Greymouth Petroleum Limited
Turangi-B Hydraulic Fracturing
Groundwater Monitoring Programme Report 2011-2013

Technical Report 2013–14

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Taranaki Regional Council
Private Bag 713
STRATFORD

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Executive summary

Greymouth Petroleum Limited (the Company) established the Turangi-B wellsite in 2011. The site is located on Turangi Road, Motunui. The resource consents held by the Company permit the drilling of up to eight wells from the wellsite.

As of 30 June 2013, the only well drilled from the Turangi-B wellsite is the Turangi-4 well. The well was drilled between August and September 2011, to a total vertical depth of approximately 4,100 metres. Following completion of the well, the hydrocarbon reservoir was stimulated by hydraulic fracturing. A total of 5 distinct producing zones were fractured over 6 separate events, between 15 November 2011 and 7 March 2012.

The discharges to land associated with the hydraulic fracturing of the Turangi-4 well were permitted under resource consent 7952-1. The consent includes a number of special conditions, including specific conditions relating to the sampling and analysis of local groundwater resources. The Council was contracted by the Company to undertake the sampling and analysis of groundwater required by the conditions of the exercised consent.

The following report describes the groundwater monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the potential effects of hydraulic fracturing activities at the Turangi-B wellsite on groundwater resources in the area surrounding the site. The results of the monitoring undertaken allow for an assessment of the Company's environmental performance to be made in relation to hydraulic fracturing activities and whether compliance with the conditions of consent 7952-1, relating specifically to the monitoring and protection of groundwater resources, has been achieved. The report covers the monitoring period 1 July 2011 to 30 June 2013.

The monitoring programme implemented by the Council included the sampling and analysis of groundwater samples from 6 private water supply wells/bores in the area surrounding the Turangi-B wellsite. In addition, samples were also obtained from 5 dedicated wellsite monitoring wells, installed around the perimeter of the wellsite itself. Groundwater samples were submitted to Hills Laboratory for comprehensive physicochemical analysis. Additional samples were also obtained from sampling sites identified as containing dissolved methane for carbon isotope analysis. Groundwater samples were obtained from the private water supplies prior to the hydraulic fracturing of the Turangi-4 well (baseline) and at intervals of 1 week, 1 month, 3 months and 12 months post hydraulic fracturing. Samples were taken from the wellsite monitoring wells on two occasions, approximately 1 month and 6 months post hydraulic fracturing. In total, 44 groundwater samples were obtained for analysis during the period under review.

The results of the analyses carried out on samples taken from private water supplies show that the concentrations of each parameter analysed for remained consistent across the sampling period, with no significant changes detected post hydraulic fracturing.

A slight increase in chloride concentration and the presence of low levels of toluene were detected (parts per billion) in two wellsite monitoring wells. The sites that displayed increases in chloride concentration and the presence of toluene are located downgradient of the wellsite and flare pit area. The concentrations of both chloride and toluene remained below their respective guideline values, as listed in the Drinking-water Standards for New Zealand (2008). It is likely that the increased chloride concentrations and the presence of

toluene are a result of general wellsite activities, including the use of the flare pit for a study of flaring emissions in February 2012, as opposed to hydraulic fracturing operations. The effects detected are highly localised and likely to be short term. Further sampling of all sites included in the monitoring programme is proposed for the forthcoming monitoring period, in order to confirm this assessment.

There is no evidence to suggest that the hydraulic fracturing of the Turangi-4 well has resulted in any significant adverse effects on shallow groundwater in the vicinity of the Turangi-B wellsite. The Company has demonstrated a high level of environmental performance and compliance with regard to relevant conditions of resource consent 7952-1.

This report includes recommendations concerning the nature of on-going groundwater monitoring in the vicinity of the Turangi-B wellsite.

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act (1991)

1.1.1 Introduction

The following report describes the groundwater monitoring programme implemented by the Taranaki Regional (the Council) in relation to hydraulic fracturing activities undertaken by Greymouth Petroleum Limited (the Company) at their Turangi-B wellsite, Turangi Road, Motunui. The results of the groundwater monitoring carried out are also presented and discussed in the report. The report encompasses the monitoring period 1 July 2011 to 30 June 2013.

During the period under review, the Company undertook a programme of hydraulic fracturing from the Turangi-4 well. The Turangi-4 well was drilled from the Turangi-B wellsite between August and September 2011. The well has a total vertical depth of approximately 4,100 metres (mTVD). The hydraulic fracturing programme resulted in 5 distinct producing zones being fractured over 6 events, between 15 November 2011 and 7 March 2012.

The discharges associated with hydraulic fracturing were permitted under resource consent 7952-1. The consent includes a number of special conditions, including specific conditions relating to the sampling and analysis of local groundwater resources. The results of the groundwater monitoring programme implemented by the Council are used to assess the Company's performance with regard to consent compliance.

The overall record of consent compliance and environmental performance at the Turangi-B wellsite is set out in the Council's exploration wellsite monitoring report for the site[1]. This report has been prepared by the Council to address specific monitoring investigations into the potential effects of hydraulic fracturing on groundwater resources in the vicinity of the Turangi-B wellsite.

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 Resource Management Act and the Council's obligations and general approach to monitoring sites through monitoring programmes. Section 1 also describes the environment in which the Turangi-B wellsite is located, the process of hydraulic fracturing, details the resource consent held by the Company for hydraulic fracturing at the Turangi-B wellsite, outlines hydraulic fracturing activities carried out at the site during the period under review, and the nature of the monitoring programme implemented by the Council.

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

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

[1] See bibliography

Section 4 presents recommendations regarding the on-going monitoring of groundwater in the vicinity of the site.

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

1.1.3 The Resource Management Act (1991) and monitoring

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

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

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

1.1.4 Evaluation of environmental performance

Besides discussing the various details of the performance and extent of compliance by the Company during the period under review, this report also assigns an overall environmental performance rating. The categories used by the Council, and their interpretation, are as follows:

- a **high** level of environmental performance and compliance indicates that essentially there were no adverse environmental effects to be concerned about, and no, or inconsequential (such as data supplied after a deadline) non-compliance with conditions.

- a **good** level of environmental performance and compliance indicates that adverse environmental effects of activities during the monitoring period were negligible or minor at most, or, 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, or, there were perhaps some items noted on inspection notices for attention but these items were not urgent nor critical, and follow-up inspections showed they have been dealt with, and inconsequential non compliances with conditions were resolved positively, co-operatively, and quickly.

- **improvement desirable** indicates that the Council may have been obliged to record a verified unauthorised incident involving measureable environmental impacts, or, there were measureable environmental effects arising from activities and intervention by Council staff was required, and there were matters that required urgent intervention, took some time to resolve, or remained unresolved at end of the period under review, and/or abatement notices may have been issued.

- **poor performance** indicates that the Council may have been obliged to record a verified unauthorised incident involving significant environmental impacts, or, there were adverse environmental effects arising from activities and there were grounds for prosecution or an infringement notice.

1.2 Existing environment

1.2.1 Site location

The Turangi-B wellsite is located on Turangi Road, Motunui (Figure 1). The land on which the wellsite is located was previously used for livestock farming, until it was subject to lease agreement in May 2011. The Turangi-B wellsite lies in an active petrochemical exploration and production area, which operates alongside rural and farming operations. The area consists of predominantly low density housing due to its rural location. The site is located approximately 1.5 kilometres (km) south of the coastal boundary.

1.2.2 Geology

The hydraulically fractured intervals are located within the Mangahewa Formation, at depths in excess of 3,400 mTVD. The fractured intervals are isolated by the overlying Turi Formation. The Turi Formation is comprised of highly impermeable shale and siltstone, which has restricted the vertical migration of gas and fluids over geologic time scales, resulting in the formation of the underlying hydrocarbon reservoir. The pressure within the reservoir is known to exceed hydrostatic pressure, confirming that it is confined from overlying formations. In addition, hundreds of metres of low permeability strata overlie the Turi Formation, further reducing the potential for any migration of formation fluids or hydrocarbons from the producing zones.

No active faults have been identified in the vicinity of the Turangi-B wellsite.

The geological formations underlying the site are summarised below in Table 1.

Figure 1 Location of Turangi-B wellsite

Table 1 Summary of geological formations underlying the Turangi-B wellsite

Formation	Description	Depth (mTVD)
Taranaki Volcanics	Volcanics ashes and gravel	35
Matemateaonga	Sandy siltstones and silty claystones	495
Urenui	Calcareous claystone with interbedded siltstone and sandstone	1,000
Mount Messenger	Claystone with very fine and fine sandstone beds	1,620
Manganui	Claystone with minor sandstone, siltstone and limestone beds	3,065
Taimana	Calcareous claystone grading into argillaceous limestone	3,182
Tikorangi	Arcillaceous limestone	3,201
Otaraoa	Calcareous silty claystone with minor calcareous siltstones	3,367
Turi	Argillaceous, carbonaceous shale and siltstone	3,400

1.2.3 Hydrogeology

The shallow water bearing geological deposits underlying the Turangi-B wellsite include the Taranaki Volcanic and Matemateaonga Formations. The Council's Wells Database indicates that there are 14 private groundwater abstractions within a 1 km radius of the Turangi-B wellsite. Specific details of each abstraction are included below in Table 2. The groundwater abstractions registered in the vicinity of the Turangi-B wellsite range in depth from 3.5 metres (m) to 42 m, and include a spring discharge. The majority of abstractions are utilised as stock water rather than for consumptive purposes. The abstractions listed below all draw their water from the shallow Taranaki Volcanics Formation.

The salinity of groundwater beneath the site increases with depth. The freshwater to saline water interface is a gradational feature, above which there is potential for freshwater to occur. The salinity of groundwater can be assessed by analysing resistivity survey logs. Based on resistivity data available for surrounding wells, and their correlation with the stratigraphic sequence of the Turangi-4 well, the freshwater/saline water interface below the Turangi-B wellsite has been estimated to occur from a depth of 215 mTVD, with pure saline water (1,000 ppm NaCL equivalent) below 960 mTVD.

Table 2 Summary of groundwater abstractions within 1 km radius of Turangi-B wellsite

Site Code	Easting (NZTM)	Northing (NZTM)	Classification	Distance from Wellhead (m)	Total Depth (m)	Static Water Level (m)	Formation / Aquifer
GND1125	1713805	5683262	Bore	787	26	10.5	Taranaki Volcanics
GND1126	1713205	5682961	Bore	611	22	NR*	Taranaki Volcanics
GND1128	1713323	5682990	Bore	566	21	8.5	Taranaki Volcanics
GND1673	1713925	5681723	Bore	835	42	7.5	Taranaki Volcanics
GND2229	1713765	5683416	Bore	927	NR*	NR*	Taranaki Volcanics
GND2230	1713540	5682843	Spring	350	N/A	N/A	Taranaki Volcanics
GND2231	1713448	5682788	Well	330	4	0.5	Taranaki Volcanics
GND2233	1713951	5682910	Well	537	3.5	1.6	Taranaki Volcanics
GND2234	1713678	5682444	Monitoring well	89	5	3.4	Taranaki Volcanics
GND2235	1713634	5682642	Monitoring well	152	5	3.5	Taranaki Volcanics
GND2236	1713598	5682643	Monitoring well	149	5	3.2	Taranaki Volcanics
GND2237	1713554	5682610	Monitoring well	125	5	4	Taranaki Volcanics
GND2238	1713536	5682553	Monitoring well	88	5	3.3	Taranaki Volcanics
GND2240	1714301	5682927	Bore	823	NR*	NR*	Taranaki Volcanics

NR* - Not recorded as no historical records available and no access to bore for manual measurement

1.3 Resource consents and Regional Fresh Water Plan

1.3.1 Discharge permits

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

The discharge of contaminants associated with hydraulic fracturing, onto and into land where contaminants may reach water, is a discretionary activity under Rule 44 of the Regional Freshwater Plan for Taranaki (RFWP).

The rule is set out below:

Discharge of contaminants onto or into land restricted by s15(1)(b) [where contaminants may reach water] and s15(1)(d) [where the discharge is from industrial or trade premises] of the Act which is not expressly provided for in Rules 21-42 or which is provided for but does not meet the standards, terms or conditions and any other discharge of contaminants to land which is provided for in Rules 21-42 but which does not meet the standards, terms or conditions of those rules [irrespective of whether the discharges are from industrial or trade premises or are likely to reach water].

1.3.2 Relevant resource consent held by the Company

Resource consent 7952-1, "*to discharge contaminants in association with hydraulic fracturing activities into land at depths greater than 3,410 mTVD*," was granted to the Company on 8 November 2011, under Section 87(e) of the Act.

Consent conditions were imposed to ensure that any potential adverse environmental effects associated with the proposed activity were avoided. A summary of the conditions attached to the consent are as follows:

- Condition 1 requires the injection of fluids to be below 3,410 mTVD;
- Condition 2 requires that no discharge occur more than 500 m horizontally from the wellsite;
- Condition 3 requires that the exercise of the consent does not contaminate or put at risk actual or potential usable freshwater aquifers above the hydrocarbon reservoir;
- Condition 4, 5 and 6 relate to groundwater monitoring requirements;
- Condition 7 is a notification requirement;
- Condition 8 requires the consent holder to submit a "Post-fracturing Discharge Report" within 30 days of the discharge ceasing;
- Condition 9 details the address and format for information submission;
- Condition 10 requires the consent holder to provide access for Council staff to obtain fluid samples;
- Condition 11 requires the best practicable option to be adopted for injection;
- Condition 12 stipulates that no hydrocarbon based fracturing fluids are to be used; and
- Condition 13 is a review condition.

The consent conditions provide the Council with an option to review the conditions of the consent at specified intervals. Optional reviews are provided for on an annual basis for the duration of the consent, with the next review date being 1 November 2013. The permit is due to expire on 1 June 2016.

At the request of the Company, the Council was contracted to undertake the groundwater monitoring required by conditions 4, 5 and 6 of the consent.

A copy of consent 7952-1 is included in Appendix I of this report.

1.4 Process description

1.4.1 Hydraulic fracturing

Hydraulic fracturing is a reservoir stimulation technique used to increase the flow of hydrocarbon fluids to the surface. The primary objective of hydraulic fracturing is to increase the area of the target reservoir that is exposed to the wellbore and which, therefore, may contribute to fluid or gas flow, once the hydraulic fracturing operation has been completed.

The process of hydraulic fracturing involves the pumping of fluids (consisting of freshwater and a small volume of chemicals) and a proppant (medium-grained sand or small ceramic pellets) down a well, through a perforated section of the well casing, and into the target reservoir. The fluid mixture is pumped at a pressure that exceeds the fracture strength of the reservoir rock in order to create artificial fractures in the receiving formation. Once fractures have been initiated, pumping continues in order to force the fluid and proppant into the fractures created. The proppant is designed to keep the fractures open when the pumping is stopped. The placement of proppant into the fractures is assisted by the use of cross-linked gels. These are solutions, which are liquid at the surface but, when mixed, form long-chain polymer bonds and thus become gels that transport the proppant into the formation. Once in the formation these gels 'break' back with time and temperature to a liquid state and are flowed back to surface without disturbing the proppant wedge. With continued flow, fluids pumped as part of hydraulic fracturing process, formation hydrocarbon fluids and gases are drawn to the surface.

1.4.2 Well design

As outlined previously, the Turangi-4 well was drilled from the Turangi-B wellsite between August and September 2011. The well was constructed using steel casing, held in place with cement, installed as a succession of tubular sections. The annular space between the casing string and the surrounding geological formations is filled with cement. The cement provides foundation stability as well as isolating the wellbore and its contents from the surrounding formations and freshwater aquifers. Both the design of the well and the materials used in its construction were selected to withstand the pressure exerted during hydraulic fracturing and were thoroughly tested and evaluated prior to the hydraulic fracturing programme commencing. The Turangi-4 well has a total depth of approximately 4,100 mTVD, with perforated intervals located between approximately 3,400 to 4,100 mTVD.

1.4.3 Hydraulic fracturing programme

To date, the only hydraulic fracturing carried out at the Turangi-B wellsite is that of the Turangi-4 well, between 15 November 2011 and 7 March 2012. The hydraulic fracturing programme consisted of 6 separate fracturing events, targeting 5 distinct producing zones, as listed in Table 3.

Table 3 Summary of hydraulic fracturing operations at the Turangi-B wellsite

Fracturing Event	Date	Well	Zone	Formation	Depth (mTVD)
1	15 November 2011	Turangi-4	Zone 1	Mangahewa	4,000 – 4,100
2	03 December 2011	Turangi-4	Zone 2	Mangahewa	4,000 – 4,100
3	22 January 2012	Turangi-4	Zone 2 (re-fracture)	Mangahewa	4,000 – 4,100
4	02 February 2012	Turangi-4	Zone 3	Mangahewa	3,700 – 3,800
5	18 February 2012	Turangi-4	Zone 4	Mangahewa	3,600 – 3,700
6	07 March 2012	Turangi-4	Zone 5	Mangahewa	3,400 – 3,500

1.4.4 Post-fracturing discharge reports

As required by special condition 8 of consent 7952-1, the Company provided Post-fracturing Discharge Reports for each of the 6 discharges. The conclusions from each of the reports submitted are summarised as follows:

Fracture Event 1: Zone 1

- The fracture interval was below 3,410 mTVD. Post job simulation indicates that the fractures were contained, and did not extend beyond this point;
- The fracturing fluid used was water based;
- The volume of fluid pumped into the formation (discharge) was 324 cubic metres (m^3) with total proppant of 38.2 tons. 364 m^3 of fluid was recovered (100%+);
- Post job history match modelling indicates that the total injected sand and fluids created a propped fracture in the reservoir of 227 m in length (each side of the well), 28 m in height (max.) and 3.2 millimetres (mm) in width (avg);
- The average wellhead pressure during the job was 8,500 pounds per square inch (psi). The maximum downhole pressure (discharge zone) was 10,700 psi;
- The total duration of treatment was 54 minutes;
- The returned water based fluid was trucked to storage facilities for future disposal. The condensate was trucked to the Omata tank farm; and
- The mitigation measurements in place worked as planned. There was no discharge into the flare pit and all fluids were collected in storage tanks after being flowed through the sand catchers and separator.

Fracture Event 2: Zone 2

- The fracture interval was below 3,410 mTVD. Post job simulation indicates that the fractures were contained, and did not extend beyond this point;
- The fracturing fluid used was water based;
- The volume of fluid pumped into the formation (discharge) was 188 m^3 with total proppant (synthetic sand) of 22.4 tons. None of the fluid was recovered

due to a screenout[2]. 12 ton of proppant was recovered after a coiled tubing clean out intervention;
- Post job history match modelling indicates that the total injected sand and fluids created a propped fracture in the reservoir of 28 m in length (each side of the well), 36 m in height (max.) and 1.4 mm in width (avg);
- The average wellhead pressure during the job was 6,400 psi. The maximum downhole pressure (discharge zone) was 9,780 psi; and
- The total duration of treatment was 30 minutes.

Fracture Event 3: Zone 2 (re-fracture)

- The fracture interval was below 3,410 mTVD. Post job simulation indicates that the fractures were contained, and did not extend beyond this point;
- The fracturing fluid used was water based;
- The volume of fluid pumped into the formation (discharge) was 516 m^3 with total proppant (synthetic sand) of 79.1 tons. 653 m^3 of fluid was recovered (100%+);
- Post job history match modelling indicates that the total injected sand and fluids created a propped fracture in the reservoir of 194 m in length (each side of the well), 42 m in height (max.) and 1.9 mm in width (avg);
- The average wellhead pressure during the job was 6,900 psi. The maximum downhole pressure (discharge zone) was 10,450 psi;
- The total duration of treatment was 130 minutes;
- The returned water based fluid was trucked to storage facilities for future disposal. The condensate was trucked to the Omata tank farm; and
- The mitigation measurements in place worked as planned. There was no discharge into the flare pit and all fluids were collected in storage tanks after being flowed through the sand catchers and separator.

Fracture Event 4: Zone 3

- The fracture interval was below 3,410 mTVD. Post job simulation indicates that the fractures were contained and did not extend beyond this point;
- The fracturing fluid used was water based;
- The volume of fluid pumped into the formation (discharge) was 564 m^3 with total proppant (synthetic sand) of 90.2 tons. 471 m^3 of fluid was recovered (84%);
- Post job history match modelling indicates that the total injected sand and fluids created a propped fracture in the reservoir of 268 m in length (each side of the well), 38 m in height (max.) and 3.1 mm in width (avg);
- The average wellhead pressure during the job was 8,100 psi. The maximum downhole pressure (discharge zone) was 9,940 psi;
- The total duration of treatment was 89 minutes;
- The returned water based fluid was trucked to storage facilities for future disposal. The condensate was trucked to the Omata tank farm; and

[2] A condition that occurs when the solids carried in a treatment fluid, such as proppant in a fracture fluid, create a bridge across the perforations or similar restricted flow area. This creates a sudden and significant restriction to fluid flow that causes a rapid rise in pump pressure (source: http://www.glossary.oilfield.slb.com)

- The mitigation measurements in place worked as planned. There was no discharge into the flare pit and all fluids were collected in storage tanks after being flowed through the sand catchers and separator.

Fracture Event 5: Zone 4

- The fracture interval was below 3,410 mTVD. Post job simulation indicates that the fractures were contained and did not extend beyond this point;
- The fracturing fluid used was water based;
- The volume of fluid pumped into the formation (discharge) was 371 m^3 with total proppant (synthetic sand) of 47.5 tons. 260 m^3 of fluid was recovered (70%);
- Post job history match modelling indicates that the total injected sand and fluids created a propped fracture in the reservoir of 217 m in length (each side of the well), 30 m in height (max.) and 2.3 mm in width (avg);
- The average wellhead pressure during the job was 7,800 psi. The maximum downhole pressure (discharge zone) was 9,950 psi;
- The total duration of treatment was 73 minutes;
- The returned water based fluid was trucked to storage facilities for future disposal. The condensate was trucked to the Omata tank farm; and
- The mitigation measurements in place worked as planned. There was no discharge into the flare pit and all fluids were collected in storage tanks after being flowed through the sand catchers and separator.

Fracture Event 6: Zone 5

- The fracture interval was below 3,400 mTVD. Post job simulation indicates that the fractures were contained and did not extend beyond this point;
- The fracturing fluid used was water based;
- The volume of fluid pumped into the formation (discharge) was 609 m^3 with total proppant (synthetic sand) of 94.7 tons. 299 m^3 of fluid was recovered (49%);
- Post job history match modelling indicates that the total injected sand and fluids created a propped fracture in the reservoir of 167 m in length (each side of the well), 57 m in height (max.) and 2.3 mm in width (avg);
- The average wellhead pressure during the job was 6,312 psi. The maximum downhole pressure (discharge zone) was 7,000 psi;
- The total duration of treatment was 120 minutes;
- The returned water based fluid was trucked to storage facilities for future disposal. The condensate was trucked to the Omata tank farm; and
- The mitigation measurements in place worked as planned. There was no discharge into the flare pit and all fluids were collected in storage tanks after being flowed through the sand catchers and separator.

1.5 Monitoring programme

1.5.1 Introduction

Section 35 of the Act 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. In addition, the Council was contracted by the Company to carry out the sampling and analysis of local groundwater resources, as required by the special conditions of consent 7952-1. The monitoring programme implemented by the Council in relation to the hydraulic fracturing activities at the Turangi-B wellsite, consisted of three main components:

- Programme design, liaison and management;
- Physicochemical sampling; and
- Carbon isotope analysis;

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

1.5.2 Programme design, liaison and management

A significant amount of time was spent in the scoping and design stage of the project. Further time was spent in discussion with the Company regarding consent conditions and their interpretation and application, monitoring requirements, providing advice and guidance on the Council's environmental management strategies, the content of regional plans, and consultation on associated matters.

1.5.3 Physicochemical sampling

In order to select suitable sites for sampling, a survey of water abstraction sites within a 1 km radius of the Turangi-B wellsite was carried out. Initially, a desktop review of data held by the Council, including a search of the Council Wells Database, was conducted. The desktop review indicated that the Council held records of several groundwater abstractions in the area of investigation (Table 2). Following the desktop review, a field survey was undertaken to confirm the location of known abstraction sites, to assess their suitability for sampling, and to identify any additional groundwater abstraction sites that may not have been registered with the Council.

During the field survey, some of the sites identified within the 1 km radius of the wellsite during the desktop review were found to be no longer in use, had been abandoned, or were inaccessible. In total, 12 sites were included in the monitoring programme. The sites selected for inclusion in the programme were comprised of 6 private water supplies, 5 dedicated shallow monitoring wells installed at various points around the perimeter of the wellsite, and one upgradient control site.

The selection of sampling sites was designed to provide a sample set representative of groundwater abstractions and usage in the investigation area, including samples from bores, wells and springs. Other criteria assessed were the distance of each potential sampling site from the Turangi-B wellsite, and whether the site was upgradient or downgradient of the wellsite, based on the inferred groundwater flow direction in the area of investigation.

A summary of sampling sites selected for inclusion in the monitoring programme are listed in below in Table 4. The locations of the sampling sites are illustrated in Figure 2.

Table 4 Summary of sampling sites selected for inclusion in the monitoring programme

Site Code	Classification	Distance from Wellhead (m)	Casing Depth (m)	Total Depth (m)	High Static Water Level (m)	Formation / Aquifer	Comment
GND0210	Bore	1,275	NR*	26	9.2	Taranaki Volcanics	Control bore
GND1125	Bore	787	19	26	10.5	Taranaki Volcanics	Downgradient of wellsite
GND1673	Bore	835	26	42	7.5	Taranaki Volcanics	Upgradient of wellsite
GND2229	Bore	927	NR*	NR*	NR*	Taranaki Volcanics	Downgradient of wellsite
GND2230	Spring	350	N/A	N/A	N/A	Taranaki Volcanics	Downgradient of wellsite
GND2231	Well	330	N/A	4	0.5	Taranaki Volcanics	Downgradient of wellsite
GND2233	Well	537	N/A	3.5	1.6	Taranaki Volcanics	Downgradient of wellsite
GND2234	Monitoring well	89	2.5	5	3.4	Taranaki Volcanics	On upgradient boundary of wellsite
GND2235	Monitoring well	152	2.5	5	3.5	Taranaki Volcanics	Downgradient of wellsite flare pit
GND2236	Monitoring well	149	2.5	5	3.2	Taranaki Volcanics	Downgradient of wellsite flare pit
GND2237	Monitoring well	125	2.5	5	4	Taranaki Volcanics	Downgradient of wellsite flare pit
GND2238	Monitoring well	88	2.5	5	3.3	Taranaki Volcanics	On downgradient boundary of wellsite

NR* - Not recorded as no historical records available and no access to bore for manual measurement

Samples were obtained from each site following standard groundwater sampling methodologies and generally in accordance with the National Protocol for State of the Environment Groundwater Sampling in New Zealand (2006). Bore samples were obtained via existing pumps installed in each bore, either at the wellhead if a sample tap was installed, from a pressure tank, or outlet supply pipework. Samples from wells and springs were obtained directly from source using a bailer.

All samples were sent to Hills Laboratory (IANZ accredited) and transported using chain of custody procedures. All samples were analysed in the laboratory for almost 100 individual chemical parameters, including a range of compounds commonly associated with hydraulic fracturing. Sampling sites and testing parameters were selected in consultation with GNS Science (the Institute of Geological and Nuclear Science).

The parameters included:

- Conventional groundwater characterisation parameters;
- Trace metals;
- Aldehydes, which can be used as biocides (disinfectants) in fracturing;
- Total petroleum hydrocarbons;
- The "BTEX" range of compounds – benzene, toluene, ethyl benzene and xylene;
- Volatile organic compounds; and
- Dissolved natural gas.

As required by the conditions of resource consent 7952-1, samples from private water supplies were obtained at the frequencies detailed below.

- Pre-hydraulic fracturing;
- 1 week post hydraulic fracturing;
- 1 month post hydraulic fracturing;
- 3 months post hydraulic fracturing; and
- 1 year post hydraulic fracturing.

Additionally, samples from the wellsite monitoring wells were obtained on 2 occasions, approximately 1 month and 6 months post hydraulic fracturing. A sample from the control bore was obtained 1 week post hydraulic fracturing.

1.5.4 Carbon isotope analysis

Carbon isotope analysis was carried out on samples from bores in which dissolved methane was identified as being present in initial groundwater samples analysed. Carbon isotope analysis can be used to determine the isotopic signature of methane gas present in groundwater 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 deep hydrocarbon reservoirs. 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}Carbon (^{12}C has 6 neutrons) and ^{13}Carbon (^{13}C has 7 neutrons). Biogenic methane contains more ^{12}Carbon while thermogenic methane contains more of the ^{13}C carbon isotope. By analysing the isotope composition of dissolved methane present in groundwater, it can be determined whether the methane present has been generated by the breakdown of organic material in the shallow subsurface, or may be due to migration or leakage from a hydrocarbon reservoir. There are areas within the Taranaki region where thermogenic methane is present in shallow groundwater, including areas where there is no history of hydraulic fracturing. In such cases, the change in the concentration of gas can be used as an indicator of increased gas migration, potentially induced by hydraulic fracturing.

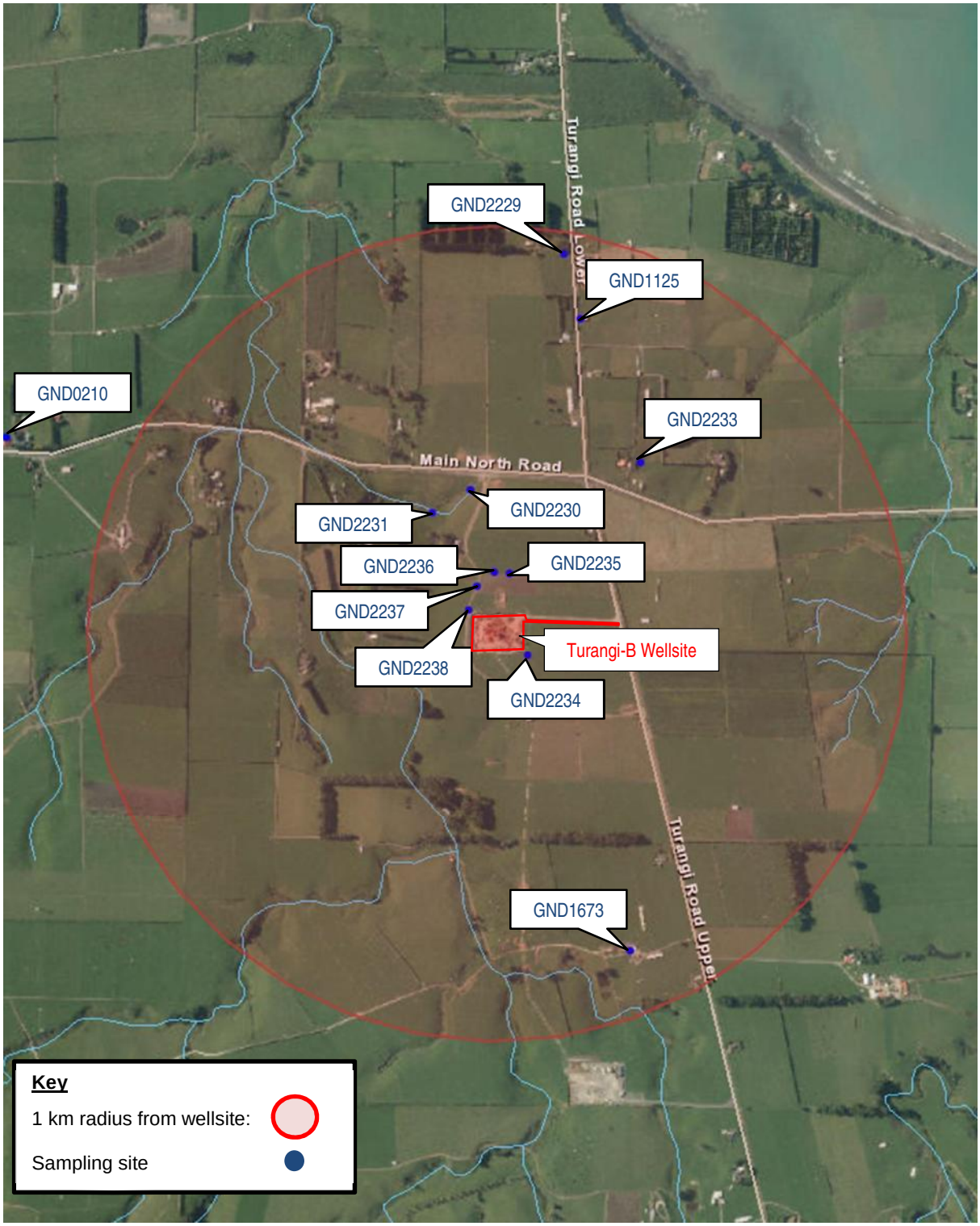

Figure 2 Location of groundwater sampling sites included in the monitoring programme

2. Results

2.1 Physicochemical

The monitoring programme incorporated a total of 7 sampling events, which took place between 11 November 2011 and 9 November 2012. A summary of each sampling event is included below in Table 5.

Table 5 Sampling event summary

Date	Sampling event	Sites sampled	Sampling comments
11 November 2011	Pre hydraulic fracturing	GND1125 GND1673 GND2229 GND2230 GND2231 GND2239	Private water supplies
23 November 2011	1 week post hydraulic fracturing	GND1125 GND1673 GND2229 GND2230 GND2231 GND2239	Private water supplies - Control bore also sampled for QC purposes (GND0210)
20 December 2011	1 month post hydraulic fracturing	GND1125 GND1673 GND2229 GND2230 GND2231 GND2239	Private water supplies
	1st round of wellsite monitoring well sampling	GND2234 GND2235 GND2236 GND2237 GND2238	Shallow wellsite monitoring wells only
14 March 2012	3 months post hydraulic fracturing	GND1125 GND1673 GND2229 GND2230 GND2231 GND2239	Private water supplies
16 April	Carbon isotope sampling	GND1125 GND1673 GND2229	Only sites containing dissolved methane used for isotope sampling
3 May 2012	2nd round of wellsite monitoring well sampling	GND2234 GND2235 GND2236 GND2237 GND2238	Shallow wellsite monitoring wells only
9 November 2012	1 year post hydraulic fracturing	GND1125 GND1673 GND2229 GND2230 GND2231 GND2239	Private water supplies

In terms of an assessing any possible effects of hydraulic fracturing upon local aquifers, several key parameters, and the relative changes in their concentration can be used as indicators of potential contamination. Inorganic indicator parameters include pH, electrical conductivity and chloride. Changes in the concentration of these parameters may indicate the migration of deep formation water, which is highly saline in composition, via fractures or conduits created by the hydraulic fracturing process, leakage from the wellbore due to integrity issues, or the mishandling of fluids at the surface. The results of the pH, electrical conductivity and chloride analyses carried out on the samples from private water supplies are plotted below in Figure 3, Figure 4 and Figure 5; respectively. The results indicate that the pH, electrical conductivity and chloride concentrations in all private water supplies sampled, remained consistent across the sampling period.

A slight increase in chloride concentration was detected in samples obtained from two of the wellsite monitoring wells sampled as part of the monitoring programme (Figure 6). The sites that displayed increases in chloride concentration, GND2237 and GND2238, are located immediately downgradient of the wellsite boundary.

Chloride concentrations of 25 milligrams per litre (mg/L) and 21 mg/L were measured in the respective wells following the first round of sampling. The respective chloride concentrations within each well had increased to 130 mg/L and 90 mg/L, following the second round of sampling. To date, only two rounds of sampling have been carried out from these wells.

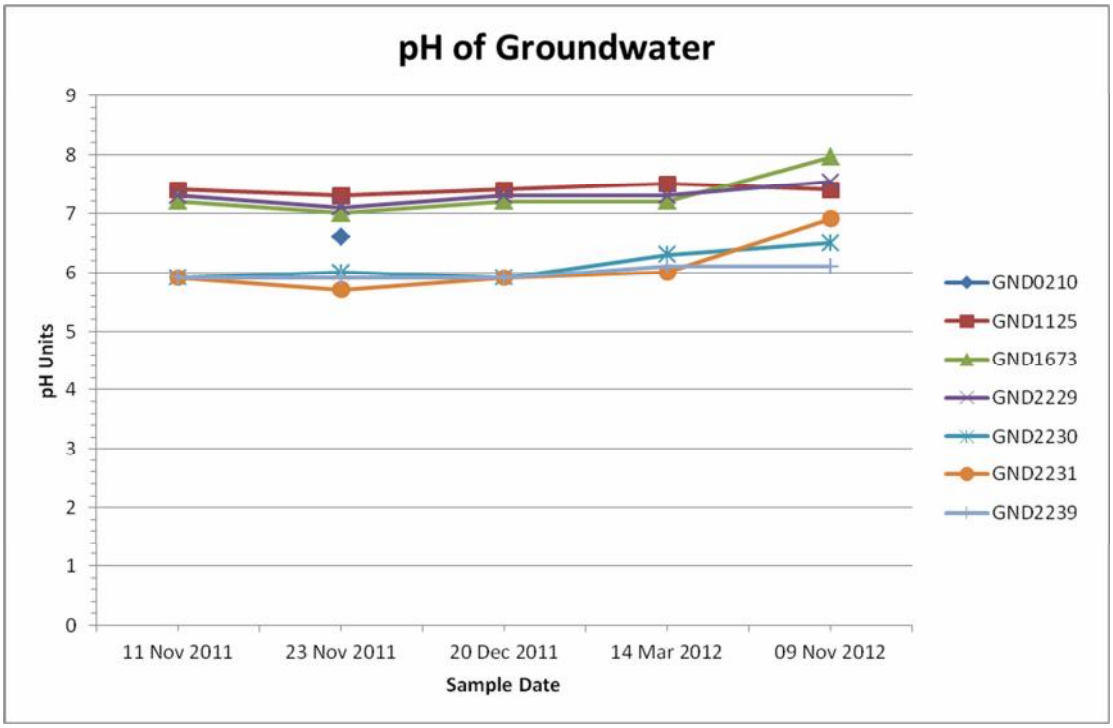

Figure 3 Results of pH analyses – private water supplies

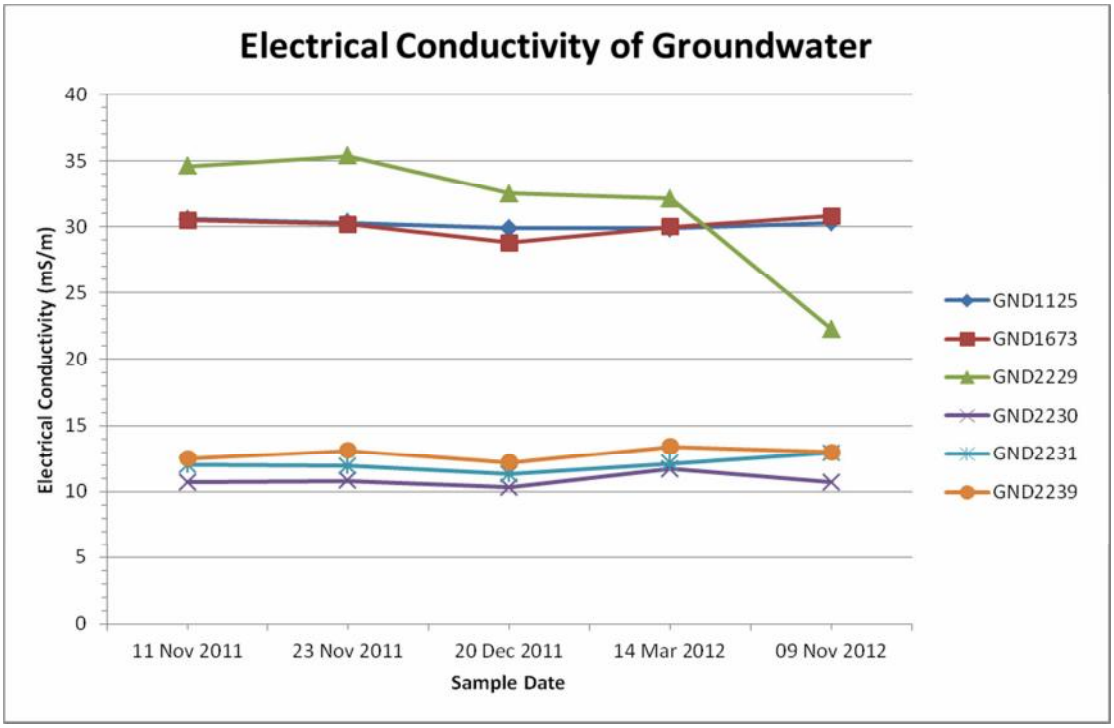

Figure 4 Results of electrical conductivity analyses – private water supplies

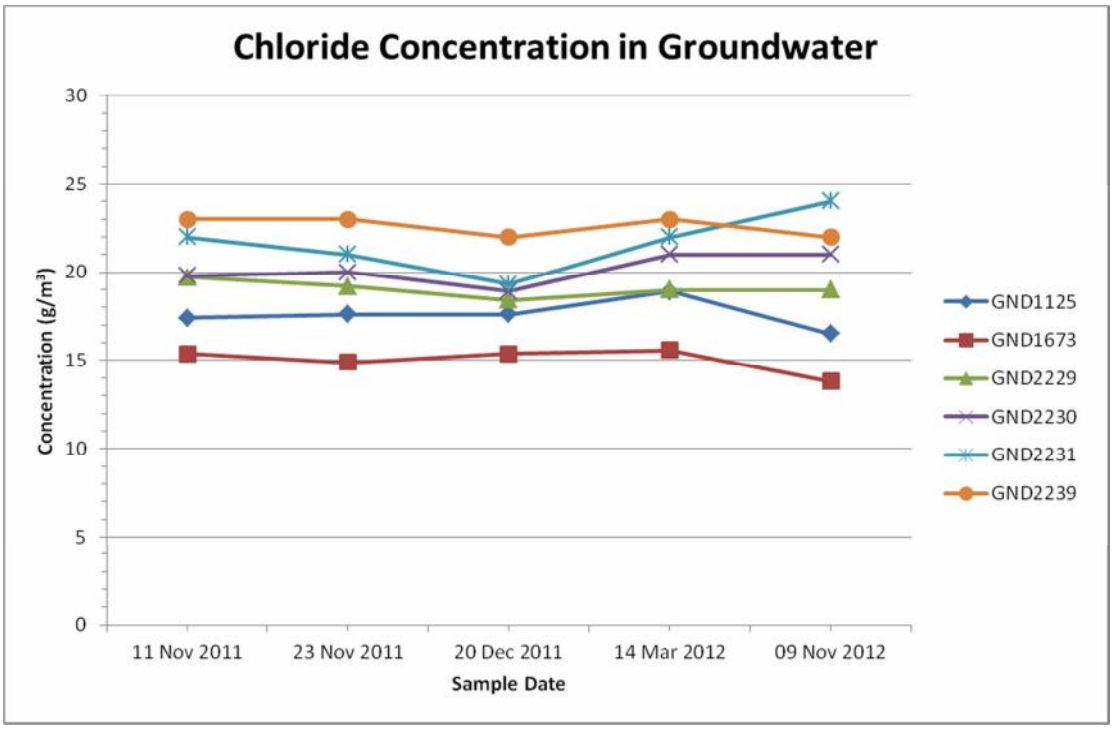

Figure 5 Results of chloride analyses – private water supplies

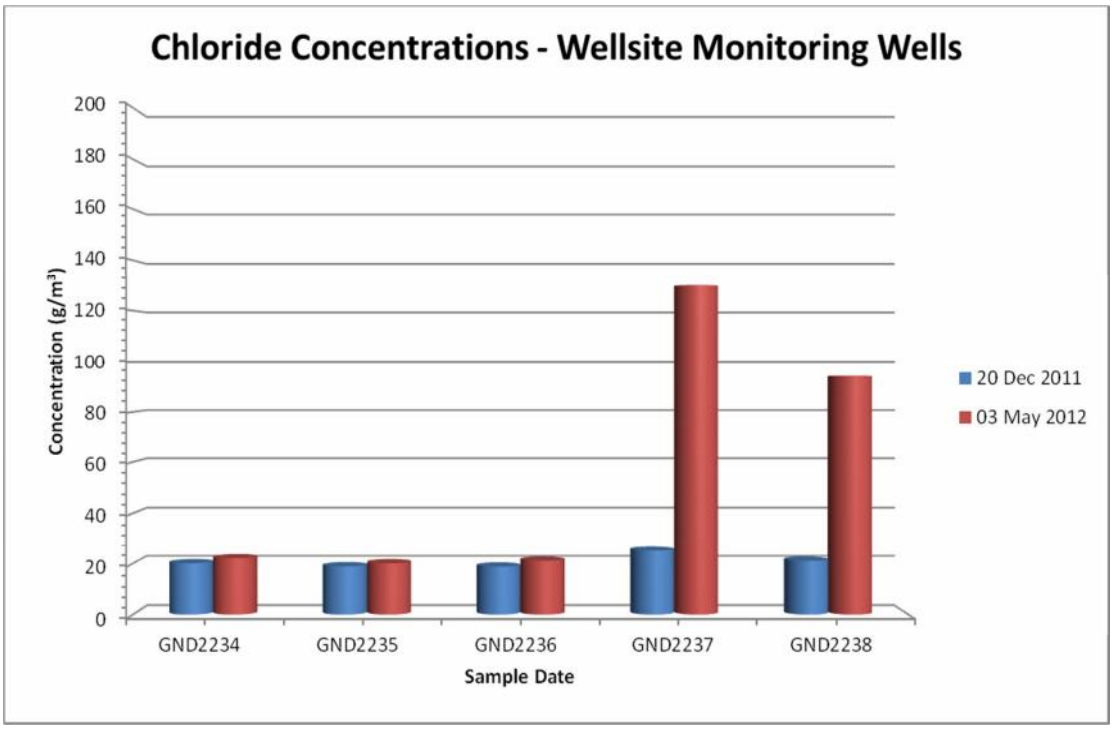

Figure 6 Results of chloride analyses – wellsite monitoring wells

The presence of hydrocarbons or any of the BTEX group of chemicals in groundwater samples may indicate the leakage or migration of deep formation or reservoir fluids. The migration of such fluids could be due to the creation of fractures or conduits by the hydraulic fracturing process, leakage from the wellbore, or the mishandling of return fluids at the surface. If the hydraulic fracturing process had created fractures or conduits within the geological seals overlying the reservoir, it

would also be expected that hydrocarbon gases would be present in groundwater. It should be noted however, biogenic methane gas can be found naturally occurring in groundwater, in areas where organic material has decomposed within groundwater bearing zones.

The results of the analyses undertaken on samples taken from private water supplies in the vicinity of the Turangi-B wellsite do not show any increases in the concentration of any key indicator parameters over the monitoring period. Traces of methane gas were detected at three of the sites sampled. The methane concentrations were variable across the sampling period, but in all cases, concentrations measured at each sampling site following the final sampling run were below the concentrations measured following the pre-hydraulic fracturing sampling event (Figure 6). Methane was only detected in the deeper sampling locations included in the monitoring programme, no methane was detected in shallow wells or springs. The concentrations of dissolved methane measured were within the typical range encountered in other groundwater bores within the Taranaki region, including those in areas where no hydraulic fracturing has ever taken place.

Trace levels of toluene were detected in two of the wellsite monitoring wells sampled, GND2235 and GND2237. GND2235 is located downgradient of the site flare pit, and GND2237, downgradient of the wellsite boundary. The respective toluene concentrations increased from below the laboratory detection level of 0.001 milligrams per litre (mg/L), to 0.0037 mg/L and 0.0043 mg/L, respectively, following the second round of sampling. A full table of analytical results is included in Appendix II of this report. Laboratory Analysis Reports are included in Appendix III.

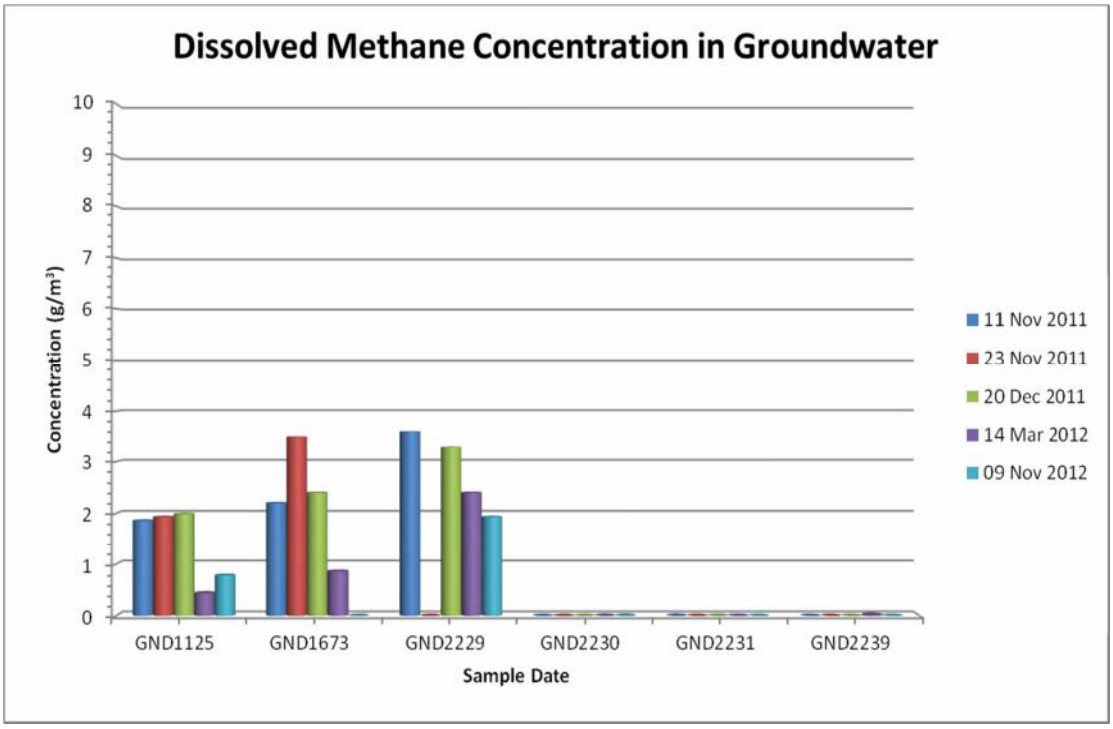

Figure 7 Results of dissolved methane analyses

2.2 Carbon isotope analysis

A total of 3 sites were identified as containing dissolved methane concentrations following the pre-hydraulic fracturing physicochemical sampling round. In order to establish the origin of the methane gas detected, further samples were obtained from each of the 3 sites on 16 April 2012, for carbon isotope analysis. The samples were obtained with assistance from GNS Science, who also carried out the analysis in their National Isotope Centre. The isotopic analysis is used to calculate a delta carbon13 ($\delta^{13}C$) value for a given sample, which is then used to determine the origin of the gas. Generally, a $\delta^{13}C$ value that exceeds -50‰ indicates biogenic methane, and a $\delta^{13}C$ value less than-50‰ indicates thermogenic methane. The higher or lower the $\delta^{13}C$ values, the stronger the isotopic signature. A $\delta^{13}C$ value in the vicinity of -50‰ can indicate a mixture of both biogenic and thermogenic methane.

The isotopic analyses carried out returned the following $\delta^{13}C$ results:

- GND1125: - 87.1 ‰
- GND1673: - 62.7‰
- GND2229: - 49.2 ‰

The results indicate that the methane gas present in GND1125 and GND1673 is strongly biogenic. The gas present in GND2229 is neither strongly biogenic or thermogenic, and could be mixture of both. It is important to note that the results were issued from the analysing laboratory with an uncertainty of measurement value of +/- 10‰.

3. Discussion

3.1 Environmental effects of hydraulic fracturing on shallow groundwater

A total of 12 sites were selected for inclusion in the groundwater monitoring programme implemented by Council. The sites included in the programme were comprised of 6 private water supplies, 5 dedicated shallow monitoring wells around the perimeter of the wellsite, including downgradient of the flare pit, and one upgradient control site. The selection of sampling sites was designed to provide a sample set representative of water abstractions and usage in the investigation area, including samples from bores, wells and springs. Samples from the private water supplies were obtained at the intervals specified in consent 7952-1, and pre-hydraulic fracturing baseline sampling. Samples were obtained from the dedicated wellsite monitoring wells on two occasions, both post hydraulic fracturing.

The results of the physicochemical analyses carried out on samples taken from private water supplies included in the monitoring programme show very little compositional variation across the sampling period. The concentration of all parameters analysed for during post fracturing sampling events remained consistent with pre hydraulic fracturing baseline values.

A total of 3 private water supplies included in the monitoring programme were identified as containing dissolved methane concentrations following the baseline physicochemical sampling round. The results indicate that the methane gas present in two bores, GND1125 and GND1673, is strongly biogenic. The gas present in GND2229 is neither strongly biogenic or thermogenic, and could be combination of both. The analysis carried out indicates that the methane present in the wells is predominantly biogenic in origin and that the hydraulic fracturing activities at the Turangi-B wellsite have not resulted in the migration of deep thermogenic methane in shallow groundwater aquifers. Further samples will need to be obtained and analysed in order to assess any changes in the isotopic signature of the methane gas present within each bore.

An increase in chloride concentration was detected in samples obtained from two of the shallow wellsite monitoring wells sampled as part of the programme. The sites that displayed increases in chloride concentration, GND2237 and GND2238, are located immediately on the perimeter of the wellsite itself. The respective concentrations of chloride detected during the second round of sampling of 130 mg/L and 90 mg/L, respectively, remain below the Drinking-water Standards for New Zealand (2008) guideline value for chloride of 250 mg/L. As outlined above, no private water supplies (downgradient of the wellsite and the wellsite monitoring wells), showed any increases in chloride concentration across the monitoring period.

Trace levels of toluene (parts per billion) were detected in two of the wellsite monitoring wells sampled, GND2235 and GND2237. GND2235 is located downgradient of the site flare pit, and GND2237, downgradient of the wellsite boundary. The respective toluene concentrations increased from below the laboratory detection level of 0.001 mg/L, to 0.0037 mg/L and 0.0043 mg/L respectively, following the second round of sampling. The concentrations of toluene

detected remain far below the Drinking-water Standards for New Zealand (2008) guideline value for toluene of 0.03 mg/L.

It is likely that the increased chloride concentrations and the presence of toluene in some of the wellsite monitoring wells are a result of general wellsite activities, as opposed to hydraulic fracturing operations. In particular, it should be noted that fracturing fluids were discharged into the flare pit for two days in February 2011, as part of a study into the effects of hydraulic fracturing fluid combustion.

As outlined above, no private water supplies downgradient of the wellsite showed any increases in chloride or toluene concentration, or any other parameters of interest. The measured concentrations of chloride and toluene within the wellsite monitoring wells are extremely low and no downgradient water supplies have been compromised. The effects of the increased chloride and toluene concentrations are localised, inconsequential and likely to be short term. Further sampling of all sites included in the monitoring programme is proposed for the forthcoming monitoring period, in order to confirm this assessment.

3.2 Evaluation of performance

The assessment of the Company's compliance performance for the period under review is based on the monitoring work carried out, and the assessment of the results. A tabular summary of the Company's compliance record, with specific regard to the groundwater related consent conditions, is set out below in Table 6.

The consent holder has achieved a high level of environmental performance and compliance in respect of the resource consent exercised. The criteria associated with a "high" level of environmental performance are outlined in Section 1.1.4 as follows:

> "a high level of environmental performance and compliance indicates that essentially there were no adverse environmental effects to be concerned about, and no, or inconsequential (such as data supplied after a deadline) non-compliance with conditions."

The results of the monitoring programme implemented show no evidence of any significant adverse effects on groundwater due to hydraulic fracturing activities at the Turangi-B wellsite.

3.3 Alterations to monitoring programmes for 2013/2014 period

In designing and implementing the monitoring programmes for discharges to land and water in the region, the Taranaki Regional Council has taken into account the extent of information made available by previous authorities, its relevance under the Resource Management Act, the obligations of the Act in terms of monitoring 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 discharging to the environment.

It is proposed that the frequency of groundwater sampling in the vicinity of the Turangi-B wellsite be reduced to a minimum of one annual sampling event per monitoring year. If further hydraulic fracturing is carried out at the wellsite, the existing data gathered during the period under review will be used as a baseline to assess any potential adverse effects on groundwater. Samples will be obtained from each private water supply site included in the monitoring programme 3 months following any future hydraulic fracturing event. It is also proposed that in the forthcoming monitoring period, a further round of samples be obtained from the shallow wellsite monitoring wells, and a follow up round of carbon isotope sampling and analysis be carried out.

Recommendations to this effect are attached to this report.

Table 6 Evaluation of compliance performance

Condition requirement	Means of monitoring during period under review	Compliance achieved?
Consent 7952-1: To discharge contaminants in association with hydraulic fracturing activities into land at depths greater than 3,410 mTVD beneath the Turangi-B wellsite		
3. The consent holder shall ensure that the exercise of this consent does not contaminate or put at risk actual or potential usable freshwater aquifers above the hydrocarbon reservoir.	Assessment of groundwater sampling results	Yes
4. The consent holder shall monitor the effects of the exercise of this consent by recording the water level and sampling all wells and bores that are used for water supply within a 1 km radius of the Turangi-B wellsite.	Implementation of groundwater monitoring programme and the submission of sampling results	Yes
5. The sampling required by condition 4 shall be undertaken before this consent is exercised and 1 week, 1 month, 3 months and 1 year after the date that this consent is first exercised.	Assessment of sampling frequency and laboratory Analysis Reports	Yes
6. All 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 [CE] for review and certification before the first sampling is undertaken. This plan shall specify the use of standard protocols recognized to constitute good professional practice including quality control and assurance. A properly accredited laboratory shall be used for all sample analysis. Results shall be provided to the CE within 30 calendar days of sampling and shall include supporting quality control and assurance information. These results will be used to assess compliance with condition 3.	Agreement on Sampling and Analysis plan prior to the first sampling being undertaken	Yes
Overall assessment of compliance and environmental performance in relation to groundwater monitoring conditions		**High**

4. Recommendations

1. THAT this report be forwarded to the Company, and to any interested parties upon request;

2. THAT for the forthcoming 2013/2014 monitoring period, the sampling of private water supplies in the vicinity of the Turangi-B wellsite be reduced to a frequency of one annual sampling event;

3. THAT if further hydraulic fracturing is carried out at the Turangi-B wellsite, a sample be obtained from each private water supply 3 months following the hydraulic fracturing programme;

4. THAT during the 2013/2014 monitoring period, a further round of samples be obtained from the shallow wellsite monitoring wells for analysis; and

5. THAT during the 2013/2014 monitoring period, a further round of carbon isotope sampling and analysis is carried out.

Glossary of common terms and abbreviations

The following abbreviations and terms are commonly used within Council reports:

Al*	aluminium
As*	arsenic
Biomonitoring	assessing the health of the environment using aquatic organisms
BOD	biochemical oxygen demand. A measure of the presence of degradable organic matter, taking into account the biological conversion of ammonia to nitrate
BODF	biochemical oxygen demand of a filtered sample
Bore	a hole drilled into the ground and completed for the abstraction of water or hydrocarbons to a depth of greater than 20 metres below the ground surface
Bund	a wall around a tank to contain its contents in the case of a leak
CBOD	carbonaceous biochemical oxygen demand. A measure of the presence of degradable organic matter, excluding the biological conversion of ammonia to nitrate
cfu	colony forming units. A measure of the concentration of bacteria usually expressed as per 100 millilitre sample
COD	chemical oxygen demand. A measure of the oxygen required to oxidise all matter in a sample by chemical reaction
Condy	conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m
Cu*	copper
Cumec	A volumetric measure of flow- 1 cubic metre per second (1 m^3s^{-1})
DO	dissolved oxygen
DRP	dissolved reactive phosphorus
E.coli	*escherichia coli,* an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample
Ent	enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample
F	fluoride
FC	faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample
Fresh	elevated flow in a stream, such as after heavy rainfall
g/m^3	grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures
GV	Guideline value (Drinking-water Standards for New Zealand 2008)
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
l/s	litres per second
MAV	Maximum acceptable value (Drinking-water Standards for New Zealand 2008)
MCI	macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats
mS/m	millisiemens per metre
Mixing zone	the zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point
NH_4	ammonium, normally expressed in terms of the mass of nitrogen (N)
NH_3	unionised ammonia, normally expressed in terms of the mass of nitrogen (N)
NO_3	nitrate, normally expressed in terms of the mass of nitrogen (N)
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water
O&G	oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons)
Pb*	lead
pH	a numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5
Physicochemical	measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment
PM_{10}	relatively fine airborne particles (less than 10 micrometre diameter)
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 including all subsequent amendments
SS	suspended solids
SQMCI	semi quantitative macroinvertebrate community index;
Temp	temperature, measured in °C (degrees Celsius)
Turb	turbidity, expressed in NTU
UI	Unauthorised Incident
UIR	Unauthorised Incident Register – contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan
Well	a hole dug, augured or drilled, tapping the water table or springs, to a depth of less than 20 metres below the ground surface
Zn*	zinc

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

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

Bibliography and references

Taranaki Regional Council. (2012 - updated May 2012). Hydrogeologic Risk Assessment of Hydraulic Fracturing for Gas Recovery in the Taranaki Region

King, G.E. 2012: Hydraulic Fracturing 101: What every representative, environmentalist, regulator, reporter, investor, university researcher, neighbour and engineer should know about estimating frac risk and improving frac performance in unconventional gas and oil wells. Society Petroleum Engineers International paper (SPE 152596) to SPE Hydraulic Fracturing Technology Conference held in The Woodlands, Texas, USA, 6-8 February 2012.

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

Taranaki Regional Council. TRC. 2011. Greymouth Petroleum Limited – Turangi-B Exploration Wellsite Monitoring Report. Technical Report (2011-104) (Document number 1073740).

Taranaki Regional Council. TRC. 2011. Officer Report. Greymouth Petroleum Limited – Turangi-B wellsite hydraulic fracturing discharge consent application (Consent 7952-1). (Document number 958299).

Appendix I

Resource consent 7952-1

Consent 7952-1

TARANAKI REGIONAL COUNCIL
CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz
Please quote our file number on all correspondence

Discharge Permit

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

Name of Consent Holder:	Greymouth Petroleum Limited P O Box 3394 NEW PLYMOUTH 4341
Decision Date:	8 November 2011
Commencement Date:	8 November 2011

Conditions of Consent

Consent Granted:	To discharge contaminants in association with hydraulic fracturing activities into land at depths greater than 3,410 mTVD beneath the Turangi-B wellsite at or about (NZTM) 1713604E-5682493N
Expiry Date:	1 June 2016
Review Date(s):	November 2012, November 2013, November 2014, November 2015
Site Location:	Turangi-B wellsite, 650 Main North Road, Motunui [Property owner: RJ Topless]
Legal Description:	Pt Lot 2 DP 7153 Blk VI Waitara SD[Discharge source & site]
Catchment:	Parahaki

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 [the Council] all the administration, monitoring and supervision costs of this consent, fixed in accordance to section 36 of the Resource Management Act.

Special conditions

1. Any discharge shall occur below 3410 mTVD.

   Note: mTVD = metres true vertical depth, i.e. the true vertical depth in metres below the surface.

2. No discharge shall occur more than 500 m horizontally from the wellsite.

3. The consent holder shall ensure that the exercise of this consent does not contaminate or put at risk actual or potential usable freshwater aquifers above the hydrocarbon reservoir.

4. The consent holder shall monitor the effects of the exercise of this consent by recording the water level and sampling all wells and bores that are used for water supply within a 1 km radius of the Turangi-B wellsite, along with two control sites. The samples shall be taken in accordance with recognized field procedures and analysed for:

   (a) pH;
   (b) Conductivity ;
   (c) Total dissolved solids;
   (d) Total suspended solids;
   (e) Major ions (Ca, Mg, K, Na, total alkalinity, chloride, nitrate-nitrogen, and sulfate);
   (f) Trace metals (cadmium, copper, iron, manganese, nickel, and zinc);
   (g) Total organic carbon;
   (h) Formaldehyde;
   (i) Dissolved methane and ethane gas;
   (j) Carbon-13 composition of dissolved methane gas ($^{13}C\text{-}CH_4$); and
   (k) Benzene, toluene, ethylbenzene, and xylenes (BTEX).

5. The sampling required by condition 4 shall be undertaken before this consent is exercised and 1 week, 1 month, 3 months and 1 year after the date that this consent is first exercised.

6. All 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 [CE] for review and certification before the first sampling is undertaken. This plan shall specify the use of standard protocols recognized to constitute good professional practice including quality control and assurance. A properly accredited laboratory shall be used for all sample analysis. Results shall be provided to the CE within 30 calendar days of sampling and shall include supporting quality control and assurance information. These results will be used to assess compliance with condition 3.

   Note: The samples required, under condition 4, could be taken and analysed by the Council or other contracted party on behalf of the consent holder.

7. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing of the date that the discharges are expected to commence. Notification shall occur by email to worknotification@trc.govt.nz, where practicable and reasonable one working day prior to the exercise of the consent, but in any event 24 hours notice shall be given.

8. At the conclusion of the discharge, the consent holder shall submit a comprehensive 'Post-fracturing discharge report' to the Chief Executive, Taranaki Regional Council. The report shall be provided within 30 working days after the discharge ceases and, as a minimum, shall contain:

   (a) Confirmation of the interval where fracturing occurred;
   (b) Confirmation of volumes and fluid compositions discharged;
   (c) The volume of returned fluids and an estimate of the proportion of fluids and proppant remaining in the reservoir;
   (d) The results of modeling the discharge, including a proppant concentration diagram or a similar diagram, showing the likely extent of the fractures generated by the discharge;
   (e) Well and discharge zone pressure durations and the maximum pressure reached;
   (f) Details of the disposal of any returned fluids, including any consents that are relied on to authorise the disposal; and
   (g) An assessment of the effectiveness of the mitigation measures in place with specific reference to those described in application 6922.

9. The reports described in condition 8 shall be emailed to consents@trc.govt.nz with a reference to the number of this consent.

10. The consent holder shall provide access to a location where the Taranaki Regional Council officers can obtain a sample of the fraccing fluids and return fluids.

11. 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 minimize any actual or likely adverse effect on the environment; in particular, ensuring that the discharge is contained within the discharge zone.

12. No hydrocarbon based fraccing fluid shall be discharged.

13. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of November each year, for the purposes of:

    (a) Requiring sampling times in addition to those specified in condition 5; and/or

    (b) ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 8 November 2011

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Appendix II

Results of physicochemical analyses

Site	Date	Sample Number	pH	Temperature (g/m^3)	Conductivity (EC)	Total Alkalinity (g/m^3 as $CaCO_3$)	Bicarbonate (g/m^3 at 25 °C)	Total Hardness (g/m^3 as CaCO3)	Suspended Solids (g/m^3)	Total Dissolved Solids (g/m^3)	Barium (g/m^3)	Bromide (g/m^3)	Dissolved Cadmium (g/m^3)	Dissolved Calcium (g/m^3)	Dissolved Copper (g/m^3)	Dissolved Iron (g/m^3)	Dissolved Magnesium (g/m^3)	Dissolved Manganese (g/m^3)	Dissolved Nickel (g/m^3)	Dissolved Potassium (g/m^3)	Dissolved Sodium (g/m^3)	Dissolved Zinc (g/m^3)	Chloride (g/m^3)
Control Bore																							
GND0210	23 Nov 2011	112976	6.6	15	21	43	52.46	55	23				0.00006	11.5	0.0018	<0.02	6.5	0.0068	<0.0005	2.4	16.4	0.062	31
Private Water Supplies																							
GND1125	11 Nov 2011	112816	7.4	16.9	30.6	132	161.04	97	310				<0.00005	21	<0.0005	0.33	10.6	0.142	0.0009	6.9	23	0.00127	17.4
	23 Nov 2011	112974	7.3	15.5	30.3	132	161.04	95	47				<0.00005	21	<0.0005	0.55	10.6	0.147	<0.0005	6.6	22	0.028	17.6
	20 Dec 2011	113250	7.4	15.8	29.9	133	162	96	82				<0.00005	21	<0.0005	0.67	10.4	0.146	<0.0005	6.6	22	0.0167	17.6
	16 Apr 2012	121414																					
	14 Mar 2012	121430	7.5	16	29.9	132	161	96	55				<0.00005	21	0.0006	4.9	10.3	0.157	0.0007	6.8	22	0.073	18.9
	09 Nov 2012	123895	7.4	15.9	30.3	132	161	92		250.7	0.021	<0.05		21	<0.0005	5.3	9.9	0.163	<0.0005	7.1	24	0.108	16.5
GND1673	11 Nov 2011	112815	7.2	16.1	30.5	137	166	91	142				<0.00005	19.2	<0.0005	0.24	10.4	0.184	0.0072	5.2	28	0.053	15.4
	23 Nov 2011	112973	7	15.3	30.2	138	168	88	18				<0.00005	18.6	0.0006	0.25	10	0.18	0.0019	5.1	27	0.0195	14.9
	20 Dec 2011	113249	7.2	15.9	28.8	131	159.82	87	129				<0.00005	18.5	<0.0005	0.3	10	0.163	0.0007	4.7	26	0.043	15.4
	16 Apr 2012	121415																					
	14 Mar 2012	121429	7.2	16	30	141	172.02	89	190				<0.00005	18.9	0.0009	6.7	10.2	0.184	0.0022	5.2	27	0.049	15.6
	09 Nov 2012	123896	7.96	15.6	31.8	142	173	89		210	0.021	<0.07		18.9	<0.0005	8.3	10.1	0.2	<0.0005	5.3	30	0.014	13.8
GND2229	11 Nov 2011	112817	7.3	16.5	34.6	151	184	111	3				<0.00005	25	0.0006	0.77	12.1	0.188	<0.0005	8	26	0.23	19.7
	23 Nov 2011	112975	7.1	15.9	35.4	156	190	113	<3				<0.00005	24	<0.0005	2.2	12.6	0.22	0.0007	7.1	24	0.27	19.2
	20 Dec 2011	113251	7.3	16.1	32.5	146	178.12	105	15				<0.00005	24	0.0005	1.84	11.1	0.178	0.0006	7.5	25	0.162	18.4
	16 Apr 2012	121413																					
	14 Mar 2012	121431	7.3	16.7	32.1	144	175.68	101	9				<0.00005	22	0.0005	4.4	11	0.162	0.0006	7.7	25	0.12	19
	09 Nov 2012	123894	7.54	15.7	24.6	86	105	71		171	0.0167	0.11		15.4	<0.0005	5.4	8	0.25	0.0014	2.3	15.9	0.115	19
GND2230	11 Nov 2011	112813	5.9	19.3	10.7	13	15.4	25	<3				<0.00005	4.5	<0.0005	<0.025	3.2	0.0034	<0.0005	1.97	9.5	0.0038	19.8
	23 Nov 2011	112971	6	15.5	10.8	13	15.5	24	<3				<0.00005	4.3	0.0006	<0.02	3.2	0.0057	<0.0005	1.92	8.6	0.012	20
	20 Dec 2011	113247	5.9	15.2	10.3	12	14.64	24	<3				<0.00005	4.5	<0.0005	<0.02	3.2	0.0025	<0.0005	1.8	8.4	0.004	18.9
	14 Mar 2012	121427	6.3	16.6	11.7	15	18.3	25	4				<0.00005	4.8	<0.00005	<0.02	3.3	0.025	<0.0005	3.2	9.2	0.0097	21
	09 Nov 2012	123897	6.5	15.4	10.7	13.6	16.6	24		77	0.0171	0.11		4.4	<0.0005	0.06	3.3	0.0136	<0.0005	2.2	10.4	0.0035	21
GND2231	11 Nov 2011	112814	5.9	17.4	12	15	18.3	26	26				<0.00005	4.9	0.0008	<0.02	3.3	0.0177	<0.0005	2.7	11.2	0.084	22
	23 Nov 2011	112972	5.7	15.2	11.9	10	12.2	25	11				<0.00005	4.7	0.0005	<0.02	3.1	0.0184	<0.0005	2.4	10.1	0.0074	21
	20 Dec 2011	113248	5.9	15.2	11.3	14	17.2	25	6				<0.00005	4.6	<0.0005	<0.02	3.3	0.0093	<0.0005	2.5	10.3	0.0052	19.3
	14 Mar 2012	121428	6	16.4	12.1	20	19.6	26	<3				<0.00005	4.9	0.0006	0.06	3.3	0.036	0.0008	2.8	10.4	0.0063	22
	09 Nov 2012	123898	6.91	15.4	13.6	9.2	11.2	27		95	0.0196	0.1		5.2	<0.0005	<0.02	3.4	0.0108	<0.0005	2.2	10.4	0.0048	24
GND2239	11 Nov 2011	112812	5.9	16	12.5	14	17.08	25	<3				0.00006	5	0.0042	<0.02	3.4	0.0035	0.0035	3.8	12.5	0.048	23
	23 Nov 2011	112970	5.9	15.4	13.1	14	17.08	25	<3				<0.00005	4.5	0.0009	<0.02	3.3	0.0026	<0.0005	3.1	11.6	0.0142	23
	20 Dec 2011	113246	5.9	15.2	12.2	14	16.5	24	<3				0.00008	4.5	0.0011	<0.02	3.2	0.004	<0.0005	8.5	11.8	0.0176	22
	14 Mar 2012	121426	6.1	15.7	13.4	16	19	25	3				<0.00005	4.8	0.0009	<0.02	2.7	0.056	<0.0005	4	9.7	0.0135	23
	09 Nov 2012	123893	6.1	15.5	13	14.4	17.6	27		82	0.026	0.1		4.7	0.0007	<0.02	3.8	0.0083	<0.0005	3.6	13	0.0054	22
Turangi-B Wellsite Monitoring Wells																							
GND2234	20 Dec 2011	113252	6.1	15.3	10.5	13	15.5	23	149				<0.00005	4.6	<0.0005	<0.02	2.9	0.0079	<0.0005	1.32	10	0.029	20
	03 May 2012	121421	6.3	15.1	10.9	13	15.86	23	390				<0.00005	4.4	0.0018	<0.02	2.9	0.131	<0.0005	1.84	10.4	0.0183	22
GND2235	20 Dec 2011	113256	6.2	16.4	12	17	21	26	148				<0.00005	5.8	0.0006	<0.02	2.8	<0.0071	<0.0005	3.1	10.6	0.03	18.8
	03 May 2012	121425	6.3	15.2	11.1	16	19.52	25	97				<0.00005	5.4	<0.0005	0.06	2.7	0.056	<0.0005	4	9.7	0.023	20
GND2236	20 Dec 2011	113255	6.1	15.7	10.1	14	17.08	22	162				<0.00005	4.4	<0.0005	<0.02	2.8	0.0031	<0.0005	1.03	9.2	0.0152	18.7
	03 May 2012	121424	6.3	15.1	10.7	15	18.4	22	77				<0.00005	4.4	0.0006	<0.02	2.7	0.0158	<0.0005	1.67	9.1	0.022	21
GND2237	20 Dec 2011	113254	6	16	12.3	18	21	25	930				<0.00005	5.2	<0.0005	<0.02	2.9	0.036	<0.0005	1.32	12.7	0.0065	25
	03 May 2012	121423	6	15.6	48.7	12	14.64	155	168				<0.00005	29	<0.0005	0.46	20	0.29	0.0007	5.9	18.3	0.02	130
GND2238	20 Dec 2011	113253	6.1	16	13.7	18	21.96	29	151				<0.00005	6.8	0.0009	<0.02	2.8	0.0111	<0.0005	4.4	12.2	0.047	21
	03 May 2012	121422	6.1	15.1	33.6	14	16.9	101	99				<0.00005	19.8	<0.0005	0.09	12.5	0.13	<0.0005	4.5	17	0.046	94

Site	Nitrite (g/m^3)	Nitrate (g/m^3)	Nitrate + Nitrite (g/m^3)	Sulphate (g/m^3)	Ethylene Glycol (g/m^3)	Methanol (g/m^3)	Formaldehyde (g/m^3)	Ethane (g/m^3)	Ethylene (g/m^3)	Methane (g/m^3)	Total Petroleum Hydrocarbons (g/m^3)	Benzene (g/m^3)	Toluene (g/m^3)	Ethylbenzene (g/m^3)	Xylene (g/m^3)	Volatile Organic Compound Scan
Control Bore																
GND0210	<0.002	1.25	1.25	7.7			<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
Private Water Supplies																
GND1125	0.003	0.002	0.005	3.3			<0.02	<0.003	<0.004	1.86	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	<0.002	<0.002	<0.5			0.02	<0.003	<0.004	1.93	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	<0.002	0.003	<0.5			<0.02	<0.003	<0.004	1.99	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
								<0.003	<0.004	0.71						
	<0.002	0.01	0.01	<0.5			<0.02	<0.003	<0.004	0.44	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	<0.002	<0.002	<0.5	<4	<2	<0.02	<0.003	<0.004	0.78	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
GND1673	<0.002	0.004	0.005	4.5			<0.02	<0.003	<0.004	2.2	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	<0.002	<0.002	<0.5			<0.02	<0.003	<0.004	3.5	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	<0.002	0.003	1.8			<0.02	<0.003	<0.004	2.4	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
								<0.003	<0.004	2.3						
	<0.002	0.003	0.003	<0.5			<0.02	<0.003	<0.004	0.86	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	<0.002	0.002	0.5	<4	<2	<0.02	<0.003	<0.004	<2.2	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
GND2229	<0.002	<0.002	0.002	<0.5			<0.02	<0.003	<0.004	3.6	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	<0.002	<0.002	<0.5			0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	<0.002	<0.002	<0.5			<0.02	<0.003	<0.004	3.3	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
								<0.003	<0.004	6.1						
	<0.002	0.009	0.009	<0.5			<0.02	<0.003	<0.004	2.4	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	<0.002	<0.002	<0.5	<4	<2	<0.02	<0.003	<0.004	1.93	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
GND2230	0.003	0.41	0.41	6			<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	0.36	0.37	5.7			<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	0.5	0.5	4.6			<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	0.35	0.35	5.4			<0.02	<0.003	<0.004	0.003	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	0.26	0.26	5.2	<4	<2	<0.02	<0.003	<0.004	0.004	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
GND2231	<0.002	0.29	0.29	11.4			<0.02	<0.003	<0.004	0.003	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	0.21	0.21	12.2			<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	0.006	0.25	0.26	5.8			<0.02	<0.003	<0.004	0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	0.27	0.27	6.5			<0.02	<0.003	<0.004	0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	0.27	0.27	11.2	<4	<2	<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
GND2239	<0.002	1.09	1.09	6.1			<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	1.31	1.31	6.1			<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	1.08	1.08	5.1			<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	1.53	1.54	6.7			<0.02	<0.003	<0.004	0.019	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	1.25	1.25	6.1	<4	<2	<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
Turangi-B Wellsite Monitoring Wells																
GND2234	0.003	0.57	0.57	3.9			<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	0.55	0.55	5.5			<0.02	<0.003	<0.004	0.03	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
GND2235	<0.002	0.32	0.33	11.2			<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	0.002	0.23	0.23	6.9			<0.02	<0.003	<0.004	0.019	<0.7	<0.0005	0.0037	<0.0005	<0.0005	< detection limits
GND2236	<0.002	0.28	0.28	5.1			<0.02	<0.003	<0.004	<0.002	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	0.24	0.24	5.2			<0.02	<0.003	<0.004	0.049	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
GND2237	0.004	0.33	0.33	5.3			<0.02	<0.003	<0.004	0.027	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	<0.002	0.41	0.41	8.3			<0.02	<0.003	<0.004	0.072	<0.7	<0.0005	0.0043	<0.0005	<0.0005	< detection limits
GND2238	0.008	0.26	0.27	12.6			<0.02	<0.003	<0.004	0.008	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits
	0.006	0.32	0.32	6.8			<0.02	<0.003	<0.004	0.024	<0.7	<0.0005	<0.0010	<0.0005	<0.0005	< detection limits

Appendix III

Laboratory Analysis Reports

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Taranaki Regional Council	**Lab No:**	952171 SPv1
Contact:	Scott Cowperthwaite	**Date Registered:**	12-Nov-2011
	C/- Taranaki Regional Council	**Date Reported:**	25-Nov-2011
	Private Bag 713	**Quote No:**	46962
	STRATFORD 4352	**Order No:**	29969
		Client Reference:	Turangi B GW
		Submitted By:	Scott Cowperthwaite

Sample Type: Aqueous

Sample Name:		112812 11-Nov-2011 11:00 am	112813 11-Nov-2011 11:40 am	112814 11-Nov-2011 12:20 pm	112815 11-Nov-2011 1:00 pm	112816 11-Nov-2011 1:30 pm
Lab Number:		952171.1	952171.2	952171.3	952171.4	952171.5
Individual Tests						
Sum of Anions	meq/L	1.12	0.96	1.16	3.3	3.2
Sum of Cations	meq/L	1.15	0.95	1.08	3.2	3.1
pH	pH Units	5.9	5.9	5.9	7.2	7.4
Total Alkalinity	g/m³ as $CaCO_3$	13.6	12.6	14.5	137	132
Bicarbonate	g/m³ at 25°C	16.6	15.4	17.7	166	161
Total Hardness	g/m³ as $CaCO_3$	25	25	26	91	97
Electrical Conductivity (EC)	mS/m	12.5	10.7	12.0	30.5	30.6
Total Suspended Solids	g/m³	< 3	< 3	26	142	310
Total Dissolved Solids (TDS)	g/m³	87	78	83	200	200
Dissolved Cadmium	g/m³	0.00006	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Calcium	g/m³	4.6	4.5	4.9	19.2	21
Dissolved Copper	g/m³	0.0042	< 0.0005	0.0008	< 0.0005	< 0.0005
Dissolved Iron	g/m³	< 0.02	< 0.02	< 0.02	0.24	0.33
Dissolved Magnesium	g/m³	3.4	3.2	3.3	10.4	10.6
Dissolved Manganese	g/m³	0.0035	0.0034	0.0177	0.184	0.142
Dissolved Nickel	g/m³	0.0035	< 0.0005	< 0.0005	0.0072	0.0009
Dissolved Potassium	g/m³	3.8	1.97	2.7	5.2	6.9
Dissolved Sodium	g/m³	12.5	9.5	11.2	28	23
Dissolved Zinc	g/m³	0.048	0.0038	0.084	0.053	0.0127
Chloride	g/m³	23	19.8	22	15.4	17.4
Nitrite-N	g/m³	< 0.002	0.003	< 0.002	< 0.002	0.003
Nitrate-N	g/m³	1.09	0.41	0.29	0.004	0.002
Nitrate-N + Nitrite-N	g/m³	1.09	0.41	0.29	0.005	0.005
Sulphate	g/m³	6.1	6.0	11.4	4.5	3.3
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m³	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater						
Ethane	g/m³	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	g/m³	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Methane	g/m³	< 0.002	< 0.002	0.003	2.2	1.86
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
BTEX in VOC Water by Purge&Trap GC-MS						

Sample Type: Aqueous						
Sample Name:		112812 11-Nov-2011 11:00 am	112813 11-Nov-2011 11:40 am	112814 11-Nov-2011 12:20 pm	112815 11-Nov-2011 1:00 pm	112816 11-Nov-2011 1:30 pm
Lab Number:		952171.1	952171.2	952171.3	952171.4	952171.5
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
m&p-Xylene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
o-Xylene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Carbon tetrachloride	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromo-3-chloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m³	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Dibromomethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichlorodifluoromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichloromethane (methylene chloride)	g/m³	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
1,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Hexachlorobutadiene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Tetrachloroethene (tetrachloroethylene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichloroethene (trichloroethylene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichlorofluoromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m³	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Vinyl chloride	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chlorobenzene (monochlorobenzene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2-Chlorotoluene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Chlorotoluene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,4-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
tert-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Isopropylbenzene (Cumene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Isopropyltoluene (p-Cymene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005

Sample Type: Aqueous						
Sample Name:		112812 11-Nov-2011 11:00 am	112813 11-Nov-2011 11:40 am	112814 11-Nov-2011 12:20 pm	112815 11-Nov-2011 1:00 pm	112816 11-Nov-2011 1:30 pm
Lab Number:		952171.1	952171.2	952171.3	952171.4	952171.5
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Propylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
sec-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Styrene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m³	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Methyl tert-butylether (MTBE)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
4-Methylpentan-2-one (MIBK)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Bromoform (tribromomethane)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroform (Trichloromethane)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dibromochloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
System monitoring Compounds for VOC - % Recovery						
4-Bromofluorobenzene	%	102	82	82	82	80
Toluene-d8	%	99	100	98	99	98

Sample Name:		112817 11-Nov-2011 2:10 pm				
Lab Number:		952171.6				
Individual Tests						
Sum of Anions	meq/L	3.6	-	-	-	-
Sum of Cations	meq/L	3.6	-	-	-	-
pH	pH Units	7.3	-	-	-	-
Total Alkalinity	g/m³ as $CaCO_3$	151	-	-	-	-
Bicarbonate	g/m³ at 25°C	184	-	-	-	-
Total Hardness	g/m³ as $CaCO_3$	111	-	-	-	-
Electrical Conductivity (EC)	mS/m	34.6	-	-	-	-
Total Suspended Solids	g/m³	3	-	-	-	-
Total Dissolved Solids (TDS)	g/m³	240	-	-	-	-
Dissolved Cadmium	g/m³	< 0.00005	-	-	-	-
Dissolved Calcium	g/m³	25	-	-	-	-
Dissolved Copper	g/m³	0.0006	-	-	-	-
Dissolved Iron	g/m³	0.77	-	-	-	-
Dissolved Magnesium	g/m³	12.1	-	-	-	-
Dissolved Manganese	g/m³	0.188	-	-	-	-
Dissolved Nickel	g/m³	< 0.0005	-	-	-	-
Dissolved Potassium	g/m³	8.0	-	-	-	-
Dissolved Sodium	g/m³	26	-	-	-	-
Dissolved Zinc	g/m³	0.23	-	-	-	-
Chloride	g/m³	19.7	-	-	-	-
Nitrite-N	g/m³	< 0.002	-	-	-	-
Nitrate-N	g/m³	< 0.002	-	-	-	-
Nitrate-N + Nitrite-N	g/m³	0.002	-	-	-	-
Sulphate	g/m³	< 0.5	-	-	-	-
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m³	< 0.02	-	-	-	-
Gases in groundwater						
Ethane	g/m³	< 0.003	-	-	-	-

Sample Type: Aqueous						
Sample Name:		112817 11-Nov-2011 2:10 pm				
Lab Number:		952171.6				
Gases in groundwater						
Ethylene	g/m³	< 0.004	-	-	-	-
Methane	g/m³	3.6	-	-	-	-
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	-	-	-	-
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m³	< 0.0005	-	-	-	-
Toluene	g/m³	< 0.0010	-	-	-	-
Ethylbenzene	g/m³	< 0.0005	-	-	-	-
m&p-Xylene	g/m³	< 0.0005	-	-	-	-
o-Xylene	g/m³	< 0.0005	-	-	-	-
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane	g/m³	< 0.002	-	-	-	-
Carbon tetrachloride	g/m³	< 0.0005	-	-	-	-
Chloroethane	g/m³	< 0.0005	-	-	-	-
Chloromethane	g/m³	< 0.0005	-	-	-	-
1,2-Dibromo-3-chloropropane	g/m³	< 0.0005	-	-	-	-
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m³	< 0.0004	-	-	-	-
Dibromomethane	g/m³	< 0.0005	-	-	-	-
Dichlorodifluoromethane	g/m³	< 0.0005	-	-	-	-
1,1-Dichloroethane	g/m³	< 0.0005	-	-	-	-
1,2-Dichloroethane	g/m³	< 0.0005	-	-	-	-
1,1-Dichloroethene	g/m³	< 0.0005	-	-	-	-
cis-1,2-Dichloroethene	g/m³	< 0.0005	-	-	-	-
trans-1,2-Dichloroethene	g/m³	< 0.0005	-	-	-	-
Dichloromethane (methylene chloride)	g/m³	< 0.010	-	-	-	-
1,2-Dichloropropane	g/m³	< 0.0005	-	-	-	-
1,3-Dichloropropane	g/m³	< 0.0005	-	-	-	-
2,2-Dichloropropane	g/m³	< 0.0005	-	-	-	-
1,1-Dichloropropene	g/m³	< 0.0005	-	-	-	-
cis-1,3-Dichloropropene	g/m³	< 0.0005	-	-	-	-
trans-1,3-Dichloropropene	g/m³	< 0.0005	-	-	-	-
Hexachlorobutadiene	g/m³	< 0.0005	-	-	-	-
1,1,1,2-Tetrachloroethane	g/m³	< 0.0005	-	-	-	-
1,1,2,2-Tetrachloroethane	g/m³	< 0.0005	-	-	-	-
Tetrachloroethene (tetrachloroethylene)	g/m³	< 0.0005	-	-	-	-
1,1,1-Trichloroethane	g/m³	< 0.0005	-	-	-	-
1,1,2-Trichloroethane	g/m³	< 0.0005	-	-	-	-
Trichloroethene (trichloroethylene)	g/m³	< 0.0005	-	-	-	-
Trichlorofluoromethane	g/m³	< 0.0005	-	-	-	-
1,2,3-Trichloropropane	g/m³	< 0.0005	-	-	-	-
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m³	< 0.004	-	-	-	-
Vinyl chloride	g/m³	< 0.0005	-	-	-	-
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m³	< 0.0005	-	-	-	-
Chlorobenzene (monochlorobenzene)	g/m³	< 0.0005	-	-	-	-
2-Chlorotoluene	g/m³	< 0.0005	-	-	-	-
4-Chlorotoluene	g/m³	< 0.0005	-	-	-	-
1,2-Dichlorobenzene	g/m³	< 0.0005	-	-	-	-
1,3-Dichlorobenzene	g/m³	< 0.0005	-	-	-	-
1,4-Dichlorobenzene	g/m³	< 0.0005	-	-	-	-

Sample Type: Aqueous						
Sample Name:		112817 11-Nov-2011 2:10 pm				
Lab Number:		952171.6				
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
1,2,3-Trichlorobenzene	g/m³	< 0.0005	-	-	-	-
1,2,4-Trichlorobenzene	g/m³	< 0.0005	-	-	-	-
1,3,5-Trichlorobenzene	g/m³	< 0.0005	-	-	-	-
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m³	< 0.0005	-	-	-	-
tert-Butylbenzene	g/m³	< 0.0005	-	-	-	-
Isopropylbenzene (Cumene)	g/m³	< 0.0005	-	-	-	-
4-Isopropyltoluene (p-Cymene)	g/m³	< 0.0005	-	-	-	-
n-Propylbenzene	g/m³	< 0.0005	-	-	-	-
sec-Butylbenzene	g/m³	< 0.0005	-	-	-	-
Styrene	g/m³	< 0.0005	-	-	-	-
1,2,4-Trimethylbenzene	g/m³	< 0.0005	-	-	-	-
1,3,5-Trimethylbenzene	g/m³	< 0.0005	-	-	-	-
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m³	< 0.05	-	-	-	-
2-Butanone (MEK)	g/m³	< 0.005	-	-	-	-
Methyl tert-butylether (MTBE)	g/m³	< 0.005	-	-	-	-
4-Methylpentan-2-one (MIBK)	g/m³	< 0.005	-	-	-	-
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m³	< 0.0005	-	-	-	-
Bromoform (tribromomethane)	g/m³	< 0.0005	-	-	-	-
Chloroform (Trichloromethane)	g/m³	< 0.0005	-	-	-	-
Dibromochloromethane	g/m³	< 0.0005	-	-	-	-
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m³	< 0.005	-	-	-	-
Naphthalene	g/m³	< 0.0005	-	-	-	-
System monitoring Compounds for VOC - % Recovery						
4-Bromofluorobenzene	%	81	-	-	-	-
Toluene-d8	%	99	-	-	-	-

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**	**Samples**
Formaldehyde in Water by DNPH & LCMSMS	DNPH derivatisation, extraction, LCMSMS	-	1-6
Gases in groundwater	Manual headspace creation and sub-sampling, GC-FID analysis.	-	1-6
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-6
Volatile Organic Compounds Trace in Water by Purge&Trap	Purge & Trap, GC-MS FS analysis	-	1-6
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-6
Total anions for anion/cation balance check	Calculation: sum of anions as mEquiv/L.	0.07 meq/L	1-6
Total cations for anion/cation balance check	Calculation: sum of cations as mEquiv/L.	0.05 meq/L	1-6
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-6
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 21st ed. 2005.	1.0 g/m³ as $CaCO_3$	1-6
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 21st ed. 2005.	1.0 g/m³ at 25°C	1-6
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21st ed. 2005.	1.0 g/m³ as $CaCO_3$	1-6

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1-6
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m^3	1-6
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) 21st ed. 2005.	10 g/m^3	1-6
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 21st ed. 2005.	-	1-6
Dissolved Cadmium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.00005 g/m^3	1-6
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m^3	1-6
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m^3	1-6
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m^3	1-6
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m^3	1-6
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m^3	1-6
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m^3	1-6
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m^3	1-6
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m^3	1-6
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0010 g/m^3	1-6
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl^- E (modified from continuous flow analysis) 21st ed. 2005.	0.5 g/m^3	1-6
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO3- I (Modified) 21st ed. 2005.	0.002 g/m^3	1-6
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N.	0.002 g/m^3	1-6
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (Modified) 21st ed. 2005.	0.002 g/m^3	1-6
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 21st ed. 2005.	0.5 g/m^3	1-6

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.

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

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Taranaki Regional Council	**Lab No:**	955926	SPv1
Contact:	Scott Cowperthwaite	**Date Registered:**	24-Nov-2011	
	C/- Taranaki Regional Council	**Date Reported:**	09-Dec-2011	
	Private Bag 713	**Quote No:**	46962	
	STRATFORD 4352	**Order No:**	30167	
		Client Reference:		
		Submitted By:	Scott Cowperthwaite	

Sample Type: Aqueous

Sample Name:		112970 23-Nov-2011 8:30 am	112971 23-Nov-2011 9:00 am	112972 23-Nov-2011 9:15 am	112973 23-Nov-2011 9:30 am	112974 23-Nov-2011 9:45 am
Lab Number:		955926.1	955926.2	955926.3	955926.4	955926.5
Individual Tests						
Sum of Anions	meq/L	1.15	0.96	1.06	3.2	3.1
Sum of Cations	meq/L	1.08	0.90	1.00	3.1	3.1
pH	pH Units	5.9	6.0	5.7	7.0	7.3
Total Alkalinity	g/m³ as $CaCO_3$	14.2	12.7	10.2	138	132
Bicarbonate	g/m³ at 25°C	17.3	15.5	12.4	168	161
Total Hardness	g/m³ as $CaCO_3$	25	24	25	88	95
Electrical Conductivity (EC)	mS/m	13.1	10.8	11.9	30.2	30.3
Total Suspended Solids	g/m³	< 3	< 3	11	18	47
Total Dissolved Solids (TDS)	g/m³	95	85	87	210	198
Dissolved Cadmium	g/m³	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Calcium	g/m³	4.5	4.3	4.7	18.6	21
Dissolved Copper	g/m³	0.0009	0.0006	0.0005	0.0006	< 0.0005
Dissolved Iron	g/m³	< 0.02	< 0.02	< 0.02	0.25	0.55
Dissolved Magnesium	g/m³	3.3	3.2	3.1	10.0	10.6
Dissolved Manganese	g/m³	0.0026	0.0057	0.0184	0.180	0.147
Dissolved Nickel	g/m³	< 0.0005	< 0.0005	< 0.0005	0.0019	< 0.0005
Dissolved Potassium	g/m³	3.1	1.92	2.4	5.1	6.6
Dissolved Sodium	g/m³	11.6	8.6	10.1	27	22
Dissolved Zinc	g/m³	0.0142	0.0120	0.0074	0.0195	0.028
Chloride	g/m³	23	20	21	14.9	17.6
Nitrite-N	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N	g/m³	1.31	0.36	0.21	< 0.002	< 0.002
Nitrate-N + Nitrite-N	g/m³	1.31	0.37	0.21	< 0.002	< 0.002
Sulphate	g/m³	6.1	5.7	12.2	< 0.5	< 0.5
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m³	< 0.02	< 0.02	< 0.02	< 0.02	0.02
Gases in groundwater						
Ethane	g/m³	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	g/m³	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Methane	g/m³	< 0.002	< 0.002	< 0.002	3.5	1.93
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
BTEX in VOC Water by Purge&Trap GC-MS						

Sample Type: Aqueous						
Sample Name:		112970 23-Nov-2011 8:30 am	112971 23-Nov-2011 9:00 am	112972 23-Nov-2011 9:15 am	112973 23-Nov-2011 9:30 am	112974 23-Nov-2011 9:45 am
Lab Number:		955926.1	955926.2	955926.3	955926.4	955926.5
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
m&p-Xylene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
o-Xylene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Carbon tetrachloride	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromo-3-chloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m³	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Dibromomethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichlorodifluoromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichloromethane (methylene chloride)	g/m³	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
1,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Hexachlorobutadiene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Tetrachloroethene (tetrachloroethylene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichloroethene (trichloroethylene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichlorofluoromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m³	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Vinyl chloride	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chlorobenzene (monochlorobenzene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2-Chlorotoluene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Chlorotoluene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,4-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
tert-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Isopropylbenzene (Cumene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Isopropyltoluene (p-Cymene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005

Sample Type: Aqueous						
Sample Name:		112970 23-Nov-2011 8:30 am	112971 23-Nov-2011 9:00 am	112972 23-Nov-2011 9:15 am	112973 23-Nov-2011 9:30 am	112974 23-Nov-2011 9:45 am
Lab Number:		955926.1	955926.2	955926.3	955926.4	955926.5
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Propylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
sec-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Styrene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m³	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Methyl tert-butylether (MTBE)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
4-Methylpentan-2-one (MIBK)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Bromoform (tribromomethane)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroform (Trichloromethane)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dibromochloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
System monitoring Compounds for VOC - % Recovery						
4-Bromofluorobenzene	%	105	106	101	106	107
Toluene-d8	%	99	100	100	101	100

Sample Name:		112975 23-Nov-2011 10:15 am	112976 23-Nov-2011 10:35 am			
Lab Number:		955926.6	955926.7			
Individual Tests						
Sum of Anions	meq/L	3.7	1.99	-	-	-
Sum of Cations	meq/L	3.6	1.88	-	-	-
pH	pH Units	7.1	6.6	-	-	-
Total Alkalinity	g/m³ as $CaCO_3$	156	43	-	-	-
Bicarbonate	g/m³ at 25°C	190	52	-	-	-
Total Hardness	g/m³ as $CaCO_3$	113	55	-	-	-
Electrical Conductivity (EC)	mS/m	35.4	21.0	-	-	-
Total Suspended Solids	g/m³	< 3	23	-	-	-
Total Dissolved Solids (TDS)	g/m³	240	147	-	-	-
Dissolved Cadmium	g/m³	< 0.00005	0.00006	-	-	-
Dissolved Calcium	g/m³	24	11.5	-	-	-
Dissolved Copper	g/m³	< 0.0005	0.0018	-	-	-
Dissolved Iron	g/m³	2.2	< 0.02	-	-	-
Dissolved Magnesium	g/m³	12.6	6.5	-	-	-
Dissolved Manganese	g/m³	0.22	0.0068	-	-	-
Dissolved Nickel	g/m³	0.0007	< 0.0005	-	-	-
Dissolved Potassium	g/m³	7.1	2.4	-	-	-
Dissolved Sodium	g/m³	24	16.4	-	-	-
Dissolved Zinc	g/m³	0.27	0.062	-	-	-
Chloride	g/m³	19.2	31	-	-	-
Nitrite-N	g/m³	< 0.002	< 0.002	-	-	-
Nitrate-N	g/m³	< 0.002	1.25	-	-	-
Nitrate-N + Nitrite-N	g/m³	< 0.002	1.25	-	-	-
Sulphate	g/m³	< 0.5	7.7	-	-	-
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m³	0.02	< 0.02	-	-	-
Gases in groundwater						
Ethane	g/m³	< 0.003	< 0.003	-	-	-

Sample Type: Aqueous						
Sample Name:		112975 23-Nov-2011 10:15 am	112976 23-Nov-2011 10:35 am			
Lab Number:		955926.6	955926.7			
Gases in groundwater						
Ethylene	g/m³	< 0.003	< 0.003	-	-	-
Methane	g/m³	< 0.002	< 0.002	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	-	-	-
C10 - C14	g/m³	< 0.2	< 0.2	-	-	-
C15 - C36	g/m³	< 0.4	< 0.4	-	-	-
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	-	-	-
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m³	< 0.0005	< 0.0005	-	-	-
Toluene	g/m³	< 0.0010	< 0.0010	-	-	-
Ethylbenzene	g/m³	< 0.0005	< 0.0005	-	-	-
m&p-Xylene	g/m³	< 0.0005	< 0.0005	-	-	-
o-Xylene	g/m³	< 0.0005	< 0.0005	-	-	-
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane	g/m³	< 0.002	< 0.002	-	-	-
Carbon tetrachloride	g/m³	< 0.0005	< 0.0005	-	-	-
Chloroethane	g/m³	< 0.0005	< 0.0005	-	-	-
Chloromethane	g/m³	< 0.0005	< 0.0005	-	-	-
1,2-Dibromo-3-chloropropane	g/m³	< 0.0005	< 0.0005	-	-	-
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m³	< 0.0004	< 0.0004	-	-	-
Dibromomethane	g/m³	< 0.0005	< 0.0005	-	-	-
Dichlorodifluoromethane	g/m³	< 0.0005	< 0.0005	-	-	-
1,1-Dichloroethane	g/m³	< 0.0005	< 0.0005	-	-	-
1,2-Dichloroethane	g/m³	< 0.0005	< 0.0005	-	-	-
1,1-Dichloroethene	g/m³	< 0.0005	< 0.0005	-	-	-
cis-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	-	-	-
trans-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	-	-	-
Dichloromethane (methylene chloride)	g/m³	< 0.010	< 0.010	-	-	-
1,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	-	-	-
1,3-Dichloropropane	g/m³	< 0.0005	< 0.0005	-	-	-
2,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	-	-	-
1,1-Dichloropropene	g/m³	< 0.0005	< 0.0005	-	-	-
cis-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	-	-	-
trans-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	-	-	-
Hexachlorobutadiene	g/m³	< 0.0005	< 0.0005	-	-	-
1,1,1,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	-	-	-
1,1,2,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	-	-	-
Tetrachloroethene (tetrachloroethylene)	g/m³	< 0.0005	< 0.0005	-	-	-
1,1,1-Trichloroethane	g/m³	< 0.0005	< 0.0005	-	-	-
1,1,2-Trichloroethane	g/m³	< 0.0005	< 0.0005	-	-	-
Trichloroethene (trichloroethylene)	g/m³	< 0.0005	< 0.0005	-	-	-
Trichlorofluoromethane	g/m³	< 0.0005	< 0.0005	-	-	-
1,2,3-Trichloropropane	g/m³	< 0.0005	< 0.0005	-	-	-
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m³	< 0.004	< 0.004	-	-	-
Vinyl chloride	g/m³	< 0.0005	< 0.0005	-	-	-
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m³	< 0.0005	< 0.0005	-	-	-
Chlorobenzene (monochlorobenzene)	g/m³	< 0.0005	< 0.0005	-	-	-
2-Chlorotoluene	g/m³	< 0.0005	< 0.0005	-	-	-
4-Chlorotoluene	g/m³	< 0.0005	< 0.0005	-	-	-
1,2-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	-	-	-
1,3-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	-	-	-
1,4-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	-	-	-

Sample Type: Aqueous						
Sample Name:		112975 23-Nov-2011 10:15 am	112976 23-Nov-2011 10:35 am			
Lab Number:		955926.6	955926.7			
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
1,2,3-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	-	-	-
1,2,4-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	-	-	-
1,3,5-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	-	-	-
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m³	< 0.0005	< 0.0005	-	-	-
tert-Butylbenzene	g/m³	< 0.0005	< 0.0005	-	-	-
Isopropylbenzene (Cumene)	g/m³	< 0.0005	< 0.0005	-	-	-
4-Isopropyltoluene (p-Cymene)	g/m³	< 0.0005	< 0.0005	-	-	-
n-Propylbenzene	g/m³	< 0.0005	< 0.0005	-	-	-
sec-Butylbenzene	g/m³	< 0.0005	< 0.0005	-	-	-
Styrene	g/m³	< 0.0005	< 0.0005	-	-	-
1,2,4-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	-	-	-
1,3,5-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	-	-	-
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m³	< 0.05	< 0.05	-	-	-
2-Butanone (MEK)	g/m³	< 0.005	< 0.005	-	-	-
Methyl tert-butylether (MTBE)	g/m³	< 0.005	< 0.005	-	-	-
4-Methylpentan-2-one (MIBK)	g/m³	< 0.005	< 0.005	-	-	-
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m³	< 0.0005	< 0.0005	-	-	-
Bromoform (tribromomethane)	g/m³	< 0.0005	< 0.0005	-	-	-
Chloroform (Trichloromethane)	g/m³	< 0.0005	< 0.0005	-	-	-
Dibromochloromethane	g/m³	< 0.0005	< 0.0005	-	-	-
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m³	< 0.005	< 0.005	-	-	-
Naphthalene	g/m³	< 0.0005	< 0.0005	-	-	-
System monitoring Compounds for VOC - % Recovery						
4-Bromofluorobenzene	%	107	106	-	-	-
Toluene-d8	%	100	100	-	-	-

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**	**Samples**
Formaldehyde in Water by DNPH & LCMSMS	DNPH derivatisation, extraction, LCMSMS	-	1-7
Gases in groundwater	Manual headspace creation and sub-sampling, GC-FID analysis.	-	1-7
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-7
Volatile Organic Compounds Trace in Water by Purge&Trap	Purge & Trap, GC-MS FS analysis	-	1-7
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-7
Total anions for anion/cation balance check	Calculation: sum of anions as mEquiv/L.	0.07 meq/L	1-7
Total cations for anion/cation balance check	Calculation: sum of cations as mEquiv/L.	0.05 meq/L	1-7
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-7
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 21st ed. 2005.	1.0 g/m³ as $CaCO_3$	1-7
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 21st ed. 2005.	1.0 g/m³ at 25°C	1-7
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21st ed. 2005.	1.0 g/m³ as $CaCO_3$	1-7

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1-7
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m^3	1-7
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) 21st ed. 2005.	10 g/m^3	1-7
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 21st ed. 2005.	-	1-7
Dissolved Cadmium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.00005 g/m^3	1-7
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m^3	1-7
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m^3	1-7
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m^3	1-7
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m^3	1-7
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m^3	1-7
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m^3	1-7
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m^3	1-7
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m^3	1-7
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0010 g/m^3	1-7
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl^- E (modified from continuous flow analysis) 21st ed. 2005.	0.5 g/m^3	1-7
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO3- I (Modified) 21st ed. 2005.	0.002 g/m^3	1-7
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N.	0.002 g/m^3	1-7
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (Modified) 21st ed. 2005.	0.002 g/m^3	1-7
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 21st ed. 2005.	0.5 g/m^3	1-7

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.

Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental Division

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Taranaki Regional Council	**Lab No:**	964547	SPv1
Contact:	Scott Cowperthwaite	**Date Registered:**	21-Dec-2011	
	C/- Taranaki Regional Council	**Date Reported:**	09-Jan-2012	
	Private Bag 713	**Quote No:**	46962	
	STRATFORD 4352	**Order No:**	30603	
		Client Reference:	GW	
		Submitted By:	Scott Cowperthwaite	

Sample Type: Aqueous

Sample Name:		113246 20-Dec-2011 9:30 am	113247 20-Dec-2011 9:50 am	113248 20-Dec-2011 10:05 am	113249 20-Dec-2011 10:20 am	113250 20-Dec-2011 10:40 am
Lab Number:		964547.1	964547.2	964547.3	964547.4	964547.5
Individual Tests						
Sum of Anions	meq/L	1.07	0.91	0.97	3.1	3.2
Sum of Cations	meq/L	1.22	0.90	1.01	3.0	3.1
pH	pH Units	5.9	5.9	5.9	7.2	7.4
Total Alkalinity	g/m³ as $CaCO_3$	13.5	12.4	14.1	131	133
Bicarbonate	g/m³ at 25°C	16.5	15.1	17.2	160	162
Total Hardness	g/m³ as $CaCO_3$	24	24	25	87	96
Electrical Conductivity (EC)	mS/m	12.2	10.3	11.3	28.8	29.9
Total Suspended Solids	g/m³	< 3	< 3	6	129	82
Total Dissolved Solids (TDS)	g/m³	80	76	78	196	193
Dissolved Cadmium	g/m³	0.00008	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Calcium	g/m³	4.5	4.5	4.6	18.5	21
Dissolved Copper	g/m³	0.0011	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Iron	g/m³	< 0.02	< 0.02	< 0.02	0.30	0.67
Dissolved Magnesium	g/m³	3.2	3.2	3.3	10.0	10.4
Dissolved Manganese	g/m³	0.0040	0.0025	0.0093	0.163	0.146
Dissolved Nickel	g/m³	< 0.0005	< 0.0005	< 0.0005	0.0007	< 0.0005
Dissolved Potassium	g/m³	8.5	1.80	2.5	4.7	6.6
Dissolved Sodium	g/m³	11.8	8.4	10.3	26	22
Dissolved Zinc	g/m³	0.0176	0.0040	0.0052	0.043	0.0167
Chloride	g/m³	22	18.9	19.3	15.4	17.6
Nitrite-N	g/m³	< 0.002	< 0.002	0.006	< 0.002	< 0.002
Nitrate-N	g/m³	1.08	0.50	0.25	< 0.002	< 0.002
Nitrate-N + Nitrite-N	g/m³	1.08	0.50	0.26	0.003	0.003
Sulphate	g/m³	5.1	4.6	5.8	1.8	< 0.5
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m³	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater						
Ethane	g/m³	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	g/m³	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Methane	g/m³	< 0.002	< 0.002	0.002	2.4	1.99
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
BTEX in VOC Water by Purge&Trap GC-MS						

Sample Type: Aqueous						
Sample Name:		113246 20-Dec-2011 9:30 am	113247 20-Dec-2011 9:50 am	113248 20-Dec-2011 10:05 am	113249 20-Dec-2011 10:20 am	113250 20-Dec-2011 10:40 am
Lab Number:		964547.1	964547.2	964547.3	964547.4	964547.5
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
m&p-Xylene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
o-Xylene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Carbon tetrachloride	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromo-3-chloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m³	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Dibromomethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichlorodifluoromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichloromethane (methylene chloride)	g/m³	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
1,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Hexachlorobutadiene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Tetrachloroethene (tetrachloroethylene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichloroethene (trichloroethylene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichlorofluoromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m³	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Vinyl chloride	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chlorobenzene (monochlorobenzene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2-Chlorotoluene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Chlorotoluene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,4-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
tert-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Isopropylbenzene (Cumene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Isopropyltoluene (p-Cymene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005

Sample Type: Aqueous						
Sample Name:		113246 20-Dec-2011 9:30 am	113247 20-Dec-2011 9:50 am	113248 20-Dec-2011 10:05 am	113249 20-Dec-2011 10:20 am	113250 20-Dec-2011 10:40 am
Lab Number:		964547.1	964547.2	964547.3	964547.4	964547.5
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Propylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
sec-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Styrene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m³	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Methyl tert-butylether (MTBE)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
4-Methylpentan-2-one (MIBK)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Bromoform (tribromomethane)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroform (Trichloromethane)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dibromochloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
System monitoring Compounds for VOC - % Recovery						
4-Bromofluorobenzene	%	104	102	101	101	103
Toluene-d8	%	106	105	105	103	105

Sample Name:		113251 20-Dec-2011 10:55 am	113252 20-Dec-2011 11:20 am	113253 20-Dec-2011 11:45 am	113254 20-Dec-2011 12:00 pm	113255 20-Dec-2011 12:20 pm
Lab Number:		964547.6	964547.7	964547.8	964547.9	964547.10
Individual Tests						
Sum of Anions	meq/L	3.4	0.94	1.23	1.18	0.94
Sum of Cations	meq/L	3.4	0.94	1.22	1.09	0.88
pH	pH Units	7.3	6.1	6.1	6.0	6.1
Total Alkalinity	g/m³ as $CaCO_3$	146	12.7	17.7	17.6	14.1
Bicarbonate	g/m³ at 25°C	178	15.5	22	21	17.2
Total Hardness	g/m³ as $CaCO_3$	105	23	29	25	22
Electrical Conductivity (EC)	mS/m	32.5	10.5	13.7	12.3	10.1
Total Suspended Solids	g/m³	15	149	151	930	162
Total Dissolved Solids (TDS)	g/m³	230	70	88	66	69
Dissolved Cadmium	g/m³	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Calcium	g/m³	24	4.6	6.8	5.2	4.4
Dissolved Copper	g/m³	0.0005	< 0.0005	0.0009	< 0.0005	< 0.0005
Dissolved Iron	g/m³	1.84	< 0.02	< 0.02	< 0.02	< 0.02
Dissolved Magnesium	g/m³	11.1	2.9	2.8	2.9	2.8
Dissolved Manganese	g/m³	0.178	0.0079	0.0111	0.036	0.0031
Dissolved Nickel	g/m³	0.0006	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Potassium	g/m³	7.5	1.32	4.4	1.32	1.03
Dissolved Sodium	g/m³	25	10.0	12.2	12.7	9.2
Dissolved Zinc	g/m³	0.162	0.029	0.047	0.0065	0.0152
Chloride	g/m³	18.4	20	21	25	18.7
Nitrite-N	g/m³	< 0.002	0.003	0.008	0.004	< 0.002
Nitrate-N	g/m³	< 0.002	0.57	0.26	0.33	0.28
Nitrate-N + Nitrite-N	g/m³	< 0.002	0.57	0.27	0.33	0.28
Sulphate	g/m³	< 0.5	3.9	12.6	5.3	5.1
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m³	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater						
Ethane	g/m³	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003

Sample Type: Aqueous						
Sample Name:		113251 20-Dec-2011 10:55 am	113252 20-Dec-2011 11:20 am	113253 20-Dec-2011 11:45 am	113254 20-Dec-2011 12:00 pm	113255 20-Dec-2011 12:20 pm
Lab Number:		964547.6	964547.7	964547.8	964547.9	964547.10
Gases in groundwater						
Ethylene	g/m³	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Methane	g/m³	3.3	< 0.002	0.008	0.027	< 0.002
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
m&p-Xylene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
o-Xylene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Carbon tetrachloride	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromo-3-chloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m³	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Dibromomethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichlorodifluoromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichloromethane (methylene chloride)	g/m³	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
1,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Hexachlorobutadiene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Tetrachloroethene (tetrachloroethylene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichloroethene (trichloroethylene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichlorofluoromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m³	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Vinyl chloride	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chlorobenzene (monochlorobenzene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2-Chlorotoluene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Chlorotoluene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,4-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005

Sample Type: Aqueous						
Sample Name:		113251 20-Dec-2011 10:55 am	113252 20-Dec-2011 11:20 am	113253 20-Dec-2011 11:45 am	113254 20-Dec-2011 12:00 pm	113255 20-Dec-2011 12:20 pm
Lab Number:		964547.6	964547.7	964547.8	964547.9	964547.10
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
1,2,3-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
tert-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Isopropylbenzene (Cumene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Isopropyltoluene (p-Cymene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
n-Propylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
sec-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Styrene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m³	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Methyl tert-butylether (MTBE)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
4-Methylpentan-2-one (MIBK)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Bromoform (tribromomethane)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroform (Trichloromethane)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dibromochloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
System monitoring Compounds for VOC - % Recovery						
4-Bromofluorobenzene	%	105	105	105	105	105
Toluene-d8	%	107	104	106	105	103

Sample Name:		113256 20-Dec-2011 12:35 pm				
Lab Number:		964547.11				
Individual Tests						
Sum of Anions	meq/L	1.13	-	-	-	-
Sum of Cations	meq/L	1.06	-	-	-	-
pH	pH Units	6.2	-	-	-	-
Total Alkalinity	g/m³ as $CaCO_3$	17.0	-	-	-	-
Bicarbonate	g/m³ at 25°C	21	-	-	-	-
Total Hardness	g/m³ as $CaCO_3$	26	-	-	-	-
Electrical Conductivity (EC)	mS/m	12.0	-	-	-	-
Total Suspended Solids	g/m³	148	-	-	-	-
Total Dissolved Solids (TDS)	g/m³	81	-	-	-	-
Dissolved Cadmium	g/m³	< 0.00005	-	-	-	-
Dissolved Calcium	g/m³	5.8	-	-	-	-
Dissolved Copper	g/m³	0.0006	-	-	-	-
Dissolved Iron	g/m³	< 0.02	-	-	-	-
Dissolved Magnesium	g/m³	2.8	-	-	-	-
Dissolved Manganese	g/m³	0.0071	-	-	-	-
Dissolved Nickel	g/m³	< 0.0005	-	-	-	-
Dissolved Potassium	g/m³	3.1	-	-	-	-
Dissolved Sodium	g/m³	10.6	-	-	-	-
Dissolved Zinc	g/m³	0.030	-	-	-	-
Chloride	g/m³	18.8	-	-	-	-

Sample Type: Aqueous						
Sample Name:		113256 20-Dec-2011 12:35 pm				
Lab Number:		964547.11				
Individual Tests						
Nitrite-N	g/m³	< 0.002	-	-	-	-
Nitrate-N	g/m³	0.32	-	-	-	-
Nitrate-N + Nitrite-N	g/m³	0.33	-	-	-	-
Sulphate	g/m³	11.2	-	-	-	-
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m³	< 0.02	-	-	-	-
Gases in groundwater						
Ethane	g/m³	< 0.003	-	-	-	-
Ethylene	g/m³	< 0.004	-	-	-	-
Methane	g/m³	< 0.002	-	-	-	-
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	-	-	-	-
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m³	< 0.0005	-	-	-	-
Toluene	g/m³	< 0.0010	-	-	-	-
Ethylbenzene	g/m³	< 0.0005	-	-	-	-
m&p-Xylene	g/m³	< 0.0005	-	-	-	-
o-Xylene	g/m³	< 0.0005	-	-	-	-
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane	g/m³	< 0.002	-	-	-	-
Carbon tetrachloride	g/m³	< 0.0005	-	-	-	-
Chloroethane	g/m³	< 0.0005	-	-	-	-
Chloromethane	g/m³	< 0.0005	-	-	-	-
1,2-Dibromo-3-chloropropane	g/m³	< 0.0005	-	-	-	-
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m³	< 0.0004	-	-	-	-
Dibromomethane	g/m³	< 0.0005	-	-	-	-
Dichlorodifluoromethane	g/m³	< 0.0005	-	-	-	-
1,1-Dichloroethane	g/m³	< 0.0005	-	-	-	-
1,2-Dichloroethane	g/m³	< 0.0005	-	-	-	-
1,1-Dichloroethene	g/m³	< 0.0005	-	-	-	-
cis-1,2-Dichloroethene	g/m³	< 0.0005	-	-	-	-
trans-1,2-Dichloroethene	g/m³	< 0.0005	-	-	-	-
Dichloromethane (methylene chloride)	g/m³	< 0.010	-	-	-	-
1,2-Dichloropropane	g/m³	< 0.0005	-	-	-	-
1,3-Dichloropropane	g/m³	< 0.0005	-	-	-	-
2,2-Dichloropropane	g/m³	< 0.0005	-	-	-	-
1,1-Dichloropropene	g/m³	< 0.0005	-	-	-	-
cis-1,3-Dichloropropene	g/m³	< 0.0005	-	-	-	-
trans-1,3-Dichloropropene	g/m³	< 0.0005	-	-	-	-
Hexachlorobutadiene	g/m³	< 0.0005	-	-	-	-
1,1,1,2-Tetrachloroethane	g/m³	< 0.0005	-	-	-	-
1,1,2,2-Tetrachloroethane	g/m³	< 0.0005	-	-	-	-
Tetrachloroethene (tetrachloroethylene)	g/m³	< 0.0005	-	-	-	-
1,1,1-Trichloroethane	g/m³	< 0.0005	-	-	-	-
1,1,2-Trichloroethane	g/m³	< 0.0005	-	-	-	-
Trichloroethene (trichloroethylene)	g/m³	< 0.0005	-	-	-	-
Trichlorofluoromethane	g/m³	< 0.0005	-	-	-	-
1,2,3-Trichloropropane	g/m³	< 0.0005	-	-	-	-
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m³	< 0.004	-	-	-	-
Vinyl chloride	g/m³	< 0.0005	-	-	-	-

Sample Type: Aqueous							
Sample Name:		113256 20-Dec-2011 12:35 pm					
Lab Number:		964547.11					
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS							
Bromobenzene	g/m³	< 0.0005	-	-	-	-	
Chlorobenzene (monochlorobenzene)	g/m³	< 0.0005	-	-	-	-	
2-Chlorotoluene	g/m³	< 0.0005	-	-	-	-	
4-Chlorotoluene	g/m³	< 0.0005	-	-	-	-	
1,2-Dichlorobenzene	g/m³	< 0.0005	-	-	-	-	
1,3-Dichlorobenzene	g/m³	< 0.0005	-	-	-	-	
1,4-Dichlorobenzene	g/m³	< 0.0005	-	-	-	-	
1,2,3-Trichlorobenzene	g/m³	< 0.0005	-	-	-	-	
1,2,4-Trichlorobenzene	g/m³	< 0.0005	-	-	-	-	
1,3,5-Trichlorobenzene	g/m³	< 0.0005	-	-	-	-	
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS							
n-Butylbenzene	g/m³	< 0.0005	-	-	-	-	
tert-Butylbenzene	g/m³	< 0.0005	-	-	-	-	
Isopropylbenzene (Cumene)	g/m³	< 0.0005	-	-	-	-	
4-Isopropyltoluene (p-Cymene)	g/m³	< 0.0005	-	-	-	-	
n-Propylbenzene	g/m³	< 0.0005	-	-	-	-	
sec-Butylbenzene	g/m³	< 0.0005	-	-	-	-	
Styrene	g/m³	< 0.0005	-	-	-	-	
1,2,4-Trimethylbenzene	g/m³	< 0.0005	-	-	-	-	
1,3,5-Trimethylbenzene	g/m³	< 0.0005	-	-	-	-	
Ketones in VOC Water by Purge&Trap GC-MS							
Acetone	g/m³	< 0.05	-	-	-	-	
2-Butanone (MEK)	g/m³	< 0.005	-	-	-	-	
Methyl tert-butylether (MTBE)	g/m³	< 0.005	-	-	-	-	
4-Methylpentan-2-one (MIBK)	g/m³	< 0.005	-	-	-	-	
Trihalomethanes in VOC Water by Purge&Trap GC-MS							
Bromodichloromethane	g/m³	< 0.0005	-	-	-	-	
Bromoform (tribromomethane)	g/m³	< 0.0005	-	-	-	-	
Chloroform (Trichloromethane)	g/m³	< 0.0005	-	-	-	-	
Dibromochloromethane	g/m³	< 0.0005	-	-	-	-	
Other VOC in Water by Purge&Trap GC-MS							
Carbon disulphide	g/m³	< 0.005	-	-	-	-	
Naphthalene	g/m³	< 0.0005	-	-	-	-	
System monitoring Compounds for VOC - % Recovery							
4-Bromofluorobenzene	%	106	-	-	-	-	
Toluene-d8	%	105	-	-	-	-	

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**	**Samples**
Formaldehyde in Water by DNPH & LCMSMS	DNPH derivatisation, extraction, LCMSMS	-	1-11
Gases in groundwater	Manual headspace creation and sub-sampling, GC-FID analysis.	-	1-11
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-11
Volatile Organic Compounds Trace in Water by Purge&Trap	Purge & Trap, GC-MS FS analysis	-	1-11
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-11
Total anions for anion/cation balance check	Calculation: sum of anions as mEquiv/L.	0.07 meq/L	1-11
Total cations for anion/cation balance check	Calculation: sum of cations as mEquiv/L.	0.05 meq/L	1-11

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Samples**
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-11
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 21st ed. 2005.	1.0 g/m³ as $CaCO_3$	1-11
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 21st ed. 2005.	1.0 g/m³ at 25°C	1-11
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21st ed. 2005.	1.0 g/m³ as $CaCO_3$	1-11
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1-11
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m³	1-11
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) 21st ed. 2005.	10 g/m³	1-11
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 21st ed. 2005.	-	1-11
Dissolved Cadmium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.00005 g/m³	1-11
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m³	1-11
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m³	1-11
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m³	1-11
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m³	1-11
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m³	1-11
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m³	1-11
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m³	1-11
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m³	1-11
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0010 g/m³	1-11
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl^- E (modified from continuous flow analysis) 21st ed. 2005.	0.5 g/m³	1-11
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO3- I (Modified) 21st ed. 2005.	0.002 g/m³	1-11
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N.	0.002 g/m³	1-11
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (Modified) 21st ed. 2005.	0.002 g/m³	1-11
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 21st ed. 2005.	0.5 g/m³	1-11

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.

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

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Taranaki Regional Council	**Lab No:**	987668	SPv1
Contact:	Scott Cowperthwaite	**Date Registered:**	15-Mar-2012	
	C/- Taranaki Regional Council	**Date Reported:**	22-Mar-2012	
	Private Bag 713	**Quote No:**	46962	
	STRATFORD 4352	**Order No:**	31652	
		Client Reference:	Turangi 3 Months	
		Submitted By:	Regan Phipps	

Sample Type: Aqueous

Sample Name:		GND 2239 14-Mar-2012 10:45 am	GND 2230 14-Mar-2012 11:20 am	GND 2231 14-Mar-2012 11:45 am	GND 1673 14-Mar-2012 12:10 pm	GND 1125 14-Mar-2012 12:30 pm
Lab Number:		987668.1	987668.2	987668.3	987668.4	987668.5
Individual Tests						
Sum of Anions	meq/L	1.20	1.04	1.09	3.3	3.2
Sum of Cations	meq/L	1.11	0.99	1.04	3.4	3.2
pH	pH Units	6.1	6.3	6.0	7.2	7.5
Total Alkalinity	g/m³ as $CaCO_3$	15.6	15.4	16.1	141	132
Bicarbonate	g/m³ at 25°C	19.0	18.8	19.6	171	161
Total Hardness	g/m³ as $CaCO_3$	25	25	26	89	96
Electrical Conductivity (EC)	mS/m	13.4	11.7	12.1	30.0	29.9
Total Suspended Solids	g/m³	3	4	< 3	190	55
Total Dissolved Solids (TDS)	g/m³	97	87	91	210	220
Dissolved Cadmium	g/m³	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Calcium	g/m³	4.8	4.8	4.9	18.9	21
Dissolved Copper	g/m³	0.0009	0.0006	0.0006	0.0009	0.0006
Dissolved Iron	g/m³	< 0.02	< 0.02	0.06	6.7	4.9
Dissolved Magnesium	g/m³	3.1	3.3	3.3	10.2	10.3
Dissolved Manganese	g/m³	0.0046	0.025	0.036	0.184	0.157
Dissolved Nickel	g/m³	< 0.0005	< 0.0005	0.0008	0.0022	0.0007
Dissolved Potassium	g/m³	4.1	3.2	2.8	5.2	6.8
Dissolved Sodium	g/m³	11.6	9.2	10.4	27	22
Dissolved Zinc	g/m³	0.0135	0.0097	0.0063	0.049	0.073
Chloride	g/m³	23	21	22	15.6	18.9
Nitrite-N	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N	g/m³	1.53	0.35	0.27	0.003	0.009
Nitrate-N + Nitrite-N	g/m³	1.54	0.35	0.27	0.003	0.010
Sulphate	g/m³	6.7	5.4	6.5	< 0.5	< 0.5
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m³	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater						
Ethane	g/m³	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	g/m³	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Methane	g/m³	< 0.002	0.003	0.002	0.86	0.44
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
BTEX in VOC Water by Purge&Trap GC-MS						

Sample Type: Aqueous						
Sample Name:		GND 2239 14-Mar-2012 10:45 am	GND 2230 14-Mar-2012 11:20 am	GND 2231 14-Mar-2012 11:45 am	GND 1673 14-Mar-2012 12:10 pm	GND 1125 14-Mar-2012 12:30 pm
Lab Number:		987668.1	987668.2	987668.3	987668.4	987668.5
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
m&p-Xylene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
o-Xylene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Carbon tetrachloride	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromo-3-chloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m³	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Dibromomethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichlorodifluoromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichloromethane (methylene chloride)	g/m³	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
1,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Hexachlorobutadiene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Tetrachloroethene (tetrachloroethylene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichloroethene (trichloroethylene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichlorofluoromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m³	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Vinyl chloride	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chlorobenzene (monochlorobenzene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2-Chlorotoluene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Chlorotoluene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,4-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
tert-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Isopropylbenzene (Cumene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Isopropyltoluene (p-Cymene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
n-Propylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005

Sample Type: Aqueous						
Sample Name:		GND 2239 14-Mar-2012 10:45 am	GND 2230 14-Mar-2012 11:20 am	GND 2231 14-Mar-2012 11:45 am	GND 1673 14-Mar-2012 12:10 pm	GND 1125 14-Mar-2012 12:30 pm
Lab Number:		987668.1	987668.2	987668.3	987668.4	987668.5
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
sec-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Styrene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m³	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Methyl tert-butylether (MTBE)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
4-Methylpentan-2-one (MIBK)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Bromoform (tribromomethane)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroform (Trichloromethane)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dibromochloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
System monitoring Compounds for VOC - % Recovery						
4-Bromofluorobenzene	%	89	94	95	89	95
Toluene-d8	%	96	97	95	93	98

Sample Name:		GND 2229 14-Mar-2012 12:50 pm				
Lab Number:		987668.6				
Individual Tests						
Sum of Anions	meq/L	3.4	-	-	-	-
Sum of Cations	meq/L	3.5	-	-	-	-
pH	pH Units	7.3	-	-	-	-
Total Alkalinity	g/m³ as $CaCO_3$	144	-	-	-	-
Bicarbonate	g/m³ at 25°C	175	-	-	-	-
Total Hardness	g/m³ as $CaCO_3$	101	-	-	-	-
Electrical Conductivity (EC)	mS/m	32.1	-	-	-	-
Total Suspended Solids	g/m³	9	-	-	-	-
Total Dissolved Solids (TDS)	g/m³	230	-	-	-	-
Dissolved Cadmium	g/m³	< 0.00005	-	-	-	-
Dissolved Calcium	g/m³	22	-	-	-	-
Dissolved Copper	g/m³	0.0005	-	-	-	-
Dissolved Iron	g/m³	4.4	-	-	-	-
Dissolved Magnesium	g/m³	11.0	-	-	-	-
Dissolved Manganese	g/m³	0.162	-	-	-	-
Dissolved Nickel	g/m³	0.0006	-	-	-	-
Dissolved Potassium	g/m³	7.7	-	-	-	-
Dissolved Sodium	g/m³	25	-	-	-	-
Dissolved Zinc	g/m³	0.120	-	-	-	-
Chloride	g/m³	19.0	-	-	-	-
Nitrite-N	g/m³	< 0.002	-	-	-	-
Nitrate-N	g/m³	0.009	-	-	-	-
Nitrate-N + Nitrite-N	g/m³	0.009	-	-	-	-
Sulphate	g/m³	< 0.5	-	-	-	-
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m³	< 0.02	-	-	-	-
Gases in groundwater						
Ethane	g/m³	< 0.003	-	-	-	-
Ethylene	g/m³	< 0.004	-	-	-	-

Sample Type: Aqueous						
Sample Name:		GND 2229 14-Mar-2012 12:50 pm				
Lab Number:		987668.6				
Gases in groundwater						
Methane	g/m³	2.4	-	-	-	-
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	-	-	-	-
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m³	< 0.0005	-	-	-	-
Toluene	g/m³	< 0.0010	-	-	-	-
Ethylbenzene	g/m³	< 0.0005	-	-	-	-
m&p-Xylene	g/m³	< 0.0005	-	-	-	-
o-Xylene	g/m³	< 0.0005	-	-	-	-
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane	g/m³	< 0.002	-	-	-	-
Carbon tetrachloride	g/m³	< 0.0005	-	-	-	-
Chloroethane	g/m³	< 0.0005	-	-	-	-
Chloromethane	g/m³	< 0.0005	-	-	-	-
1,2-Dibromo-3-chloropropane	g/m³	< 0.0005	-	-	-	-
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m³	< 0.0004	-	-	-	-
Dibromomethane	g/m³	< 0.0005	-	-	-	-
Dichlorodifluoromethane	g/m³	< 0.0005	-	-	-	-
1,1-Dichloroethane	g/m³	< 0.0005	-	-	-	-
1,2-Dichloroethane	g/m³	< 0.0005	-	-	-	-
1,1-Dichloroethene	g/m³	< 0.0005	-	-	-	-
cis-1,2-Dichloroethene	g/m³	< 0.0005	-	-	-	-
trans-1,2-Dichloroethene	g/m³	< 0.0005	-	-	-	-
Dichloromethane (methylene chloride)	g/m³	< 0.010	-	-	-	-
1,2-Dichloropropane	g/m³	< 0.0005	-	-	-	-
1,3-Dichloropropane	g/m³	< 0.0005	-	-	-	-
1,1-Dichloropropene	g/m³	< 0.0005	-	-	-	-
cis-1,3-Dichloropropene	g/m³	< 0.0005	-	-	-	-
trans-1,3-Dichloropropene	g/m³	< 0.0005	-	-	-	-
Hexachlorobutadiene	g/m³	< 0.0005	-	-	-	-
1,1,1,2-Tetrachloroethane	g/m³	< 0.0005	-	-	-	-
1,1,2,2-Tetrachloroethane	g/m³	< 0.0005	-	-	-	-
Tetrachloroethene (tetrachloroethylene)	g/m³	< 0.0005	-	-	-	-
1,1,1-Trichloroethane	g/m³	< 0.0005	-	-	-	-
1,1,2-Trichloroethane	g/m³	< 0.0005	-	-	-	-
Trichloroethene (trichloroethylene)	g/m³	< 0.0005	-	-	-	-
Trichlorofluoromethane	g/m³	< 0.0005	-	-	-	-
1,2,3-Trichloropropane	g/m³	< 0.0005	-	-	-	-
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m³	< 0.004	-	-	-	-
Vinyl chloride	g/m³	< 0.0005	-	-	-	-
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m³	< 0.0005	-	-	-	-
Chlorobenzene (monochlorobenzene)	g/m³	< 0.0005	-	-	-	-
2-Chlorotoluene	g/m³	< 0.0005	-	-	-	-
4-Chlorotoluene	g/m³	< 0.0005	-	-	-	-
1,2-Dichlorobenzene	g/m³	< 0.0005	-	-	-	-
1,3-Dichlorobenzene	g/m³	< 0.0005	-	-	-	-
1,4-Dichlorobenzene	g/m³	< 0.0005	-	-	-	-
1,2,3-Trichlorobenzene	g/m³	< 0.0005	-	-	-	-
1,2,4-Trichlorobenzene	g/m³	< 0.0005	-	-	-	-

Sample Type: Aqueous						
Sample Name:		GND 2229 14-Mar-2012 12:50 pm				
Lab Number:		987668.6				
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
1,3,5-Trichlorobenzene	g/m³	< 0.0005	-	-	-	-
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m³	< 0.0005	-	-	-	-
tert-Butylbenzene	g/m³	< 0.0005	-	-	-	-
Isopropylbenzene (Cumene)	g/m³	< 0.0005	-	-	-	-
4-Isopropyltoluene (p-Cymene)	g/m³	< 0.0005	-	-	-	-
n-Propylbenzene	g/m³	< 0.0005	-	-	-	-
sec-Butylbenzene	g/m³	< 0.0005	-	-	-	-
Styrene	g/m³	< 0.0005	-	-	-	-
1,2,4-Trimethylbenzene	g/m³	< 0.0005	-	-	-	-
1,3,5-Trimethylbenzene	g/m³	< 0.0005	-	-	-	-
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m³	< 0.05	-	-	-	-
2-Butanone (MEK)	g/m³	< 0.005	-	-	-	-
Methyl tert-butylether (MTBE)	g/m³	< 0.005	-	-	-	-
4-Methylpentan-2-one (MIBK)	g/m³	< 0.005	-	-	-	-
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m³	< 0.0005	-	-	-	-
Bromoform (tribromomethane)	g/m³	< 0.0005	-	-	-	-
Chloroform (Trichloromethane)	g/m³	< 0.0005	-	-	-	-
Dibromochloromethane	g/m³	< 0.0005	-	-	-	-
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m³	< 0.005	-	-	-	-
Naphthalene	g/m³	< 0.0005	-	-	-	-
System monitoring Compounds for VOC - % Recovery						
4-Bromofluorobenzene	%	94	-	-	-	-
Toluene-d8	%	101	-	-	-	-

Analyst's Comments

It has been noted that the method performance for 2,2-dichloropropane for VOC analysis is not acceptable therefore we are unable to report this compound at this present time.

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**	**Samples**
Formaldehyde in Water by DNPH & LCMSMS	DNPH derivatisation, extraction, LCMSMS	-	1-6
Gases in groundwater	Manual headspace creation and sub-sampling, GC-FID analysis.	-	1-6
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-6
Volatile Organic Compounds Trace in Water by Purge&Trap	Purge & Trap, GC-MS FS analysis	-	1-6
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-6
Total anions for anion/cation balance check	Calculation: sum of anions as mEquiv/L.	0.07 meq/L	1-6
Total cations for anion/cation balance check	Calculation: sum of cations as mEquiv/L.	0.05 meq/L	1-6
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-6
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 21st ed. 2005.	1.0 g/m³ as $CaCO_3$	1-6
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 21st ed. 2005.	1.0 g/m³ at 25°C	1-6

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21st ed. 2005.	1.0 g/m³ as $CaCO_3$	1-6
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1-6
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m³	1-6
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) 21st ed. 2005.	10 g/m³	1-6
Dissolved Cadmium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.00005 g/m³	1-6
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m³	1-6
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m³	1-6
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m³	1-6
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m³	1-6
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m³	1-6
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m³	1-6
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m³	1-6
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m³	1-6
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0010 g/m³	1-6
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl^- E (modified from continuous flow analysis) 21st ed. 2005.	0.5 g/m³	1-6
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO3- I (Modified) 21st ed. 2005.	0.002 g/m³	1-6
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N.	0.002 g/m³	1-6
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (Modified) 21st ed. 2005.	0.002 g/m³	1-6
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 21st ed. 2005.	0.5 g/m³	1-6

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.

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

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Taranaki Regional Council	**Lab No:**	1004502	SPv1
Contact:	Scott Cowperthwaite	**Date Registered:**	04-May-2012	
	C/- Taranaki Regional Council	**Date Reported:**	10-May-2012	
	Private Bag 713	**Quote No:**	46962	
	STRATFORD 4352	**Order No:**		
		Client Reference:	Turangi MW's	
		Submitted By:	Regan Phipps	

Sample Type: Aqueous

Sample Name:		MW1 03-May-2012 1:00 pm	MW2 03-May-2012 1:20 pm	MW3 03-May-2012 1:50 pm	MW4 03-May-2012 2:15 pm	MW5 03-May-2012 3:00 pm
Lab Number:		1004502.1	1004502.2	1004502.3	1004502.4	1004502.5
Individual Tests						
Sum of Anions	meq/L	1.05	1.01	4.1	3.1	1.05
Sum of Cations	meq/L	1.02	0.89	4.1	2.9	0.97
pH	pH Units	6.3	6.3	6.0	6.1	6.3
Total Alkalinity	g/m³ as $CaCO_3$	16.2	15.1	11.5	13.9	13.3
Bicarbonate	g/m³ at 25°C	19.7	18.4	14.0	16.9	16.2
Total Hardness	g/m³ as $CaCO_3$	25	22	155	101	23
Electrical Conductivity (EC)	mS/m	11.1	10.7	48.7	33.6	10.9
Total Suspended Solids	g/m³	97	77	168	99	390
Total Dissolved Solids (TDS)	g/m³	82	83	390	270	86
Dissolved Cadmium	g/m³	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Dissolved Calcium	g/m³	5.4	4.4	29	19.8	4.4
Dissolved Copper	g/m³	< 0.0005	0.0006	< 0.0005	< 0.0005	0.0018
Dissolved Iron	g/m³	0.06	< 0.02	0.46	0.09	< 0.02
Dissolved Magnesium	g/m³	2.7	2.7	20	12.5	2.9
Dissolved Manganese	g/m³	0.056	0.0158	0.29	0.130	0.131
Dissolved Nickel	g/m³	< 0.0005	< 0.0005	0.0007	< 0.0005	< 0.0005
Dissolved Potassium	g/m³	4.0	1.67	5.9	4.5	1.84
Dissolved Sodium	g/m³	9.7	9.1	18.3	17.0	10.4
Dissolved Zinc	g/m³	0.023	0.022	0.020	0.046	0.0183
Chloride	g/m³	20	21	130	94	22
Nitrite-N	g/m³	0.002	< 0.002	< 0.002	0.006	< 0.002
Nitrate-N	g/m³	0.23	0.24	0.41	0.32	0.55
Nitrate-N + Nitrite-N	g/m³	0.23	0.24	0.41	0.32	0.55
Sulphate	g/m³	6.9	5.2	8.3	6.8	5.5
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m³	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater						
Ethane	g/m³	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	g/m³	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Methane	g/m³	0.019	0.049	0.072	0.024	0.030
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
BTEX in VOC Water by Purge&Trap GC-MS						

Sample Type: Aqueous						
Sample Name:		MW1 03-May-2012 1:00 pm	MW2 03-May-2012 1:20 pm	MW3 03-May-2012 1:50 pm	MW4 03-May-2012 2:15 pm	MW5 03-May-2012 3:00 pm
Lab Number:		1004502.1	1004502.2	1004502.3	1004502.4	1004502.5
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Toluene	g/m³	0.0037	< 0.0010	0.0043	< 0.0010	< 0.0010
Ethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
m&p-Xylene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
o-Xylene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane (Methyl Bromide)	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Carbon tetrachloride	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromo-3-chloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m³	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Dibromomethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichlorodifluoromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,2-Dichloroethene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichloromethane (methylene chloride)	g/m³	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
1,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2,2-Dichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,3-Dichloropropene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Hexachlorobutadiene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2,2-Tetrachloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Tetrachloroethene (tetrachloroethylene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichloroethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichloroethene (trichloroethylene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichlorofluoromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichloropropane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m³	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Vinyl chloride	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chlorobenzene (monochlorobenzene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2-Chlorotoluene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Chlorotoluene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,4-Dichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trichlorobenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
tert-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Isopropylbenzene (Cumene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Isopropyltoluene (p-Cymene)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005

Sample Type: Aqueous						
Sample Name:		MW1 03-May-2012 1:00 pm	MW2 03-May-2012 1:20 pm	MW3 03-May-2012 1:50 pm	MW4 03-May-2012 2:15 pm	MW5 03-May-2012 3:00 pm
Lab Number:		1004502.1	1004502.2	1004502.3	1004502.4	1004502.5
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Propylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
sec-Butylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Styrene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trimethylbenzene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m³	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Methyl tert-butylether (MTBE)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
4-Methylpentan-2-one (MIBK)	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Bromoform (tribromomethane)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroform (Trichloromethane)	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dibromochloromethane	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m³	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	g/m³	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
System monitoring Compounds for VOC - % Recovery						
4-Bromofluorobenzene	%	97	98	98	98	97
Toluene-d8	%	99	98	97	98	97

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**	**Samples**
Formaldehyde in Water by DNPH & LCMSMS	DNPH derivatisation, extraction, LCMSMS	-	1-5
Gases in groundwater	Manual headspace creation and sub-sampling, GC-FID analysis.	-	1-5
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-5
Volatile Organic Compounds Trace in Water by Purge&Trap	Purge & Trap, GC-MS FS analysis	-	1-5
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-5
Total anions for anion/cation balance check	Calculation: sum of anions as mEquiv/L.	0.07 meq/L	1-5
Total cations for anion/cation balance check	Calculation: sum of cations as mEquiv/L.	0.05 meq/L	1-5
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-5
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 21st ed. 2005.	1.0 g/m³ as $CaCO_3$	1-5
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 21st ed. 2005.	1.0 g/m³ at 25°C	1-5
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21st ed. 2005.	1.0 g/m³ as $CaCO_3$	1-5
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1-5
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21st ed. 2005.	3 g/m³	1-5
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) 21st ed. 2005.	10 g/m³	1-5
Dissolved Cadmium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.00005 g/m³	1-5

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m³	1-5
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m³	1-5
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m³	1-5
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m³	1-5
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m³	1-5
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m³	1-5
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m³	1-5
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m³	1-5
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0010 g/m³	1-5
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl^- E (modified from continuous flow analysis) 21st ed. 2005.	0.5 g/m³	1-5
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO3- I (Modified) 21st ed. 2005.	0.002 g/m³	1-5
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N.	0.002 g/m³	1-5
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (Modified) 21st ed. 2005.	0.002 g/m³	1-5
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 21st ed. 2005.	0.5 g/m³	1-5

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.

Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental Division

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Taranaki Regional Council	**Lab No:**	1068206	SPv1
Contact:	Regan Phipps	**Date Registered:**	10-Nov-2012	
	C/- Taranaki Regional Council	**Date Reported:**	19-Nov-2012	
	Private Bag 713	**Quote No:**	47915	
	STRATFORD 4352	**Order No:**		
		Client Reference:	Groundwater	
		Submitted By:	Regan Phipps	

Sample Type: Aqueous

Sample Name:		GND2239 09-Nov-2012 9:20 am	GND2229 09-Nov-2012 10:00 am	GND1125 09-Nov-2012 10:30 am	GND1673 09-Nov-2012 10:50 am	GND2230 09-Nov-2012 11:15 am
Lab Number:		1068206.1	1068206.2	1068206.3	1068206.4	1068206.5
Individual Tests						
Sum of Anions	meq/L	1.12	2.3	3.1	3.2	0.98
Sum of Cations	meq/L	1.20	2.4	3.2	3.5	1.00
pH	pH Units	6.1	6.6	7.4	7.2	6.5
Total Alkalinity	g/m³ as $CaCO_3$	14.4	86	132	142	13.6
Bicarbonate	g/m³ at 25°C	17.6	105	161	173	16.6
Total Hardness	g/m³ as $CaCO_3$	27	71	92	89	24
Electrical Conductivity (EC)	mS/m	13.0	22.3	30.3	30.8	10.7
Total Dissolved Solids (TDS)	g/m³	82	171	210	210	77
Dissolved Barium	g/m³	0.026	0.0167	0.021	0.021	0.0171
Dissolved Calcium	g/m³	4.7	15.4	21	18.9	4.4
Dissolved Copper	g/m³	0.0007	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Iron	g/m³	< 0.02	5.4	5.3	8.3	0.06
Dissolved Magnesium	g/m³	3.8	8.0	9.9	10.1	3.3
Dissolved Manganese	g/m³	0.0083	0.25	0.163	0.20	0.0136
Dissolved Nickel	g/m³	< 0.0005	0.0014	< 0.0005	< 0.0005	< 0.0005
Dissolved Potassium	g/m³	3.6	2.3	7.1	5.3	2.2
Dissolved Sodium	g/m³	13.0	15.9	24	30	10.4
Dissolved Zinc	g/m³	0.0054	0.115	0.108	0.0140	0.0035
Bromide	g/m³	0.10	0.11	< 0.05	0.07	0.11
Chloride	g/m³	22	19.0	16.5	13.8	21
Nitrite-N	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N	g/m³	1.25	< 0.002	< 0.002	< 0.002	0.26
Nitrate-N + Nitrite-N	g/m³	1.25	< 0.002	< 0.002	0.002	0.26
Sulphate	g/m³	6.1	< 0.5	< 0.5	0.5	5.2
Ethylene Glycol in Water						
Ethylene glycol*	g/m³	< 4	< 4	< 4	< 4	< 4
Propylene Glycol in Water						
Propylene glycol*	g/m³	< 4	< 4	< 4	< 4	< 4
Methanol in Water - Aqueous Solvents						
Methanol*	g/m³	< 2	< 2	< 2	< 2	< 2
BTEX in Water by Headspace GC-MS						
Benzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
m&p-Xylene	g/m³	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	g/m³	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010

Sample Type: Aqueous						
Sample Name:		GND2239 09-Nov-2012 9:20 am	GND2229 09-Nov-2012 10:00 am	GND1125 09-Nov-2012 10:30 am	GND1673 09-Nov-2012 10:50 am	GND2230 09-Nov-2012 11:15 am
Lab Number:		1068206.1	1068206.2	1068206.3	1068206.4	1068206.5
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m³	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater						
Ethane	g/m³	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	g/m³	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Methane	g/m³	< 0.002	1.93	0.78	2.2	0.004
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m³	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m³	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7

Sample Name:		GND2231 09-Nov-2012 11:45 am				
Lab Number:		1068206.6				
Individual Tests						
Sum of Anions	meq/L	1.12	-	-	-	-
Sum of Cations	meq/L	1.05	-	-	-	-
pH	pH Units	5.8	-	-	-	-
Total Alkalinity	g/m³ as $CaCO_3$	9.2	-	-	-	-
Bicarbonate	g/m³ at 25°C	11.2	-	-	-	-
Total Hardness	g/m³ as $CaCO_3$	27	-	-	-	-
Electrical Conductivity (EC)	mS/m	12.9	-	-	-	-
Total Dissolved Solids (TDS)	g/m³	95	-	-	-	-
Dissolved Barium	g/m³	0.0196	-	-	-	-
Dissolved Calcium	g/m³	5.2	-	-	-	-
Dissolved Copper	g/m³	< 0.0005	-	-	-	-
Dissolved Iron	g/m³	< 0.02	-	-	-	-
Dissolved Magnesium	g/m³	3.4	-	-	-	-
Dissolved Manganese	g/m³	0.0108	-	-	-	-
Dissolved Nickel	g/m³	< 0.0005	-	-	-	-
Dissolved Potassium	g/m³	2.2	-	-	-	-
Dissolved Sodium	g/m³	10.4	-	-	-	-
Dissolved Zinc	g/m³	0.0048	-	-	-	-
Bromide	g/m³	0.10	-	-	-	-
Chloride	g/m³	24	-	-	-	-
Nitrite-N	g/m³	< 0.002	-	-	-	-
Nitrate-N	g/m³	0.27	-	-	-	-
Nitrate-N + Nitrite-N	g/m³	0.27	-	-	-	-
Sulphate	g/m³	11.2	-	-	-	-
Ethylene Glycol in Water						
Ethylene glycol*	g/m³	< 4	-	-	-	-
Propylene Glycol in Water						
Propylene glycol*	g/m³	< 4	-	-	-	-
Methanol in Water - Aqueous Solvents						
Methanol*	g/m³	< 2	-	-	-	-
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	-	-	-	-
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m³	< 0.02	-	-	-	-

Sample Type: Aqueous						
Sample Name:		GND2231 09-Nov-2012 11:45 am				
Lab Number:		1068206.6				
Gases in groundwater						
Ethane	g/m³	< 0.003	-	-	-	-
Ethylene	g/m³	< 0.004	-	-	-	-
Methane	g/m³	< 0.002	-	-	-	-
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	-	-	-	-

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**	**Samples**
Ethylene Glycol in Water*	Direct injection, dual column GC-FID	-	1-6
Propylene Glycol in Water*	Direct injection, dual column GC-FID	-	1-6
Methanol in Water - Aqueous Solvents*	Direct injection, dual column GC-FID	-	1-6
BTEX in Water by Headspace GC-MS	Headspace GC-MS analysis, US EPA 8260B	-	1-6
Formaldehyde in Water by DNPH & LCMSMS	DNPH derivatisation, extraction, LCMSMS	-	1-6
Gases in groundwater	Manual headspace creation and sub-sampling, GC-FID analysis.	-	1-6
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines	-	1-6
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-6
Total anions for anion/cation balance check	Calculation: sum of anions as mEquiv/L.	0.07 meq/L	1-6
Total cations for anion/cation balance check	Calculation: sum of cations as mEquiv/L.	0.05 meq/L	1-6
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-6
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 21st ed. 2005.	1.0 g/m³ as $CaCO_3$	1-6
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 21st ed. 2005.	1.0 g/m³ at 25°C	1-6
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21st ed. 2005.	1.0 g/m³ as $CaCO_3$	1-6
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.1 mS/m	1-6
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) 21st ed. 2005.	10 g/m³	1-6
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.00010 g/m³	1-6
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m³	1-6
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m³	1-6
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m³	1-6
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m³	1-6
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m³	1-6
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m³	1-6
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m³	1-6
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m³	1-6

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0010 g/m³	1-6
Bromide	Filtered sample. Ion Chromatography. APHA 4110 B 21st ed. 2005.	0.05 g/m³	1-6
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl^- E (modified from continuous flow analysis) 21st ed. 2005.	0.5 g/m³	1-6
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO3- I (Modified) 21st ed. 2005.	0.002 g/m³	1-6
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N.	0.002 g/m³	1-6
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (Modified) 21st ed. 2005.	0.002 g/m³	1-6
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 21st ed. 2005.	0.5 g/m³	1-6

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.

Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental Division