The dates and report references of the GMEs are provided in Table 1 below.

Table 1 STOS Kapuni - Third Party Abstraction Wells GMEs

Date	Report Reference
19 December 2012	Letter report to STOS, dated 16 April 2013 and entitled STOS Kapuni – Third Party Abstraction Well - Groundwater Monitoring
2 May 2013	Letter report to STOS, dated 12 June 2013 and entitled STOS Kapuni – Third Party Abstraction Well - Groundwater Monitoring Event May 2013
30 July 2013	Letter report to STOS, dated 20 September 2013 and entitled STOS Kapuni – Third Party Abstraction Well - Groundwater Monitoring Event July 2013
13 November 2013	Letter report to STOS, dated 19 December 2013 and entitled STOS Kapuni – Third Party Abstraction Well - Groundwater Monitoring Event November 2013
10 February 2014	Letter report to STOS, dated 29 April 2014 and entitled STOS Kapuni – Third Party Abstraction Wells - Groundwater Monitoring Event February 2014
12 August 2014	Letter report to STOS, 19 November 2014 and entitled STOS Kapuni – Third Party Abstraction Wells - Groundwater Monitoring Event August 2014

This current letter report presents the results of the GME completed at the four, third party abstraction wells on 30 January 2015, and the results of a GME completed at the former emergency bore at the STOS KA9 well site on 23 March 2015.

The four abstraction wells monitored are located at the following third party sites:

- Site 1 – M Barr, 873 Skeet Road
- Site 2 – PKW Farms, 468 Hastings Road
- Site 3 – Kiley Estate, Inuawai Road
- Site 4 – Naplin Trust, Ahipaipa Road

The former emergency bore (Site KA9-EB) is located at the STOS KA9 well site off Lower Duthie Road (Rapid #83).

The location of each site is shown on **Figure 1** (attached).

3.0 Scope of Works

The groundwater monitoring comprised the following scope of works:

- Purging and collection of groundwater samples from the third party wells and the former emergency bore.
- Laboratory analysis of groundwater samples.
- Preparation of this factual letter report.

4.0 Sampling Methodology

Groundwater samples were collected from the third party wells on 30 January 2015, and from the former emergency bore (KA9-EB) on 23 March 2015. The sampling methodology for each site is summarised in the attached appendices for each site as follows:

- **Appendix A** – Site 1 (M Barr, 873 Skeet Road)
- **Appendix B** – Site 2 (PKW Farms, 468 Hastings Road)
- **Appendix C** – Site 3 (Kiley Estate, Inuawai Road)
- **Appendix D** – Site 4 (Naplin Trust, Ahipaipa Road)
- **Appendix E** – Site KA9-EB (STOS KA9 well site, Lower Duthie Road)

The groundwater sample collected from Site 1 was collected directly from a tap attached to a secondary storage tank housed in a pump house close to the well. Groundwater samples collected from Site 2, Site 3 and Site 4 were collected from sampling ports close to the wellhead of each abstraction well. The groundwater sample collected from Site KA9-EB was collected using a down hole bladder pump.

Field sampling records for each site are attached.

4.1 Groundwater Sample Collection and Analysis

Groundwater samples were collected directly into laboratory supplied sample bottles. The samples were kept under chilled conditions and transported to Hill Laboratories Limited under standard chain of custody procedures.

Groundwater samples were analysed for the following analytes:

- pH
- Conductivity
- Anions and cations
- Bicarbonate
- Total dissolved solids, total alkalinity, total hardness
- Major ions (calcium, magnesium, potassium, sodium, chloride, nitrate-nitrogen, and sulphate)
- Dissolved (field filtered) metals (barium, copper, iron, manganese, mercury, nickel, and zinc)
- Total petroleum hydrocarbons (TPH)
- Dissolved methane, ethylene and ethane gas
- Benzene, toluene, ethylbenzene, and xylenes (BTEX)
- Formaldehyde
- Methanol
- Glycols
- Alkyl Quaternary Ammonium Compounds (analysis to test for the presence of corrosion inhibitor)
- Bromide (Sites 1 through 4).

Groundwater samples collected were also submitted to GNS Science, Gracefield Lower Hutt (GNS), for determination of Carbon-13 ($\delta^{13}\text{C}$) composition of dissolved methane, to identify the likely source of the methane.

Chain of custody documents and laboratory reports as received are attached.

4.2 Quality Assurance/Quality Control (QA/QC)

For quality assurance/quality control (QA/QC) purposes, a trip blank sample (identified as TB) and a duplicate sample collected from Site 4 (identified as Dup) were collected during the GME completed on 30 January 2015.

The trip blank sample was prepared in the laboratory with deionised water, prior to bottles being shipped.

The duplicate sample was collected directly into laboratory supplied jars, chilled and transported to Hill Laboratories Limited under URS chain of custody procedures. The trip blank sample was analysed for TPH and BTEX. The duplicate sample was analysed for dissolved metals, TPH and BTEX.

Chain of custody documents and the laboratory report as received are attached.

Trip blank KA9-MWY accompanied the sample from Site KA9-EB on 23 March 2015. KA9-MWY also accompanied shallow groundwater samples collected from the onsite and offsite monitoring wells at the KA9 well site. The trip blank was analysed for TPH/BTEX (Lab reference #1402723.10).

5.0 Groundwater Sample Results

5.1.1 Third Party Sites (Sites 1 to 4)

The groundwater analysis results for the January 2015 monitoring event for each third party site have been tabulated and are presented in the site specific appendices attached. Results for the August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events are included in the tables for these sites.

General Groundwater Parameters

General baseline groundwater parameters for groundwater samples collected from the third party wells in January 2015 were similar to results from the August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events. The results are also generally consistent with background groundwater quality for Taranaki groundwater, as reported in *Taranaki Where We Stand - State of the Environment Report, 2009*, published by the Taranaki Regional Council (Refer to Table 4.23 – Average values for groundwater quality for state of the environment monitoring sites 1999-2007).

Slightly elevated concentrations of dissolved barium, dissolved iron, dissolved manganese, dissolved potassium and dissolved zinc were recorded for the groundwater sample collected from Site 1, compared to the other sites.

Activity Parameters

Concentrations of TPH, BTEX compounds, dissolved ethylene and ethane, formaldehyde, methanol, glycols and alkyl quaternary ammonium compounds were not detected above laboratory method detection limits (MDLs) in the groundwater samples collected from any of the four third party abstraction wells.

The results do not indicate contamination of third party abstraction wells by hydrocarbons or other contaminants of concern.

Dissolved Methane

Concentrations of dissolved methane ranging from 6.4 mg/L (Site 3) to 11.6 mg/L (Site 4) were detected in the groundwater samples collected in January 2015. These concentrations are similar to those detected in November 2013, February 2014 and August 2014.

5.1.2 Site KA9-EB

General Groundwater Parameters

General baseline groundwater parameters for the groundwater sample collected from Site KA9-EB were very similar to the results for Site 1, except for dissolved zinc, which was approximately two-orders of magnitude greater at Site KA9-EB than in the groundwater from Site 1. Calcium and magnesium were also slightly elevated. The wells at the Site 1 and Site KA9-EB are relatively shallow wells (65 m and 35, respectively), finished in Taranaki volcanic aquifer.

Activity Parameters

Concentrations of TPH, benzene, ethylbenzene, xylenes, dissolved ethylene and ethane, formaldehyde, methanol, glycols and alkyl quaternary ammonium compounds were not detected above MDLs in the groundwater

sample collected from Site KA9-EB. Toluene was detected in the groundwater sample at 0.002 mg/L, compared with the MDL of 0.001 mg/L.

The results do not indicate contamination of the well by hydrocarbons or other contaminants of concern. Further sampling and analysis will assist with understanding the presence and significance of the trace level of toluene detected in the sample.

Dissolved Methane

Dissolved methane was detected at a concentration of 13.8 mg/L in the groundwater sample collected from Site KA9-EB.

5.2 Methane $\delta^{13}\text{C}$ Analysis Results (All Sites)

The $\delta^{13}\text{C}$ analysis results for groundwater samples collected from Site 1 through Site 4 for the January 2015 monitoring event, and from Site KA9-EB for the 23 March 2015 monitoring event, are summarised in **Table 2**.

Table 2 Dissolved Methane Concentrations

Site	$\delta^{13}\text{C}$ Value (‰)	Dissolved methane concentration (mg/L)
Site 1	-76.74	9.4
Site 2	-81.75	9.4
Site 3	-80.78	6.4
Site 4	-81.56	11.6
Site KA9-EB	-54.70	13.8

Osborne et al. (2011)¹ cite that generally, $\delta^{13}\text{C}$ composition in dissolved methane gas values which are enriched above approximately -50‰ indicates methane that has been formed as a result of thermogenic (deep) processes, whereas $\delta^{13}\text{C}$ composition in dissolved methane gas more negative than approximately -64‰ indicates methane that has been formed as a result of microbial (biogenic) activity.

The $\delta^{13}\text{C}$ composition in dissolved methane gas values for Sites 1 through Site 4 are more negative than -64‰ which would indicate that the dissolved methane in the groundwater from these four sites is formed through biogenic processes and not through deeper thermogenic processes. The results are similar to the August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events.

The $\delta^{13}\text{C}$ composition in dissolved methane gas value for the former emergency bore is slightly more negative than -50‰, which could be interpreted as mixed thermogenic/biogenic gas. However, the absence of dissolved ethane and ethylene gas in the sample indicates a biogenic source rather than a thermogenic source. Further sampling and analysis will assist in the understanding of the origin of the methane.

5.3 QA/QC Results

The QA/QC results for Sites 1 to 4 have been tabulated and are attached. The following points are noted:

- Concentrations of TPH and BTEX were not detected above the laboratory method detection limits in the trip blank sample.
- Concentrations of TPH and BTEX were not detected above the laboratory method detection limits in the primary or duplicate groundwater sample collected from Site 4.
- Concentrations of trace metals detected in the primary and duplicate groundwater sample collected from Site 4 showed good agreement.

The QA/QC results are considered to meet the data quality objectives for this investigation.

No TPH or BTEX were detected in the trip blank for Site KA9-EB sample.

¹ *Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing*, published in Proceedings of the National Academy of Sciences by Osborne S. G., Vengosh A, Warner N. R. and Jackson R. B. (2011) 108 (20), pp. 8172-8176

6.0 Summary

The results of the GME completed for the four, third party abstraction wells in January 2015 do not indicate contamination of the deep abstraction wells by hydrocarbons or any other contaminants of concern. Dissolved methane concentrations detected in groundwater in these wells are considered to be a result of biogenic processes rather than deeper thermogenic processes. The results of the January 2015 monitoring are consistent with the results of the August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring rounds.

The results of the GME completed for the former emergency bore at Site KA9-EB in March 2015 indicate that the bore is not contaminated by hydrocarbons or any other contaminants of concern. Further sampling and analysis is required to assess the significance of the trace concentration of toluene detected in the sample.

Dissolved methane detected in groundwater could be interpreted as mixed thermogenic/biogenic gas. However, the absence of dissolved ethane and ethylene gas in the sample indicates a biogenic source rather than a thermogenic source.

7.0 Closure

We trust that this report meets your requirements. Please do not hesitate to contact AECOM if you wish to discuss the results.

Yours sincerely



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encl: Limitations
Figure 1 - Site Location Plan
Groundwater Sampling Sheets
Laboratory Analytical Results and Chain of Custody Documentation
QA/QC Table

Appendices

- Appendix A – Site 1 (M Barr, 873 Skeet Road)
- Appendix B – Site 2 (PKW Farms, 468 Hastings Road)
- Appendix C – Site 3 (Kiley Estate, Inuawai Road)
- Appendix D – Site 4 (Naplin Trust, Ahipaipa Road)
- Appendix E – Site KA9-EB (Former Emergency Bore). STOS KA9 Well Site (Lower Duthie Road)

Limitations

All information in this Report is provided strictly in accordance with and subject to the following limitations and recommendations:

- a) This Report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by AECOM for use of any part of this Report in any other context.
- b) This conclusion is based solely on the information and findings contained in this Report.
- c) This conclusion is based solely on the scope of work agreed between AECOM and Shell Todd Oil Services Limited and described in section 3 ("Scope of Works") of this Report.
- d) This Report is based on the conditions encountered during the site monitoring conducted, and information reviewed, between January and June 2015. AECOM accepts no responsibility for any events arising from any changes in site conditions or in the information reviewed that have occurred after the completion of the site monitoring.
- e) The investigations carried out for the purposes of the Report have been undertaken, and the Report has been prepared, in accordance with normal prudent practice and by reference to applicable environmental regulatory authority and industry standards, guidelines and assessment criteria in existence at the date of this Report.
- f) Where this Report indicates that information has been provided to AECOM by third parties, AECOM has made no independent verification of this information except as expressly stated in the Report. AECOM assumes no liability for any inaccuracies in or omissions to that information.
- g) AECOM has tested only for those chemicals specifically referred to in this Report. AECOM makes no statement or representation as to the existence (or otherwise) of any other chemicals.
- h) Subsurface conditions can vary across a particular site and cannot be exhaustively defined by the investigations described in this Report. It is unlikely therefore that the results and estimations expressed in this Report will represent conditions at any location removed from the specific points of sampling.
- i) A site which appears to be unaffected by contamination at the time the Report was prepared may later, due to natural phenomena or human intervention, become contaminated.
- j) Except as specifically stated above, AECOM makes no warranty, statement or representation of any kind concerning the suitability of the site for any purpose or the permissibility of any use, development or re-development of the site.
- k) This Report has been prepared for the sole benefit of Shell Todd Oil Services Limited. Except as required by law, no third party may use or rely on, this Report unless otherwise agreed by AECOM in writing. Where such agreement is provided, AECOM will provide a letter of reliance to the agreed third party in the form required by AECOM.
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Issue Status: FINAL

THIRD PARTY WELL MONITORING
SITE LOCATION PLAN
 SHELL TODD OIL SERVICES LIMITED (STOS)
 Project No.: 42788630 Date: 2/06/2015

AECOM
 Figure: 1

Groundwater Sampling Sheets

STOS Offsite Bores GROUNDWATER SAMPLING DATA SHEET

Site No: 1 (873 Skeet Road)

Project No 42788630Project Name STOS Offsite MonitoringSampled by: NWDate 30/01/15Sample ID Site 1Duplicate ID —

Purging

Time Started 1300Time Stopped 1319Flow Rate 0.3 l/mVolume Removed 5.7Comments Bore being pumped
for farm use during
sampling.

Sampling

Time Started 1320Time Stopped 1330Flow Rate 0.3 l/mComments _____

Field Analyses

Time	Vol Removed (L)	TDS (ppm)	EC (uS/cm)	pH	T (C)	Redox (mV)	Dissolved Oxygen (%) (ppm)		Comments (Color, turbidity)
1310	3	—	321.4	6.6	16.4	46.2	2.9	0.27	med clarity, yellow tinge
1313	3.9	—	321.1	6.57	16.5	46.9	2.0	0.2	" "
1316	4.8	—	319.2	6.57	16.5	47.4	1.9	0.18	" "
1319	5.7	—	318.3	6.57	16.4	47.6	1.8	0.18	" "

STOS Offsite Bores GROUNDWATER SAMPLING DATA SHEET

Site No: 2 (468 Hastings Road)

Project No 42788630Project Name STOS Offsite MonitoringSampled by: NWDate 30/01/15Sample ID Site 2Duplicate ID —

Purging

Time Started 1205Time Stopped 1215 1230Flow Rate 0.3 l/mVolume Removed 6.6Comments Bore pump operating
simultaneously.

Sampling

Time Started 1230Time Stopped 1240Flow Rate 0.3 l/m

Comments

Field Analyses

Time	Vol Removed (L)	TDS (ppm)	EC (uS/cm)	pH	T (C)	Redox (mV)	Dissolved Oxygen (%) (ppm)		Comments (Color, turbidity)
1215	3	—	338.5	8.25	18.2	-72	38.3	3.52	High clarity, colourless
1218	3.9	—	340.1	8.3	18.2	-90.5	48.6	4.81	"
1221	4.8	—	359.9	8.3	18.2	-113.4	49.1	4.51	"
1224	5.7	—	3160.4	8.3	18.2	-119.1	47.7	4.36	"
1227	6.6	—	340.3	8.3	18.2	-120.1	46.8	4.31	"

STOS Offsite Bores GROUNDWATER SAMPLING DATA SHEET

Site No: 3 (Kiley Trust Farm)

Project No 42788630Project Name STOS Offsite MonitoringSampled by: NWDate 30/01/15Sample ID Site 3Duplicate ID —

Purging

Time Started 1010Time Stopped 1032Flow Rate 0.3 l/mVolume Removed 6.6LComments Landowner using water
from bore simultaneously

Sampling

Time Started 1033Time Stopped 1045Flow Rate 0.3Comments _____

Field Analyses

Time	Vol Removed (L)	TDS (ppm)	EC (uS/cm)	pH	T (C)	Redox (mV)	Dissolved Oxygen (%) (ppm)		Comments (Color, turbidity)
1020	3.0	—	306.2	8.77	18.8	-108	61	5.59	High clarity, colourless
1023	3.9	—	307.6	8.79	18.8	-106.7	61.4	6.7	"
1026	4.8	—	307.3	8.8	18.8	-107.2	68.1	6.47	"
1029	5.7	—	307.6	8.8	18.8	-106.3	69.4	6.59	"
1032	6.6	—	307.1	8.8	18.9	-108.1	69.9	6.77	"

STOS Offsite Bores GROUNDWATER SAMPLING DATA SHEET

Site No: 4 (Naplin Trust Farm)

Project No 42788630Project Name STOS Offsite MonitoringSampled by: NWDate 30/01/15Sample ID Site 4Duplicate ID DUP

Purging

Time Started 1110Time Stopped 1130Flow Rate 0.3 l/mVolume Removed 5.7

Comments Bore is artesian, constant
trickle through bore outlet
pipe to holding tank.

Sampling

Time Started 1130Time Stopped 1142Flow Rate 0.3

Comments _____

Field Analyses

Time	Vol Removed (L)	TDS (ppm)	EC (uS/cm)	pH	T (C)	Redox (mV)	Dissolved Oxygen (%) (ppm)		Comments (Color, turbidity)
1120	3	—	373.4	7.89	18.4	-126.6	2.9	0.28	High clarity, colourless
1123	3.9	—	375	7.9	18.3	-128.1	1.5	0.14	"
1126	4.8	—	377.2	7.9	18.3	-133.6	1	0.8	"
1129	5.7	—	375.5	7.9	18.3	-132.3	1.25	0.10	"

Site No: KA9 - Emergency BoreProject Name **STOS Offsite Monitoring**

Sampled by:

Date _____

Sample ID Site KA9
Duplicate ID -

Sampling

END SWL : 13.07

Time Started 14:29

Time Stopped 15:20

Flow Rate

Flow Rate

Volume Removed _____

Comments

Comments On very slow purge flow rate - still losing small amount of head

Comments

Comments Increased pump rate to sample a
sample would take too long to fill at slow pump rate.
Head stabilised @ 14.41 @ 13.07 mbroc (16cm drop)

Field Analyses

DWL

[illegible]

42-96

Laboratory Analytical Results and Chain of Custody Documentation



ANALYSIS REPORT

Page 1 of 4

Client:	URS New Zealand Limited	Lab No:	1379473	SPV1
Contact:	Sean Hudgens	Date Registered:	31-Jan-2015	
	C/- URS New Zealand Limited	Date Reported:	17-Feb-2015	
	PO Box 3367	Quote No:	50053	
	WELLINGTON 6140	Order No:	302912US	
		Client Reference:	42788630	
		Submitted By:	Ned Wells	

Sample Type: Aqueous

Sample Name:	Site1 30-Jan-2015	Site 2 30-Jan-2015	Site 3 30-Jan-2015	Site 4 30-Jan-2015	TB 30-Jan-2015
Lab Number:	1379473.1	1379473.2	1379473.3	1379473.4	1379473.5

Individual Tests

Sum of Anions	meq/L	3.1	3.6	3.4	4.0	-
Sum of Cations	meq/L	3.2	4.1	3.2	4.3	-
pH	pH Units	7.0	8.3	8.8	8.0	-
Total Alkalinity	g/m ³ as CaCO ₃	107	165	154	186	-
Bicarbonate	g/m ³ at 25°C	130	197	178	220	-
Total Hardness	g/m ³ as CaCO ₃	58	54	13.4	108	-
Electrical Conductivity (EC)	mS/m	32.4	34.1	32.3	37.9	-
Total Dissolved Solids (TDS)	g/m ³	230	196	200	230	-
Dissolved Barium	g/m ³	0.032	0.00197	0.00107	0.0064	-
Dissolved Calcium	g/m ³	14.1	13.3	3.8	24	-
Dissolved Copper	g/m ³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	-
Dissolved Iron	g/m ³	4.6	0.03	< 0.02	0.13	-
Dissolved Magnesium	g/m ³	5.6	5.0	0.93	11.6	-
Dissolved Manganese	g/m ³	0.54	0.0136	0.0067	0.027	-
Dissolved Mercury	g/m ³	< 0.00008	< 0.00008	< 0.00008	< 0.00008	-
Dissolved Nickel	g/m ³	0.0073	0.0077	< 0.0005	< 0.0005	-
Dissolved Potassium	g/m ³	13.3	1.73	0.77	3.4	-
Dissolved Sodium	g/m ³	34	68	66	46	-
Dissolved Zinc	g/m ³	0.066	0.0041	< 0.0010	0.0034	-
Bromide	g/m ³	0.12	0.08	0.06	0.06	-
Chloride	g/m ³	34	11.2	11.6	12.0	-
Nitrite-N	g/m ³	0.002	< 0.002	< 0.002	< 0.002	-
Nitrate-N	g/m ³	< 0.002	< 0.002	< 0.002	< 0.002	-
Nitrate-N + Nitrite-N	g/m ³	0.004	< 0.002	< 0.002	< 0.002	-
Sulphate	g/m ³	< 0.5	< 0.5	< 0.5	< 0.5	-

Alkyl Quaternary Ammonium Compounds in Water by LCMSMS

Benzalkonium Chloride (C12 homologue)	g/m ³	< 0.010	< 0.010	< 0.010	< 0.010	-
Benzalkonium Chloride (C14 homologue)	g/m ³	< 0.010	< 0.010	< 0.010	< 0.010	-
Benzalkonium Chloride (C16 homologue)	g/m ³	< 0.010	< 0.010	< 0.010	< 0.010	-
Benzalkonium Chloride (Total)	g/m ³	< 0.018	< 0.018	< 0.018	< 0.018	-
DDAC (Didecyltrimethylammonium chloride)	g/m ³	< 0.010	< 0.010	< 0.010	< 0.010	-
Dodine	g/m ³	< 0.010	< 0.010	< 0.010	< 0.010	-
IPBC (3-Iodo-2-propynyl-n-butylcarbamate)	g/m ³	< 0.010	< 0.010	< 0.010	< 0.010	-

Ethylene Glycol in Water

Ethylene glycol*	g/m ³	< 4	< 4	< 4	< 4	-
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Propylene Glycol in Water



This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.

The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

Sample Type: Aqueous						
Sample Name:		Site1 30-Jan-2015	Site 2 30-Jan-2015	Site 3 30-Jan-2015	Site 4 30-Jan-2015	TB 30-Jan-2015
Lab Number:		1379473.1	1379473.2	1379473.3	1379473.4	1379473.5
Propylene Glycol in Water						
Propylene glycol*	g/m ³	< 4	< 4	< 4	< 4	-
Methanol in Water - Aqueous Solvents						
Methanol*	g/m ³	< 2	< 2	< 2	< 2	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
m&p-Xylene	g/m ³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m ³	< 0.02	< 0.02	< 0.02	< 0.02	-
Gases in groundwater						
Ethane	g/m ³	< 0.003	< 0.003	< 0.003	< 0.003	-
Ethylene	g/m ³	< 0.003	< 0.003	< 0.003	< 0.003	-
Methane	g/m ³	9.4	9.4	6.4	11.6	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m ³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m ³	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m ³	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m ³	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Sample Name:	Dup 30-Jan-2015					
Lab Number:	1379473.6					
Individual Tests						
Dissolved Barium	g/m ³	0.0063	-	-	-	-
Dissolved Copper	g/m ³	< 0.0005	-	-	-	-
Dissolved Iron	g/m ³	0.12	-	-	-	-
Dissolved Manganese	g/m ³	0.027	-	-	-	-
Dissolved Mercury	g/m ³	< 0.00008	-	-	-	-
Dissolved Nickel	g/m ³	< 0.0005	-	-	-	-
Dissolved Zinc	g/m ³	0.0035	-	-	-	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m ³	< 0.0010	-	-	-	-
Toluene	g/m ³	< 0.0010	-	-	-	-
Ethylbenzene	g/m ³	< 0.0010	-	-	-	-
m&p-Xylene	g/m ³	< 0.002	-	-	-	-
o-Xylene	g/m ³	< 0.0010	-	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m ³	< 0.10	-	-	-	-
C10 - C14	g/m ³	< 0.2	-	-	-	-
C15 - C36	g/m ³	< 0.4	-	-	-	-
Total hydrocarbons (C7 - C36)	g/m ³	< 0.7	-	-	-	-

Analyst's Comments

Appendix No.1 - Chain of Custody

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Alkyl Quaternary Ammonium Compounds in Water by LCMSMS	Acetonitrile dilution, LCMSMS analysis. NB - BAC total = C12 + C14 + C16 homologues.	0.010 g/m ³	1-4
Ethylene Glycol in Water*	Direct injection, dual column GC-FID	4 g/m ³	1-4
Propylene Glycol in Water*	Direct injection, dual column GC-FID	4 g/m ³	1-4

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Methanol in Water - Aqueous Solvents*	Direct injection, dual column GC-FID	1.0 g/m ³	1-4
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B [KBIs:26687,3629]	0.0010 - 0.002 g/m ³	1-6
Formaldehyde in Water by DNPH & LCMSMS	DNPH derivatisation, extraction, LCMSMS	0.02 g/m ³	1-4
Gases in groundwater	Manual headspace creation and sub-sampling, GC-FID analysis.	0.002 - 0.003 g/m ³	1-4
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines [KBIs:2803,10734]	0.10 - 0.7 g/m ³	1-6
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-4
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E 22 nd ed. 2012.	0.07 meq/L	1-4
Total cations for anion/cation balance check	Sum of cations as mEq/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H ⁺) also included in calculation if available. APHA 1030 E 22 nd ed. 2012.	0.05 meq/L	1-4
pH	pH meter. APHA 4500-H ⁺ B 22 nd ed. 2012.	0.1 pH Units	1-4
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 22 nd ed. 2012.	1.0 g/m ³ as CaCO ₃	1-4
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO ₂ D 22 nd ed. 2012.	1.0 g/m ³ at 25°C	1-4
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 22 nd ed. 2012.	1.0 g/m ³ as CaCO ₃	1-4
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 22 nd ed. 2012.	0.1 mS/m	1-4
Total Dissolved Solids (TDS)	Filtration through GF/C (1.2 µm), gravimetric. APHA 2540 C (modified; drying temperature of 103 - 105°C used rather than 180 ± 2°C) 22 nd ed. 2012.	10 g/m ³	1-4
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.00010 g/m ³	1-4, 6
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.05 g/m ³	1-4
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0005 g/m ³	1-4, 6
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.02 g/m ³	1-4, 6
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.02 g/m ³	1-4
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0005 g/m ³	1-4, 6
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m ³	1-4, 6
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0005 g/m ³	1-4, 6
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.05 g/m ³	1-4
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.02 g/m ³	1-4
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0010 g/m ³	1-4, 6
Bromide	Filtered sample. Ion Chromatography. APHA 4110 B 22 nd ed. 2012.	0.05 g/m ³	1-4
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl ⁻ E (modified from continuous flow analysis) 22 nd ed. 2012.	0.5 g/m ³	1-4
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₃ ⁻ I 22 nd ed. 2012.	0.002 g/m ³	1-4
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO ₂ N. In-House.	0.0010 g/m ³	1-4
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO ₃ ⁻ I 22 nd ed. 2012.	0.002 g/m ³	1-4
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 22 nd ed. 2012.	0.5 g/m ³	1-4

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This report must not be reproduced, except in full, without the written consent of the signatory.

A handwritten signature in blue ink, appearing to read 'Peter Robinson', with a stylized flourish at the end.

Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental Division



CHAIN OF CUSTODY AND SAMPLE RECEIPT DOCUMENTATION

FROM:		TO:		ANALYSES REQUIRED												
URS - an AECOM Company Level 3, 80 The Terrace Wellington PO Box 27277 Ph: (04) 896 6000 Fax: (04) 896 6001		R J Hill Laboratories Limited 1 Clyde Street Hamilton Ph: (07) 858 2000 URS Client: Shell Todd Oil Services Ltd.		CONTAINERS												
RESULTS ATTENTION: Suzanne Lowe PROJECT NO: 42788630 PURCHASE ORDER NO: 302912US SAMPLER(S): Ned Wells		LAB QUOTE NO: <input checked="" type="checkbox"/> 30443 Normal Priority <input type="checkbox"/> 30833 High Priority <input type="checkbox"/> 30481 Urgent Priority <input type="checkbox"/> Special Quote			ANALYTES	As Per Quote 50053	TPH/BTEX	Trace Metals								
SAMPLE ID	MATRIX	DATE/TIME	COMMENTS													
Site 1	Aqueous	30-Jan-15			X											
Site 2	Aqueous	30-Jan-15			X											
Site 3	Aqueous	30-Jan-15			X											
Site 4	Aqueous	30-Jan-15			X											
TB	Aqueous	30-Jan-15				X										
Dup	Aqueous	30-Jan-15				X	X									
Total No. of Sample Bottles: 51				Including:	7				Blank or Duplicate Samples							
CHAIN OF CUSTODY DATA																
RELINQUISHED BY				RECEIVED BY				METHOD OF SHIPMENT								
NAME: Ned Wells				NAME: <i>Katie Taylor</i>				DATE: <i>30-Jan-15</i>				URS RECEIPT				
COMPANY: URS - an AECOM Company				COMPANY: <i>URS</i>				TIME: <i>15:00</i>				HILLS DOCK				
SAMPLE RECEIPT DATA																
PLEASE COMPLETE THIS SECTION (CIRCLE AS APPROPRIATE) AND RETURN FAX A COPY IMMEDIATELY AFTER RECEIVING SAMPLES																
ALL SAMPLES AND ASSOCIATED DOCUMENTATION WERE RECEIVED IN GOOD ORDER				YES / NO		PLEASE CONTACT THE LABORATORY				CUSTODY SEAL INTACT:		YES / NO / NA		Temp:		
										SAMPLES CHILLED:		YES / NO / NA				
										LABORATORY BATCH NO:						
SPECIAL HANDLING/STORAGE OR DISPOSAL INSTRUCTIONS:								REPORTING								
CAUTION - SAMPLES MAY CONTAIN HAZARDOUS SUBSTANCES								REPORT FORMAT: FAX <input type="checkbox"/> LETTER <input type="checkbox"/> EMAIL <input checked="" type="checkbox"/> DISK <input type="checkbox"/>								
								EMAIL ADDRESS: <i>suzanne.lowe@aecom.com, sean.hudgens@aecom.com</i>								
INTERNAL USE - URS WORK INSTRUCTIONS AND CHECKLIST OVERLEAF																

Pag

Received by: Lisa Bailey

Job No: 137 9473
 Date Recv: 31-Jan-15 08:54

**Client**Name **URS New Zealand Limited** 33348Address **PO Box 3367, WELLINGTON 6140**Phone **04 496 3750** Fax **04 496 3755**Client Reference **42788630**Quote No **50053** Order No **302912US**Primary Contact **Sean Hudgens** 184706Submitted By **Sean Hudgens** 184706Charge To **URS New Zealand Limited** 33347Results To ☐ Mail Primary Contact ☐ Mail Submitter☐ Fax Results☐ Email Results**ADDITIONAL INFORMATION****Quoted Sample Types**

Ground Water (GW)

ANALYSIS REQUESTR J Hill Laboratories Ltd
1 Clyde Street,
Private Bag 3205,
Hamilton 3240, New ZealandPhone: +64 7 858 2000
Fax: +64 7 858 2001
Email: mail@hill-labs.co.nz
Web: www.hill-labs.co.nz

Office use

Job No:

CHAIN OF CUSTODY RECORDSent to
Hill Laboratories

Date & Time:

☐ Please tick if you
require COC to be
emailed back

Name:

Signature:

Received at
Hill Laboratories

Date & Time:

Name: **Katie Taylor**

Signature:

Condition

Temp:

☐ Room Temp ☐ Chilled ☐ Frozen☐ Sample & Analysis details checked

Signature:

Priority ☐ Low ☒ Normal ☐ High☐ Urgent (ASAP, extra charge applies, please contact lab first)

NOTE: The estimated turnaround time for the types and number of samples and analyses specified on this quote is by 4:30 pm, 10 working days following the day of receipt of the samples at the laboratory.

Requested Reporting Date:

No. Sample Name Sample Date/Time Sample Type Tests Required

1	Site1		GW	BaDt, CuDt, FeDt, MnDt, HgDF, NiDt, ZnDt, TDS, ANCATL, Br, AQuat, EthyleneGlycol, PropyleneGlycol, methanol, Formaldehyde, GGWorg, TPHOIBXp
2	Site 2		GW	BaDt, CuDt, FeDt, MnDt, HgDF, NiDt, ZnDt, TDS, ANCATL, Br, AQuat, EthyleneGlycol, PropyleneGlycol, methanol, Formaldehyde, GGWorg, TPHOIBXp
3	Site 3		GW	BaDt, CuDt, FeDt, MnDt, HgDF, NiDt, ZnDt, TDS, ANCATL, Br, AQuat, EthyleneGlycol, PropyleneGlycol, methanol, Formaldehyde, GGWorg, TPHOIBXp
4	Site 4		GW	BaDt, CuDt, FeDt, MnDt, HgDF, NiDt, ZnDt, TDS, ANCATL, Br, AQuat, EthyleneGlycol, PropyleneGlycol, methanol, Formaldehyde, GGWorg, TPHOIBXp
5	TB		GW	TPHOIBXp
6	Dup		GW	BaDt, CuDt, FeDt, MnDt, HgDF, NiDt, ZnDt, TDS, ANCATL, Br, AQuat, EthyleneGlycol, PropyleneGlycol, methanol, Formaldehyde, GGWorg, TPHOIBXp
7				
8				
9				
10				



ANALYSIS REPORT

Page 1 of 3

Client:	AECOM Consulting Services (NZ) Limited	Lab No:	1402708	SPV1
Contact:	S Lowe	Date Registered:	25-Mar-2015	
	C/- AECOM Consulting Services (NZ) Limited	Date Reported:	13-Apr-2015	
	PO Box 3367	Quote No:	67560	
	WELLINGTON 6140	Order No:	322378US	
		Client Reference:	42793310	
		Submitted By:	R Miller	

Sample Type: Aqueous

Sample Name:	KA9 - Emergency Bore 23-Mar-2015 8:00 am				
Lab Number:	1402708.1				

Individual Tests

Sum of Anions	meq/L	6.8	-	-	-	-
Sum of Cations	meq/L	6.6	-	-	-	-
pH	pH Units	7.5	-	-	-	-
Total Alkalinity	g/m ³ as CaCO ₃	300	-	-	-	-
Bicarbonate	g/m ³ at 25°C	370	-	-	-	-
Total Hardness	g/m ³ as CaCO ₃	155	-	-	-	-
Electrical Conductivity (EC)	mS/m	62.7	-	-	-	-
Total Dissolved Solids (TDS)	g/m ³	310	-	-	-	-
Dissolved Barium	g/m ³	0.082	-	-	-	-
Dissolved Calcium	g/m ³	28	-	-	-	-
Dissolved Copper	g/m ³	< 0.0005	-	-	-	-
Dissolved Iron	g/m ³	3.6	-	-	-	-
Dissolved Magnesium	g/m ³	20	-	-	-	-
Dissolved Manganese	g/m ³	0.24	-	-	-	-
Dissolved Mercury	g/m ³	< 0.00008	-	-	-	-
Dissolved Nickel	g/m ³	0.0008	-	-	-	-
Dissolved Potassium	g/m ³	17.1	-	-	-	-
Dissolved Sodium	g/m ³	51	-	-	-	-
Dissolved Zinc	g/m ³	23	-	-	-	-
Chloride	g/m ³	25	-	-	-	-
Nitrite-N	g/m ³	< 0.002	-	-	-	-
Nitrate-N	g/m ³	< 0.002	-	-	-	-
Nitrate-N + Nitrite-N	g/m ³	< 0.002	-	-	-	-
Sulphate	g/m ³	< 0.5	-	-	-	-

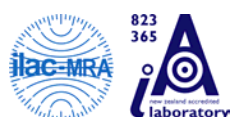
Alkyl Quaternary Ammonium Compounds in Water by LCMSMS

Benzalkonium Chloride (C12 homologue)	g/m ³	< 0.010	-	-	-	-
Benzalkonium Chloride (C14 homologue)	g/m ³	< 0.010	-	-	-	-
Benzalkonium Chloride (C16 homologue)	g/m ³	< 0.010	-	-	-	-
Benzalkonium Chloride (Total)	g/m ³	< 0.018	-	-	-	-
DDAC (Didecyltrimethylammonium chloride)	g/m ³	< 0.010	-	-	-	-
Dodine	g/m ³	< 0.010	-	-	-	-
IPBC (3-Iodo-2-propynyl-n-butylcarbamate)	g/m ³	< 0.010	-	-	-	-

Ethylene Glycol in Water

Ethylene glycol*	g/m ³	< 4	-	-	-	-
------------------	------------------	-----	---	---	---	---

Propylene Glycol in Water



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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

Sample Type: Aqueous						
Sample Name:		KA9 - Emergency Bore 23-Mar-2015 8:00 am				
Lab Number:		1402708.1				
Propylene Glycol in Water						
Propylene glycol*	g/m ³	< 4	-	-	-	-
Methanol in Water - Aqueous Solvents						
Methanol*	g/m ³	< 2	-	-	-	-
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m ³	< 0.02	-	-	-	-
Gases in groundwater						
Ethane	g/m ³	< 0.003	-	-	-	-
Ethylene	g/m ³	< 0.003	-	-	-	-
Methane	g/m ³	13.8	-	-	-	-

Analyst's Comments

Appendix No.1 - Chain of Custody

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Alkyl Quaternary Ammonium Compounds in Water by LCMSMS	Acetonitrile dilution, LCMSMS analysis. NB - BAC total = C12 + C14 + C16 homologues.	-	1
Ethylene Glycol in Water*	Direct injection, dual column GC-FID	4 g/m ³	1
Propylene Glycol in Water*	Direct injection, dual column GC-FID	4 g/m ³	1
Methanol in Water - Aqueous Solvents*	Direct injection, dual column GC-FID	1.0 g/m ³	1
Formaldehyde in Water by DNPH & LCMSMS	DNPH derivatisation, extraction, LCMSMS	0.02 g/m ³	1
Gases in groundwater	Manual headspace creation and sub-sampling, GC-FID analysis.	0.002 - 0.003 g/m ³	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E 22 nd ed. 2012.	0.07 meq/L	1
Total cations for anion/cation balance check	Sum of cations as mEq/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H ⁺) also included in calculation if available. APHA 1030 E 22 nd ed. 2012.	0.05 meq/L	1
pH	pH meter. APHA 4500-H ⁺ B 22 nd ed. 2012.	0.1 pH Units	1
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 22 nd ed. 2012.	1.0 g/m ³ as CaCO ₃	1
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO ₂ D 22 nd ed. 2012.	1.0 g/m ³ at 25°C	1
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 22 nd ed. 2012.	1.0 g/m ³ as CaCO ₃	1
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 22 nd ed. 2012.	0.1 mS/m	1
Total Dissolved Solids (TDS)	Filtration through GF/C (1.2 µm), gravimetric. APHA 2540 C (modified; drying temperature of 103 - 105°C used rather than 180 ± 2°C) 22 nd ed. 2012.	10 g/m ³	1
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.00010 g/m ³	1
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.05 g/m ³	1
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0005 g/m ³	1
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.02 g/m ³	1
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.02 g/m ³	1

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0005 g/m ³	1
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m ³	1
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0005 g/m ³	1
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.05 g/m ³	1
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.02 g/m ³	1
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0010 g/m ³	1
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl E (modified from continuous flow analysis) 22 nd ed. 2012.	0.5 g/m ³	1
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₃ ⁻ I 22 nd ed. 2012.	0.002 g/m ³	1
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO ₂ N. In-House.	0.0010 g/m ³	1
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NQ ₃ ⁻ I 22 nd ed. 2012.	0.002 g/m ³	1
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 22 nd ed. 2012.	0.5 g/m ³	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

Job No: **140 2708** Date Recv: 25-Mar-78

Received by: Jennifer Singlewood

CHAIN OF CUSTODY AND SAMPLE RECEIPT DOCUMENT

FROM:		TO:		ANALYSES REQUIRED																			
AECOM Consulting Services ANZ Ltd 80 The Terrace PO Box 27277 Wellington 6141 Ph: (04) 896 6000		R J Hill Laboratories Limited 1 Clyde Street Hamilton Ph: (07) 858 2000 URS Client: Shell Todd Oil Services		CONTAINERS		ANALYTES		HOLD COLD		TPH		MAH		TPH/BTEX		DISSOLVED METALS		CONDUCTIVITY		SALINITY		CHLORIDE	
RESULTS ATTENTION: Suzanne Lowe PROJECT NO: 4275310 PURCHASE ORDER NO: 322379US SAMPLERS: Sean Hodgins, Richie Miller		LAB QUOTE NO: <input type="checkbox"/> 30443 Normal Priority <input checked="" type="checkbox"/> 67559 High Priority <input type="checkbox"/> 30481 Urgent Priority <input type="checkbox"/> Special Quote		RESULTS REQUIRED BY:		DATE/TIME 23/3/15		COMMENTS															
SAMPLE ID KA9 - Emergency 6026		MATRIX AQUEOUS																					
Total No. of Sample Bottles:				CHAIN OF CUSTODY DATA				Blank or Duplicate Samples															
RECEIVED BY NAME: <u>Richie Miller</u> DATE: <u>24/3/15</u> COMPANY: <u>AECOM Consulting Services Ltd.</u> TIME: <u>08:00</u>				RECEIVED BY NAME: <u>David</u> DATE: <u>24/3/15</u> COMPANY: <u>URS</u> TIME: <u>08:00</u>				METHOD OF SHIP JPS RECEIPT HILLS DOCK															
SAMPLE RECEIPT DATA PLEASE COMPLETE THIS SECTION (CIRCLE AS APPROPRIATE) AND RETURN FAX A COPY IMMEDIATELY AFTER RECEIVING SAMPLE(S)				YES / NO				PLEASE CONTACT THE LABORATORY				CUSTOMER SEAL INTACT: YES / NO / NA SAMPLES CHILLED: YES / NO / NA LABORATORY BATCH NO:				REPORTING REPORT FORMAT: <input type="checkbox"/> FAX <input type="checkbox"/> LETTER <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> DISK <input type="checkbox"/>							
SPECIAL HANDLING/STORAGE OR DISPOSAL INSTRUCTIONS: CAUTION - SAMPLES MAY CONTAIN HAZARDOUS SUBSTANCES				INTERNAL USE - URS WORK INSTRUCTIONS AND CHECKLIST OVERLEAF																			



ANALYSIS REPORT

Page 1 of 1

Client:	AECOM Consulting Services (NZ) Limited	Lab No:	1403749	SPv1
Contact:	S Lowe	Date Registered:	26-Mar-2015	
	C/- AECOM Consulting Services (NZ) Limited	Date Reported:	31-Mar-2015	
	PO Box 3367	Quote No:		
	WELLINGTON 6140	Order No:	322378US	
		Client Reference:	42793310	
		Submitted By:	R Miller	

Sample Type: Aqueous						
Sample Name:		KA9 - Emergency				
		Bore 23-Mar-2015				
		8:00 am				
Lab Number:		1403749.1				
BTEX in Water by Headspace GC-MS						
Benzene	g/m ³	< 0.0010	-	-	-	-
Toluene	g/m ³	0.0020	-	-	-	-
Ethylbenzene	g/m ³	< 0.0010	-	-	-	-
m&p-Xylene	g/m ³	< 0.002	-	-	-	-
o-Xylene	g/m ³	< 0.0010	-	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m ³	< 0.10	-	-	-	-
C10 - C14	g/m ³	< 0.2	-	-	-	-
C15 - C36	g/m ³	< 0.4	-	-	-	-
Total hydrocarbons (C7 - C36)	g/m ³	< 0.7	-	-	-	-

Analyst's Comments
Appendix No.1 - Chain of Custody

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B [KBIs:26687,3629]	0.0010 - 0.002 g/m ³	1
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines [KBIs:2803,10734]	0.10 - 0.7 g/m ³	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Martin Cowell - BSc
Client Services Manager - Environmental Division



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The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

CHAIN OF CUSTODY AND SAMPLE RECEIPT DOCUMENTATION

FROM:		TO:	
AECOM Consulting Services NZ Ltd 80 The Terrace PO Box 27277 Wellington 6141 Ph: (04) 896 6000		R J Hill Laboratories Limited 1 Clyde Street Hamilton Ph: (07) 858 2000 URS Client: Shell Todd Oil Services	
RESULTS ATTENTION: Suzanne Lowe PROJECT NO: 42793310 PURCHASE ORDER NO: 322378US SAMPLE(S): Sean Hodggens, Richie Miller LAB QUOTE NO: <input type="checkbox"/> 30443 Normal Priority <input type="checkbox"/> 67559 High Priority <input type="checkbox"/> 30481 Urgent Priority <input type="checkbox"/> Special Quote		RESULTS REQUIRED BY: DATE/TIME: 23/3/15 COMMENTS:	
SAMPLE ID	MATRIX	ANALYTES	
KAG - Emergency	AQUEOUS	CONTAINERS	
Total No. of Sample Bottles:		Including:	
8000		Blank or Duplicate Samples	
3114037194		METHOD OF SH	
RECEIVED BY: <i>Richie Miller</i>		RECEIVED BY: <i>Richie Miller</i>	
NAME: <i>Richie Miller</i>		NAME: <i>Richie Miller</i>	
DATE: 23/3/15		DATE: 23/3/15	
TIME: 08:00		TIME: 08:00	
COMPANY: AECOM Consulting Services Ltd.		COMPANY: AECOM Consulting Services Ltd.	
PLEASE COMPLETE THIS SECTION (CIRCLE AS APPROPRIATE) AND RETURN FAX A COPY IMMEDIATELY AFTER RECEIVING SAMPLE(S)			
ALL SAMPLES AND ASSOCIATED DOCUMENTATION WERE RECEIVED IN GOOD ORDER		YES / NO	
SPECIAL HANDLING/STORAGE OR DISPOSAL INSTRUCTIONS:		REPORT FORMAT:	
CAUTION - SAMPLES MAY CONTAIN HAZARDOUS SUBSTANCES		FAX <input type="checkbox"/> LETTER <input type="checkbox"/> EMAIL <input checked="" type="checkbox"/> DISK <input type="checkbox"/>	
INTERNAL USE - URS WORK INSTRUCTIONS AND CHECKLIST OVERLEAF		REPORTING	
LABORATORY BATCH NO:		CUSTODY SEAL INTACT:	
YES / NO / NA		YES / NO / NA	
TEMP: 10 °C		HILLS DOCK	
URS RECEIPT		HILLS DOCK	

Job No:

Date Recv: 26-Mar-15 11:27

140 3749

Received by: Darryl Brown

STABLE ISOTOPE RESULTS

URS
URS
PO Box 3367
Wellington 6140
New Zealand



National Isotope Centre
30 Gracefield Road
Lower Hutt 5010
PO Box 31 312
Lower Hutt 5040
New Zealand
T +64-4-570 1444
F +64-4-570 4657
www.gns.cri.nz

Project Title 42788630
SIL Order No.:
Client Ref.: 306422US
Date Received: 3/02/2015
Date Measured:
Approved By:
Date Reported: 20/02/2015

Invoice
Attn:

URS
Sean Hudgens
PO Box 3367

Wellington 6140
New Zealand

Sample Type: methane (H & C)

SIL ID	External ID	$\delta^{13}\text{C}$ Value	Analysis Type	
G-1500310	Site 1	-76.74	C13	
G-1500311	Site 2	-81.75	C13	
G-1500312	Site 3	-80.78	C13	
G-1500313	Site 4	-81.56	C13	

STABLE ISOTOPE RESULTS

URS
AECOM
PO Box 27277
Wellington 6141
New Zealand



Project Title 42788630
SIL Order No.:
Client Ref.: 306422US
Date Received: 26/03/2015
Date Measured:
Approved By:
Date Reported: 9/04/2015

Invoice
Attn:

URS, An AECOM company
Suzanne Lowe
PO Box 3367

Wellington 6140
New Zealand

Sample Type: methane (H & C)

SIL ID	External ID	Delta 13C (‰)	Analysis Type
G-1500904	KA9-Emergency Bore	-54.7	C13

QA/QC Table



QA/QC - Sample Details and Analytical Results

Sample Location	QA/QC	
	Trip Blank	Duplicate of sample collected from Site 4
URS Sample Number	TB	Dup
Laboratory Sample Reference	1379473.5	1379473.6
Date Sampled	30.01.15	30.01.15
Total Petroleum Hydrocarbons (TPH)		
C ₇ -C ₉	< 0.10	< 0.10
C ₁₀ -C ₁₄	< 0.2	< 0.2
C ₁₅ -C ₃₆	< 0.4	< 0.4
Total hydrocarbons (C ₇ - C ₃₆)	< 0.7	< 0.7
BTEX Compounds		
Benzene	< 0.0010	< 0.0010
Toluene	< 0.0010	< 0.0010
Ethylbenzene	< 0.0010	< 0.0010
Total Xylenes	< 0.003	< 0.003
Dissolved Metals		
Dissolved Barium	-	0.0063
Dissolved Copper	-	< 0.0005
Dissolved Iron	-	0.12
Dissolved Manganese	-	0.027
Dissolved Mercury	-	< 0.00008
Dissolved Nickel	-	< 0.0005
Dissolved Zinc	-	0.0035

Notes:

All results and criteria are expressed in units of mg/L.

Project: 42788630

Client: Shell Todd Oil Services Limited

Filename: J:\WLG\42788630\6 Deliv\Final\Jan 2015 Round\Analytical Results Tables_Jan15.xlsAnalytical Results Tables_Jan15.xlsQAQC

Appendix A – M Barr - 873 Skeet Road (Site 1)

Site Name	M Barr – 873 Skeet Road (Site 1)
Well Details	The abstraction well at 873 Skeet Road is approximately 65 m deep and is screened from 30 to 60 m below ground level. The static groundwater level is recorded as 18 m below ground level. The well is finished with an 100 mm diameter steel well casing that sticks up above ground level by approximately 400 mm. The well is operational with a pump and outlet risers permanently mounted to the well head. The well appears to fill a storage tank which feeds a small secondary above ground tank in a pump house used for reticulation.
Pump Details	Submersible pump of unknown model.
Sampling Date	30 January 2015.
Sampler	AECOM.
Well use prior to sampling	Farm pumping water from well for irrigation prior to and during sampling.
Sampling Methodology	<p>A groundwater sample was unable to be collected directly from the well and therefore the groundwater sample was collected by connecting silicon and Teflon tubing directly to a tap attached to the secondary tank in the pump house. Groundwater was purged for approximately 19 minutes with a flow rate of approximately 0.3 L/min. An inline flow cell was used in conjunction with a multi parameter probe (YSI Professional Plus) to measure conductivity, pH, temperature, dissolved oxygen and redox in the purged groundwater. The well was sampled when parameters had stabilised.</p> <p>Water was observed to be slightly yellow throughout purging and sampling.</p> <p>The groundwater sample was collected directly into laboratory supplied sample bottles. The portion of the sample that was analysed for dissolved metals was filtered in the field as per previous monitoring events. The groundwater sample was kept under chilled conditions and transported to Hill Laboratories Limited under standard chain of custody procedures. A sub sample was also kept under chilled conditions and transported to GNS Science (GNS) under standard chain of custody procedures.</p>
Laboratory Analysis	<p>The groundwater sample was identified as “Site 1” and was analysed by Hill Laboratories for the following analytes:</p> <ul style="list-style-type: none"> - pH - Conductivity - Anions and cations - Bicarbonate - Total dissolved solids, total alkalinity, total hardness - Major ions (calcium, magnesium, potassium, sodium, bromide, chloride, nitrate-nitrogen, and sulphate) - Dissolved field filtered metals (barium, copper, iron, manganese, mercury, nickel, and zinc) - Total petroleum hydrocarbons (TPH) - Dissolved methane, ethylene and ethane gas - Benzene, toluene, ethylbenzene, and xylenes (BTEX) - Formaldehyde - Methanol - Glycols - Alkyl Quaternary Ammonium Compounds (analysis to test for the presence of corrosion inhibitor) <p>The sub sample sent to GNS was analysed for Carbon-13 composition of dissolved methane gas.</p>
Results Discussion	Results for the January 2015, August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring rounds are tabulated and attached. Results for the January 2015 monitoring event are similar to those recorded for the August 2014, February

	<p>2014, November 2013, July 2013, May 2013 and December 2012 monitoring events.</p> <p>General baseline groundwater parameters for the abstraction well at 873 Skeet Road are consistent with background groundwater quality for Taranaki groundwater as reported in <i>Taranaki Where We Stand - State of the Environment Report, 2009</i>, published by the Taranaki Regional Council (Refer to Table 4.23 – Average values for groundwater quality for state of the environment monitoring sites 1999-2007). However, consistent with previous sampling events, slightly elevated concentrations of dissolved barium, dissolved iron, dissolved manganese and dissolved zinc were recorded for the groundwater sample collected from Site 1.</p> <p>Concentrations of TPH, BTEX, formaldehyde, methanol, glycols, alkyl quaternary ammonium compounds, and dissolved ethylene and ethane gas were not detected above laboratory method detection limits.</p> <p>A concentration of 9.4 mg/L of dissolved methane was detected in the groundwater sample collected from Site 1 in the January 2015 monitoring event. The concentration of methane measured in the well during the seven monitoring events to date has ranged between 0.64 mg/L and 9.4 mg/L.</p> <p>The carbon-13 composition of dissolved methane gas as analysed by GNS is more negative than -64‰ indicating that the methane has been formed as a result of microbial activity (biogenic processes) and not through deeper thermogenic processes, as described in <i>Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing</i>, published in Proceedings of the National Academy of Sciences by Osborne S. G., Vengosh A, Warner N. R. and Jackson R. B. (2011) 108 (20), pp. 8172-8176.</p>
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The information included within this Appendix has been provided to Shell Todd Oil Services Limited for the purpose of and in accordance with the conditions of our engagement “STOS Kapuni Off-Site Monitoring – P/O 4512147904”.



Site 1 - Sample Details and Analytical Results

Sample Location	Units	873 Skeet Road						
URS Sample Number		Site 1	Site 1	Site 1	Site 1	Site 1	Site 1	Site 1
Laboratory Sample Reference		1084034.1	1131198.1	1162256.1	1202867.1	1234484.1	1310590.1	1379473.1
Date Sampled		19/12/12	2/05/13	30/07/13	13/11/13	10/02/14	12/08/14	30/01/15
Total Petroleum Hydrocarbons (TPH)								
C ₇ -C ₉	mg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C ₁₀ -C ₁₄	mg/L	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C ₁₅ -C ₃₆	mg/L	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C ₇ - C ₃₆)	mg/L	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
BTEX Compounds								
Benzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total Xylenes	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Dissolved Metals								
Dissolved Barium	mg/L	0.026	0.030	0.029	0.028	0.030	0.031	0.032
Dissolved Calcium	mg/L	14.4	15.0	14.7	14.4	14.3	14.5	14.1
Dissolved Copper	mg/L	0.0007	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0005	< 0.0005
Dissolved Iron	mg/L	1.43	1.89	2.3	1.58	2.5	4.4	4.6
Dissolved Magnesium	mg/L	4.8	5.6	5.6	5.7	5.6	5.7	5.6
Dissolved Manganese	mg/L	0.52	0.61	0.61	0.64	0.61	0.66	0.54
Dissolved Mercury	mg/L	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Nickel	mg/L	0.0086	0.0165	0.0015	0.0015	0.0008	0.0117	0.0073
Dissolved Potassium	mg/L	11.5	12.1	12.5	12.9	12.3	12.8	13.3
Dissolved Sodium	mg/L	31	31	33	34	32	36	34
Dissolved Zinc	mg/L	0.31	0.49	0.42	0.182	0.157	0.183	0.066
Alkyl Quaternary Ammonium Compounds in Water by LCMSMS								
Benzalkonium Chloride (C12 homologue)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C14 homologue)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C16 homologue)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (total)	mg/L	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018
DDAC (Didecyl dimethyl ammonium chloride)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Dodine	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
IPBC (3-Iodo-2-propynyl-n-butylcarbamate)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Ethylene Glycol in Water								
Ethylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Propylene Glycol in Water								
Propylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Methanol in Water - Aqueous Solvents								
Methanol	mg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Formaldehyde in Water by DNPH & LCMSMS								
Formaldehyde	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater								
Ethane	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	mg/L	< 0.003	< 0.004	< 0.004	< 0.003	< 0.004	< 0.003	< 0.003
Methane	mg/L	0.64	4.4	4.2	8.6	7.5	7.9	9.4
Other Analyses								
Sum of Anions	meq/L	3.0	3.2	3.2	3.1	3.1	3.1	3.1
Sum of Cations	meq/L	2.8	3.0	3.1	3.1	3.0	3.3	3.2
pH	pH Units	7	6.8	6.8	7	7.1	6.9	7.0
Total Alkalinity	mg/L as CaCO ₃	105	113	111	107	108	104	107
Bicarbonate	mg/L at 25°C	127	137	135	130	131	127	130
Total Hardness	mg/L as CaCO ₃	55	61	60	59	59	60	58
Electrical Conductivity (EC)	mS/m	31.9	32.3	32.6	30.8	32.1	32.3	32.4
Total Dissolved Solids (TDS)	mg/L	210	220	220	220	220	220	230
Bromide	mg/L	0.15	0.14	0.06	0.12	0.06	0.14	0.12
Chloride	mg/L	34	35	33	34	34	35	34
Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	0.002
Nitrate-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.02	< 0.002
Nitrate-N + Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	0.002	< 0.02	0.004
Sulphate	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Appendix B – PKW Farms - 468 Hastings Road (Site 2)

Site Name	PKW Farms – 468 Hastings Road (Site 2)
Well Details	The abstraction well at 468 Hastings Road is 337 m deep and is cased to 92 m below ground level (bgl). The depth to groundwater is unknown. The well casing is steel with a diameter of approximately 90 mm and is finished above ground. The well is operational with pump and outlet tubes permanently mounted to the well head. The well is pumped every day to supply the farm and dairy shed. Approximately 130,000 litres of groundwater is pumped each day.
Pump Details	Submersible pump of unknown model.
Sampling Date	30 January 2015.
Sampler	AECOM.
Well use prior to sampling	Farm pumping water from well for irrigation prior to and during sampling.
Sampling Methodology	<p>A groundwater sample was collected by attaching silicone tubing directly to the outlet of the well and opening a valve on the outlet. Groundwater was purged for approximately 25 minutes with a flow rate of approximately 0.3 L/min. An inline flow cell was used in conjunction with a multi parameter probe (YSI Professional Plus) to measure conductivity, pH, temperature, dissolved oxygen and redox in the purged groundwater. The well was sampled when parameters had stabilised.</p> <p>Water was observed to be clear during purging and sampling.</p> <p>The groundwater sample was collected directly into laboratory supplied sample bottles. The portion of the sample that was analysed for dissolved metals was filtered in the field as per previous monitoring events. The groundwater sample was kept under chilled conditions and transported to Hill Laboratories Limited under standard chain of custody procedures. A sub sample was also kept under chilled conditions and transported to GNS Science (GNS) under standard chain of custody procedures.</p>
Laboratory Analysis	<p>The groundwater sample was identified as “Site 2” and was analysed by Hill Laboratories for the following analytes:</p> <ul style="list-style-type: none"> - pH - Conductivity - Anions and cations - Bicarbonate - Total dissolved solids, total alkalinity, total hardness - Major ions (calcium, magnesium, potassium, sodium, bromide, chloride, nitrate-nitrogen, and sulphate) - Dissolved field filtered metals (barium, copper, iron, manganese, mercury, nickel, and zinc) - Total petroleum hydrocarbons (TPH) - Dissolved methane, ethylene and ethane gas - Benzene, toluene, ethylbenzene, and xylenes (BTEX) - Formaldehyde - Methanol - Glycols - Alkyl Quaternary Ammonium Compounds (analysis to test for the presence of corrosion inhibitor) <p>The sub sample sent to GNS was analysed for Carbon-13 composition of dissolved methane gas.</p>
Results Discussion	<p>Results for the January 2015, August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring rounds are tabulated and attached.</p> <p>Results for the January 2015 monitoring event are similar to those recorded for the August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events.</p>

	<p>General baseline groundwater parameters for the abstraction well at 468 Hastings Road are consistent with background groundwater quality for Taranaki groundwater as reported in <i>Taranaki Where We Stand - State of the Environment Report, 2009</i>, published by the Taranaki Regional Council (Refer to Table 4.23 – Average values for groundwater quality for state of the environment monitoring sites 1999-2007).</p> <p>Concentrations of TPH, BTEX, formaldehyde, methanol, ethylene glycol, alkyl quaternary ammonium compounds, and dissolved ethylene and ethane gas were not detected above laboratory method detection limits.</p> <p>A concentration of 9.4 mg/L of dissolved methane was detected in the groundwater sample collected from Site 2 in the January 2015 monitoring event. The concentration of methane measured in the well during the seven monitoring events to date has ranged between 2.3 mg/L and 9.4 mg/L.</p> <p>The carbon-13 composition of dissolved methane gas as analysed by GNS is more negative than -64‰ indicating that the methane has been formed as a result of microbial activity (biogenic processes) not through deeper thermogenic processes, as described in <i>Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing</i>, published in Proceedings of the National Academy of Sciences by Osborne S. G., Vengosh A, Warner N. R. and Jackson R. B. (2011) 108 (20), pp. 8172-8176.</p>
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The information included within this Appendix has been provided to Shell Todd Oil Services Limited for the purpose of and in accordance with the conditions of our engagement “STOS Kapuni Off-Site Monitoring – P/O 4512147904”.



Site 2 - Sample Details and Analytical Results

Sample Location	Units	468 Hastings Road						
URS Sample Number		Site 2	Site 2	Site 2	Site 2	Site 2	Site 2	Site 2
Laboratory Sample Reference		1084034.2	1131198.2	1162256.2	1202867.2	1234484.2	1310590.2	1379473.2
Date Sampled		19/12/12	2/05/13	30/07/13	13/11/13	10/02/14	12/08/14	30/01/15
Total Petroleum Hydrocarbons (TPH)								
C ₇ -C ₉	mg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C ₁₀ -C ₁₄	mg/L	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C ₁₅ -C ₃₆	mg/L	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C ₇ - C ₃₆)	mg/L	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
BTEX Compounds								
Benzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total Xylenes	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Dissolved Metals								
Dissolved Barium	mg/L	0.00199	0.0021	0.00195	0.0021	0.00199	0.00196	0.00197
Dissolved Calcium	mg/L	13.8	13.1	12.9	12.9	13.2	13.2	13.3
Dissolved Copper	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Iron	mg/L	0.05	0.06	0.05	0.04	0.05	0.04	0.03
Dissolved Magnesium	mg/L	4.2	4.4	4.5	4.7	4.8	4.7	5
Dissolved Manganese	mg/L	0.015	0.0129	0.0133	0.013	0.0134	0.0134	0.0136
Dissolved Mercury	mg/L	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Nickel	mg/L	0.0024	0.0008	< 0.0005	0.0013	0.0006	0.0085	0.0077
Dissolved Potassium	mg/L	1.41	1.43	1.46	1.45	1.41	1.38	1.73
Dissolved Sodium	mg/L	58	56	60	65	57	64	68
Dissolved Zinc	mg/L	0.0053	0.0012	0.0018	0.0045	0.0017	0.0018	0.0041
Alkyl Quaternary Ammonium Compounds in Water by LCMSMS								
Benzalkonium Chloride (C12 homologue)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C14 homologue)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C16 homologue)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (total)	mg/L	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018
DDAC (Didecyl dimethyl ammonium chloride)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Dodine	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
IPBC (3-Iodo-2-propynyl-n-butyl carbamate)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Ethylene Glycol in Water								
Ethylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Propylene Glycol in Water								
Propylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Methanol in Water - Aqueous Solvents								
Methanol	mg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Formaldehyde in Water by DNPH & LCMSMS								
Formaldehyde	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater								
Ethane	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	mg/L	< 0.004	< 0.004	< 0.004	< 0.003	< 0.004	< 0.003	< 0.003
Methane	mg/L	2.3	5.4	3.9	5.8	6.8	7.0	9.4
Other Analyses								
Sum of Anions	meq/L	3.7	3.7	3.6	3.6	3.6	3.6	3.6
Sum of Cations	meq/L	3.6	3.5	3.7	3.9	3.6	3.9	4.1
pH	pH Units	8.4	8.4	8.4	8.3	8.3	8.4	8.3
Total Alkalinity	mg/L as CaCO ₃	169	166	166	166	166	164	165
Bicarbonate	mg/L at 25°C	200	198	198	199	198	196	197
Total Hardness	mg/L as CaCO ₃	52	51	51	51	53	52	54
Electrical Conductivity (EC)	mS/m	33.8	33.3	33.5	33.4	33.3	33.6	34.1
Total Dissolved Solids (TDS)	mg/L	200	210	200	220	200	200	196
Bromide	mg/L	0.06	0.07	< 0.05	0.05	< 0.05	0.07	0.08
Chloride	mg/L	11.4	12.0	10.9	10.7	10.4	11.1	11.2
Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N + Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Sulphate	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Appendix C – Kiley Estate - Inuawai Road (Site 3)

Site Name	Kiley Estate - Inuawai Road (Site 3)
Well Details	The abstraction well at Kiley Estate is 448 m deep and is cased to 280 m below ground level. The depth to groundwater is unknown. The well casing is steel with a diameter of approximately 90 mm and is finished above ground. The well is operational with pump and outlet tubes permanently mounted to the well head. The well is pumped to supply water to the dairy shed.
Pump Details	Submersible pump of unknown model. Potential also for artesian supply.
Sampling Date	30 January 2015.
Sampler	AECOM.
Well use prior to sampling	Farm pumping water from well for irrigation prior to and during sampling.
Sampling Methodology	<p>A groundwater sample was collected by attaching silicone tubing directly to the outlet of the well and opening a valve on the outlet. Groundwater was purged for approximately 22 minutes with a flow rate of approximately 0.3 L/min. An inline flow cell was used in conjunction with a multi parameter probe (YSI Professional Plus) to measure conductivity, pH, temperature, dissolved oxygen and redox in the purged groundwater. The well was sampled when parameters had stabilised.</p> <p>Water was observed to be clear during purging and sampling.</p> <p>The groundwater sample was collected directly into laboratory supplied sample bottles. The portion of the sample that was analysed for dissolved metals was filtered in the field as per previous monitoring events. The groundwater sample was kept under chilled conditions and transported to Hill Laboratories Limited under standard chain of custody procedures. A sub sample was also kept under chilled conditions and transported to GNS Science (GNS) under standard chain of custody procedures.</p>
Laboratory Analysis	<p>The groundwater sample was identified as “Site 3” and was analysed by Hill Laboratories for the following analytes:</p> <ul style="list-style-type: none"> - pH - Conductivity - Anions and cations - Bicarbonate - Total dissolved solids, total alkalinity, total hardness - Major ions (calcium, magnesium, potassium, sodium, bromide, chloride, nitrate-nitrogen, and sulphate) - Dissolved field filtered metals (barium, copper, iron, manganese, mercury, nickel, and zinc) - Total petroleum hydrocarbons (TPH) - Dissolved methane, ethylene and ethane gas - Benzene, toluene, ethylbenzene, and xylenes (BTEX) - Formaldehyde - Methanol - Glycols - Alkyl Quaternary Ammonium Compounds (analysis to test for the presence of corrosion inhibitor) <p>The sub sample sent to GNS was analysed for Carbon-13 composition of dissolved methane gas.</p>
Results Discussion	<p>Results for January 2015, August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring rounds are tabulated and attached. Results for the January 2015 monitoring event are similar to those recorded for the August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events.</p> <p>General baseline groundwater parameters for the abstraction well at Kiley Estate are</p>

	<p>consistent with background groundwater quality for Taranaki groundwater as reported in <i>Taranaki Where We Stand - State of the Environment Report, 2009</i>, published by the Taranaki Regional Council (Refer to Table 4.23 – Average values for groundwater quality for state of the environment monitoring sites 1999-2007).</p> <p>Concentrations of TPH, BTEX, formaldehyde, methanol, glycols, alkyl quaternary ammonium compounds, and dissolved ethane and ethylene gas were not detected above laboratory method detection limits.</p> <p>A concentration of 6.4 mg/L of dissolved methane was detected in the groundwater sample collected from Site 3 in the January 2015 monitoring event. The concentration of methane measured in the well during the seven monitoring events to date has ranged between 1.94 mg/L and 8.5 mg/L.</p> <p>The carbon-13 composition of dissolved methane gas as analysed by GNS is more negative than -64‰ indicating that the methane has been formed as a result of microbial activity (biogenic processes) not through deeper thermogenic processes, as described in <i>Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing</i>, published in Proceedings of the National Academy of Sciences by Osborne S. G., Vengosh A, Warner N. R. and Jackson R. B. (2011) 108 (20), pp. 8172-8176.</p>
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The information included within this Appendix has been provided to Shell Todd Oil Services Limited for the purpose of and in accordance with the conditions of our engagement “STOS Kapuni Off-Site Monitoring – P/O 4512147904”.



Site 3 - Sample Details and Analytical Results

Sample Location	Units	Inuawai Road						
URS Sample Number		Site 3	Site 3	Site 3	Site 3	Site 3	Site 3	Site 3
Laboratory Sample Reference		1084034.3	1131198.3	1162256.3	1202867.3	1234484.3	1310590.3	1379473.3
Date Sampled		19/12/12	2/05/13	30/07/13	13/11/13	10/02/14	12/08/14	30/01/15
Total Petroleum Hydrocarbons (TPH)								
C ₇ -C ₉	mg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C ₁₀ -C ₁₄	mg/L	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C ₁₅ -C ₃₆	mg/L	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C ₇ - C ₃₆)	mg/L	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
BTEX Compounds								
Benzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total Xylenes	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Dissolved Metals								
Dissolved Barium	mg/L	0.00108	0.00110	0.00138	0.00129	0.00107	0.00116	0.00107
Dissolved Calcium	mg/L	3.8	4.0	3.6	3.8	3.8	3.7	3.8
Dissolved Copper	mg/L	< 0.0005	< 0.0005	0.0006	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Iron	mg/L	< 0.02	0.07	0.02	< 0.02	0.02	0.02	< 0.02
Dissolved Magnesium	mg/L	0.9	0.87	0.84	0.9	0.89	0.88	0.93
Dissolved Manganese	mg/L	0.0066	0.0073	0.0069	0.0064	0.0063	0.0065	0.0067
Dissolved Mercury	mg/L	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Nickel	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Potassium	mg/L	0.78	0.85	0.84	0.82	0.84	0.77	0.77
Dissolved Sodium	mg/L	67	70	74	78	71	80	66
Dissolved Zinc	mg/L	< 0.0010	0.0029	< 0.0010	0.0014	< 0.0010	< 0.0010	< 0.0010
Alkyl Quaternary Ammonium Compounds in Water by LCMSMS								
Benzalkonium Chloride (C12 homologue)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C14 homologue)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C16 homologue)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (total)	mg/L	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018
DDAC (Didecylidimethylammonium chloride)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Dodine	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
IPBC (3-Iodo-2-propynyl-n-butylcarbamate)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Ethylene Glycol in Water								
Ethylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Propylene Glycol in Water								
Propylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Methanol in Water - Aqueous Solvents								
Methanol	mg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Formaldehyde in Water by DNPH & LCMSMS								
Formaldehyde	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater								
Ethane	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	mg/L	< 0.004	< 0.004	< 0.004	< 0.003	< 0.004	< 0.003	< 0.003
Methane	mg/L	1.94	4.9	4.1	6.7	7.8	8.5	6.4
Other Analyses								
Sum of Anions	meq/L	3.5	3.4	3.4	3.4	3.4	3.4	3.4
Sum of Cations	meq/L	3.2	3.3	3.5	3.7	3.4	3.7	3.2
pH	pH Units	8.8	8.9	8.9	8.7	8.8	8.9	8.8
Total Alkalinity	mg/L as CaCO ₃	158	154	153	155	156	153	154
Bicarbonate	mg/L at 25°C	181	175	179	179	179	174	178
Total Hardness	mg/L as CaCO ₃	13.3	13.4	12.5	13.3	13.1	12.7	13.4
Electrical Conductivity (EC)	mS/m	31.8	31.4	31.6	31.4	31.7	31.7	32.3
Total Dissolved Solids (TDS)	mg/L	199	198	197	210	200	193	200
Bromide	mg/L	0.07	0.07	< 0.05	0.05	< 0.05	0.07	0.06
Chloride	mg/L	11.6	12.3	11.4	11.1	10.7	11.6	11.6
Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N	mg/L	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N + Nitrite-N	mg/L	0.003	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Sulphate	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Appendix D – Naplin Trust - Ahipaipa Road (Site 4)

Site Name	Naplin Trust - Ahipaipa Road (Site 4)
Well Details	The abstraction well at Naplin Trust is 432 m deep and is cased to 123 m below ground level. The depth to groundwater is unknown. The well casing is steel with a diameter of approximately 125 mm and is finished above ground. The well is operational with pump and outlet tubes permanently mounted to the well head. The well is artesian and fills a storage tank adjacent to the dairy shed.
Pump Details	Artesian.
Sampling Date	30 January 2015.
Sampler	AECOM.
Well use prior to sampling	Unknown.
Sampling Methodology	<p>A groundwater sample was collected by attaching silicone tubing directly to the outlet of the well and opening a valve on the outlet. Groundwater was purged for approximately 20 minutes with a flow rate of approximately 0.3 L/min. An inline flow cell was used in conjunction with a multi parameter probe (YSI Professional Plus) to measure conductivity, pH, temperature, dissolved oxygen and redox in the purged groundwater. The well was sampled when parameters had stabilised.</p> <p>Water was observed to be clear during purging and sampling.</p> <p>The groundwater sample was collected directly into laboratory supplied sample bottles. The portion of the sample that was analysed for dissolved metals was filtered in the field as per previous monitoring events. The groundwater sample was kept under chilled conditions and transported to Hill Laboratories Limited under standard chain of custody procedures. A sub sample was also kept under chilled conditions and transported to GNS Science (GNS) under standard chain of custody procedures.</p>
Laboratory Analysis	<p>The groundwater sample was identified as “Site 4” and was analysed by Hill Laboratories for the following analytes:</p> <ul style="list-style-type: none"> - pH - Conductivity - Anions and cations - Bicarbonate - Total dissolved solids, total alkalinity, total hardness - Major ions (calcium, magnesium, potassium, sodium, bromide, chloride, nitrate-nitrogen, and sulphate) - Dissolved field filtered metals (barium, copper, iron, manganese, mercury, nickel, and zinc) - Total petroleum hydrocarbons (TPH) - Dissolved methane, ethylene and ethane gas - Benzene, toluene, ethylbenzene, and xylenes (BTEX) - Formaldehyde - Methanol - Glycols - Alkyl Quaternary Ammonium Compounds (analysis to test for the presence of corrosion inhibitor) <p>The sub sample sent to GNS was analysed for Carbon-13 composition of dissolved methane gas.</p>
Results Discussion	<p>Results for January 2015, August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring rounds are tabulated and attached. Results for the January 2015 monitoring event are similar to those recorded for the August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events.</p> <p>General baseline groundwater parameters for the abstraction well at Naplin Trust are</p>

	<p>consistent with background groundwater quality for Taranaki groundwater as reported in <i>Taranaki Where We Stand - State of the Environment Report, 2009</i>, published by the Taranaki Regional Council (Refer to Table 4.23 – Average values for groundwater quality for state of the environment monitoring sites 1999-2007).</p> <p>Concentrations of TPH, BTEX, formaldehyde, methanol, glycols, alkyl quaternary ammonium compounds, and dissolved ethane gas were not detected above laboratory method detection limits.</p> <p>A concentration of 11.6 mg/L of dissolved methane was detected in the groundwater sample collected from Site 4 in the January 2015 monitoring event. The concentration of methane measured in the well during the seven monitoring events to date has ranged between 2.8 mg/L and 11.6 mg/L.</p> <p>The carbon-13 composition of dissolved methane gas as analysed by GNS is more negative than -64‰ indicating that the methane has been formed as a result of microbial activity (biogenic processes) not through deeper thermogenic processes, as described in <i>Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing</i>, published in Proceedings of the National Academy of Sciences by Osborne S. G., Vengosh A, Warner N. R. and Jackson R. B. (2011) 108 (20), pp. 8172-8176.</p>
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The information included within this Appendix has been provided to Shell Todd Oil Services Limited for the purpose of and in accordance with the conditions of our engagement “STOS Kapuni Off-Site Monitoring – P/O 4512147904”.



Site 4 - Sample Details and Analytical Results

Sample Location	Units	Ahipaipa Road						
URS Sample Number		Site 4	Site 4	Site 4	Site 4	Site 4	Site 4	Site 4
Laboratory Sample Reference		1084034.4	1131198.4	1162256.4	1202867.4	1234484.4	1310590.4	1379473.4
Date Sampled		19/12/12	2/05/13	30/07/13	13/11/13	10/02/14	12/08/14	30/01/15
Total Petroleum Hydrocarbons (TPH)								
C ₇ -C ₉	mg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.15	< 0.10	< 0.10
C ₁₀ -C ₁₄	mg/L	< 0.2	< 0.2	< 0.2	< 0.2	< 0.4	< 0.2	< 0.2
C ₁₅ -C ₃₆	mg/L	< 0.4	< 0.4	< 0.4	< 0.4	< 0.8	< 0.4	< 0.4
Total hydrocarbons (C ₇ - C ₃₆)	mg/L	< 0.7	< 0.7	< 0.7	< 0.7	< 1.4	< 0.7	< 0.7
BTEX Compounds								
Benzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total Xylenes	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Dissolved Metals								
Dissolved Barium	mg/L	0.006	0.0070	0.0064	0.0065	0.0064	0.0066	0.0064
Dissolved Calcium	mg/L	24	27	24	24	24	24	24
Dissolved Copper	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Iron	mg/L	0.17	0.20	0.12	0.13	0.12	0.12	0.13
Dissolved Magnesium	mg/L	9.6	11.3	11.2	12.3	11.2	12.0	11.6
Dissolved Manganese	mg/L	0.03	0.030	0.028	0.029	0.028	0.027	0.027
Dissolved Mercury	mg/L	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Nickel	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Potassium	mg/L	2.8	3.3	3.1	3	3	2.8	3.4
Dissolved Sodium	mg/L	39	42	42	45	41	45	46
Dissolved Zinc	mg/L	0.0068	0.0022	0.0029	0.0045	0.0027	0.0018	0.0034
Alkyl Quaternary Ammonium Compounds in Water by LCMSMS								
Benzalkonium Chloride (C12 homologue)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C14 homologue)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C16 homologue)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (total)	mg/L	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018
DDAC (Didecyl dimethyl ammonium chloride)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Dodine	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
IPBC (3-Iodo-2-propynyl-n-butylcarbamate)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Ethylene Glycol in Water								
Ethylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Propylene Glycol in Water								
Propylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Methanol in Water - Aqueous Solvents								
Methanol	mg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Formaldehyde in Water by DNPH & LCMSMS								
Formaldehyde	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater								
Ethane	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	mg/L	< 0.004	< 0.004	< 0.004	< 0.003	< 0.004	< 0.003	< 0.003
Methane	mg/L	2.8	6.4	5.7	9.3	7.9	10.8	11.6
Other Analyses								
Sum of Anions	meq/L	4.1	4.1	4.1	4.1	4.0	4.0	4.0
Sum of Cations	meq/L	3.8	4.2	4.0	4.2	4.0	4.2	4.3
pH	pH Units	8.1	8.1	8.1	8.1	8.2	8.1	8
Total Alkalinity	mg/L as CaCO ₃	188	185	186	186	186	185	186
Bicarbonate	mg/L at 25°C	230	220	220	220	220	220	220
Total Hardness	mg/L as CaCO ₃	101	113	106	111	106	109	108
Electrical Conductivity (EC)	mS/m	37.3	36.6	37.2	37	36.9	37.8	37.9
Total Dissolved Solids (TDS)	mg/L	220	230	220	250	230	230	230
Bromide	mg/L	0.07	0.07	< 0.05	0.05	< 0.05	0.07	0.06
Chloride	mg/L	12	12.9	12.0	11.6	11.2	12.2	12.0
Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N + Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Sulphate	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Appendix E –Site KA9-EB (Former Emergency Bore). STOS KA9 Well Site (Lower Duthie Road)

Site Name	STOS KA9 Well Site, Lower Duthie Road (Site KA9-EB)
Well Details	The well at Site KA9-EB is between 35 m and 55 m deep and is cased through the water table to approximately 35 m below ground level. The depth to groundwater is approximately 13 m. The well casing is steel with a diameter of approximately 100 mm and is finished above ground. The well was formerly used as a firewater abstraction bore but is not currently used and no pump is installed in the well.
Pump Details	No pump installed.
Sampling Date	23 March 2015.
Sampler	AECOM.
Well use prior to sampling	None.
Sampling Methodology	<p>A groundwater sample was collected by inserting a downhole bladder pump into the well, connected via dedicated low density polyethylene (LDPE) tubing to the surface. Groundwater was purged for approximately 27 minutes with a flow rate of approximately 0.03 L/min. An inline flow cell was used in conjunction with a multi parameter probe (YSI Professional Plus) to measure conductivity, pH, temperature, dissolved oxygen and redox in the purged groundwater. The well was sampled when parameters had stabilised.</p> <p>Water was observed to be clear during purging and sampling.</p> <p>The groundwater sample was collected directly into laboratory supplied sample bottles. The portion of the sample that was analysed for dissolved metals was filtered in the field. The groundwater sample was kept under chilled conditions and transported to Hill Laboratories Limited under standard chain of custody procedures. A sub sample was also kept under chilled conditions and transported to GNS Science (GNS) under standard chain of custody procedures.</p>
Laboratory Analysis	<p>The groundwater sample was identified as “KA9 – Emergency Bore” and was analysed by Hill Laboratories for the following analytes:</p> <ul style="list-style-type: none"> - pH - Conductivity - Anions and cations - Bicarbonate - Total dissolved solids, total alkalinity, total hardness - Major ions (calcium, magnesium, potassium, sodium, chloride, nitrate-nitrogen, and sulphate) - Dissolved field filtered metals (barium, copper, iron, manganese, mercury, nickel, and zinc) - Total petroleum hydrocarbons (TPH) - Dissolved methane, ethylene and ethane gas - Benzene, toluene, ethylbenzene, and xylenes (BTEX) - Formaldehyde - Methanol - Glycols - Alkyl Quaternary Ammonium Compounds (analysis to test for the presence of corrosion inhibitor) <p>The sub sample sent to GNS was analysed for Carbon-13 composition of dissolved methane gas.</p>
Results Discussion	<p>Results for the March 2015 monitoring event is tabulated and attached.</p> <p>General baseline groundwater parameters for the groundwater sample collected from Site KA9-EB were very similar to the results for Site 1, except for dissolved zinc, which was approximately two-orders of magnitude greater at Site KA9-EB than in the groundwater from Site 1. Calcium and magnesium were also slightly elevated. The wells at the Site 1 and Site</p>

	<p>KA9-EB are relatively shallow wells (65 m and 35, respectively), finished in Taranaki volcanic aquifer.</p> <p>Concentrations of TPH, benzene, ethylbenzene, xylenes, dissolved ethylene and ethane, formaldehyde, methanol, glycols and alkyl quaternary ammonium compounds were not detected above MDLs in the groundwater sample collected from Site KA9-EB. Toluene was detected in the groundwater sample at 0.002 mg/L, compared with the MDL of 0.001 mg/L.</p> <p>A concentration of 13.8 mg/L of dissolved methane was detected in the groundwater sample collected from the former emergency bore in the March 2015 monitoring event.</p> <p>The carbon-13 composition of dissolved methane gas value for the former emergency bore as analysed by GNS is more negative than -50‰, which could be interpreted as mixed thermogenic/biogenic gas, as described in <i>Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing</i>, published in Proceedings of the National Academy of Sciences by Osborne S. G., Vengosh A, Warner N. R. and Jackson R. B. (2011) 108 (20), pp. 8172-8176.. However, the absence of dissolved ethane and ethylene gas in the sample indicates a biogenic source rather than a thermogenic source.</p>
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Site KA9-EB (Former Emergency Bore)

Sample Location	Units	Lower Duthie Road	
URS Sample Number		KA9 - Emergency Bore	KA9 - Emergency Bore
Laboratory Sample Reference		1402708.1	1403749.1
Date Sampled		23/03/15	23/03/15
Total Petroleum Hydrocarbons (TPH)			
C ₇ -C ₉	mg/L	-	< 0.10
C ₁₀ -C ₁₄	mg/L	-	< 0.2
C ₁₅ -C ₃₆	mg/L	-	< 0.4
Total hydrocarbons (C ₇ - C ₃₆)	mg/L	-	< 0.7
BTEX Compounds			
Benzene	mg/L	-	< 0.0010
Toluene	mg/L	-	0.0020
Ethylbenzene	mg/L	-	< 0.0010
Total Xylenes	mg/L	-	< 0.003
Dissolved Metals			
Dissolved Barium	mg/L	0.082	-
Dissolved Calcium	mg/L	28	-
Dissolved Copper	mg/L	< 0.0005	-
Dissolved Iron	mg/L	3.6	-
Dissolved Magnesium	mg/L	20	-
Dissolved Manganese	mg/L	0.24	-
Dissolved Mercury	mg/L	< 0.00008	-
Dissolved Nickel	mg/L	0.0008	-
Dissolved Potassium	mg/L	17.1	-
Dissolved Sodium	mg/L	51	-
Dissolved Zinc	mg/L	23	-
Alkyl Quaternary Ammonium Compounds in Water by LCMSMS			
Benzalkonium Chloride (C12 homologue)	mg/L	< 0.010	-
Benzalkonium Chloride (C14 homologue)	mg/L	< 0.010	-
Benzalkonium Chloride (C16 homologue)	mg/L	< 0.010	-
Benzalkonium Chloride (total)	mg/L	< 0.018	-
DDAC (Didecyltrimethylammonium chloride)	mg/L	< 0.010	-
Dodine	mg/L	< 0.010	-
IPBC (3-Iodo-2-propynyl-n-butylcarbamate)	mg/L	< 0.010	-
Ethylene Glycol in Water			
Ethylene glycol	mg/L	< 4	-
Propylene Glycol in Water			
Propylene glycol	mg/L	< 4	-
Methanol in Water - Aqueous Solvents			
Methanol	mg/L	< 2	-
Formaldehyde in Water by DNPH & LCMSMS			
Formaldehyde	mg/L	< 0.02	-
Gases in groundwater			
Ethane	mg/L	< 0.003	-
Ethylene	mg/L	< 0.003	-
Methane	mg/L	13.8	-
Other Analyses			
Sum of Anions	meq/L	6.8	-
Sum of Cations	meq/L	6.6	-
pH	pH Units	7.5	-
Total Alkalinity	mg/L as CaCO ₃	300	-
Bicarbonate	mg/L at 25°C	370	-
Total Hardness	mg/L as CaCO ₃	155	-
Electrical Conductivity (EC)	mS/m	62.7	-
Total Dissolved Solids (TDS)	mg/L	310	-
Bromide	mg/L	-	-
Chloride	mg/L	25	-
Nitrite-N	mg/L	< 0.002	-
Nitrate-N	mg/L	< 0.002	-
Nitrate-N + Nitrite-N	mg/L	< 0.002	-
Sulphate	mg/L	< 0.5	-



19 November 2014
Project No. 42788630

Shell Todd Oil Services Limited
Private Bag 2035,
New Plymouth 4342

Attention: Louise Bullen
Environmental Advisor

Dear Louise

Subject: STOS Kapuni – Third Party Abstraction Wells - Groundwater Monitoring Event August 2014

1 Terms of Reference

This letter has been prepared for Shell Todd Oil Services Ltd (STOS) by URS New Zealand Limited (URS) in accordance with the URS proposal to STOS dated 5 July 2012 and subsequent variations. It documents the findings of a sixth groundwater monitoring event completed at four, third party abstraction wells, located within the Kapuni area.

2 Objectives and Background

The objective of the groundwater monitoring is to assess groundwater quality in deep abstraction wells located in the Kapuni area.

Five previous groundwater monitoring events of the third party abstraction wells have been completed.

The first groundwater monitoring event was completed on 19 December 2012, as detailed in the letter report from URS to STOS, dated 16 April 2013 and entitled STOS Kapuni – Third Party Abstraction Well - Groundwater Monitoring.

A second groundwater monitoring event was completed on 2 May 2013, as detailed in the letter report from URS to STOS, dated 12 June 2013 and entitled STOS Kapuni – Third Party Abstraction Well - Groundwater Monitoring Event May 2013.

A third groundwater monitoring event was completed on 30 July 2013, as detailed in the letter report from URS to STOS, dated 20 September 2013 and entitled STOS Kapuni – Third Party Abstraction Well - Groundwater Monitoring Event July 2013.

A fourth groundwater monitoring event was completed on 13 November 2013, as detailed in the letter report from URS to STOS, dated 19 December 2013 and entitled STOS Kapuni – Third Party Abstraction Well - Groundwater Monitoring Event November 2013.

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A fifth groundwater monitoring event was completed on 10 February 2014, as detailed in the letter report from URS to STOS, dated 29 April 2014 and entitled STOS Kapuni – Third Party Abstraction Wells - Groundwater Monitoring Event February 2014.

This current letter report presents the results of the groundwater monitoring event completed on 12 August 2014.

The four abstraction wells monitored are located at the following third party sites:

- Site 1 – M Barr, 873 Skeet Road
- Site 2 – PKW Farms, 468 Hastings Road
- Site 3 – Kiley Estate, Inuawai Road
- Site 4 – Naplin Trust, Ahipaipa Road

The location of each site is shown on **Figure 1** (attached). The locations of Kapuni Production Station and the STOS Kapuni produced water re-injection well (KW-2) are also shown on **Figure 1**.

3 Scope of Works

The groundwater monitoring comprised the following scope of works:

- Purging and collection of groundwater samples from the third party wells.
- Laboratory analysis of groundwater samples.
- Preparation of this factual letter report.

4 Sampling Methodology

Groundwater samples were collected from the third party wells on 12 August 2014. The sampling methodology for each site is summarised in the attached appendices for each site as follows:

- **Appendix A** – Site 1 (M Barr, 873 Skeet Road)
- **Appendix B** – Site 2 (PKW Farms, 468 Hastings Road)
- **Appendix C** – Site 3 (Kiley Estate, Inuawai Road)
- **Appendix D** – Site 4 (Naplin Trust, Ahipaipa Road)

The groundwater sample collected from Site 1 was collected directly from a tap attached to a secondary storage tank housed in a pump house close to the well. Groundwater samples collected from Site 2, Site 3 and Site 4 were collected from sampling ports close to the wellhead of each abstraction well.

Field sampling records for each site are attached.

4.1 Groundwater Sample Collection and Analysis

Groundwater samples were collected directly into laboratory supplied sample bottles. The samples were kept under chilled conditions and transported to Hill Laboratories Limited under standard chain of custody procedures.

Groundwater samples were analysed for the following analytes:

- pH
- Conductivity
- Anions and cations
- Bicarbonate
- Total dissolved solids, total alkalinity, total hardness
- Major ions (calcium, magnesium, potassium, sodium, bromide, chloride, nitrate-nitrogen, and sulphate)
- Dissolved (field filtered) metals (barium, copper, iron, manganese, mercury, nickel, and zinc)
- Total Petroleum Hydrocarbons (TPH)
- Dissolved methane, ethylene and ethane gas
- Benzene, toluene, ethylbenzene, and xylenes (BTEX)
- Formaldehyde
- Methanol
- Glycols
- Alkyl Quaternary Ammonium Compounds (analysis to test for the presence of corrosion inhibitor)

Groundwater samples collected were also submitted to GNS Science, Gracefield Lower Hutt (GNS), for determination of Carbon-13 ($\delta^{13}\text{C}$) composition of dissolved methane, to identify the likely source of the methane.

Chain of custody documents and laboratory reports as received are attached.

4.2 Quality Assurance/Quality Control (QA/QC)

For quality assurance/quality control (QA/QC) purposes, a trip blank sample (identified as TB) and a duplicate sample collected from Site 4 (identified as DUP) were collected during the groundwater sampling event.

The trip blank sample was prepared in the laboratory with deionised water, prior to bottles being shipped.

The duplicate sample was collected directly into laboratory supplied jars, chilled and transported to Hill Laboratories Limited under URS chain of custody procedures. The trip blank sample was analysed for TPH and BTEX. The duplicate sample was analysed for dissolved metals, TPH and BTEX.

Chain of custody documents and the laboratory report as received are attached.

5 Results

5.1 Groundwater Sample Results

The groundwater analysis results for the August 2014 monitoring event for each site have been tabulated along with results for the February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events and are presented in the site specific appendices attached.

General Groundwater Parameters

General baseline groundwater parameters for groundwater samples collected from the third party wells in August 2014 were similar to results from the February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events. The results are also generally consistent with background groundwater quality for Taranaki groundwater, as reported in *Taranaki Where We Stand - State of the Environment Report, 2009*, published by the Taranaki Regional Council (Refer to Table 4.23 – Average values for groundwater quality for state of the environment monitoring sites 1999-2007).

Slightly elevated concentrations of dissolved barium, dissolved iron, dissolved manganese, dissolved potassium and dissolved zinc were recorded for the groundwater sample collected from Site 1, compared to the other sites. It is considered likely that the higher concentrations of dissolved metals at Site 1 compared to the results from the other sites, are the result of the sample being collected from the secondary storage tank and not directly from the wellhead.

Concentrations of TPH, BTEX and dissolved ethylene and ethane, formaldehyde, methanol, glycols and alkyl quaternary ammonium compounds were not detected above laboratory method detection limits in the groundwater samples collected from any of the four, third party abstraction wells.

The results do not indicate contamination of third party abstraction wells by hydrocarbons or other contaminants of concern.

Dissolved Methane

Concentrations of dissolved methane ranging from 7.0 mg/L (Site 2) to 10.8 mg/L (Site 4) were detected in the groundwater samples collected in August 2014. These concentrations are similar to those detected in the November 2013 and February 2014 monitoring events, and are on average about 50% higher than the concentrations detected in the December 2012, May 2013 and July 2013 monitoring events.

The $\delta^{13}\text{C}$ analysis results for groundwater samples collected from Site 1 through Site 4 for the August 2014 monitoring event are summarised in Table 1.

Table 1: Dissolved Methane Concentrations

Site	$\delta^{13}\text{C}$ Value (‰)	Dissolved methane concentration (mg/L)
Site 1	-79.2	7.9
Site 2	-81.3	7.0
Site 3	-82.1	8.5
Site 4	-81.7	10.8

Osborne et al. (2011)¹ cite that generally, $\delta^{13}\text{C}$ composition in dissolved methane gas values which are enriched above approximately -50‰ indicates methane that has been formed as a result of thermogenic (deep) processes, whereas $\delta^{13}\text{C}$ composition in dissolved methane gas more negative than approximately -64‰ indicates methane that has been formed as a result of microbial (biogenic) activity. The $\delta^{13}\text{C}$ composition in dissolved methane gas values for Sites 1 through Site 4 are more negative than -64‰ which would indicate that the dissolved methane in the groundwater from these four sites is formed through biogenic processes and not through deeper thermogenic processes. The results are similar to the February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events.

5.2 QA/QC Results

The QA/QC results have been tabulated and are attached. The following points are noted:

- Concentrations of TPH and BTEX were not detected above the laboratory method detection limits in the trip blank sample.
- Concentrations of TPH and BTEX were not detected above the laboratory method detection limits in the primary or duplicate groundwater sample collected from Site 4.
- Concentrations of trace metals detected in the primary and duplicate groundwater sample collected from Site 4 showed good agreement.

The QA/QC results are considered to meet the data quality objectives for this investigation.

6 Summary

The results of the groundwater monitoring event completed for the four, third party abstraction wells in August 2014 do not indicate contamination of the deep abstraction wells by hydrocarbons or any other contaminants of concern.

Dissolved methane concentrations detected in groundwater are considered to be a result of biogenic processes rather than deeper thermogenic processes.

¹ *Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing*, published in Proceedings of the National Academy of Sciences by Osborne S. G., Vengosh A, Warner N. R. and Jackson R. B. (2011) 108 (20), pp. 8172-8176



Louise Bullen
Environmental Advisor
19 November 2014
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The results of the August 2014 monitoring are consistent with the results of the February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring rounds.

7 Closure

We trust that this report meets your requirements. Please do not hesitate to contact URS if you wish to discuss the results.

Yours sincerely
URS New Zealand Limited

Suzanne Lowe
Associate Environmental Scientist

Kevin Tearney
Senior Principal

Attachments
Limitations
Figure 1 – Site Location Plan
Groundwater Sampling Sheets
Laboratory Analytical Results and Chain of Custody Documentation
QA/QC Table



Louise Bullen
Environmental Advisor
19 November 2014
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Appendices

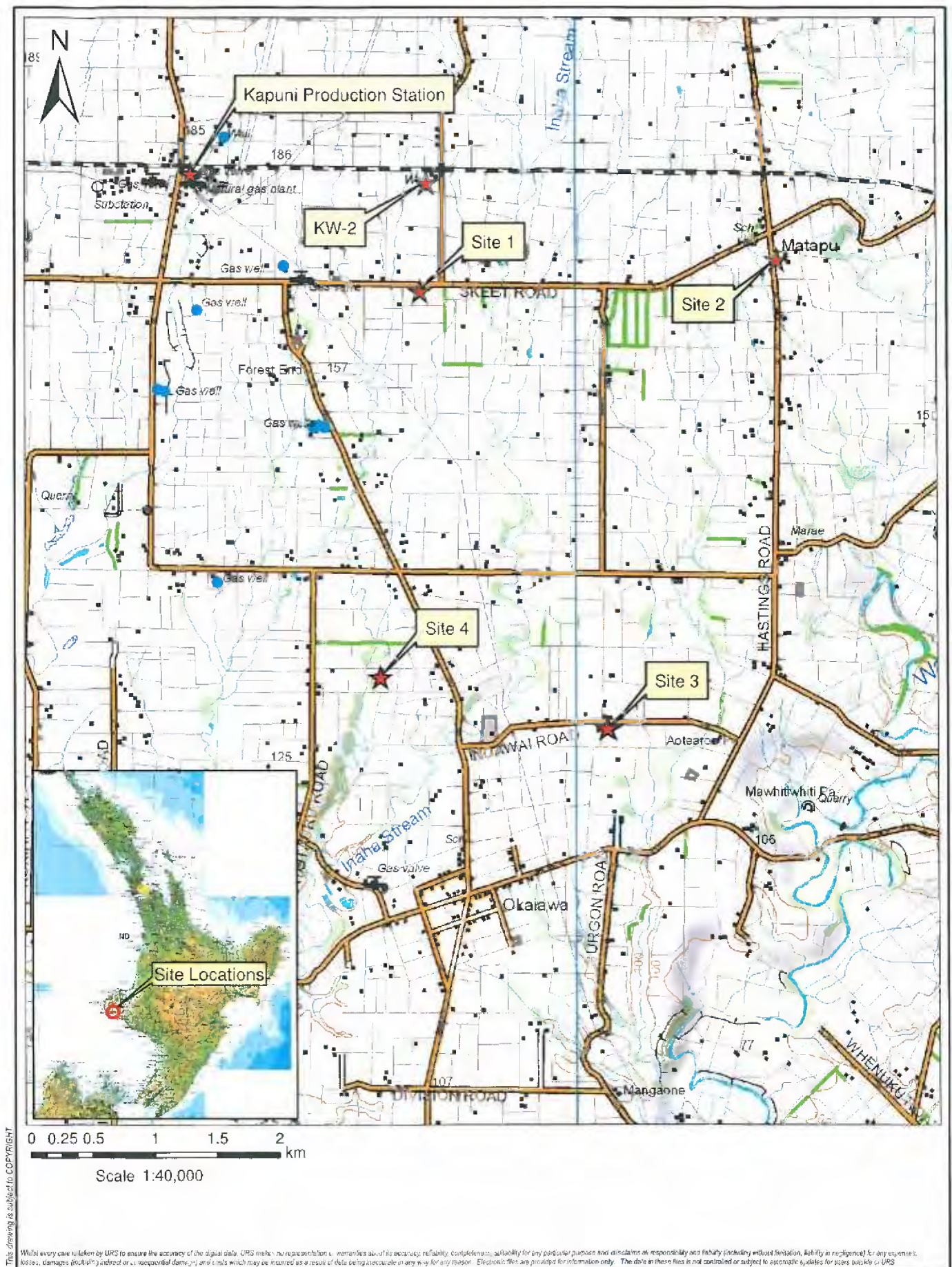
- Appendix A – Site 1 (M Barr, 873 Skeet Road)
- Appendix B – Site 2 (PKW Farms, 468 Hastings Road)
- Appendix C – Site 3 (Kiley Estate, Inuawai Road)
- Appendix D – Site 4 (Naplin Trust, Ahipaipa Road)

Limitations

All information in this Report is provided strictly in accordance with and subject to the following limitations and recommendations:

- a) This Report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by URS for use of any part of this Report in any other context.
- b) This conclusion is based solely on the information and findings contained in this Report.
- c) This conclusion is based solely on the scope of work agreed between URS and Shell Todd Oil Services Limited and described in section 3 ("Scope of Works") of this Report.
- d) This Report is based on the conditions encountered during the site monitoring conducted, and information reviewed, in August and September 2014. URS accepts no responsibility for any events arising from any changes in site conditions or in the information reviewed that have occurred after the completion of the site monitoring.
- e) The investigations carried out for the purposes of the Report have been undertaken, and the Report has been prepared, in accordance with normal prudent practice and by reference to applicable environmental regulatory authority and industry standards, guidelines and assessment criteria in existence at the date of this Report.
- f) Where this Report indicates that information has been provided to URS by third parties, URS has made no independent verification of this information except as expressly stated in the Report. URS assumes no liability for any inaccuracies in or omissions to that information.
- g) URS has tested only for those chemicals specifically referred to in this Report. URS makes no statement or representation as to the existence (or otherwise) of any other chemicals.
- h) Subsurface conditions can vary across a particular site and cannot be exhaustively defined by the investigations described in this Report. It is unlikely therefore that the results and estimations expressed in this Report will represent conditions at any location removed from the specific points of sampling.
- i) A site which appears to be unaffected by contamination at the time the Report was prepared may later, due to natural phenomena or human intervention, become contaminated.
- j) Except as specifically stated above, URS makes no warranty, statement or representation of any kind concerning the suitability of the site for any purpose or the permissibility of any use, development or re-development of the site.
- k) This Report has been prepared for the sole benefit of Shell Todd Oil Services Limited. Except as required by law, no third party may use or rely on, this Report unless otherwise agreed by URS in writing. Where such agreement is provided, URS will provide a letter of reliance to the agreed third party in the form required by URS.
- l) To the extent permitted by law, URS expressly disclaims and excludes liability for any loss, damage, cost or expenses suffered by any third party relating to or resulting from the use of, or reliance on, any information contained in this Report. URS does not admit that any action, liability or claim may exist or be available to any third party.

Figure 1 – Site Location Plan



SHELL TODD
OIL SERVICES
LIMITED

THIRD PARTY WELL MONITORING

SITE LOCATION PLAN

URS

File:42788630\Site_Locations.mxd

Drawn: SS

Approved: SL

Date: 16/04/2013

Figure: 1

Rev: A

A4



Groundwater Sampling Sheets

BORE DEVELOPMENT, PURGING AND GROUNDWATER SAMPLING DATA SHEET

BORE No: Site 1

Project No 42788630 Project Name KPS FB Sampling

Date 12/08/14 Sampled by: NW

Development

Development Method _____

Time Started _____

Time Stopped _____

Comments _____

SWL (start) _____

SWL (end) _____

Volume Removed _____

Discharge Rate _____

Bore Depth (start) _____

Bore Depth (end) _____

NAPL Present _____

(If yes thickness) _____

Purging

Purge Method _____

Time Started _____

Time Stopped _____

Comments _____

Purge Depth _____

SWL (start) _____

SWL (end) _____

Bore Volume _____

Volume Removed _____

Bore Depth (start) _____

Bore Depth (end) _____

NAPL Present _____

(If yes thickness) _____

Sampling

Sampling Method Farm Bore

Time Started 1040

Time Stopped 1120

Comments med clarity dropping to low clarity for final two volumes, light brown/crusty finge, odorless.

Sampling Depth -

SWL (start) -

SWL (end) -

OVA Monitoring

Time	Ambient	Bore Head	Discharge

Field Analyses

Time	Vol Removed (L)	EC (uS/cm)	pH	T (C)	Redox oep (mV)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	Comments (Color, turbidity)
1040	0.5	327.3	6.69	12.3	104.2	27.3	2.82	med clarity light brown
1043	2	324.3	6.67	12.3	104.8	20.3	2.10	"
1046	3.5	323.8	6.66	11.9	117.2	14.2	1.46	"
1049	5.0	323.3	6.65	11.8	120.3	11.5	1.20	"
1052	6.5	323.0	6.65	11.8	123.1	10.9	1.11	"
1055	8	322.7	6.66	11.8	125.1	10.5	1.09	"

BORE DEVELOPMENT, PURGING AND GROUNDWATER SAMPLING DATA SHEET

BORE No: Site 2

Project No 42788630 Project Name KPS FB Sampling

Date 12/08/14 Sampled by: NW

Development

Development Method _____
 Time Started _____ SWL (start) _____ Volume Removed _____ Bore Depth (start) _____
 Time Stopped _____ SWL (end) _____ Discharge Rate _____ Bore Depth (end) _____
 Comments _____ NAPL Present _____
 (If yes thickness) _____

Purging

Purge Method _____ Purge Depth _____
 Time Started _____ SWL (start) _____ Bore Volume _____ Bore Depth (start) _____
 Time Stopped _____ SWL (end) _____ Volume Removed _____ Bore Depth (end) _____
 Comments _____ NAPL Present _____
 (If yes thickness) _____

Sampling

Sampling Method Farm Bore Sampling Depth -
 Time Started 1200 SWL (start) -
 Time Stopped 1227 SWL (end) -
 Comments High clarity, colourless, odourless

OVA Monitoring

Time	Ambient	Bore Head	Discharge

Field Analyses

Time	Vol Removed (L)	EC (uS/cm)	pH	T (C)	Redox (mV)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	Comments (Color, turbidity)
1203	4.0	337.6	8.37	17.9	40	47	4.3	High clarity, colourless
1206	5.5	335.7	8.37	17.9	29.6	38.6	3.55	"
1209	7.0	333.3	8.38	17.9	11	29.6	2.73	"
1212	8.5	331.6	8.38	17.9	9.3	28.8	2.65	"
1215	10	330.4	8.38	17.9	8.1	27.6	2.49	"

BORE DEVELOPMENT, PURGING AND GROUNDWATER SAMPLING DATA SHEET

BORE No: Site 3

Project No 42788630

Project Name KPS FB Sampling

Date 12/05/14

Sampled by: NW

Development

Development Method _____

Time Started _____

Time Stopped _____

Comments _____

SWL (start) _____

SWL (end) _____

Volume Removed _____

Discharge Rate _____

Bore Depth (start) _____

Bore Depth (end) _____

NAPL Present _____

(If yes thickness) _____

Purging

Purge Method _____

Time Started _____

Time Stopped _____

Comments _____

Purge Depth _____

SWL (start) _____

SWL (end) _____

Bore Volume _____

Volume Removed _____

Bore Depth (start) _____

Bore Depth (end) _____

NAPL Present _____

(If yes thickness) _____

Sampling

Sampling Method Farm Bore

Time Started 1255

Time Stopped 1325

Comments High clarity, colourless, odourless.

Sampling Depth -

SWL (start) -

SWL (end) -

OVA Monitoring

Time	Ambient	Bore Head	Discharge

Field Analyses

Time	Vol Removed (L)	EC (uS/cm)	pH	T (C)	Redox (mV)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	Comments (Color, turbidity)
1258	4	315.2	8.89	15.8	-16.2	3.5	0.33	High clarity, colourless
1301	5.5	317.0	8.91	15.9	-23.2	2.6	0.24	"
1304	7	315.1	8.90	15.4	-30.1	2.6	0.24	"
1307	8.5	319.1	8.89	14.8	-38.1	1.4	0.16	"
1310	10	317.2	8.89	14.5	-39.9	1.5	0.16	"
1315	11.5	316.8	8.89	14.7	-41.8	1.4	0.15	"

BORE DEVELOPMENT, PURGING AND GROUNDWATER SAMPLING DATA SHEET

BORE No: S. to 4

Project No 42785630 Project Name KPS FB Sampling

Date 12/08/14 Sampled by: NW

Development

Development Method _____ SWL (start) _____ Volume Removed _____ Bore Depth (start) _____
 Time Started _____ SWL (end) _____ Discharge Rate _____ Bore Depth (end) _____
 Time Stopped _____
 Comments _____ NAPL Present _____
 (If yes thickness) _____

Purging

Purge Method _____ Purge Depth _____ Bore Volume _____ Bore Depth (start) _____
 Time Started _____ SWL (start) _____ Volume Removed _____ Bore Depth (end) _____
 Time Stopped _____ SWL (end) _____
 Comments _____ NAPL Present _____
 (If yes thickness) _____

Sampling

Sampling Method Farm Bore Sampling Depth -
 Time Started 1340 SWL (start) -
 Time Stopped 1415 SWL (end) -
 Comments High clarity, colorless, odorless.

OVA Monitoring

Time	Ambient	Bore Head	Discharge

Field Analyses

Time	Vol Removed (L)	EC (uS/cm)	pH	T (C)	Redox (mV)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	Comments (Color, turbidity)
1348	5.0	377.6	8.0	17.0	-35.1	7.0	0.67	High clarity, colorless
1351	6.5	372.6	8.0	17.1	-46.1	3.4	0.31	"
1354	8.0	371.3	8.0	17.1	-44.8	2.2	0.2	"
1357	9.5	375.0	8.0	17.1	-41.6	2.2	0.2	"
1400	11.0	373.5	8.0	17.2	-42.6	2.1	0.18	"

* Dip TH/BTEX
 & Metals
 collected



Laboratory Analytical Results and Chain of Custody Documentation

STABLE ISOTOPE RESULTS

Suzanne Lowe
URS
PO Box 3367
Wellington 6140
New Zealand



National Isotope Centre
30 Gracefield Road
Lower Hutt 5010
PO Box 31 312
Lower Hutt 5040
New Zealand
T +64-4-570 1444
F +64-4-570 4657
www.gns.cri.nz

Project Title 42788630
SIL Order No.:
Client Ref.: WEL-13-45073B
Date Received: 13/08/2014
Date Measured:
Approved By:
Date Reported: 22/08/2014

Invoice URS
Attn: Suzanne Lowe
PO Box 3367

Wellington 6140
New Zealand

Sample Type: methane (H & C)

SIL ID	External ID	$\delta^{13}\text{C}$ Value	Analysis Type	Meters or Feet
G-1402638	Site 1	-79.2	C13	m
G-1402639	Site 2	-81.3	C13	m
G-1402640	Site 3	-82.1	C13	m
G-1402641	Site 4	-81.7	C13	m



ANALYSIS REPORT

Page 1 of 4

Client:	URS New Zealand Limited	Lab No:	1310590	SP.2
Contact:	Sean Hudgens C/- URS New Zealand Limited PO Box 3367 WELLINGTON 6140	Date Registered:	13-Aug-2014	
		Date Reported:	03-Sep-2014	
		Quote No:	50053	
		Order No:	302912US	
		Client Reference:	42788630	
		Submitted By:	Ned Wells	

Amended Report

This report replaces an earlier report issued on the 26 Aug 2014 at 4:08 pm
Following a client query and QOW Q#54756, the result for propylene glycol
for sample 1310590.2 has been amended due to carryover during the
original analysis.

Sample Type: Aqueous

Sample Name:		Site 1 12-Aug-2014	Site 2 12-Aug-2014	Site 3 12-Aug-2014	Site 4 12-Aug-2014	DUP 12-Aug-2014
Lab Number:		1310590.1	1310590.2	1310590.3	1310590.4	1310590.5
Individual Tests						
Sum of Anions	meq/L	3.1	3.6	3.4	4.0	-
Sum of Cations	meq/L	3.3	3.9	3.7	4.2	-
pH	pH Units	6.9	8.4	8.9	8.1	-
Total Alkalinity	g/m ³ as CaCO ₃	104	164	153	185	-
Bicarbonate	g/m ³ at 25°C	127	196	174	220	-
Total Hardness	g/m ³ as CaCO ₃	60	52	12.7	109	-
Electrical Conductivity (EC)	mS/m	32.3	33.6	31.7	37.8	-
Total Dissolved Solids (TDS)	g/m ³	220	200	193	230	-
Dissolved Barium	g/m ³	0.031	0.00196	0.00116	0.0066	0.0064
Dissolved Calcium	g/m ³	14.5	13.2	3.7	24	-
Dissolved Copper	g/m ³	0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Iron	g/m ³	4.4	0.04	0.02	0.12	0.13
Dissolved Magnesium	g/m ³	5.7	4.7	0.88	12.0	-
Dissolved Manganese	g/m ³	0.66	0.0134	0.0065	0.027	0.028
Dissolved Mercury	g/m ³	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Nickel	g/m ³	0.0117	0.0085	< 0.0005	< 0.0005	< 0.0005
Dissolved Potassium	g/m ³	12.8	1.38	0.78	2.8	-
Dissolved Sodium	g/m ³	36	64	80	45	-
Dissolved Zinc	g/m ³	0.183	0.0018	< 0.0010	0.0018	0.0020
Bromide	g/m ³	0.14	0.07	0.07	0.07	-
Chloride	g/m ³	35	11.1	11.6	12.2	-
Nitrite-N	g/m ³	< 0.02	< 0.002	< 0.002	< 0.002	-
Nitrate-N	g/m ³	< 0.02	< 0.002	< 0.002	< 0.002	-
Nitrate-N + Nitrite-N	g/m ³	< 0.02 #1	< 0.002	< 0.002	< 0.002	-
Sulphate	g/m ³	< 0.5	< 0.5	< 0.5	< 0.5	-
Alkyl Quaternary Ammonium Compounds in Water by LCMSMS						
Benzalkonium Chloride (C12 homologue)	g/m ³	< 0.010	< 0.010	< 0.010	< 0.010	-
Benzalkonium Chloride (C14 homologue)	g/m ³	< 0.010	< 0.010	< 0.010	< 0.010	-
Benzalkonium Chloride (C16 homologue)	g/m ³	< 0.010	< 0.010	< 0.010	< 0.010	-
Benzalkonium Chloride (Total)	g/m ³	< 0.018	< 0.018	< 0.018	< 0.018	-
DDAC (Didecyltrimethylammonium chloride)	g/m ³	< 0.010	< 0.010	< 0.010	< 0.010	-
Dodine	g/m ³	< 0.010	< 0.010	< 0.010	< 0.010	-
IPBC (3-Iodo-2-propenyl-n-butylcarbamate)	g/m ³	< 0.010	< 0.010	< 0.010	< 0.010	-



This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

Sample Type: Aqueous					
Sample Name:		Site 1	Site 2	Site 3	Site 4
		12-Aug-2014	12-Aug-2014	12-Aug-2014	12-Aug-2014
Lab Number:		1310590.1	1310590.2	1310590.3	1310590.4
					DUP
					12-Aug-2014
					1310590.5
Ethylene Glycol in Water					
Ethylene glycol*	g/m ³	< 4	< 4	< 4	< 4
Propylene Glycol in Water					
Propylene glycol*	g/m ³	< 4	< 4	< 4	< 4
Methanol in Water - Aqueous Solvents					
Methanol*	g/m ³	< 2	< 2	< 2	< 2
BTEX in Water by Headspace GC-MS					
Benzene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
m&p-Xylene	g/m ³	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	g/m ³	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Formaldehyde in Water by DNPH & LCMSMS					
Formaldehyde	g/m ³	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater					
Ethane	g/m ³	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	g/m ³	< 0.003	< 0.003	< 0.003	< 0.003
Methane	g/m ³	7.9	7.0	8.5	10.8
Total Petroleum Hydrocarbons in Water					
C7 - C9	g/m ³	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m ³	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m ³	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m ³	< 0.7	< 0.7	< 0.7	< 0.7

Sample Name:		TB 12-Aug-2014				
Lab Number:		1310590.6				
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	-	-	-	-
Toluene	g/m³	< 0.0010	-	-	-	-
Ethylbenzene	g/m³	< 0.0010	-	-	-	-
m&p-Xylene	g/m³	< 0.002	-	-	-	-
o-Xylene	g/m³	< 0.0010	-	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	-	-	-	-
C10 - C14	g/m³	< 0.2	-	-	-	-
C15 - C36	g/m³	< 0.4	-	-	-	-
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	-	-	-	-

Analyst's Comments

#1 Severe matrix interferences required that a dilution be performed prior to analysis, resulting in a detection limit higher than that normally achieved for the NOxN /NO2N analysis.

Appendix No.1 - Chain of Custody

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Alkyl Quaternary Ammonium Compounds in Water by LCMSMS	Acetonitrile dilution, LCMSMS analysis. NB - BAC total = C12 + C14 + C16 homologues.	0.010 g/m ³	1-4
Ethylene Glycol in Water*	Direct injection, dual column GC-FID	4 g/m ³	1-4
Propylene Glycol in Water*	Direct injection, dual column GC-FID	4 g/m ³	1-4
Methanol in Water - Aqueous Solvents*	Direct injection, dual column GC-FID	1.0 g/m ³	1-4
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B [KBIs:26687,3629]	0.0010 - 0.002 g/m ³	1-6

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Formaldehyde in Water by DNPH & LCMSMS	DNPH derivatisation, extraction, LCMSMS	0.02 g/m ³	1-4
Gases in groundwater	Manual headspace creation and sub-sampling, GC-FID analysis.	0.002 - 0.003 g/m ³	1-4
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines [KBIs:2803,10734]	0.10 - 0.7 g/m ³	1-6
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-4
Total anions for anion/cation balance check	Calculation: sum of anions as mEq/L.	0.07 meq/L	1-4
Total cations for anion/cation balance check	Calculation: sum of cations as mEq/L.	0.05 meq/L	1-4
pH	pH meter. APHA 4500-H ⁺ B 22 nd ed. 2012.	0.1 pH Units	1-4
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 22 nd ed. 2012.	1.0 g/m ³ as CaCO ₃	2-4
Total Alkalinity	Titration to pH 4.5 (M-alkalinity). APHA 2320 B (Modified for alk <20) 22 nd ed. 2012.	1.0 g/m ³ as CaCO ₃	1
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO ₂ D 22 nd ed. 2012.	1.0 g/m ³ at 25°C	1-4
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 22 nd ed. 2012.	1.0 g/m ³ as CaCO ₃	1-4
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 22 nd ed. 2012.	0.1 mS/m	1-4
Total Dissolved Solids (TDS)	Filtration through GF/C (1.2 µm), gravimetric. APHA 2540 C (modified; drying temperature of 103 - 105°C used rather than 180 ± 2°C) 22 nd ed. 2012.	10 g/m ³	1-4
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.00010 g/m ³	1-5
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.05 g/m ³	1-4
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0005 g/m ³	1-5
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.02 g/m ³	1-5
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.02 g/m ³	1-4
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0005 g/m ³	1-5
Dissolved Mercury	0.45µm filtration, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m ³	1-5
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0005 g/m ³	1-5
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.05 g/m ³	1-4
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.02 g/m ³	1-4
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 22 nd ed. 2012.	0.0010 g/m ³	1-5
Bromide	Filtered sample. Ion Chromatography. APHA 4110 B 22 nd ed. 2012.	0.05 g/m ³	1-4
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl ⁻ E (modified from continuous flow analysis) 22 nd ed. 2012.	0.5 g/m ³	1-4
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₂ ⁻ I 22 nd ed. 2012.	0.002 g/m ³	1-4
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO ₂ N. In-House.	0.0010 g/m ³	1-4
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO ₃ ⁻ I 22 nd ed. 2012.	0.002 g/m ³	1-4
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 22 nd ed. 2012.	0.5 g/m ³	1-4

These samples were collected by yourselves (or your agent) and analysed as received **at** the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This report must not be reproduced, except in full, without the written consent of the signatory.

A handwritten signature in blue ink, appearing to read 'M. Cowell', is positioned above the printed name.

Martin Cowell - BSc
Client Services Manager - Environmental Division



Hill Laboratories

BETTER TESTING BETTER RESULTS

Client Name **URS New Zealand Limited** 33348

Address **PO Box 3367, WELLINGTON 6140**

Phone **04 49750** Fax **04 496 3755**

Client Reference **788630**

Quote No **500t** Order No **302912US**

Primary Contact **Sean Hudgens** 184706

Submitted By **Sean Hudgens** 184706

Charge To **URS New Zealand Limited** 33347

Results To ☐ Mail Primary Contact ☐ Mail Submitter

☐ Fax Results

☐ Email Results

ADDITIONAL INFORMATION

Quoted Sample Types

Ground Water (GW)

ANALYSIS REQUEST

R J Hill Laboratories Limited
1 Clyde Street,
Private Bag 3205
Hamilton, New Zealand

Phone: +64 7 858 2000
Fax: +64 7 858 2001
Email: mail@hill-labs.co.nz
Web: www.hill-laboratories.com

Office use

Job No:

CHAIN OF CUSTODY RECORD

Sent to
Hill Laboratories

Date & Time:

☐ Please tick if you
require COC to be
emailed back

Name:

Signature:

Received at
Hill Laboratories

Date & Time:

Name:

Signature:

Condition

Temp:

☐ Room Temp ☐ Chilled ☐ Frozen

☐ Sample & Analysis details checked

Signature:

Priority ☐ Low ☒ Normal ☐ High

☐ Urgent (ASAP, extra charge applies, please contact lab first)

NOTE: The estimated turnaround time for the types and number of samples and analyses specified on this quote is by 4:30 pm, 10 working days following the day of receipt of the samples at the laboratory.

Requested Reporting Date:

No.	Sample Name	Sample Date/Time	Sample Type	Tests Required
1	Site1		GW	BaDt, CuDt, FeDt, MnDt, HgDF, NiDt, ZnDt, TDS, ANCATL, Br, AQual, EthyleneGlycol, PropyleneGlycol, methanol, Formaldehyde, GGWorg, TPHOIBXp
2	Site 2		GW	BaDt, CuDt, FeDt, MnDt, HgDF, NiDt, ZnDt, TDS, ANCATL, Br, AQual, EthyleneGlycol, PropyleneGlycol, methanol, Formaldehyde, GGWorg, TPHOIBXp
3	Site 3		GW	BaDt, CuDt, FeDt, MnDt, HgDF, NiDt, ZnDt, TDS, ANCATL, Br, AQual, EthyleneGlycol, PropyleneGlycol, methanol, Formaldehyde, GGWorg, TPHOIBXp
4	Site 4		GW	BaDt, CuDt, FeDt, MnDt, HgDF, NiDt, ZnDt, TDS, ANCATL, Br, AQual, EthyleneGlycol, PropyleneGlycol, methanol, Formaldehyde, GGWorg, TPHOIBXp
5	TB		GW	TPHOIBXp
6	Dup		GW	BaDt, CuDt, FeDt, MnDt, HgDF, NiDt, ZnDt, TDS, ANCATL, Br, AQual, EthyleneGlycol, PropyleneGlycol, methanol, Formaldehyde, GGWorg, TPHOIBXp
7				
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Received by: Jennifer Singewood

Job No: **131 0590** Date Recv: 13-Aug-14 05:33



QA/QC Table



QA/QC - Sample Details and Analytical Results

Sample Location	QA/QC	
	Trip Blank	Duplicate of sample collected from Site 4
URS Sample Number	TB	Dup
Laboratory Sample Reference	1310590.6	1310590.5
Date Sampled	12.08.14	12.08.14
Total Petroleum Hydrocarbons (TPH)		
C ₇ -C ₉	< 0.10	< 0.10
C ₁₀ -C ₁₄	< 0.2	< 0.2
C ₁₅ -C ₃₆	< 0.4	< 0.4
Total hydrocarbons (C ₇ - C ₃₆)	< 0.7	< 0.7
BTEX Compounds		
Benzene	< 0.0010	< 0.0010
Toluene	< 0.0010	< 0.0010
Ethylbenzene	< 0.0010	< 0.0010
Total Xylenes	< 0.003	< 0.003
Dissolved Metals		
Dissolved Barium	-	0.0064
Dissolved Copper	-	< 0.0005
Dissolved Iron	-	0.13
Dissolved Manganese	-	0.028
Dissolved Mercury	-	< 0.00008
Dissolved Nickel	-	< 0.0005
Dissolved Zinc	-	0.0020

Notes:

All results and criteria are expressed in units of mg/L.

Project: 42788630

Client: Shell Todd Oil Services Limited

Filename: J:\WLG\42788630\6 Deliv\Final\Aug 2014 Round\Analytical Results Tables.xlsAnalytical Results Tables.xlsQAQC

Appendix A – M Barr - 873 Skeet Road (Site 1)

Site Name	M Barr – 873 Skeet Road (Site 1)
Well Details	The abstraction well at 873 Skeet Road is approximately 65 m deep and is screened from 30 to 60 m below ground level. The static groundwater level is recorded as 18 m below ground level. The well is finished with an 100 mm diameter steel well casing that sticks up above ground level by approximately 400 mm. The well is operational with a pump and outlet risers permanently mounted to the well head. The well appears to fill a storage tank which feeds a small secondary above ground tank in a pump house used for reticulation.
Pump Details	Submersible pump of unknown model.
Sampling Date	12 August 2014.
Sampler	URS.
Well use prior to sampling	Unknown.
Sampling Methodology	<p>A groundwater sample was unable to be collected directly from the well and therefore the groundwater sample was collected by connecting silicon and Teflon tubing directly to a tap attached to the secondary tank in the pump house. Groundwater was purged for approximately 15 minutes with a flow rate of approximately 0.5 L/min. An inline flow cell was used in conjunction with a multi parameter probe (YSI Professional Plus) to measure conductivity, pH, temperature, dissolved oxygen and redox in the purged groundwater. The well was sampled when parameters had stabilised.</p> <p>Water was observed to be light brown throughout purging and sampling.</p> <p>The groundwater sample was collected directly into laboratory supplied sample bottles. The portion of the sample that was analysed for dissolved metals was filtered in the field as per previous monitoring events. The groundwater sample was kept under chilled conditions and transported to Hill Laboratories Limited under standard chain of custody procedures. A sub sample was also kept under chilled conditions and transported to GNS Science (GNS) under standard chain of custody procedures.</p>
Laboratory Analysis	<p>The groundwater sample was identified as "Site 1" and was analysed by Hill Laboratories for the following analytes:</p> <ul style="list-style-type: none"> • pH • Conductivity • Anions and cations • Bicarbonate • Total dissolved solids, total alkalinity, total hardness • Major ions (calcium, magnesium, potassium, sodium, bromide, chloride, nitrate-nitrogen, and sulphate) • Dissolved field filtered metals (barium, copper, iron, manganese, mercury, nickel, and zinc) • Total Petroleum Hydrocarbons (TPH)

Appendix A – M Barr - 873 Skeet Road (Site 1)

	<ul style="list-style-type: none"> • Dissolved methane, ethylene and ethane gas • Benzene, toluene, ethylbenzene, and xylenes (BTEX) • Formaldehyde • Methanol • Glycols • Alkyl Quaternary Ammonium Compounds (analysis to test for the presence of corrosion inhibitor) <p>The sub sample sent to GNS was analysed for Carbon-13 composition of dissolved methane gas.</p>
Results Discussion	<p>Results for the August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring rounds are tabulated and attached. Results for the August 2014 monitoring event are similar to those recorded for the February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events.</p> <p>General baseline groundwater parameters for the abstraction well at 873 Skeet Road are consistent with background groundwater quality for Taranaki groundwater as reported in <i>Taranaki Where We Stand - State of the Environment Report, 2009</i>, published by the Taranaki Regional Council (Refer to Table 4.23 – Average values for groundwater quality for state of the environment monitoring sites 1999-2007). However, consistent with previous sampling events, slightly elevated concentrations of dissolved barium, dissolved iron, dissolved manganese and dissolved zinc were recorded for the groundwater sample collected from Site 1. The elevated concentrations of dissolved metals are likely a result of the sample being collected from the above ground tank.</p> <p>Concentrations of TPH, BTEX, formaldehyde, methanol, glycols, alkyl quaternary ammonium compounds, and dissolved ethylene and ethane gas were not detected above laboratory method detection limits.</p> <p>A concentration of 7.9 mg/L of dissolved methane was detected in the groundwater sample collected from Site 1 in the August 2014 monitoring event. The concentration of methane measured in the well during the six monitoring events to date has ranged between 0.64 mg/L and 8.6 mg/L.</p> <p>The carbon-13 composition of dissolved methane gas as analysed by GNS is more negative than -64‰ indicating that the methane has been formed as a result of microbial activity (biogenic processes) and not through deeper thermogenic processes, as described in <i>Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing</i>, published in Proceedings of the National Academy of Sciences by Osborne S. G., Vengosh A, Warner N. R. and Jackson R. B. (2011) 108 (20), pp. 8172-8176.</p>

The information included within this Appendix has been provided to Shell Todd Oil Services Limited for the purpose of and in accordance with the conditions of our engagement "STOS Kapuni Off-Site Monitoring – P/O 4512147904".



Site 1 - Sample Details and Analytical Results

Sample Location	Units	673 Street Road					
		Site 1	Site 1	Site 1	Site 1	Site 1	Site 1
		(084054)	(135119)	(117225)	(120267)	(125484)	(131090)
		Date Sampled	10/12/12	2/05/13	30/07/13	13/11/13	10/02/14
Total Petroleum Hydrocarbons (TPH)							
C-C	mg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.10
C ₁₀ -C ₁₄	mg/L	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2
C ₁₅ -C ₁₉	mg/L	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	0.4
Total Hydrocarbons (C-C ₁₉)	mg/L	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	0.7
BTEX Compounds							
Benzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total Benzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total Xylenes	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Dissolved Metals							
Dissolved Barium	mg/L	0.026	0.030	0.029	0.028	0.030	0.051
Dissolved Calcium	mg/L	14.4	15.9	14.7	14.4	14.3	14.5
Dissolved Copper	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0005
Dissolved Iron	mg/L	1.45	1.89	2.3	1.55	2.5	4.4
Dissolved Magnesium	mg/L	4.8	5.6	5.6	5.7	5.6	5.7
Dissolved Manganese	mg/L	0.52	0.41	0.61	0.64	0.61	0.66
Dissolved Mercury	mg/L	< 0.00005	< 0.00004	< 0.00004	< 0.00004	< 0.00004	< 0.00004
Dissolved Nickel	mg/L	0.0046	0.0155	0.0015	0.0015	0.0018	0.0117
Dissolved Potassium	mg/L	11.5	12.1	12.5	12.9	12.3	12.8
Dissolved Sodium	mg/L	31	31	33	34	32	36
Dissolved Zinc	mg/L	0.31	0.40	0.42	0.182	0.157	0.183
Allyl Quaternary Ammonium Compounds in Water by LCMSMS							
Benzalkonium Chloride (C12 homologues)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C14 homologues)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C16 homologues)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (total)	mg/L	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018
DDAC (Didecyl dimethylammonium chloride)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Dodecyl	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
DPBC (3,3,3-tri-2-propyl-iso-butylcarbamate)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Ethylene Glycol in Water							
Ethylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4
Propylene Glycol in Water							
Propylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4
Methanol in Water - Aqueous Solvents							
Methanol	mg/L	< 2	< 2	< 2	< 2	< 2	< 2
Formaldehyde in Water by DNPH & LCMSMS							
Formaldehyde	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater							
Ethane	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	mg/L	< 0.003	< 0.004	< 0.003	< 0.003	< 0.004	< 0.003
Methane	mg/L	0.04	4.4	4.2	8.6	7.5	7.9
Other Analyses							
Sum of Anions	mg/L	3.0	3.2	3.2	3.1	3.1	3.1
Sum of Cations	mg/L	3.0	3.0	3.1	3.1	3.0	3.3
pH	pH Units	7	6.8	6.8	7	7.1	6.9
Total Alkalinity	mg/L as CaCO ₃	105	111	111	107	108	104
Bicarbonate	mg/L at 25 °C	127	137	135	130	131	127
Total Hardness	mg/L as CaCO ₃	55	61	60	59	59	60
Electrical Conductivity (EC)	mS/m	31.9	32.3	32.6	30.8	32.1	32.3
Total Dissolved Solids (TDS)	mg/L	210	220	220	260	220	220
Bromide	mg/L	0.15	0.14	0.06	0.12	0.06	0.14
Chloride	mg/L	74	35	33	34	34	35
Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N + Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Sulphate	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Notes:
* see lab report

Appendix B – PKW Farms - 468 Hastings Road (Site 2)

Site Name	PKW Farms – 468 Hastings Road (Site 2)
Well Details	The abstraction well at 468 Hastings Road is 337 m deep and is cased to 92 m below ground level (bgl). The depth to groundwater is unknown. The well casing is steel with a diameter of approximately 90 mm and is finished above ground. The well is operational with pump and outlet tubes permanently mounted to the well head. The well is pumped every day to supply the farm and dairy shed. Approximately 130,000 litres of groundwater is pumped each day.
Pump Details	Submersible pump of unknown model.
Sampling Date	12 August 2014.
Sampler	URS.
Well use prior to sampling	Unknown.
Sampling Methodology	<p>A groundwater sample was collected by attaching silicone tubing directly to the outlet of the well and opening a valve on the outlet. Groundwater was purged for approximately 15 minutes with a flow rate of approximately 0.7 L/min. An inline flow cell was used in conjunction with a multi parameter probe (YSI Professional Plus) to measure conductivity, pH, temperature, dissolved oxygen and redox in the purged groundwater. The well was sampled when parameters had stabilised.</p> <p>Water was observed to be clear during purging and sampling.</p> <p>The groundwater sample was collected directly into laboratory supplied sample bottles. The portion of the sample that was analysed for dissolved metals was filtered in the field as per previous monitoring events. The groundwater sample was kept under chilled conditions and transported to Hill Laboratories Limited under standard chain of custody procedures. A sub sample was also kept under chilled conditions and transported to GNS Science (GNS) under standard chain of custody procedures.</p>
Laboratory Analysis	<p>The groundwater sample was identified as "Site 2" and was analysed by Hill Laboratories for the following analytes:</p> <ul style="list-style-type: none"> • pH • Conductivity • Anions and cations • Bicarbonate • Total dissolved solids, total alkalinity, total hardness • Major ions (calcium, magnesium, potassium, sodium, bromide, chloride, nitrate-nitrogen, and sulphate) • Dissolved field filtered metals (barium, copper, iron, manganese, mercury, nickel, and zinc) • Total Petroleum Hydrocarbons (TPH) • Dissolved methane, ethylene and ethane gas • Benzene, toluene, ethylbenzene, and xylenes (BTEX)

Appendix B – PKW Farms - 468 Hastings Road (Site 2)

	<ul style="list-style-type: none"> • Formaldehyde • Methanol • Glycols • Alkyl Quaternary Ammonium Compounds (analysis to test for the presence of corrosion inhibitor) <p>The sub sample sent to GNS was analysed for Carbon-13 composition of dissolved methane gas.</p>
Results Discussion	<p>Results for the August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring rounds are tabulated and attached. Results for the August 2014 monitoring event are similar to those recorded for the February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events.</p> <p>General baseline groundwater parameters for the abstraction well at 468 Hastings Road are consistent with background groundwater quality for Taranaki groundwater as reported in <i>Taranaki Where We Stand - State of the Environment Report, 2009</i>, published by the Taranaki Regional Council (Refer to Table 4.23 – Average values for groundwater quality for state of the environment monitoring sites 1999-2007).</p> <p>Concentrations of TPH, BTEX, formaldehyde, methanol, ethylene glycol, alkyl quaternary ammonium compounds, and dissolved ethylene and ethane gas were not detected above laboratory method detection limits.</p> <p>A concentration of 7.0 mg/L of dissolved methane was detected in the groundwater sample collected from Site 2 in the August 2014 monitoring event. The concentration of methane measured in the well during the six monitoring events to date has ranged between 2.3 mg/L and 7.0 mg/L.</p> <p>The carbon-13 composition of dissolved methane gas as analysed by GNS is more negative than -64‰ indicating that the methane has been formed as a result of microbial activity (biogenic processes) not through deeper thermogenic processes, as described in <i>Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing</i>, published in Proceedings of the National Academy of Sciences by Osborne S. G., Vengosh A, Warner N. R. and Jackson R. B. (2011) 108 (20), pp. 8172-8176.</p>

The information included within this Appendix has been provided to Shell Todd Oil Services Limited for the purpose of and in accordance with the conditions of our engagement "STOS Kapuni Off-Site Monitoring – P/O 4512147904".



Site 2 - Sample Details and Analytical Results

Sample Location	Units	498 Hastings Road					
		Site 2	Site 2	Site 2	Site 2	Site 2	Site 2
		11/12/12	11/21/12	11/22/12	12/28/12	12/34/12	12/34/12
URS Sample Number		11/12/12	11/21/12	11/22/12	12/28/12	12/34/12	12/34/12
Lab Sample Reference		11/12/12	11/21/12	11/22/12	12/28/12	12/34/12	12/34/12
Date Sampled		11/12/12	11/21/12	11/22/12	12/28/12	12/34/12	12/34/12
Total Petroleum Hydrocarbons (TPH)							
C ₁₀ -C ₁₄	mg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C ₁₅ -C ₁₉	mg/L	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C ₂₀ -C ₂₄	mg/L	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total Hydrocarbons (C ₁₀ -C ₂₄)	mg/L	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
RTX Compounds							
Benzene	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Toluene	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Ethylbenzene	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Total Xylenes	mg/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Dissolved Metals							
Dissolved Barium	mg/L	0.00199	0.0021	0.00155	0.0021	0.00199	0.00196
Dissolved Calcium	mg/L	13.8	13.1	12.9	12.9	13.2	13.2
Dissolved Copper	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Iron	mg/L	0.05	0.06	0.05	0.04	0.05	0.04
Dissolved Magnesium	mg/L	4.2	4.4	4.5	4.7	4.8	4.7
Dissolved Manganese	mg/L	0.015	0.0129	0.0133	0.013	0.0134	0.0134
Dissolved Mercury	mg/L	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Nickel	mg/L	0.0074	0.0078	0.0065	0.0073	0.0066	0.0065
Dissolved Potassium	mg/L	1.41	1.43	1.46	1.43	1.41	1.43
Dissolved Selenium	mg/L	58	56	60	65	57	64
Dissolved Zinc	mg/L	0.0053	0.0052	0.0053	0.0045	0.0047	0.0048
Allyl Quaternary Ammonium Compounds in Water by LC/MS/MS							
Benzalkonium Chloride (C12 homologs)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzyldimethylammonium Chloride (C14 homologs)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C16 homologs)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C18 homologs)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
DDAC (Didecylmethylammonium chloride)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Dodecyl	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
IPBC (3,3,3-tri-(n-butyl)-n-butylcarbamate)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Ethylene Glycol in Water							
Ethylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4
Propylene Glycol in Water							
Propylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4
Methanol in Water - Aqueous Solvents							
Methanol	mg/L	< 2	< 2	< 2	< 2	< 2	< 2
Formaldehyde in Water by DNPH & LC/MS/MS							
Formaldehyde	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater							
Ethane	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	mg/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Methane	mg/L	2.3	5.4	3.9	3.8	6.8	7.0
Other Analyses							
Sum of Anions	meq/L	3.7	3.7	3.6	3.6	3.6	3.6
Sum of Cations	meq/L	3.6	3.5	3.7	3.9	3.6	3.9
pH	pH Units	8.4	8.4	8.4	8.3	8.3	8.4
Total Alkalinity	mg/L as CaCO ₃	169	166	166	166	166	164
Bicarbonate	mg/L at 25°C	200	198	198	199	198	196
Total Hardness	meq/L as CaCO ₃	32	31	31	31	31	32
Electrical Conductivity (EC)	mS/m	33.3	33.3	33.5	33.4	33.3	33.6
Total Dissolved Solids (TDS)	mg/L	290	210	200	220	200	200
Bromide	mg/L	0.06	0.07	< 0.05	0.05	< 0.05	0.07
Chloride	mg/L	11.4	12.0	10.9	10.7	10.4	11.1
Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N + Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Sulfate	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Appendix C – Kiley Estate - Inuawai Road (Site 3)

Site Name	Kiley Estate - Inuawai Road (Site 3)
Well Details	The abstraction well at Kiley Estate is 448 m deep and is cased to 280 m below ground level. The depth to groundwater is unknown. The well casing is steel with a diameter of approximately 90 mm and is finished above ground. The well is operational with pump and outlet tubes permanently mounted to the well head. The well is pumped to supply water to the dairy shed.
Pump Details	Submersible pump of unknown model. Potential also for artesian supply.
Sampling Date	12 August 2014.
Sampler	URS.
Well use prior to sampling	Unknown.
Sampling Methodology	<p>A groundwater sample was collected by attaching silicone tubing directly to the outlet of the well and opening a valve on the outlet. Groundwater was purged for approximately 18 minutes with a flow rate of approximately 0.6 L/min. An inline flow cell was used in conjunction with a multi parameter probe (YSI Professional Plus) to measure conductivity, pH, temperature, dissolved oxygen and redox in the purged groundwater. The well was sampled when parameters had stabilised.</p> <p>Water was observed to be clear during purging and sampling.</p> <p>The groundwater sample was collected directly into laboratory supplied sample bottles. The portion of the sample that was analysed for dissolved metals was filtered in the field as per previous monitoring events. The groundwater sample was kept under chilled conditions and transported to Hill Laboratories Limited under standard chain of custody procedures. A sub sample was also kept under chilled conditions and transported to GNS Science (GNS) under standard chain of custody procedures.</p>
Laboratory Analysis	<p>The groundwater sample was identified as "Site 3" and was analysed by Hill Laboratories for the following analytes:</p> <ul style="list-style-type: none"> • pH • Conductivity • Anions and cations • Bicarbonate • Total dissolved solids, total alkalinity, total hardness • Major ions (calcium, magnesium, potassium, sodium, bromide, chloride, nitrate-nitrogen, and sulphate) • Dissolved field filtered metals (barium, copper, iron, manganese, mercury, nickel, and zinc) • Total Petroleum Hydrocarbons (TPH) • Dissolved methane, ethylene and ethane gas • Benzene, toluene, ethylbenzene, and xylenes (BTEX) • Formaldehyde

Appendix C – Kiley Estate - Inuawai Road (Site 3)

	<ul style="list-style-type: none"> • Methanol • Glycols • Alkyl Quaternary Ammonium Compounds (analysis to test for the presence of corrosion inhibitor) <p>The sub sample sent to GNS was analysed for Carbon-13 composition of dissolved methane gas.</p>
Results Discussion	<p>Results for the August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring rounds are tabulated and attached. Results for the August 2014 monitoring event are similar to those recorded for the February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events.</p> <p>General baseline groundwater parameters for the abstraction well at Kiley Estate are consistent with background groundwater quality for Taranaki groundwater as reported in <i>Taranaki Where We Stand - State of the Environment Report, 2009</i>, published by the Taranaki Regional Council (Refer to Table 4.23 – Average values for groundwater quality for state of the environment monitoring sites 1999-2007).</p> <p>Concentrations of TPH, BTEX, formaldehyde, methanol, glycols, alkyl quaternary ammonium compounds, and dissolved ethane and ethylene gas were not detected above laboratory method detection limits.</p> <p>A concentration of 8.5 mg/L of dissolved methane was detected in the groundwater sample collected from Site 3 in the August 2014 monitoring event. The concentration of methane measured in the well during the six monitoring events to date has ranged between 1.94 mg/L and 8.5 mg/L.</p> <p>The carbon-13 composition of dissolved methane gas as analysed by GNS is more negative than -64‰ indicating that the methane has been formed as a result of microbial activity (biogenic processes) not through deeper thermogenic processes, as described in <i>Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing</i>, published in Proceedings of the National Academy of Sciences by Osborne S. G., Vengosh A, Warner N. R. and Jackson R. B. (2011) 108 (20), pp. 8172-8176.</p>

The information included within this Appendix has been provided to Shell Todd Oil Services Limited for the purpose of and in accordance with the conditions of our engagement "STOS Kapuni Off-Site Monitoring – P/O 4512147904".



Site 3 - Sample Details and Analytical Results

Sample Location		Inman Road					
URS Sample Number	Units	Site 2	Site 3	Site 3	Site 3	Site 3	Site 3
Laboratory Sample Reference		1084054.3	1131158.3	1162258.3	1202867.3	1244484.3	1310550.3
Date Sampled		19/12/12	2/05/13	30/07/13	13/11/13	10/02/14	12/08/14
Total Petroleum Hydrocarbons (TPH)							
C ₁ -C ₆	mg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C ₇ -C ₁₀	mg/L	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C ₁₁ -C ₂₀	mg/L	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C ₇ - C ₂₀)	mg/L	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
BTEX Compounds							
Benzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total Xylenes	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Dissolved Metals							
Dissolved Barium	mg/L	0.00168	0.00116	0.00154	0.00129	0.00107	0.00116
Dissolved Calcium	mg/L	3.8	4.0	3.6	3.8	3.5	3.7
Dissolved Copper	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Iron	mg/L	0.02	0.07	0.02	< 0.02	0.02	0.02
Dissolved Manganese	mg/L	0.7	0.87	0.94	0.9	0.89	0.85
Dissolved Magnesium	mg/L	0.0065	0.0077	0.0069	0.0064	0.0063	0.0065
Dissolved Mercury	mg/L	< 0.00008	< 0.00008	< 0.00005	< 0.00008	< 0.00008	< 0.00008
Dissolved Nickel	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Potassium	mg/L	0.75	0.75	0.84	0.82	0.64	0.78
Dissolved Sodium	mg/L	67	70	74	75	71	80
Dissolved Zinc	mg/L	< 0.0010	0.0029	< 0.0010	0.0014	< 0.0010	< 0.0010
Alkyl Quaternary Ammonium Compounds in Water by LC/MS/MS							
Benzalkonium Chloride (C12 homologues)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C13 homologues)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C14 homologues)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (total)	mg/L	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018
DDAC (Didecyl dimethyl ammonium chloride)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Genlon	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
IPBC (3,4,4'-tri-2-propoxy-2-butyloxybenzophenone)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Ethylene Glycol in Water							
Ethylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4
Propylene Glycol in Water							
Propylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4
Methanol in Water - Aquatic Solvents							
Methanol	mg/L	< 2	< 2	< 2	< 2	< 2	< 2
Formaldehyde in Water by BNPH & LC/MS/MS							
Formaldehyde	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater							
Ethane	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	mg/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Methane	mg/L	1.94	4.9	4.1	6.7	7.8	8.5
Other Analyses							
Sum of Anions	mg/L	3.5	3.4	3.4	3.4	3.4	3.4
Sum of Cations	mg/L	3.2	3.3	3.5	3.7	3.4	3.7
pH	nH Units	8.8	8.9	8.9	8.7	8.8	8.9
Total Alkalinity	mg/L as CaCO ₃	151	154	153	155	156	153
Bicarbonate	mg/L at 25°C	181	175	172	179	179	174
Total Hardness	mg/L as CaCO ₃	15.3	13.4	12.5	13.3	13.1	12.7
Theoretical Conductivity (EC)	mS/cm	31.8	31.4	31.6	31.4	31.7	31.7
Total Dissolved Solids (TDS)	mg/L	199	196	197	210	260	193
Bromide	mg/L	0.07	0.07	< 0.05	0.05	< 0.05	0.07
Chloride	mg/L	11.6	12.5	11.4	10.7	11.6	11.6
Nitrate-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate+N+Nitrite+N	mg/L	0.005	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Sulphate	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

Appendix D – Naplin Trust - Ahipaipa Road (Site 4)

Site Name	Naplin Trust - Ahipaipa Road (Site 4)
Well Details	The abstraction well at Naplin Trust is 432 m deep and is cased to 123 m below ground level. The depth to groundwater is unknown. The well casing is steel with a diameter of approximately 125 mm and is finished above ground. The well is operational with pump and outlet tubes permanently mounted to the well head. The well is artesian and fills a storage tank adjacent to the dairy shed.
Pump Details	Artesian
Sampling Date	12 August 2014.
Sampler	URS.
Well use prior to sampling	Unknown.
Sampling Methodology	<p>A groundwater sample was collected by attaching silicone tubing directly to the outlet of the well and opening a valve on the outlet. Groundwater was purged for approximately 20 minutes with a flow rate of approximately 0.6 L/min. An inline flow cell was used in conjunction with a multi parameter probe (YSI Professional Plus) to measure conductivity, pH, temperature, dissolved oxygen and redox in the purged groundwater. The well was sampled when parameters had stabilised.</p> <p>Water was observed to be clear during purging and sampling.</p> <p>The groundwater sample was collected directly into laboratory supplied sample bottles. The portion of the sample that was analysed for dissolved metals was filtered in the field as per previous monitoring events. The groundwater sample was kept under chilled conditions and transported to Hill Laboratories Limited under standard URS chain of custody procedures. A sub sample was also kept under chilled conditions and transported to GNS Science (GNS) under standard URS chain of custody procedures.</p>
Laboratory Analysis	<p>The groundwater sample was identified as "Site 4" and was analysed by Hill Laboratories for the following analytes:</p> <ul style="list-style-type: none"> • pH • Conductivity • Anions and cations • Bicarbonate • Total dissolved solids, total alkalinity, total hardness • Major ions (calcium, magnesium, potassium, sodium, bromide, chloride, nitrate-nitrogen, and sulphate) • Dissolved field filtered metals (barium, copper, iron, manganese, mercury, nickel, and zinc) • Total Petroleum Hydrocarbons (TPH) • Dissolved methane, ethylene and ethane gas • Benzene, toluene, ethylbenzene, and xylenes (BTEX) • Formaldehyde

Appendix D – Naplin Trust - Ahipaipa Road (Site 4)

	<ul style="list-style-type: none"> • Methanol • Glycols • Alkyl Quaternary Ammonium Compounds (analysis to test for the presence of corrosion inhibitor) <p>The sub sample sent to GNS was analysed for Carbon-13 composition of dissolved methane gas.</p>
Results Discussion	<p>Results for the August 2014, February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring rounds are tabulated and attached. Results for the August 2014 monitoring event are similar to those recorded for the February 2014, November 2013, July 2013, May 2013 and December 2012 monitoring events.</p> <p>General baseline groundwater parameters for the abstraction well at Naplin Trust are consistent with background groundwater quality for Taranaki groundwater as reported in <i>Taranaki Where We Stand - State of the Environment Report, 2009</i>, published by the Taranaki Regional Council (Refer to Table 4.23 – Average values for groundwater quality for state of the environment monitoring sites 1999-2007).</p> <p>Concentrations of TPH, BTEX, formaldehyde, methanol, glycols, alkyl quaternary ammonium compounds, and dissolved ethane gas were not detected above laboratory method detection limits.</p> <p>A concentration of 10.8 mg/L of dissolved methane was detected in the groundwater sample collected from Site 4 in the August 2014 monitoring event. The concentration of methane measured in the well during the six monitoring events to date has ranged between 2.8 mg/L and 10.8 mg/L.</p> <p>The carbon-13 composition of dissolved methane gas as analysed by GNS is more negative than -64‰ indicating that the methane has been formed as a result of microbial activity (biogenic processes) not through deeper thermogenic processes, as described in <i>Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing</i>, published in <i>Proceedings of the National Academy of Sciences</i> by Osborne S. G., Vengosh A, Warner N. R. and Jackson R. B. (2011) 108 (20), pp. 8172-8176.</p>

The information included within this Appendix has been provided to Shell Todd Oil Services Limited for the purpose of and in accordance with the conditions of our engagement "STOS Kapuni Off-Site Monitoring – P/O 4512147904".



Site 4 - Sample Details and Analytical Results

Sample Location	Units	Atterbury Road					
		Site 4	Site 4	Site 4	Site 4	Site 4	Site 4
		1074054.4	1191179.4	1262255.4	1292867.4	1314473.4	1340590.4
Date Sampled		15/12/12	20/1/13	30/07/13	15/11/13	10/02/14	12/08/14
Total Petroleum Hydrocarbons (TPH)							
C ₁ -C ₆	mg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.15	< 0.10
C ₁₀ -C ₁₄	mg/L	< 0.2	< 0.2	< 0.2	< 0.2	< 0.4	< 0.2
C ₁₅ -C ₁₉	mg/L	< 0.4	< 0.4	< 0.4	< 0.4	< 0.8	< 0.4
Total hydrocarbons (C ₁ - C ₁₉)	mg/L	< 0.7	< 0.7	< 0.7	< 0.7	< 1.4	< 0.7
BTEX Compounds							
Benzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total Xylenes	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.005	< 0.003
Dissolved Metals							
Dissolved Barium	mg/L	0.006	0.007	0.004	0.0065	0.0064	0.0065
Dissolved Cadmium	mg/L	24	27	24	24	24	24
Dissolved Copper	mg/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Dissolved Iron	mg/L	0.17	0.20	0.12	0.13	0.12	0.12
Dissolved Manganese	mg/L	0.02	0.03	0.028	0.029	0.028	0.027
Dissolved Molybdenum	mg/L	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Dissolved Mercury	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Nickel	mg/L	2.5	2.1	3	3	2.8	2.8
Dissolved Potassium	mg/L	33	42	42	45	41	45
Dissolved Sodium	mg/L	0.0658	0.0622	0.0629	0.0645	0.0637	0.0618
Dissolved Zinc	mg/L	0.0658	0.0622	0.0629	0.0645	0.0637	0.0618
Alkyl Quaternary Ammonium Compounds in Water by LC/MS/MS							
Benzalkonium Chloride (C12 homologues)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C14 homologues)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C16 homologues)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Benzalkonium Chloride (C18)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
DDBAC (Dibutylammonium chloride)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Dadac	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
IPBC (3-Isobutyl-2-propyl-1-methylcarbamate)	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Ethylene Glycol in Water							
Ethylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4
Propylene Glycol in Water							
Propylene glycol	mg/L	< 4	< 4	< 4	< 4	< 4	< 4
Methanol in Water - Aqueous Solvents							
Methanol	mg/L	< 2	< 2	< 2	< 2	< 2	< 2
Formaldehyde in Water by DNPH & LC/MS/MS							
Formaldehyde	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater							
Ethane	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	mg/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Methane	mg/L	2.8	5.4	5.7	9.3	7.9	10.3
Other Analytes							
Sum of Anions	meq/L	4.1	4.1	4.1	4.1	4.0	4.0
Sum of Cations	meq/L	3.8	4.2	4.0	4.2	4.0	4.2
pH	pH Units	8.1	8.1	8.1	8.1	8.2	8.1
Total Alkalinity	mg/L as CaCO ₃	188	186	186	186	186	185
Inorganic Carbon	mg/L at 25°C	230	220	220	220	220	220
Total Hardness	mg/L as CaCO ₃	101	113	106	111	106	109
Electrical Conductivity (EC)	µS/cm	27.3	36.6	27.2	37	36.9	37.8
Total Dissolved Solids (TDS)	mg/L	226	220	220	220	220	220
Bromide	mg/L	0.07	0.07	< 0.05	0.07	< 0.05	0.07
Chloride	mg/L	12	12.9	11.6	11.6	11.2	12.2
Nitrate-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrite-N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate+N+Nitrite+N	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Sulphate	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

