Greymouth Petroleum Limited
Turangi B Exploration Wellsite
Monitoring Programme Report

Technical Report 2011-104

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Executive Summary

Greymouth Petroleum Limited established a hydrocarbon exploration site located on Turangi Road, Motunui, in the Waitara catchment. The site is called Turangi B and was operational from 29 July 2011 - 31 December 2012. This report describes the monitoring programme implemented by the Taranaki Regional Council to assess the Company's environmental performance in relation to drilling operations at the Turangi B wellsite during the period under review, and the results and environmental effects of the Company's activities.

Greymouth Petroleum Limited holds a total of 6 resource consents, for the activities at the Turangi B well, which include a total of 62 conditions setting out the requirements that the Company must satisfy. Greymouth Petroleum Limited holds the following consents:

- Consent 7857-1 to allow it to take groundwater
- Consent 7853-1 to discharge treated stormwater, produced water and drilling water onto land and into the Parahaki Stream
- Consent 7855-1 to discharge emissions to air from flaring at this site
- Consent 7952-1 to discharge contaminants in association with hydraulic fracturing
- Consent 7852-1 to discharge stormwater and sediment onto and into land in association with earthworks
- Consent 7854-1 to discharge emissions to air from flaring associated with hydrocarbon production activities

The Council's monitoring programme for the period under review included 19 inspections of the site and surrounding environment, and 1 discharge sample from the skimmer pit was collected for physicochemical analysis. With the nearest water course downslope being over 300 metres away, there was no biomonitoring surveys of receiving waters. Eleven ground water bores/wells were regularly sampled over a 12 month period, to monitor for discharges to groundwater at the site (particularly around the flare/blowdown pit), and for any effects on shallow groundwater aquifers either from fracturing activities or spillages. An investigation of air quality arising from flaring of fracturing fluids was carried out. This work has been repeated separately.

The monitoring showed that no adverse environmental effects were associated with the combustion of gas and fracturing fluids into air[1], or from the discharge of stormwater onto land or hydraulic fracturing fluids into land at the Turangi B wellsite during the monitoring period.

Bunding of both wet and dry chemicals/hazardous substances was an important and integral consideration when setting up the site. Most chemicals were stored in low traffic areas. Goods stored within the bunded areas were often covered to stop materials getting wet.

Throughout the monitoring period the well site's stormwater system, consisting of a ring drain and two skimmer pits, appeared to work effectively to capture and treat stormwater before it discharged offsite.

The receiving surface water body was visually inspected on occasion , but not sampled due to the distance the wellsite was from the stream, and lack of any indication of a discharge into it.

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[1] A full report on the effects of the combustion of fracturing fluids within the flare is available at http://www.trc.govt.nz/hydraulic-fracturing/ as *Investigation of air quality arising from flaring of fracturing fluids - emissions and ambient air quality* – Taranaki Regional Council, published 2012

Staff on site were cooperative with requests made by officers of Taranaki Regional Council with any required works being completed to a satisfactory standard.

There were no Unauthorised Incidents recorded in respect of this consent holder during the period under review.

The drill cuttings were removed from the site by contractor and disposed of at Remediation's Uruti licensed waste processing site.

Flaring was carried out on site during the well clean up and testing and fracturing phases.

During the monitoring period, Greymouth Petroleum Limited demonstrated a high level of environmental performance and compliance with the resource consents.

The site is now a producing well.

This report includes recommendations for future drilling operations at this and other sites.

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period 29 July 2011 - 31 December 2012 by the Taranaki Regional Council on the monitoring programme associated with resource consents held by Greymouth Petroleum Limited.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by Greymouth Petroleum Limited that relate to exploration activities at the Turangi B wellsite on Turangi Road, Motunui, within the Waitara catchment.

One of the intents of the Resource Management Act (1991) is that environmental management should be integrated across all media, so that a consent holder's use of water, air, and land should be considered from a single comprehensive environmental perspective. Accordingly, the Taranaki Regional Council generally implements integrated environmental monitoring programmes and reports the results of the programmes jointly. This report discusses the environmental effects of Greymouth Petroleum Limited's use of water, land, and air, and is the 1st report by the Taranaki Regional Council for the site.

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 annual programmes, the resource consents held by Greymouth Petroleum Limited in the Waitara catchment, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted at the Turangi B wellsite during exploration activities.

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.

Section 4 presents recommendations to be implemented during future drilling operations.

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

1.1.3 The Resource Management Act (1991) and monitoring

The Resource Management 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 (e.g. 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 Taranaki Regional 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 Resource Management Act to assess the effects of the exercise of consents. In accordance with section 35 of the Resource Management Act 1991, 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 monitoring) also enables the Council to continuously assess its own performance in resource management as well as that of resource users particularly consent holders. It further enables the Council to continually re-evaluate its approach and that of consent holders to resource management, and, ultimately, through the refinement of methods, and considered responsible resource utilisation to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental performance

Besides discussing the various details of the performance and extent of compliance by Greymouth Petroleum Limited in the catchment during the period under review, this report also assigns an overall 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 trivial (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 neither urgent nor critical, and follow-up inspections showed they have been dealt with and trivial 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 measurable environmental impacts, or, there were measurable environmental effects arising from activities and/or 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 or infringement 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 Process description

Greymouth Petroleum Limited holds a 30 year exploration mining permit 38161 to mine oil, condensate, LPG, petroleum and gas within a 28.03 square kilometre area. The Turangi B wellsite is one of many sites within this area that have been established in order to explore, evaluate and produce hydrocarbons from within the Mangahewa formation.

The wellsite is located on Upper Turangi Road at Motunui, approximately 350 metres south of the intersection between Turangi Road and Main North Road/SH3.

Surrounding land uses are predominantly agricultural, however a number of wellsites and pipelines associated with hydrocarbon exploration, production and processing are located within a 10km radius of the site [including the Turangi Road wellsite, the Turangi Road production station, the methanol plant at Motunui, and the Pohokura production station].

The topography of the subject site is flat countryside. The Parahaki Stream is located to the west of the wellsite. The wellhead is located at least 300 metres from the stream's tributary downslope of the site.

The Turangi B wellsite was established in 2011 and involved the removal of topsoil to create a firm level platform on which to erect a drilling rig and house associated equipment. Site establishment also involved the installation of:

- A wastewater control, treatment and disposal facilities;
- A system to collect and control stormwater and contaminants;
- A flare pit;
- Other on-site facilities such as accommodation, parking and storage.

Well creation

The well was drilled progressively using different sized drill bits. The width of the well is widest at the surface and smaller drill bits are used as the well gets deeper. Once each section of the well is drilled, a steel casing is installed. Cement is then pumped down the well to fill the annulus (the space between the steel casing and the surrounding rock). This process is repeated until the target depth is reached, with each section of steel casing interlocked with the next.

Production tubing is then fitted within the steel casing to the target depth. A packer is fitted between the production tubing and casing to stop oil/gas/produced water from entering the annulus (the space between the production tubing and the casing). The packer is pressure tested to ensure it is sealed.

Once the well is sealed and tested the casing is perforated at the target depth, allowing fluids and gas to flow freely between the formation and the well.

The Turangi B well site currently has one well. Turangi B was drilled to a depth of approximately 4100m.

Management of stormwater, wastewater and solid drilling waste

The Turangi B wellsite is situated approximately 375m from an unnamed tributary of the Parahaki Stream. Management systems were put in place to avoid any adverse effects on the surrounding environment from exploration and production activities on the wellsite. There are several sources of potential contamination from water and solid waste material, which therefore require appropriate management. These are:

- Stormwater from 'clean' areas of the site [e.g. parking areas] which may run off during rainfall. There is potential that this runoff will pick up small amounts of hydrocarbons and silt due to the nature of the activities on site;
- Stormwater which collects in the area surrounding the drilling platform and ancillary drilling equipment. This stormwater has a higher likelihood of contact with potential contaminants, particularly hydrocarbons;
- Produced water which flows from the producing formation and is separated from the gas and water phase at the surface;
- Drilling water [brought onto the site for making mud] which is surplus; and
- Drill cuttings, mud and residual fluid which are separated from the liquid waste generated during drilling.

Important requirements of the site establishment are to ensure that the site is contoured so that all stormwater and any runoff from 'clean' areas of the site flow into perimeter drains. The drains direct stormwater into a skimmer pit system on site consisting of one or two settling ponds. Any hydrocarbons present in the stormwater float to the surface and can be removed. The ponds also provide an opportunity for suspended sediment to settle. Treated stormwater is then discharged from the wellsite onto and into land or across land to subsequently enter into the Parahaki Stream.

Drilling mud and cuttings brought to the surface during drilling operations are separated out using a shale shaker. The drilling mud and some of the water was reused in the drilling process. Cuttings were collected in bins located at the base of the shaker and disposed of off site.

Hydraulic Fracturing

Hydraulic fracturing involves pumping fluids (consisting of freshwater, fraccing chemicals) and a proppant [medium-grained sand or small ceramic pellets] at high pressure down the well through the perforated casing and into the reservoir to exceed the fracture strength of the reservoir rock and hydraulically cause artificial fractures to develop in the receiving formation, but not in the overlaying geological seals that define the hydrocarbon reservoir. To do this the fraccing fluid is maintained under pressure for a period of time.

Once a fracture has been initiated, the fraccing fluid and proppant are carried into the fracture. The proppant keeps the fracture open when the pumping is stopped. The placement of proppant in 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 as back flow without disturbing the proppant wedge [i.e. the sand, small ceramic pellets or other particulates that prevent the fractures from closing when the injection is stopped], trapped in the fracture. With continued flow, formation hydrocarbon fluids should be drawn into the fracture, through the perforations into the wellbore, and hence to the surface.

Flaring from exploration activities

It is possible that flaring may occur via the following activities:

- well testing and clean-up;
- production testing;
- return of fracturing fluids;
- emergencies; and
- maintenance and enhancement activities [well workovers].

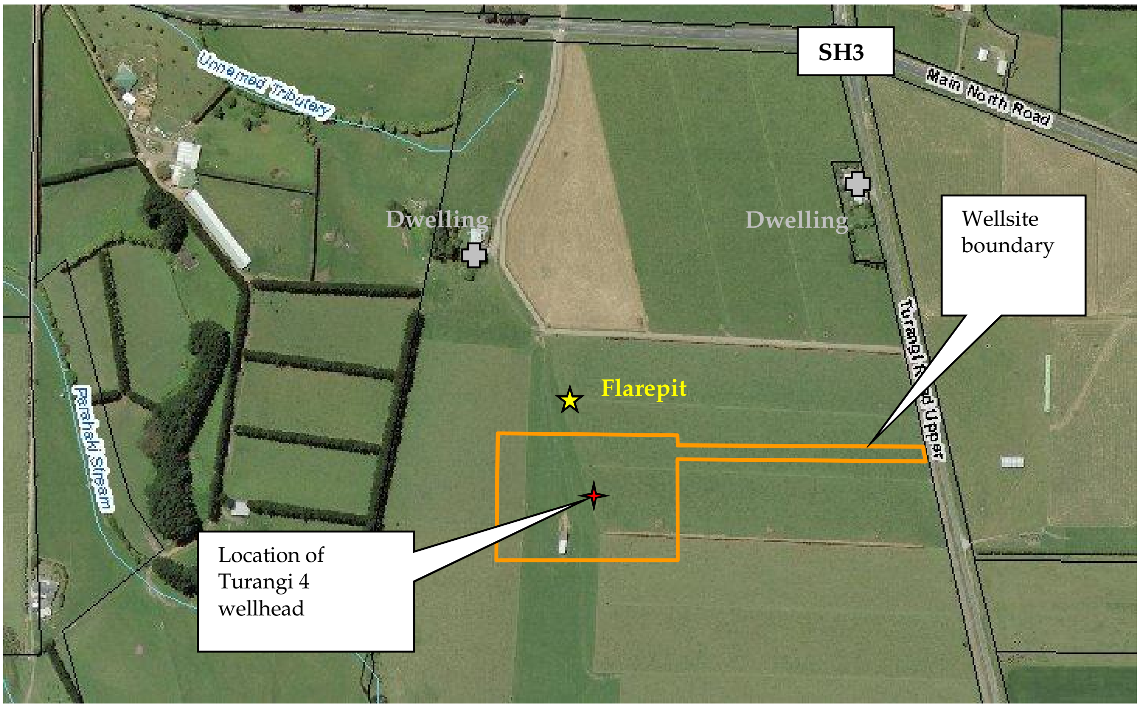

Photo 1 Aerial view showing the location of Turangi B well site

1.3 Resource consents

1.3.1 Background

Greymouth Petroleum Limited holds 6 resource consents related to exploration activities at the Turangi B site. Consents 7852-1, 7853-1, 7854-1, 7855-1 and 7857-1 were granted on 16 June 2011. Consent 7952-1 was granted on 8 November 2011. The consent applications were processed on a non-notified basis as Greymouth Petroleum Limited had obtained the landowner's approval as an affected party, and the Council was satisfied that the environmental effects of the activity would be minor.

The consents are discussed below.

Copies of the consents describing the associated activities are contained in Appendix I to this report.

1.3.2 Water abstraction permit

Section 14 of the Resource Management Act stipulates that no person may take, use, dam or divert any water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or it falls within some particular categories set out in Section 14.

As Greymouth Petroleum Limited was unable to estimate the rate or volume of the take, and as such, may exceed the limits of the permitted activity Rule [Rule 48 of the RFWP], the take of groundwater fell for consideration under Rule 49 of the RFWP as a controlled activity.

The standards of Rule 49 require that:

- The abstraction shall cause not more than a 10% lowering of static water-level by interference with any adjacent bore;
- The abstraction shall not cause the intrusion of saltwater into any fresh water aquifer.

Any produced water was likely to be from reserves below that which is used for domestic or farm purposes. In addition, there are no known bores within 500 m of the proposed wellsite. Shallow groundwater [which does not have any saltwater content] was to be protected by casing within the bore hole. Given these factors, the abstraction will not cause the above adverse effects.

The Council was satisfied that the activity meets all the standards for a controlled activity. It had to therefore grant the consent but imposed conditions in respect of those matters over which it had reserved control. Those matters over which the Council has reserved its control are:

- Volume and rate of abstraction;
- Daily timing of abstraction;
- Effect on adjacent bores, the aquifer, river levels, wetlands and sea water intrusion;
- Fitting of equipment to regulate flows and to monitor water volumes, levels,

flows and pressures;

- Payment of administrative charges;
- Monitoring and reporting requirements;
- Duration of consent;
- Review of the conditions of consent and the timing and purpose of the review.

Greymouth Petroleum Limited holds water take permit **7857-1** to **take groundwater, which is encountered as produced water during drilling at the Turangi B wellsite.**

This permit was issued by the Taranaki Regional Council on 16 June 2011 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2021.

In granting the consent it was considered that the taking of groundwater was unlikely to have any adverse affect on the environment.

Consent conditions were imposed on Greymouth Petroleum Limited to ensure that adverse effects are avoided in the first instance. A summary can be viewed in Table 5, Chapter 3.3.

A copy of the permit is attached to this report in Appendix I.

1.3.3 Water discharge permit (treated stormwater)

Section 15(1)(a) of the Resource Management Act stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations.
The discharge of contaminants from an industrial premise to land where the discharge is likely to enter water is a discretionary activity under Rule 44 of the RFWP, as the activity is not specifically provided for as a permitted activity.

Greymouth Petroleum Limited holds water discharge permit **7853-1 to discharge treated stormwater, produced water and drilling water from hydrocarbon operations on the wellsite**.

This permit was issued by the Taranaki Regional Council on 16 June 2011 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2027.
The discharge of stormwater may result in contaminants (e.g. sediment) entering surface water. These contaminants have the potential to smother in-stream flora and fauna. On-site management of stormwater, as discussed in 1.2 above, is necessary to avoid/remedy any adverse effects on water quality.

Consent conditions were imposed on Greymouth Petroleum Limited to ensure that adverse effects are avoided in the first instance. A summary can be viewed in Table 4, Chapter 3.3.

1.3.4 Water discharge permit (stormwater and sediment – earthworks)

Section 15(1)(a) of the Resource Management Act stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations.

As there was the potential that earthworks might be undertaken in winter [between 1 May and 31 October], the discharge of stormwater and sediment into and onto land in association with the earthworks fell for consideration under Rule 27 of the RFWP as a controlled activity [which may be non-notified without written approval].

The standards of Rule 27 require that:

- A site erosion and sediment control management plan shall be submitted to the Taranaki Regional Council.

Section 1.2.1 summarises the proposed erosion and sediment control plan, which was submitted within the application.

The Council was satisfied that the activity met all the standards for a controlled activity. It had to therefore grant the consent but imposed conditions in respect of those matters over which it reserved control. Those matters over which the Council reserved its control were:

- Approval of a site erosion and sediment control management plan and the matters contained therein;
- Setting of conditions relating to adverse effects on water quality and the values of the waterbody;
- Timing of works;
- Any measures necessary to reinstate the land following the completion of the activity;
- Monitoring and information requirements;
- Duration of consent;
- Review of conditions of consent and the timing and purpose of the review;
- Payment of administrative charges and financial contributions.

Greymouth Petroleum Limited holds water discharge permit **7852-1 to discharge stormwater and sediment onto and into land in association with earthworks for the construction of the wellsite.**

This permit was issued by the Taranaki Regional Council on 16 July 2011 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2015.

Consent conditions were imposed on Greymouth Petroleum Limited to ensure that adverse effects are avoided in the first instance. A summary can be viewed in Table 3, Chapter 3.3.

1.3.5 Air discharge permit (exploration activities)

Section 15(1)(c) of the Resource Management Act stipulates that no person may discharge any contaminant from any industrial or trade premises into air, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

Flaring in association with exploration activities falls for consideration under Rule 10 of the RAQP as a discretionary activity as there are no permitted rules for this activity.

Provided the activities are conducted in accordance with the applications and in compliance with the recommended special conditions, then no significant effects are anticipated. Special conditions were imposed on Greymouth Petroleum Limited to ensure that adverse effects were avoided in the first instance.

Greymouth Petroleum Limited holds air discharge permit **7855-1 to discharge emissions to air from flaring associated with well clean up and well testing.**

This permit was issued by the Taranaki Regional Council on 16 June 2011 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2027.

Consent conditions were imposed on Greymouth Petroleum Limited to ensure that adverse effects are avoided in the first instance. A summary can be viewed in Table 6, Chapter 3.3.

1.3.6 Air discharge permit (production activities)

Section 15(1)(c) of the Resource Management Act stipulates that no person may discharge any contaminant from any industrial or trade premises into air, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

Flaring in association with production activities falls for consideration under Rule 11 of the RAQP as a discretionary activity

The standard/term/condition of Rule 11 states that the:

- Discharger must at all times adopt the best practicable option to prevent or minimise any adverse effects on the environment.

Greymouth Petroleum Limited advised the Council that they would undertake the best practicable option. As such, Council was satisfied that the above standard/term/condition would be met.

Greymouth Petroleum Limited holds air discharge permit **7854-1 to discharge emissions to air during flaring from well workovers and in emergency situations.** This permit was issued by the Taranaki Regional Council on 16 June 2011 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2027.

Consent conditions were imposed on Greymouth Petroleum Limited to ensure that adverse effects are avoided in the first instance. A summary can be viewed in Table 7, Chapter 3.3.

1.3.7 Discharges to land (hydraulic fracturing)

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

The 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 RFWP.

The rule is a "catch all" rule as there is currently no specific rule for the discharge of fraccing contaminants. 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].

Provided the activities were conducted in accordance with the applications and in compliance with the recommended special conditions, then no significant effects are anticipated.

Greymouth Petroleum Limited holds discharge permit **7952-1 to discharge contaminants in association with hydraulic fracturing activities into land at depths greater than 3000mTVD.**

This permit was issued by the Taranaki Regional Council on 8 November 2011 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2016.

Consent conditions were imposed on Greymouth Petroleum Limited to ensure that adverse effects were avoided in the first instance. A summary can be viewed in Table 8, Chapter 3.3.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the Resource Management Act sets out obligation/s upon the Taranaki Regional Council to: gather information, monitor, and conduct research on the exercise of resource consents and the effects arising, within the Taranaki region and report upon these.

The Taranaki Regional Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations, and seek information from consent holders. The monitoring programme for exploration well sites consists of seven primary components. They are:

- Programme liaison and management
- Site inspections
- Chemical sampling
- Solid wastes
- Air quality monitoring
- Discharges to land (hydraulic fracturing)
- Ecological Surveys

The monitoring programme for the Turangi B wellsite focused primarily on programme liaison and management, site inspections, and chemical sampling. However, the seven components are discussed below.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Taranaki Regional Council in on-going liaison with resource consent holders over consent conditions and their interpretation and application, in discussion over monitoring requirements, preparation for any reviews, renewals, or new consents, advice on the Council's environmental management strategies and the content of regional plans, and consultation on associated matters.

1.4.3 Site inspections

Site inspections are undertaken to ensure that good environmental practices were adhered to and resource consent special conditions were complied with.

The inspections also provide an opportunity for monitoring officers to liaise with staff about on site operations; monitoring and supervision; discuss matters of concern; and resolve any issues in a quick and informal manner.

Inspections pay special attention to the ring drains, mud sumps, treatment by skimmer pits and the final discharge point from the skimmer pit on to land and then into water.

During each inspection the following are checked and noted:

- weather;
- flow rate of surface waters in the general vicinity;
- flow rate of water take;
- whether pumping of water was occurring;
- general tidiness of site;
- ring drains;
- hazardous substance bunds;
- treatment by skimmer pits;
- drilling mud;
- drill cuttings;
- mud pit capacity and quantity contained in pit;
- sewage treatment and disposal;
- cementing waste disposal;
- surface works;
- whether flaring was in progress, and if there was a potential for flaring, whether the Council had been advised;
- discharges and surface waters in the vicinity for effects on colour and clarity, aquatic life and odour;
- site records; and
- general observations

1.4.4 Chemical sampling

The Taranaki Regional Council undertakes sampling of discharges from site and from sites upstream and downstream of the discharge point to ensure that resource consent special conditions are complied with.

1.4.5 Solid wastes

Taranaki Regional Council monitors the disposal of drill cuttings on site via mixed bury cover to ensure compliance with resource consent conditions.

In recent times consent holders have opted to remove drilling waste from the site by contractor and dispose of it at licensed disposal areas (land farming).

1.4.6 Air quality monitoring

Air quality monitoring is usually carried out in association with the well testing and clean-up phase, where flaring can cause smoke emissions.

Assessments were made by officers of the Council during site inspections to ensure that Greymouth Petroleum Limited took all practicable steps to mitigate any effects from flaring gas

Officers checked that that plant equipment is working effectively, that there is the provision of liquid and solid separation, and that staff on site have regard to wind direction and speed at the time of flaring.

The flare pit was also inspected to ensure that solid and liquid hydrocarbons are not combusted within the flare pit.

It is also a requirement that Taranaki Regonal Council and immediate land owners are notified prior to any gas being flared. This requirement was checked to ensure compliance.

In the case of flaring activities at the Turangi B wellsite, the Council undertook a comprehensive air quality monitoring investigation, surveying both the emissions from the flare pit and downwind (ambient or receiving environment) air quality. Since hydraulic fracturing was being undertaken, this presented the first opportunity for the Council to measure the effects of flaring used for the destruction of returned fracturing fluids. The work is summarised in Appendix II and fully reported separately.

1.4.7 Discharges to land (hydraulic fracturing)

Monitoring the effects of hydraulic fracturing discharges is difficult due to the nature of the discharge (into land). Sampling and analysis of the fraccing fluid, return flow, groundwater from monitoring bores and nearby streams may be carried out. Inspections of the site and surrounding land and water may be carried out to ensure that no visible effects had occurred as a result of the discharge to land. Pre and post hydraulic fracturing reports may be submitted detailing among other things, the effectiveness of the mitigation measures put in place to protect the environment.

In this case the Council initiated a comprehensive (sampling of monitoring bores, springs and existing water abstraction wells over a wide area) and long term (12 months) programme of groundwater monitoring to determine whether there were any effects on shallow groundwater aquifers from any site activity, including hydraulic fracturing or the use of the flare pit.

1.4.8 Ecological surveys

Ecological surveys may be carried out pre and post occupation of the well site to assess whether the activities carried out on site, and associated discharges have had any effect on ecosystems.

Given that in this case the nearest potential receiving water course was more than 300 metres away, and that the inspections of the water course confirmed an absence of any indication that a discharge from the site had entered the tributary, no ecological surveys were justified.

2. Results

2.1 Water

2.1.1 Inspections

The Turangi B site, adjacent land and streams were inspected 19 times from the site construction phase through to the completion of drilling and flaring phases.

Below are copies of the comments that were noted on the day of each inspection.

29 July 2011
Site earthworks were progressing. A geotextile mat and a hard coarse top layer had been applied by the time of inspection. The flare pit had been constructed. A large earth bund had been placed along the perimeter on the southern and western sides. The ring drains had been formed and they led to two skimmer pits that then discharged into a drain and then onto land. It was noted the skimmer pits/settlement ponds may not be capable of complying with condition 2 of consent 7852-1 as they needed to have a capacity of 200cu metres for every 1ha exposed.

The following action was to be taken: Please ensure that condition 2 of resource consent 7852-1 is being complied with at all times.

16 August 2011
Earthworks associated with site construction had ceased and drilling had commenced. The ring drains did not contain water in them. Both skimmer pits were nearly empty. Stormwater entering the first pit was being pumped and reused. The site was clean and tidy. No flaring was occurring at the time of inspection. Consent conditions were being complied with at the time of inspection.

23 August 2011
Resource consent conditions were being complied with at time of inspection. The ring drains were dry. The first skimmer pit was half full and water was being pumped out and reused on site. The second skimmer pit was empty. No flaring was occurring at the time of inspection.

29 August 2011
Resource consent conditions were being complied with at the time of inspection. No stormwater was discharging from the site. The skimmer pits were empty of water. It was noted that a brown "molasses colour" liquid was discharging from the working area of the site and migrating towards the ring drain.

The following action was to be taken: Ensure that the best practicable option is adopted to prevent or minimise any actual or likely effect on the environment.

8 September 2011
The site, including ring drains and skimmer pits was dry. Drilling was continuing at present but may stop soon. The Council Officer discussed with Andy (site supervisor) the idea of putting sawdust around the mud pump, as oily water was discharging onto ground and flowing towards the ring drain. It appeared that all consent conditions were being complied with at time of inspection.

13 September 2011
The site was wet from heavy rain during the night. There were a lot of puddles on site, of which a few had hydrocarbon sheens on the surface. The ring drains contained stormwater which was flowing into the first skimmer pit. The first skimmer pit was half full and the second skimmer pit was empty. It was observed that waste oil had been spilt but contained within the bulk fuel bund. Andy (site supervisor) said that the oil would be cleaned up. It was observed that puddles around the waste mud/sawdust pile were grey in colour, potentially containing salt. These puddles were draining to the first skimmer pit. No stormwater was discharging off the site at the time of inspection.

19 September 2011
There were puddles on the site from recent rain. The ring drain was dry. The first skimmer pit was nearly full and discoloured. The second skimmer pit was empty. No stormwater or produced water had discharged from site via the discharge pipe. Down hole operations were still progressing. No flaring had occurred.

30 September 2011
Drilling operations had ceased and the rig and all associated equipment were going to be moved off site within the next couple of days. The ring drains were dry. The first skimmer pit contained stormwater. The second skimmer pit was dry. It was observed that drilling muds/fluids and water had discharged onto the ground below the rig and associated equipment including the mud pumps, D tanks, and the shale shaker. An attempt had been made in some places to contain the discharges in drains and sumps.

The following action was to be taken: To ensure that the site was remediated once all drilling equipment had been removed, to ensure compliance with Special Condition 1 of Resource Consent 7853-1.

5 October 2011
The site was sodden from torrential rain a couple of days prior. The ring drains were free of pooled stormwater. Both skimmer pits contained stormwater. It was evident that stormwater had discharged onto nearby land. No adverse effects were observed on the land at the time of inspection. A water sample was taken from the second skimmer pit. No flaring was occurring at time of inspection.

15 November 2011
A site visit was carried out to coincide with a hydraulic fracturing operation. The site was dry. Some clear water (appeared to be groundwater) was observed within the skimmer pits and no stormwater was discharging to land via the discharge pipe. There was good bunding on site with chemicals and storage tanks placed within earth bunds. Plastic drip trays were also in use. No flaring was occurring at the time of inspection; however a sand catcher and separation equipment had been set up in preparation for the flow of hydrocarbons from the well. The original flare pit had been doubled in size and stones had been laid along the bottom and half way up the side of the pit. The discharge of fraccing fluids was going to take place below 3500 metres (true vertical depth). Samples of the discharged crosslinked gel/proppant were taken for analysis at the time of inspection.

24 November 2011
Stormwater had pooled within the ring drains as a result of rain overnight. No hydrocarbon sheens were observed on puddles. Stormwater within the first skimmer pit appeared unusual in colour (brown/green). There was also brown foam on the surface. It was suggested by staff that the stormwater be pumped out and disposed of off site. A sucker truck arrived during the inspection. The second skimmer pit was dry and no stormwater was discharging via the exit pipe. Flaring had been occurring via the separator. There was no flaring at the time of inspection. The flare pit was dry with no visible signs of liquid or solid hydrocarbon. Bunding was in place around storage containers/chemicals.

1 December 2011
Works were underway to prepare the site for a second hydraulic fracturing operation. The site was reasonably clean and tidy. Most, but not all chemicals were bunded. Some minor spills/stains were observed onsite (outside bunded areas). The site and ring drains were dry. The first skimmer pit contained a small amount of clean water and the second skimmer pit was dry. The flare pit was clean. At the time of inspection none of the consents were being exercised as stormwater or emissions were not being discharged, ground water had not been encountered, and contaminants were not being discharged.

10 December 2011
The resource consents were not being exercised at time of inspection. It was likely that the stormwater consent (7853-1) would be exercised if it continued to rain. The ring drains were full and discharging brown water (silt and sediment) into the first skimmer pit. Stormwater was not flowing from the first to the second skimmer pit. The second skimmer pit contained clean (ground) water and was not discharging offsite. All conditions of consent 7853-1 were being complied with at the time of inspection.

26 January 2012
Drilling operations had ceased and testing operations had commenced. The site was dry. A small volume of stormwater was present in both skimmer pits with no water discharging off site. Flaring of hydrocarbons associated with the well clean up and well testing was occurring at the time of inspection. Liquid and solid hydrocarbon was separated from gas with only gas being flared. The flare was clean with no smoke observed. Neighbours within 300m of the wellsite confirmed they had been notified of the commencement of flaring. Consent 7952-1 was recently exercised. No effects were observed at ground level as a result of fracturing operations. Neighbours within 300m of the wellsite stated they did not notice anything out of the ordinary over the previous weekend.

9 February 2012
The resource consents were not being exercised at the time of inspection. No water was discharging from the site. Gas was not being flared. No groundwater had been encountered. Hydraulic fracturing had occurred earlier in the week with consent conditions being complied with. Flaring was also carried out earlier in the week and was monitored by Council staff. The site was dry but the skimmer pits contain clear groundwater.

20 February 2012
The well was being tested for hydrocarbons at the time of inspection. Flaring was occurring at the time of inspection. Council had been notified that flaring was to occur. Gas from the well went through a separator prior to being flared. The flare was burning clean with no smoke visible. The site was dry with no discharge of stormwater from the site. It appeared that consent conditions were being complied with.

27 February 2012
The site was dry. No stormwater was discharging offsite. The skimmer pits contained groundwater. No flaring occurred at the time of inspection. The flare pit contained a copper coloured liquid solution. The level of the solution had dropped over the past week, indicating that it had evaporated during the dry period, or had been pumped out or discharged to ground. A crust was forming on top of the solution. Hydraulic fracturing was not occurring at the time of inspection.

5 March 2012
Some areas of the site contained puddles caused by rain over the preceding days. The ring drains were dry. The first skimmer pit was nearly full and there was evidence that stormwater had discharged into the second skimmer pit. The second skimmer pit was half full and it did not appear to have discharged via the exit pipe. No flaring had taken place in the last seven days. The dry crust observed in the flare pit during the last inspection had disappeared. Copper coloured water was still present in the base of the flare pit. Works were being undertaken to prepare the well for further hydraulic fracturing below 3410m. No groundwater had been abstracted. It appeared that all consent conditions were being complied with.

1 May 2012
The drilling rig and associated equipment had been removed from the site. Personnel were on site installing structures associated with the installation of pipelines. The site was mostly dry. The ring drain was dry and vegetation was observed growing in and around the drain. The first skimmer pit was three quarters full and contained fine suspended solids. The second pit was empty. The bulk storage containers were bunded. There were a lot of containers (mostly empty) in the southern corner of the site. Some of the containers contained fracturing waste and were not sealed. Others contained chemicals (labelled toxic) and were not bunded. Personnel on site advised that these would be removed from the site that day. The site was stained in places from oil, grease, and drilling waste and appeared that the site has not been cleaned since the drill rig left. The flare pit contained a dark brown liquid that covered a small part of the base of the pit. A chemical odour was present.

2.1.2 Results of abstraction and discharge monitoring

During the period under review it was confirmed that stormwater had discharged from the skimmer pits to land on one occasion following a heavy rainfall event. During an inspection on 5 October 2011 a sample was collected from the second skimmer pit and chemical analysis of the stormwater was carried out.

Results (see Table 1) found that the concentration of chloride was within the discharge limits set by condition 6 of resource consent 7853-1. The levels of hydrocarbons and pH in the discharge were well below the point at which concentrations adversely affect water quality.

Further site Visits
Additional visits to the site were undertaken on six occasions between 11 November 2011 and 9 November 2012 for the primary purpose of collecting groundwater samples as part of the continuing survey of possible long-term or latent environment effects at such sites. While not comprising comprehensive site inspections (as per earlier monitoring inspections) due to the lack of activity on the site during this period, observations during these visits indicated an absence of effects throughout the remainder of the period under review.

The concentration of suspended solids (140gm^3) in the sample was higher than the limit of 100gm^3 typically set by Taranaki Regional Council in cases of a direct discharge to water. The discharge flowed in an easterly direction onto a neighbouring paddock and towards an unnamed tributary of the Parahaki Stream. The discharge from site was unlikely to reach the stream due to the distance the wellsite was from the stream and more likely to have soaked into the paddock.

Towards the end of the monitoring period when there were periods of low rainfall it was observed that clear groundwater had entering the skimmer pits. While it was theoretically possible that contaminants from the site might have discharged into groundwater due to the permeable nature of the pit walls, preliminary results of groundwater monitoring around the site showed in fact that no effects were detected.

All sewage from the camp was directed for treatment through a septic tank system and removed by contractor to a licensed disposal facility.

Cementing wastes were contained and disposed of offsite.

No water was abstracted from the Parahaki Stream. Municipal water was trucked to site.

During exploration activities on the site both synthetic based muds (SBM) and water based muds (WBM) were used. WBM were used to drill the surface and production sections of the well, and SBM was used to drill the intermediate section of the well.

The drill cuttings were removed from the site by contractor and disposed of at Remediation's Uruti licensed waste processing site.

Table 1 Results of water sample taken on 5 October 2011

	Discharge Sample
Chloride (g/m^{-3})	28.8
Conductivity at 20 °C	11.2
pH	7
Hydrocarbons (gm^{-3})	3
Suspended solids (gm^{-3})	140

2.1.3 Results of receiving environment monitoring

The unnamed tributary of the Parahaki Stream was visually inspected on occasion in association with a site inspection. The need for weekly inspection was not considered necessary to the due to the distance the wellsite was from the stream and the infrequency of discharges from the site. For this reason no chemical analysis or bio-monitoring surveys of receiving waters was carried out.

When the stream was visually inspected no effects were observed and the stream appeared clear with no visual change in colour or clarity. There was also no odour, oil, grease films, scum, foam or suspended solids observed in the stream during the monitoring period.

2.2 Air

2.2.1 Inspections

Air quality monitoring inspections were carried out in conjunction with general compliance monitoring inspections. See section 2.1.1 above for comments concerning site inspections.

2.2.2 Results of discharge monitoring

Greymouth Petroleum Limited notified Taranaki Regional Council of its intention to test the well and flare gas on 10 November 2011. There are residents living within a 1km radius of the well. The air discharge consent required that these residents be notified 24 hours prior to any gas being flared. Taranaki Regional Council contacted local residents to confirm that this condition was complied with.

It appeared that Greymouth Petroleum Limited took all practicable steps to mitigate any effects from smoke which included ensuring that plant equipment was working effectively and having regard to wind direction and speed. No smoke complaints were received by Taranaki Regional Council and no offensive or objectionable smoke or odours were observed by monitoring officers.

The flare pit was inspected during every inspection to ensure that solid and liquid hydrocarbons were not combusted within the flare pit. There was no evidence to suggest that solid and liquid hydrocarbons were being combusted through the gas flare system (other than the special investigations reported below in 2.2.3.1).

From observations during site inspections it appeared that special conditions relating to the control of emissions to air from the flaring of hydrocarbons were complied with.

2.2.3 Results of receiving environment monitoring

2.2.3.1 Investigation of air quality arising from flaring of fracturing fluids – emissions and ambient air quality

Recent speculation has focused on the nature of potential effects arising from the use of hydraulic fracturing (HF) fluids within production enhancement activities, as these fluids include compounds additional to those used in drilling.

These compounds include biocides, gelling and gel-breaking agents, inert proppants such as sand or microscopic ceramic beads, and 'slicking' agents.

Under emergency circumstances, safety and equipment protection requirements may necessitate the discharge of the fluids to a flare pit without separation so that the entrained hydrocarbon gas can be combusted for reasons of safety.

The Council therefore undertook a study of the nature of flare characteristics and downwind consequences at the site, when the pit contained hydraulic fracturing fluids.

The investigation covered combustion zone emissions of particulate matter (PM), dioxins and furans (PCDD/PCDF), polyaromatic hydrocarbons (PAHs), aldehydes (formaldehyde, acetaldehyde, and propionaldehyde), volatile organic compounds (VOC), methanol, and the more conventional products of combustion (oxygen, carbon dioxide, carbon monoxide, nitrogen oxides, and sulphur dioxide).

The results discussed below[2] show that no adverse environmental effects were associated with the combustion of gas and fracturing fluids at the Turangi B wellsite during the monitoring period.

Particulate matter (PM2.5, PM10)
The air downwind of the flare would be rated according to MfE criteria as 'excellent' in respect of the PM10 concentration. The PM2.5 concentrations in the vicinity of the flare were similar to or slightly below those found elsewhere in the region as background (ambient) concentrations, and are far below international guidelines.

Dioxins and furans
Emissions of dioxins and furans expressed as toxic equivalents could not be distinguished from zero.

Polyaromatic hydrocarbons (including BaP)
Within the evaporation zone above the surface of the fracturing fluid, levels of BaP equivalents were lower than is found in ambient air within central city locations in New Zealand, and only minimal further dilution (dispersion) would be required to reduce PAH/BaP concentrations to levels similar to or lower than is typically encountered more widely in urban areas.

Aldehydes (including formaldehyde)
The formaldehyde concentrations in the vicinity of the flare, including those sites closest to the flare, are similar to those found elsewhere in the region, and are well below (less than 20% of) the MfE guideline. The air downwind of the flare beyond the closest ambient monitoring location would be rated as 'excellent' according to MfE criteria in respect of the formaldehyde concentrations, and even at the site 70 metres downwind would be rated as 'good'.

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[2] The full report is available at http://www.trc.govt.nz/hydraulic-fracturing/ as *Investigation of air quality arising from flaring of fracturing fluids - emissions and ambient air quality* – Taranaki Regional Council, published 2012

Volatile organic compounds (including BTEX):
Benzene results show that within a distance of 300 metres from the flare, benzene levels had reduced to a steady (background) level. All results, including those closest to the flare, were below the MfE guideline criterion, and at 140 metres downwind were half or less of the MfE guideline value.

Air beyond 140 metres downwind of the flare would be rated as 'good' according to MfE criteria in respect of the benzene concentrations, and further away (beyond 300 metres) would be rated as 'excellent' in respect of benzene concentrations.

Toluene and xylene were found 70 metres downwind of the flare, at 10% and 3% respectively of the MfE ambient guidelines. The air at all points sampled downwind of the flare would be rated as 'excellent' according to MfE criteria in respect of the toluene and xylene concentrations.

Methanol
Even within the combustion zone and the evaporation zone as sampled, the levels of methanol were far below limits that might be derived for population health protection.

Carbon monoxide and carbon dioxide
No carbon monoxide was detected downwind at the limit of detection of the meter used. This means that the air at all points sampled downwind of the flare would be rated as 'good' or better according to MfE criteria in respect of the carbon monoxide concentration.

2.2.4 Other ambient monitoring

No other ambient air sampling was undertaken, as the controls implemented by Greymouth Petroleum Limited did not give rise to any concerns with regard to air quality.

2.3 Land

2.3.1 Inspections (hydraulic fracturing)

Land monitoring inspections were carried out in conjunction with general compliance monitoring inspections.

2.3.2 Results of discharge monitoring (hydraulic fracturing)

The unnamed tributary of the Parahaki Stream was visually inspected on occasion in association with a site inspection. No effects were observed and the receiving surface water bodies appeared clear with no visual change in colour or clarity before, during and after the discharge. There was also no odour, oil, grease films, scum, foam or suspended solids observed in the receiving surface water bodies during the monitoring period.

Greymouth Petroleum Limited first notified Taranaki Regional Council of its intention to hydraulically fracture the well on 9 November 2011.

On/after a hydraulic fracturing event took place local residents were spoken to. They were asked if they had felt any vibrations or noticed whether anything unusual had occurred. None of the local residents had experienced any effects from the discharge of fracturing fluids into land. Samples of the fracturing fluid were obtained prior to it being discharged into land and when it flowed back to surface. These samples were held in storage and analysed.

Resource Consent 7952-1 required a post fracture discharge report to be submitted that provided details of the activity and its effects (such as the depth, length and height of fractures; total volume of liquid pumped into the ground and the amount of fluid removed from the ground). A report for each discharge was submitted to the Council.

A summary of the information contained within those reports is set out below:
5 zones were hydraulically fractured over 6 events. Zone 1 was fractured on 15 November 2011, zone 2 on 3 December 2011 and 22 January 2012, zone 3 on 2 February 2012, zone 4 on 18 February 2012 and zone 5 on 7 March 2012.

Condition 1 of resource consent 7952-1 required that the discharge of fracturing fluids occur below 3410m. Zones 1 and 2 were located between 4000m and 4100m, zone 3 was located between 3700m and 3800m, zone 4 was located between 3600m and 3700m and zone 5 was located between 3400m and 3500m.

The average time to complete a fracture was 77 minutes. Individual fracturing operations took between 30 and 130 minutes to complete.

In total 2572m^3 of fracturing fluid was pumped into the ground. This equates to an average of 428m^3 per zone. In total 2047m^3 of fluid was recovered from the well. Zones 1 and 2 returned more fluids than was pumped down the well suggesting that produced saline water was extracted during the period of return flow. The 3 other zones returned only a percentage of the fracturing fluid (between 49% and 84%) with the balance remaining within the formation. Overall 28% of the fracturing fluid remained in the formation.

The total percentage of hydraulic fluid remaining in the formation will reduce further as hydrocarbon production occurs. The reduction occurs when formation fluids in the reservoir are brought to the surface for treatment (i.e. water/chemicals and in-situ saline formation fluids are separated from hydrocarbons). Any calculation of residual HF fluids remaining long term underground has to take these points into consideration.

In total 372.1 tonne of proppant was pumped into the ground. This equates to 62 tonne of proppant per fracturing operation. 97% of the proppant was pumped into the target formations with only 3% (12 tonne) of proppant returning to surface.

Table 2 shows the difference between zones in the amount of fluid/proppant discharged to land and returned to surface.

All returned water was collected and stored in tanks before being disposed of either within the flare pit as described earlier, or offsite and all condensate was trucked to the Omata Tank Farm.

Table 2 Difference between zones in the amount of fluid/proppant discharge to land and returned to surface

	Fluid Discharged (m^3)	Proppant Discharged (tn)	Fluid Returned (m^3)	Proppant Returned (tn)
Zone 1	324	38.2	364	0
Zone 2	131	12	0	0
Zone 2a	516	79.1	653	0
Zone 3	564	90.2	471	0
Zone 4	371	47.5	260	0
Zone 5	609	94.7	299	0

Council records show that on average 97% of the total volume of fracturing fluids contained water. 98% of the fluids pumped into zone 1 consisted of water. 97% of the fluids pumped into zones 2, 3 and 4 consisted of water and 96% of the fluids pumped into zone 5 consisted of water.

Condition 2 of resource consent 7952-1 stated that no discharge shall occur more than 500m horizontally from the wellsite. The resultant hydraulic fractures varied between zones. The information submitted to Council shows that no fracture extended beyond 500m horizontally from the wellsite. Table 3 shows the differences between zones in fracture dimensions and proppant density.

Table 3 Hydraulic fracture dimensions and proppant density

	Fracture Length (m)	Fracture Height (m)	Fracture Width (mm)	Proppant Density (kg/m^2)
Zone 1	227	28	3.2	4.2
Zone 2	28	36	1.4	2.8
Zone 2a	194	42	1.9	3.8
Zone 3	268	38	3.1	4.8
Zone 4	217	30	2.3	4.7
Zone 5	167	57	2.3	4.3

Greymouth Petroleum Limited's mitigation measurements worked as planned. There was a zero discharge into the flare pit (except for the discharge of fracturing fluids associated with Taranaki Regional Council's investigation of air quality arising from flaring of fracturing fluids) and all fluids were collected in storage tanks after being flowed through the sand catchers and a separator.

2.3.3 Results of receiving environment monitoring (hydraulic fracturing)

Five groundwater bores were installed around the site and a further 6 existing water wells were used to monitor any effects that might have arisen as a result of hydraulic fracturing. 1 bore and 1 well was upstream of the site and the other 9 bores/wells were downstream. A baseline sample was collected prior to hydraulic fracturing operations commencing. Further samples were collected 1 week, 1 month, 3 months, 6 months and 1 year after the initial discharge.

As discussed in 2.1.2 above, it was observed that groundwater had entered the skimmer pits and it was considered possible that contaminants from the site may have discharged into groundwater due to the permeable nature of the pit walls.

A report detailing the findings of the groundwater monitoring is being drafted. Preliminary results show that there was no increase in the level of contaminants above background levels and that no groundwater effects were detected from any of the activities carried out at the wellsite.

2.3.4 Land status

The well site was constructed on flat land in a rural dairy farming area. Significant earthworks were required to construct the site. The land had not been reinstated at the time of the last inspection (1 May 2012) and Taranaki Regional Council has not been notified of any intention for reinstatement of the site. Such notice is required by special condition 8 of Resource Consent 7853-1, when reinstatement is to occur.

The land has not been reinstated as the well is currently being tested/producing.

2.4 Contingency plan

Greymouth Petroleum Limited has provided a general contingency plan, as required by condition 4 of Resource Consent 7853-1, with site specific maps which covers onshore sites that they operate. The contingency plan has been reviewed and approved by officers of the Taranaki Regional Council.

2.5 Investigations, interventions, and incidents

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

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

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

In the period under review, there were no abatement notices issued and no Unauthorised Incidents (UI) recorded by the Council in relation to the operations occurring at the Turangi B wellsite.

Any minor potential non-compliance with consent conditions was addressed during site inspections. Greymouth Petroleum Limited's staff would quickly take steps to ensure that requests made by Council officers were adhered to without delay.

3. Discussion

3.1 Discussion of consent compliance

Of the 6 resource consents relating to the Turangi B wellsite, consents 7952-1 (hydraulic fracturing), 7855-1 (flaring associated with well clean-up), 7853-1 (stormwater discharge - exploration, and 7852-1 (stormwater discharge – earthworks) were exercised and actively monitored.

Consent 7857-1 (take groundwater) was not exercised as no groundwater was encountered during the drilling phase.

Greymouth Petroleum Limited provided Council with the following plans and information in compliance with the consents:

- A spill contingency plan for accidental spillage or discharge of contaminants
- Maximum stormwater catchment area
- Advice of drilling mud's and fluids composition;
- Final site layout plan;
- Notification of the various stages of activity.

Careful management on site ensured that no effects to the environment occurred.

From observations during site inspections, from information submitted to Council and through analysing sample results it is believed that all conditions of the above resource consents were complied with during the monitoring period.

3.2 Environmental effects of exercise of consents

Stormwater

The discharge of stormwater from earthworks had the potential for sediment to enter surface water where it may have smothered in-stream flora and fauna. To mitigate discharges that might lead to these effects, perimeter drains were established during the construction of the wellsite, and care was taken to ensure runoff from disturbed areas was directed into the drains or directed through adequate silt control structures.

Once the well was constructed, attention was given to controlling stormwater that ran off the wellsite and the associated plant and equipment.

Adverse effects on surface water quality had the potential to occur if contaminated water escaped through the stormwater system. Interceptor pits are designed to trap and retain sediment and hydrocarbons through gravity separation. Any water that was unsuitable for release via the interceptor pits was directed to the drilling sumps, or removed for off-site disposal.

Greymouth Petroleum Limited also undertook the following mitigation measures in order to minimise off-site adverse effects:

- All stormwater was directed via perimeter drains to the skimmer pits for treatment prior to discharge;
- Additional bunding was constructed around the bulk fuel tank, chemical storage area and other areas where there was a possibility of runoff from areas containing contaminants;
- Regular inspections of the interceptor pits occurred, and
- Repairs and maintenance were carried out if required.

Interceptor pits did not discharge directly to surface water, and instead discharged onto and into land where the discharge could soak into the soil before reaching surface water. However, if rainfall was such that the discharge may have reached surface water, significant dilution would have occurred. Inspections of receiving waters found no evidence of any discharge.

There were numerous on-site procedures included in drilling and health and safety documentation that aimed at preventing spills on-site, and further procedures that addressed clean-up to remedy a spill situation before adverse environmental effects would have had the opportunity to occur (e.g. bunding of chemicals and bulk fuel, and absorption and recovery of small on site spills).

Groundwater

Small amounts of groundwater may have been encountered as produced water during drilling. It was anticipated that the abstraction of groundwater would not impact on any groundwater resource and that shallow groundwater would not be affected as it would be protected by the well casing. No adverse effects were observed during the monitoring period and no complaints were received with regard to this activity.

Flaring

The environmental effects from flaring have been evaluated and reported in previous and separate studies prepared by the Council in relation to the flaring emissions from specific wells in the region.

The measures to be undertaken by Greymouth Petroleum Limited to avoid or mitigate potential or actual adverse environmental impacts on air quality include:

- The use of a test separator to separate solids and fluids from gas during all well clean ups, and workover activities where necessary, thus reducing emissions to air. In particular, this eliminated the potential for heavy smoke incidents associated with elevated PAH and dioxin emissions;
- All residents with dwellings within 300m of the site were notified at least 24 hours prior to any flaring commencing wherever possible;
- Records of flaring events were kept by Greymouth Petroleum Limited and provided to the Council if required;
- Every endeavour was made by Greymouth Petroleum Limited to minimise the total volume of gas flared while ensuring that adequate flow and pressure data is gathered to inform a prudent investment decision;

- Every endeavour was made by Greymouth Petroleum Limited to minimise smoke emissions from the flare.

Odour and dust

Wet suppression of dust was to be considered if it was apparent that dust may be travelling in such a direction to adversely affect off-site parties. Odour may stem from the product, flare, or some of the chemicals used on site. Care was taken to minimise the potential for odour emissions [e.g. by keeping containers sealed, and ensuring the flare burns cleanly].

Hazardous substances

The use and storage of hazardous substances on-site had the potential to contaminate surface water and soils in the event of a spill.

Greymouth Petroleum Limited proposed the following mitigation measures:

- All potentially hazardous material was to be used and stored in accordance with the relevant Hazardous Substances regulations;
- All areas containing hazardous chemicals were to be bunded;
- Ignition sources were not permitted on any site;
- Sufficient separation distances of chemicals from the flare pit were maintained for safety reasons;
- In the unlikely event of a spill escaping from bunded areas, the site perimeter drain and interceptor pit system would provide secondary containment on site;
- A spill contingency plan was prepared. This set out emergency response procedures to be followed in the event of a spill.

Hydraulic fracturing ("fraccing")

The process of fraccing results in some of the chemicals [e.g. clay stablisers] being absorbed into the rock and some gel residually trapped near the fracture face. The chemicals used in the hydraulic fracturing process are chemicals that are classified as hazardous substances. However, these additives used in the process make up less than 2% of the total volume of fluid, the remaining being water. While in a concentrated form some of the chemicals used in the fluid are at toxic concentrations, but prior to the activity they are highly diluted as part of the process. The majority of the fluid returns to the surface, for recovery and controlled disposal at a consented facility.

Hence there is a discharge of contaminants [energy, chemicals, water and sand/ small ceramic pellets] to land at considerable depth that causes minor changes to the physical and chemical condition of the land [reservoir] in a way that does not affect other foreseeable users of the land and water resources.

The interval to be fractured was over 3.4 km below the fresh/saline water interface. It is isolated by a considerable thickness of impermeable rock. The reservoir sands are known to contain hydrocarbons at pressures that exceed hydrostatic pressure, proving that the cap rock is relatively impermeable to the flow of water and hydrocarbons over very long time scales and high pressures.

The hydro-geological risks of fraccing affecting potable groundwater above arise from two potential sources. The integrity of the well being used for the fraccing, including the well casing and cement programme, and the geologic integrity of the reservoir seal and seals above this.

Throughout the fracturing operation, the activity was carefully monitored to track exact composition, volume and pressure of all fluids being injected into the sub-surface environment. The surrounding countryside (especially waterways) was surveyed for any evidence of effects.

Summary

There were no environmental effects observed to water, land or air as a result of the exploration drilling during the monitoring period. There was no unauthorised discharge observed or reported from the Turangi B wellsite.

3.3 Evaluation of performance

A tabular summary of the Company's compliance record for the year under review is set out in Tables 4-9.

Table 4 Summary of performance for Consent 7852-1 - to discharge stormwater and sediment onto and into land

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Visually inspecting site, procedures & processes	Yes
2. Any stormwater from exposed areas of the site travel through settlement ponds of an appropriate size, taking into account the time of year and the area exposed	Visually inspecting the site to see that stormwater travels to the settlement ponds of the correct size	Yes
3. Erosion and sediment control measures can be removed when the site is stabilised.	Visually inspecting the site to check that appropriate measures have been put in place to stabilise the site.	Yes
4. All earth worked areas shall be stabilised as soon as practicable	Visual inspection	Yes
5. 7 days notice required prior to wellsite and access works commencing	Notification received 7 days prior to works commencing	Yes – received 29 June 2011
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**

Table 5 Summary of performance for Consent 7853-1 - to discharge treated stormwater, produced water and drilling water from hydrocarbon operations

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent Holder to adopt best practicable option at all times	Visually inspecting site, procedures & processes	Yes
2. Stormwater catchment area < 14000m2	By comparing submitted & approved plans with the built site	Yes
3. 7 days written notice prior to site works and also drilling	By confirming if works commenced before/after 7 days from date notice was given	Yes - received 30 July 2011
4. Maintain a contingency plan	Contingency plan received and approved	Yes
5. Stormwater directed through system before being discharge	Visual Inspection of stormwater system	Yes
6. No discharge of produced water with a chloride concentration >50ppm	Water sampling	Yes
7. Hazardous substances to be bunded/contained	Visual Inspection	Yes
8. 48hrs notice of the reinstatement of the site	Inspection / notification from company	N/A
9. Consent shall lapse if not implemented by date specified	Notification received/not received	N/A
10. Notice of Council to review consent	Notice of intention served/not served	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**

Table 6 Summary of performance for Consent 7857-1 - to take groundwater

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. The abstraction must not cause more than a 10% lowering of static water level by interference with any adjacent bore	Groundwater sampling/Complaints/Installation of a data logger in adjacent bores	Yes
2. The abstraction does not cause the intrusion of salt water into any freshwater aquifer	Water sampling adjacent bores pre/post drilling	Yes
3. A well log to 1000m must be submitted to TRC	Well log to 1000m submitted	Yes
4. Consent shall lapse if not implemented by date specified	Notification received/not received	N/A
5. Notice of Council to review consent	Notice of intention served/not served	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**N/A**

Table 7 Summary of performance for Consent 7855-1 - to discharge emissions to air from flaring (exploration activities)

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Flaring shall not occur for more than 15 days per zone, 4 zones per well up to 8 wells.	Inspection of records	Yes
2. 24hrs notice of flaring to TRC for initial flare of each zone	Notification received 24hrs prior to flaring	Yes
3. 24hr notice of flaring to all residents within 300 metres of the wellsite	Inspection of company records	Yes
4. Liquid and solid separation to occur before flaring to minimise smoke emissions	Inspection of flare pit and flare	Yes
5. Only gaseous hydrocarbons originating from well stream to be combusted in flare pit	Visual inspection of site	Yes
6. Best practicable option adopted	Visually inspecting site, procedures & processes	Yes
7. No offensive odour or smoke beyond boundary	Assessment by investigating officer	Yes
8. Control of carbon monoxide	Chemical analysis of emissions	Yes
9. Control of nitrogen oxides	Chemical analysis of emissions	Yes
10. Control of other emissions	Chemical analysis of emissions	Yes
11. Analysis of typical gas and crude oil stream from field to be made available to TRC	Available upon request	Not requested
12. Log all flaring including time, duration, zone and volumes flared	Inspection of company records	Yes
13. Consent shall lapse if not implemented by date specified	Notification of flaring received/not received	N/A
14. Notice of Council to review consent	Notice of intention served/not served	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**

Table 8 Summary of performance for Consent 7854-1 - to discharge emissions to air (production activities)

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. 24hrs notice of flaring to TRC when flaring is longer than 5 minutes in duration	Notification received 24hrs prior to flaring	N/A
2. 24hr notice of flaring to all residents within 300 metres of the wellsite	Residents confirm 24hr notice provided	N/A

Condition requirement	Means of monitoring during period under review	Compliance achieved?
3. Liquid and solid separation to occur before flaring to minimise smoke emissions	Inspection of flare pit and flare	N/A
4. Only gaseous hydrocarbons originating from well stream to be combusted in flare pit	Visual inspection of site	N/A
5. Best practicable option adopted	Visually inspecting site, procedures & processes	N/A
6. No offensive odour or smoke beyond boundary	Assessment by investigating officer	N/A
7. All storage tanks to have vapour recovery systems fitted.	Visual inspection of site	N/A
8. Control of carbon monoxide	Chemical analysis of emissions	N/A
9. Control of nitrogen oxides	Chemical analysis of emissions	N/A
10. Control of other emissions	Chemical analysis of emissions	N/A
11. Analysis of typical gas and condensate stream from field to be made available to TRC	Available upon request	N/A
12. Log all flaring including time, duration, zone and volumes flared	Inspection of company records	N/A
13. Consent shall lapse if not implemented by date specified	Notification of flaring received/not received	N/A
14. Notice of Council to review consent	Notice of intention served/not served	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**N/A**

Table 9 Summary of performance for Consent 7952-1 - to discharge contaminants in association with hydraulic fracturing activities into land

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Any discharge shall occur below 3410m TVD	Inspection of company records	Yes
2. Discharge shall occur no more than 500m horizontally from each wellsite	Inspection of company records	Yes
3. Exercise of consent shall not contaminate or put at risk freshwater aquifers	Sampling fresh water bores pre/post discharge	Yes
4. Sampling and testing programme to be undertaken to monitor effects on groundwater	TRC monitoring officers implement sampling and testing programme	Yes

Condition requirement	Means of monitoring during period under review	Compliance achieved?
5. Sampling to be undertaken prior to, 1 week, 1 month, 3 months and 1 year after the date that this consent is first exercised	TRC monitoring officers implement sampling and testing programme	Yes
6. Sampling and analysis to be undertaken in accordance with Sampling and Analysis Plan	Sampling and analysis is undertaken in accordance with Sampling and Analysis Plan	Yes
7. 24hrs notice to TRC prior to each discharge	Check that notification has been received by TRC	Yes
8. A post fracturing discharge report is to be provided to TRC within 30 days after the discharge has ceased	Post fracturing discharge report submitted within 30 days	Yes
9. The report must be emailed to consents@trc.govt.nz	The report is emailed to consents@trc.govt.nz	Yes
10. The consent holder shall provide access to a location where samples of fraccing fluids and return fluids can be obtained.	Access provided	Yes
11. Best practicable option adopted at all times	Visually inspecting site, procedures & processes	Yes
12. No hydrocarbon based fraccing fluids are to be discharged	Sample taken of discharge and return fluids	Yes
13. Notice of Council to review consent	Notice of intention served/not served	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**

N/A = not applicable

During the monitoring period, Greymouth Petroleum Limited demonstrated a "High" level of environmental performance and compliance with the resource consents. During the period under review there were no unauthorised spills or discharges to a surface water body. All Taranaki Regional Council requirements were adhered to swiftly and without question. The site was neat, tidy, and well maintained.

3.4 Exercise of optional review of consents

Condition 10 of consent 7853-1, condition 14 of consents 7854-1and 7855-1, condition 5 of consent 7857-1 and condition 13 of consent 7952-1 respectively allow the Council to review the consents in 2015, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of the resource consent, which either were not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Based on the results of monitoring during the period under review it is considered that there are no grounds that require a review to be pursued.

A recommendation to this effect is presented in Section 4 of this report.

3.5 Alterations to monitoring programmes for fracturing activities

In designing and implementing the monitoring programmes for air/water discharges and water abstractions at wellsites in the region, the Taranaki Regional Council takes into account the extent of information made available by previous and other authorities, its relevance under the Resource Management Act, the obligations of the Act in terms of monitoring emissions/discharges and effects, and of 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 wellsite processes within Taranaki.

The Council has routinely monitored wellsite activities for more than 20 years in the region. This work has included in the order of hundreds of water samples and biomonitoring surveys in the vicinity of wellsites, and has demonstrated robustly that a monitoring regime based on frequent and comprehensive inspections is rigorous and thorough, in terms of identifying any adverse effects from wellsite and associated activities. Accordingly the Council had for a time not routinely required the imposition of additional targeted physicochemical and biological monitoring unless a site-specific precautionary approach indicated this would be warranted for certainty and clarity around site effects.

In the case of the Turangi B wellsite, the monitoring programme was based on this pre-existing regime. Given that the primary effects of concern (had they occurred) would have involved the movement of either sediment and/or hydrocarbons, both of which are easily detectable through inspection and visual scrutiny, this represented an appropriate and well-grounded approach. The wide-ranging scope of the routine inspections in this particular programme to include adjacent waterways and feedback from local residents should particularly be noted.

However, the Council has also noted a general community desire for a heightened level of information feedback and certainty around the results and outcomes of monitoring at wellsites where fracturing is to occur or has occurred. Notwithstanding the long track record of a demonstrable suitability of an inspection-based monitoring programme, the Council has therefore moved to extend the previous regime, to make the sampling and extensive analysis of shallow groundwater and surface waters in the general vicinity of a wellsite where hydraulic fracturing occurs, and the programmed bio-monitoring of surface water ecosystems, an integral part of the basic monitoring programme for such activities. Therefore the implementation of the programme for the Turangi B site was extended as reported herein, to put an enhanced programme into effect.

It is proposed that for any further work at the Turangi B wellsite, the new standard programme will be continued, notwithstanding the lack of any effects or concerns previously found. A recommendation to this effect is attached to this report.

4. Recommendations

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

2. THAT the Company be asked to inform the Council of the intention to either drill, test or undertake reinstatement.

3. THAT the monitoring of consented activities at Turangi B wellsite continues at the same level as implemented during the 29 July 2011 - 31 December 2012 monitoring period.

4. THAT subject to the findings of monitoring of any further activities at the Turangi B wellsite, consents 7852-1, 7853-1, 7854-1, 7855-1, 7857-1, and 7952-1 not be reviewed in 2015.

Glossary of common terms and abbreviations

The following abbreviations and terms may have been used within this report:

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
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
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	grammes per cubic metre, and equivalent to milligrammes per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures
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

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 subsequent amendments
SS	suspended solids,
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
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

Appendix I

Resource consents held by Greymouth Petroleum Limited

TARANAKI REGIONAL COUNCIL
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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:	16 June 2011
Commencement Date:	16 June 2011

Conditions of Consent

Consent Granted:	To discharge stormwater and sediment from earthworks during the construction of the Turangi-B wellsite onto and into land at or about (NZTM) 1713603E-5682493N
Expiry Date:	1 June 2015
Site Location:	Turangi-B wellsite, Turangi Road, Motunui [Property owner: RJ Topless]
Legal Description:	Pt Lot 2 DP 7153 [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 all the administration, monitoring and supervision costs of this consent, fixed in accordance to section 36 of the Resource Management Act.

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment associated with the discharge of contaminants from the site.

2. If any area of soil is exposed, all run off from that area shall pass through settlement ponds or sediment traps with a minimum total capacity of;

   a) 100 cubic metres for every hectare of exposed soil between 1 November to 30 April; and
   b) 200 cubic metres for every hectare of exposed soil between 1 May to 31 October;

   unless other sediment control measures that achieve an equivalent standard are agreed to by the Chief Executive of the Taranaki Regional Council.

3. The obligation described in condition 2 above shall cease to apply, and accordingly the erosion and sediment control measures can be removed, in respect of any particular site or area of any site, only when the site is stabilised.

   Note: For the purpose of conditions 3 and 4 "stabilised" in relation to any site or area means inherently resistant to erosion or rendered resistant, such as by using rock or by the application of basecourse, colluvium, grassing, mulch, or another method to the reasonable satisfaction of the Chief Executive, Taranaki Regional Council and as specified in the Taranaki Regional Council's Guidelines for Earthworks in the Taranaki Region, 2006. Where seeding or grassing is used on a surface that is not otherwise resistant to erosion, the surface is considered stabilised once, on reasonable visual inspection by an officer of the Taranaki Regional Council, an 80% vegetative cover has been established.

4. All earthworked areas shall be stabilised vegetatively or otherwise as soon as is practicable immediately following completion of soil disturbance activities.

   Note: For the purposes of this condition "stabilised" has the same definition as that set out in condition 3.

5. At least 7 working days prior to the commencement of earthworks the consent holder shall notify the Taranaki Regional Council of the proposed start date for the earthworks. Notification shall include the consent number and a brief description of the activity consented and shall be emailed to worknotification@trc.govt.nz.

Signed at Stratford on 16 June 2011

For and on behalf of
Taranaki Regional Council

Chief Executive

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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:	16 June 2011
Commencement Date:	16 June 2011

Conditions of Consent

Consent Granted:	To discharge treated stormwater and produced water from hydrocarbon exploration and production operations at the Turangi-B wellsite onto and into land at or about (NZTM) 1713547E-5682544N
Expiry Date:	1 June 2027
Review Date(s):	June 2015, June 2021
Site Location:	Turangi-B wellsite, Turangi Road, Motunui [Property owner: RJ Topless]
Legal Description:	Pt Lot 2 DP 7153 [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 all the administration, monitoring and supervision costs of this consent, fixed in accordance to section 36 of the Resource Management Act.

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or likely adverse effect on the environment associated with the discharge of contaminants from the site.

2. Stormwater discharged shall be collected from a catchment area of no more than 1.4 ha.

3. The Chief Executive, Taranaki Regional Council, shall be advised in writing at least 7 working days prior to any site works commencing, and again in writing at least 7 days prior to any well drilling operation commencing. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.

4. The consent holder shall maintain a contingency plan that, to the satisfaction of the Chief Executive, Taranaki Regional Council, details measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants not authorised by this consent and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge.

5. All stormwater and produced water shall be directed for treatment through the skimmer pit[s] before being discharged.

6. There shall be no discharge of produced water with a chloride concentration greater than 50 ppm.

7. Any significant volumes of hazardous substances [e.g. bulk fuel, oil, drilling fluid] on site shall be:

   a) contained in a double skinned tank, or

   b) stored in a dedicated bunded area with drainage to sumps, or to other appropriate recovery systems, and not directly to the site stormwater system.

8. The consent holder shall advise the Chief Executive, Taranaki Regional Council, in writing at least 48 hours prior to the reinstatement of the site and the reinstatement shall be carried out so as to minimise adverse effects on stormwater quality. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.

9. This consent shall lapse on 30 June 2016, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

10. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2015 and/or June 2021, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 16 June 2011

For and on behalf of
Taranaki Regional Council

Chief Executive

TARANAKI REGIONAL COUNCIL

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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 [Change]:	5 December 2011
Commencement Date [Change]:	5 December 2011 [Granted: 16 June 2011]

Conditions of Consent

Consent Granted:	To discharge emissions to air associated with production activities at the Turangi-B wellsite, including: • flaring from well workovers; • flaring in emergency situations; and • emissions from other miscellaneous activities, at or about (NZTM) 1713656E-5682453N and 1713611E-5682583N
Expiry Date:	1 June 2027
Review Date(s):	June 2012, June 2015, June 2021
Site Location:	Turangi-B wellsite, Turangi Road, Motunui [Property owner: RJ Topless]
Legal Description:	Pt Lot 2 DP 7153 [Discharge source & site]

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

General condition

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

Special conditions

1. Other than in emergencies, the consent holder shall notify the Chief Executive, Taranaki Regional Council, whenever the continuous flaring of hydrocarbons [other than purge gas] is expected to occur for more than five minutes in duration. Notification shall be no less than 24 hours before the flaring commences. Notification shall include the consent number and be emailed to worknotification@trc.govt.nz.

2. At least 24 hours before any flaring, other than in emergencies, the consent holder shall provide notification of the commencement of flaring to all residents within 300 metres of the wellsite. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and complaints received in respect of any flaring activity.

3. To the greatest extent possible, all gas that is flared must first be treated by effective liquid and solid separation and recovery, other than for the purpose of any simulation of flaring of recovered fracture fluid together with any other material derived from the well stream with written approval by the Chief Executive, Taranaki Regional Council, prior to any simulation.

4. Only materials derived from the well or entrained in the well steam shall be combusted within the flare pit. However, this condition shall not apply in any simulation of flaring of fracture fluid with prior written approval by the Chief Executive, Taranaki Regional Council.

5. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air from the flare, including, but not limited to, having regard to the prevailing and predicted wind speed and direction at the time of initiation of, and throughout, any episode of flaring so as to minimise offsite effects [other than for the maintenance of a pilot flare flame].

6. The discharge shall not cause any objectionable or offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.

7. All permanent tanks used as hydrocarbon storage vessels, shall be fitted with vapour recovery systems.

8. The consent holder shall control all emissions of carbon monoxide to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of carbon monoxide arising from the exercise of this consent measured under ambient conditions does not exceed 10 milligrams per cubic metre [mg/m^3] [eight-hour average exposure], or 30 mg/m^3 one-hour average exposure] at or beyond the boundary of the property where the wellsite is located.

9. The consent holder shall control all emissions of nitrogen oxides to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of nitrogen dioxide arising from the exercise of this consent measured under ambient conditions does not exceed 100 micrograms per cubic metre [µg/m^3] [24-hour average exposure], or 200 µg/m^3 [1-hour average exposure] at or beyond the boundary of the of the property where the wellsite is located.

10. The consent holder shall control emissions to the atmosphere from the wellsite and flare of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides so that, whether alone or in conjunction with any emissions from the flare, the maximum ground level concentration for any particular contaminant arising from the exercise of this consent measured at or beyond the boundary of the property where the wellsite is located, is not increased above background levels:

    a) by more than 1/30th of the relevant Occupational Threshold Value-Time Weighted Average, or by more than the Short Term Exposure Limit at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour]; or

    b) if no Short Term Exposure Limit is set, by more than three times the Time Weighted Average at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour].

11. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure C_6 or higher number of compounds.

12. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council, a 'flaring log' that includes:

    a) the date, time and duration of all flaring episodes;

    b) the zone from which flaring occurred;

    c) the volume of substances flared;

    d) whether there was smoke at any time during the flaring episode and if there was, the time, duration and cause of each 'smoke event'.

13. This consent shall lapse on 30 June 2016, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

14. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2012 and/or June 2015 and/or June 2021, for any of the following purposes:

    a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or

    b) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or

    c) to alter, add or delete limits on mass discharge quantities or discharge or ambient concentrations of any contaminant.

Signed at Stratford on 5 December 2011

For and on behalf of
Taranaki Regional Council

Director-Resource Management

TARANAKI
REGIONAL
COUNCIL

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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:	16 June 2011
Commencement Date:	16 June 2011

Conditions of Consent

Consent Granted:	To discharge emissions to air associated with exploration activities at the Turangi-B wellsite, including: • flaring of hydrocarbons associated with well clean-up and well testing; and • emissions from other miscellaneous activities at or about (NZTM) 1713611E-5682583N
Expiry Date:	1 June 2027
Review Date(s):	June 2015, June 2021
Site Location:	Turangi-B wellsite, Turangi Road, Motunui [Property owner: RJ Topless]
Legal Description:	Pt Lot 2 DP 7153 [Discharge source & site]

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

General condition

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

Special conditions

1. Flaring shall not occur on more than 15 days, cumulatively, per zone for each well [with a maximum of 4 zones per well], for up to 8 wells.

2. The consent holder shall notify the Chief Executive, Taranaki Regional Council, at least 24 hours before the initial flaring of each zone being commenced. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.

3. At least 24 hours before any flaring, other than in emergencies, the consent holder shall provide notification of the commencement of flaring to all residents within 300 metres of the wellsite. The consent holder shall include in the notification a 24-hour contact telephone number for a representative of the consent holder, and shall keep and make available to the Chief Executive, Taranaki Regional Council, a record of all queries and complaints received in respect of any flaring activity.

4. To the greatest extent possible, all gas that is flared must first be treated by effective liquid and solid separation and recovery.

5. Only gaseous hydrocarbons originating from the well stream shall be combusted within the flare pit.

6. The consent holder shall adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any actual or potential effect on the environment arising from any emission to air from the flare, including, but not limited to, having regard to the prevailing and predicted wind speed and direction at the time of initiation of, and throughout, any episode of flaring so as to minimise offsite effects [other than for the maintenance of a pilot flare flame].

7. The discharge shall not cause any objectionable or offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.

8. The consent holder shall control all emissions of carbon monoxide to the atmosphere from the flare so that, whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of carbon monoxide arising from the exercise of this consent measured under ambient conditions does not exceed 10 milligrams per cubic metre [mg/m^3] [eight-hour average exposure], or 30 mg/m^3 one-hour average exposure] at or beyond the boundary of the property where the wellsite is located.

9. The consent holder shall control all emissions of nitrogen oxides to the atmosphere from the flare, so that whether alone or in conjunction with any other emissions from the wellsite, the maximum ground level concentration of nitrogen dioxide arising from the exercise of this consent measured under ambient conditions does not exceed 100 micrograms per cubic metre [$\mu g/m^3$] [24-hour average exposure], or 200 $\mu g/m^3$ [1-hour average exposure] at or beyond the boundary of the property where the wellsite is located.

10. The consent holder shall control emissions to the atmosphere from the wellsite and flare of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides, so that whether alone or in conjunction with any emissions from the flare, the maximum ground level concentration for any particular contaminant arising from the exercise of this consent measured at or beyond the boundary of the property where the wellsite is located, is not increased above background levels:

    a) by more than $1/30^{th}$ of the relevant Occupational Threshold Value-Time Weighted Average, or by more than the Short Term Exposure Limit at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour]; or

    b) if no Short Term Exposure Limit is set, by more than three times the Time Weighted Average at any time [all terms as defined in Workplace Exposure Standards, 2002, Department of Labour].

11. The consent holder shall make available to the Chief Executive, Taranaki Regional Council, upon request, an analysis of a typical gas and condensate stream from the field, covering sulphur compound content and the content of carbon compounds of structure C_6 or higher number of compounds.

12. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council, a 'flaring log' that includes:

    a) the date, time and duration of all flaring episodes;

    b) the zone from which flaring occurred;

    c) the volume of substances flared;

    d) whether there was smoke at any time during the flaring episode and if there was, the time, duration and cause of each 'smoke event'.

13. This consent shall lapse on 30 June 2016, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

14. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2015 and/or June 2021, for any of the following purposes:

    a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or

    b) requiring the consent holder to adopt specific practices in order to achieve the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge; and/or

    c) to alter, add or delete limits on mass discharge quantities or discharge or ambient concentrations of any contaminant.

Signed at Stratford on 16 June 2011

For and on behalf of
Taranaki Regional Council

Chief Executive

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

Water 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:	16 June 2011
Commencement Date:	16 June 2011

Conditions of Consent

Consent Granted:	To take groundwater that may be encountered during hydrocarbon exploration and production operations at the Turangi-B wellsite at or about (NZTM) 1713603E-5682493N
Expiry Date:	1 June 2021
Review Date(s):	June 2015
Site Location:	Turangi-B wellsite, 121 Turangi Road, Motunui [Property owner: RJ Topless]
Legal Description:	Pt Lot 2 DP 7153 [Site of take]
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 all the administration, monitoring and supervision costs of this consent, fixed in accordance to section 36 of the Resource Management Act.

Special conditions

1. The consent holder shall ensure the abstraction does not cause more than a 10% lowering of static water-level by interference with any adjacent bore.

2. The consent holder shall ensure the abstraction does not cause the intrusion of salt water into any freshwater aquifer.

3. The consent holder shall submit a summary well log to a depth of 1000 metres, within three months of the completion of drilling. The report shall:

   a) provide a log to show the true vertical depth to all geological formation tops intersected within the freshwater zone;

   b) identify the true vertical depth to, and thickness of, any freshwater aquifers intersected by the well;

   c) identify the true vertical depth to the freshwater- saline water interface in the well.

4. This consent shall lapse on 30 June 2016, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

5. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2015, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 16 June 2011

For and on behalf of
Taranaki Regional Council

Chief Executive

TARANAKI REGIONAL COUNCIL

CHIEF EXECUTIVE
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47 CLOTEN ROAD
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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

Air quality investigations

Executive summary

The Taranaki Regional Council has previously investigated the nature of air emissions and downwind effects arising from the flaring of hydrocarbons (both natural gas and condensate) at exploration sites. This information has proven valuable in the development of robust and defensible technical requirements for incorporation into the Council's regional air quality plans[1], and for assessing applications for discharges to air from flaring at exploration and production sites. The combustible flows to flare pits giving rise to flaring activities will initially include entrained materials used in drilling activities, such as drilling mud residues.

However, more recently speculation has focused on the nature of potential effects arising from the use of hydraulic fracturing (HF) fluids within production enhancement activities, as these fluids include compounds additional to those used in drilling. These compounds will include biocides, gelling and gel-breaking agents, inert proppants such as sand or microscopic ceramic beads, and 'slicking' agents.

Normal exploration practice is to separate the recovered fluids from the entrained hydrocarbon gas. However, under emergency circumstances, safety and equipment protection requirements may necessitate the discharge of the fluids to a flare pit without separation so that the entrained hydrocarbon gas can be combusted for reasons of safety. In this situation, some of the fluids will be combusted/evaporated with the gas, with the majority remaining within the pit for recovery from the pit at some point after the emergency event is under control. While used at extremely low concentrations within the hydraulic fluids (which comprise approximately 98% water and proppants), the presence of hydraulic fracture compounds within the mixture entering a flare raises the possibility of additional environmental effects.

The Council therefore undertook a study of the nature of flare characteristics and downwind consequences, at a wellsite in North Taranaki in February 2012. While the region's exploration and production companies endorsed the project, it should be noted that its design and implementation were completely independent of any influence or direction from the companies. The design was subject to peer review. It reflected and developed the original flaring investigations conduced by the Council in 1998.

The HF fluids used within this study had additives at a somewhat higher concentration that is typical.

The investigation covered combustion zone emissions of particulate matter (PM), dioxins and furans (PCDD/PCDF), polyaromatic hydrocarbons (PAHs), aldehydes (formaldehyde, acetaldehyde, and propionaldehyde), volatile organic compounds (VOC), methanol, and the more conventional products of combustion (oxygen, carbon dioxide, carbon monoxide, nitrogen oxides, and sulphur dioxide).

Emissions from the fluid surface were collected to determine emissions (evaporation) of PAHs, aldehydes, VOCs, and methanol.

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[1] Most recently the *Regional Air Quality Plan for Taranaki*, Taranaki Regional Council, July 2011

Ambient (downwind) measurements covered particulate (of particle sizes PM1.0, 2.5, and 10), carbon monoxide and dioxide, formaldehyde, and volatile organic compounds.

Estimations were made of ambient concentrations of dioxins, PAHs, and methanol, using emission and receiving environment data for other parameters. It should be noted that because of differences in timing around sample collection for various parameters, these estimations should be used with caution and regarded as approximations only. Nevertheless they serve a useful purpose if regarded as indicative rather than absolute.

It should be noted that all results relate to a field study carried out under specific source, topographic, and meteorological conditions. Therefore they cannot and must not be applied universally. To gain greater value and more regional application from this study, modelling of dispersion under varying meteorological conditions is being undertaken, utilising the emission data generated herein. As a provisional finding, it can be noted that the results of this study are consistent with and uphold those of the studies (field monitoring and modelling studies) conducted in 1998, which established that a separation distance of 300 metres between a flare and residential properties gave a substantial health and safety buffer for the protection of local populations.

Particulate matter (PM2.5, PM10): the PM2.5 data showed no correlation of distance downwind of the flare with concentration (the closest sampling point was about 120 metres downwind), indicating that at the most by 120 metres from the flare and site there was no effect upon ambient PM2.5. The two sites closest to the flare and wellsite had the lowest PM2.5 results.

The PM2.5 concentrations in the vicinity of the flare were similar to or slightly below those found elsewhere in the region as background (ambient) concentrations, and are far below international guidelines.

The PM10 data showed no correlation of distance downwind of the flare with concentration (the closest sampling point was about 120 metres downwind), indicating that at the most by 120 metres from the flare and wellsite there was no effect upon ambient PM10. The two sites closest to the flare and wellsite had the lowest PM10 results, while the second highest result was recorded at the site that was furthest away.

The PM10 concentrations in the vicinity of a flare are somewhat below those found elsewhere in the region, and are far below (less than 10% of) the national environmental standards for air quality (AQNES) (50 $\mu g/m^3$). The air downwind of the flare would be rated according to MfE criteria as 'excellent' in respect of the PM10 concentration.

Dioxins/furans: emissions of dioxins and furans expressed as toxic equivalents could not be distinguished from zero (i.e there was no meaningful difference between the combustion zone result and the laboratory blank result, at the limits of detection of mass quantities used within the study). This is consistent with the very low levels of particulate matter emitted from the combustion zone.

Polyaromatic hydrocarbons (including BaP): PAHs were detected within the combustion zone and at much lower concentrations within the evaporation zone. The two samples had quite different compositions. BaP, the PAH of most significance, comprised 63% of the USEPA BaP toxicity equivalent concentration in the PAHs found in the combustion zone sample, but was not detected in the evaporation zone sample.

The estimation of downwind (ambient) PAH concentration suggested an elevation in downwind concentration of all PAHs at a distance of 70 metres, of between 12 and 38 ng/m^3 (total BaP equivalent), and in actual BaP of between 7.5 and 24 ng/m^3. As noted above, these figures should be regarded as estimates only; and further, that they are specific to this particular study.

Within the evaporation zone, levels of BaP equivalents were lower than is found in ambient air within central city locations in New Zealand, and that only minimal further dilution (dispersion) would be required to reduce PAH/BaP concentrations to levels similar to or lower than is typically encountered in urban areas.

Aldehydes (including formaldehyde): the formaldehyde concentrations in the vicinity of the flare, including those sites closest to the flare, are similar to those found elsewhere in the region, and are well below (less than 20% of) the MfE guideline.

The air downwind of the flare beyond the closest ambient monitoring location would be rated as 'excellent' according to MfE criteria in respect of the formaldehyde concentrations, and even at the site 70 metres downwind would be rated as 'good'.

Volatile organic compounds (including BTEX): benzene results show that within a distance of 300 metres from the flare, benzene levels had reduced to a steady (background) level. All results, including those closest to the flare, were below the MfE guideline criterion, and at 140 metres downwind were half or less of the MfE guideline value.

Air beyond 140 metres downwind of the flare would be rated as 'good' according to MfE criteria in respect of the benzene concentrations, and further away (beyond 300 metres) would be rated as 'excellent' in respect of benzene concentrations.

Toluene and xylene were found 70 metres downwind of the flare, at 10% and 3% respectively of the MfE ambient guidelines. The air at all points sampled downwind of the flare would be rated as 'excellent' according to MfE criteria in respect of the toluene and xylene concentrations.

The study has identified that benzene is the parameter of most interest in terms of most closely approaching guideline values; whereas toluene is the BTEX of highest concentration.

Methanol: even within the combustion zone and the evaporation zone as sampled, the levels of methanol were far below limits that might be derived for population health protection.

Carbon monoxide and carbon dioxide: no carbon monoxide was detected downwind at the limit of detection of the meter used. This means that the air at all points sampled downwind of the flare would be rated as 'good' or better according to MfE criteria in respect of the carbon monoxide concentration.

This report includes recommendations in Section 5, as follows:-

1. THAT it be noted that the findings of this study are that there were minimal effects upon ambient air quality in the vicinity of a flare at which the incidental combustion of

hydraulic fracturing fluids was undertaken, in the context of prevailing air quality within the region and nationwide;

2. THAT it be noted that all results relate to a field study carried out under specific source, topographic, and meteorological conditions, but as a provisional finding, it can be noted that the results of this study are consistent with and uphold those of the air quality studies of flaring (field monitoring and modelling studies) conducted in 1998;

3. THAT this report be referenced by the Taranaki Regional Council in the assessment of any applications for air discharge permits for contingency flaring, and in any review of the *Regional Air Quality Plan for Taranaki* (2011)

4. THAT this report be distributed to hydrocarbon exploration companies and their consultants, for reference in the preparation of Assessments of Environmental Effects in support of applications for air discharge permits, and to other interested parties upon request

5. THAT the emission data contained herein be incorporated into modelling of dispersion from flares in which hydraulic fracturing fluids are combusted, to apply the findings and results of this study more widely across the variety of meteorology and landscapes that could be encountered within Taranaki.

Appendix III

Results of groundwater monitoring

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ANALYSIS REPORT

SPv1

Client:	Taranaki Regional Council	**Lab No:**	952171
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/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Toluene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
m&p-Xylene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
o-Xylene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane	g/m^3	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Carbon tetrachloride	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromo-3-chloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m^3	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Dibromomethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichlorodifluoromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,2-Dichloroethene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,2-Dichloroethene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichloromethane (methylene chloride)	g/m^3	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
1,2-Dichloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2,2-Dichloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloropropene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,3-Dichloropropene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,3-Dichloropropene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Hexachlorobutadiene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1,2-Tetrachloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2,2-Tetrachloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Tetrachloroethene (tetrachloroethylene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichloroethene (trichloroethylene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichlorofluoromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m^3	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Vinyl chloride	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chlorobenzene (monochlorobenzene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2-Chlorotoluene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Chlorotoluene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,4-Dichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
tert-Butylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Isopropylbenzene (Cumene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Isopropyltoluene (p-Cymene)	g/m^3	< 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/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
sec-Butylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Styrene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trimethylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trimethylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m^3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Methyl tert-butylether (MTBE)	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
4-Methylpentan-2-one (MIBK)	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Bromoform (tribromomethane)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroform (Trichloromethane)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dibromochloromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	g/m^3	< 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/m^3 as $CaCO_3$	151	-	-	-	-
Bicarbonate	g/m^3 at 25°C	184	-	-	-	-
Total Hardness	g/m^3 as $CaCO_3$	111	-	-	-	-
Electrical Conductivity (EC)	mS/m	34.6	-	-	-	-
Total Suspended Solids	g/m^3	3	-	-	-	-
Total Dissolved Solids (TDS)	g/m^3	240	-	-	-	-
Dissolved Cadmium	g/m^3	< 0.00005	-	-	-	-
Dissolved Calcium	g/m^3	25	-	-	-	-
Dissolved Copper	g/m^3	0.0006	-	-	-	-
Dissolved Iron	g/m^3	0.77	-	-	-	-
Dissolved Magnesium	g/m^3	12.1	-	-	-	-
Dissolved Manganese	g/m^3	0.188	-	-	-	-
Dissolved Nickel	g/m^3	< 0.0005	-	-	-	-
Dissolved Potassium	g/m^3	8.0	-	-	-	-
Dissolved Sodium	g/m^3	26	-	-	-	-
Dissolved Zinc	g/m^3	0.23	-	-	-	-
Chloride	g/m^3	19.7	-	-	-	-
Nitrite-N	g/m^3	< 0.002	-	-	-	-
Nitrate-N	g/m^3	< 0.002	-	-	-	-
Nitrate-N + Nitrite-N	g/m^3	0.002	-	-	-	-
Sulphate	g/m^3	< 0.5	-	-	-	-
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m^3	< 0.02	-	-	-	-
Gases in groundwater						
Ethane	g/m^3	< 0.003	-	-	-	-

Sample Type: Aqueous						
Sample Name:		112817 11-Nov-2011 2:10 pm				
Lab Number:		952171.6				
Gases in groundwater						
Ethylene	g/m^3	< 0.004	-	-	-	-
Methane	g/m^3	3.6	-	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	< 0.10	-	-	-	-
C10 - C14	g/m^3	< 0.2	-	-	-	-
C15 - C36	g/m^3	< 0.4	-	-	-	-
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	-	-	-	-
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m^3	< 0.0005	-	-	-	-
Toluene	g/m^3	< 0.0010	-	-	-	-
Ethylbenzene	g/m^3	< 0.0005	-	-	-	-
m&p-Xylene	g/m^3	< 0.0005	-	-	-	-
o-Xylene	g/m^3	< 0.0005	-	-	-	-
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane	g/m^3	< 0.002	-	-	-	-
Carbon tetrachloride	g/m^3	< 0.0005	-	-	-	-
Chloroethane	g/m^3	< 0.0005	-	-	-	-
Chloromethane	g/m^3	< 0.0005	-	-	-	-
1,2-Dibromo-3-chloropropane	g/m^3	< 0.0005	-	-	-	-
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m^3	< 0.0004	-	-	-	-
Dibromomethane	g/m^3	< 0.0005	-	-	-	-
Dichlorodifluoromethane	g/m^3	< 0.0005	-	-	-	-
1,1-Dichloroethane	g/m^3	< 0.0005	-	-	-	-
1,2-Dichloroethane	g/m^3	< 0.0005	-	-	-	-
1,1-Dichloroethene	g/m^3	< 0.0005	-	-	-	-
cis-1,2-Dichloroethene	g/m^3	< 0.0005	-	-	-	-
trans-1,2-Dichloroethene	g/m^3	< 0.0005	-	-	-	-
Dichloromethane (methylene chloride)	g/m^3	< 0.010	-	-	-	-
1,2-Dichloropropane	g/m^3	< 0.0005	-	-	-	-
1,3-Dichloropropane	g/m^3	< 0.0005	-	-	-	-
2,2-Dichloropropane	g/m^3	< 0.0005	-	-	-	-
1,1-Dichloropropene	g/m^3	< 0.0005	-	-	-	-
cis-1,3-Dichloropropene	g/m^3	< 0.0005	-	-	-	-
trans-1,3-Dichloropropene	g/m^3	< 0.0005	-	-	-	-
Hexachlorobutadiene	g/m^3	< 0.0005	-	-	-	-
1,1,1,2-Tetrachloroethane	g/m^3	< 0.0005	-	-	-	-
1,1,2,2-Tetrachloroethane	g/m^3	< 0.0005	-	-	-	-
Tetrachloroethene (tetrachloroethylene)	g/m^3	< 0.0005	-	-	-	-
1,1,1-Trichloroethane	g/m^3	< 0.0005	-	-	-	-
1,1,2-Trichloroethane	g/m^3	< 0.0005	-	-	-	-
Trichloroethene (trichloroethylene)	g/m^3	< 0.0005	-	-	-	-
Trichlorofluoromethane	g/m^3	< 0.0005	-	-	-	-
1,2,3-Trichloropropane	g/m^3	< 0.0005	-	-	-	-
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m^3	< 0.004	-	-	-	-
Vinyl chloride	g/m^3	< 0.0005	-	-	-	-
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m^3	< 0.0005	-	-	-	-
Chlorobenzene (monochlorobenzene)	g/m^3	< 0.0005	-	-	-	-
2-Chlorotoluene	g/m^3	< 0.0005	-	-	-	-
4-Chlorotoluene	g/m^3	< 0.0005	-	-	-	-
1,2-Dichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,3-Dichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,4-Dichlorobenzene	g/m^3	< 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/m^3	< 0.0005	-	-	-	-
1,2,4-Trichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,3,5-Trichlorobenzene	g/m^3	< 0.0005	-	-	-	-
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m^3	< 0.0005	-	-	-	-
tert-Butylbenzene	g/m^3	< 0.0005	-	-	-	-
Isopropylbenzene (Cumene)	g/m^3	< 0.0005	-	-	-	-
4-Isopropyltoluene (p-Cymene)	g/m^3	< 0.0005	-	-	-	-
n-Propylbenzene	g/m^3	< 0.0005	-	-	-	-
sec-Butylbenzene	g/m^3	< 0.0005	-	-	-	-
Styrene	g/m^3	< 0.0005	-	-	-	-
1,2,4-Trimethylbenzene	g/m^3	< 0.0005	-	-	-	-
1,3,5-Trimethylbenzene	g/m^3	< 0.0005	-	-	-	-
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m^3	< 0.05	-	-	-	-
2-Butanone (MEK)	g/m^3	< 0.005	-	-	-	-
Methyl tert-butylether (MTBE)	g/m^3	< 0.005	-	-	-	-
4-Methylpentan-2-one (MIBK)	g/m^3	< 0.005	-	-	-	-
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m^3	< 0.0005	-	-	-	-
Bromoform (tribromomethane)	g/m^3	< 0.0005	-	-	-	-
Chloroform (Trichloromethane)	g/m^3	< 0.0005	-	-	-	-
Dibromochloromethane	g/m^3	< 0.0005	-	-	-	-
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m^3	< 0.005	-	-	-	-
Naphthalene	g/m^3	< 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/m^3 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/m^3 at 25°C	1-6
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21st ed. 2005.	1.0 g/m^3 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.

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

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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

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BETTER TESTING **BETTER RESULTS**

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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/m^3	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Methane	g/m^3	3.3	< 0.002	0.008	0.027	< 0.002
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m^3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m^3	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Toluene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
m&p-Xylene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
o-Xylene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane	g/m^3	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Carbon tetrachloride	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromo-3-chloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m^3	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Dibromomethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichlorodifluoromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,2-Dichloroethene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,2-Dichloroethene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichloromethane (methylene chloride)	g/m^3	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
1,2-Dichloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2,2-Dichloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloropropene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,3-Dichloropropene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,3-Dichloropropene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Hexachlorobutadiene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1,2-Tetrachloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2,2-Tetrachloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Tetrachloroethene (tetrachloroethylene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichloroethene (trichloroethylene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichlorofluoromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m^3	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Vinyl chloride	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chlorobenzene (monochlorobenzene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2-Chlorotoluene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Chlorotoluene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,4-Dichlorobenzene	g/m^3	< 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/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
tert-Butylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Isopropylbenzene (Cumene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Isopropyltoluene (p-Cymene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
n-Propylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
sec-Butylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Styrene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trimethylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trimethylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m^3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Methyl tert-butylether (MTBE)	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
4-Methylpentan-2-one (MIBK)	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Bromoform (tribromomethane)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroform (Trichloromethane)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dibromochloromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	g/m^3	< 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/m^3 as $CaCO_3$	17.0	-	-	-	-
Bicarbonate	g/m^3 at 25°C	21	-	-	-	-
Total Hardness	g/m^3 as $CaCO_3$	26	-	-	-	-
Electrical Conductivity (EC)	mS/m	12.0	-	-	-	-
Total Suspended Solids	g/m^3	148	-	-	-	-
Total Dissolved Solids (TDS)	g/m^3	81	-	-	-	-
Dissolved Cadmium	g/m^3	< 0.00005	-	-	-	-
Dissolved Calcium	g/m^3	5.8	-	-	-	-
Dissolved Copper	g/m^3	0.0006	-	-	-	-
Dissolved Iron	g/m^3	< 0.02	-	-	-	-
Dissolved Magnesium	g/m^3	2.8	-	-	-	-
Dissolved Manganese	g/m^3	0.0071	-	-	-	-
Dissolved Nickel	g/m^3	< 0.0005	-	-	-	-
Dissolved Potassium	g/m^3	3.1	-	-	-	-
Dissolved Sodium	g/m^3	10.6	-	-	-	-
Dissolved Zinc	g/m^3	0.030	-	-	-	-
Chloride	g/m^3	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/m^3	< 0.0005	-	-	-	-
Chlorobenzene (monochlorobenzene)	g/m^3	< 0.0005	-	-	-	-
2-Chlorotoluene	g/m^3	< 0.0005	-	-	-	-
4-Chlorotoluene	g/m^3	< 0.0005	-	-	-	-
1,2-Dichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,3-Dichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,4-Dichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,2,3-Trichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,2,4-Trichlorobenzene	g/m^3	< 0.0005	-	-	-	-
1,3,5-Trichlorobenzene	g/m^3	< 0.0005	-	-	-	-
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m^3	< 0.0005	-	-	-	-
tert-Butylbenzene	g/m^3	< 0.0005	-	-	-	-
Isopropylbenzene (Cumene)	g/m^3	< 0.0005	-	-	-	-
4-Isopropyltoluene (p-Cymene)	g/m^3	< 0.0005	-	-	-	-
n-Propylbenzene	g/m^3	< 0.0005	-	-	-	-
sec-Butylbenzene	g/m^3	< 0.0005	-	-	-	-
Styrene	g/m^3	< 0.0005	-	-	-	-
1,2,4-Trimethylbenzene	g/m^3	< 0.0005	-	-	-	-
1,3,5-Trimethylbenzene	g/m^3	< 0.0005	-	-	-	-
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m^3	< 0.05	-	-	-	-
2-Butanone (MEK)	g/m^3	< 0.005	-	-	-	-
Methyl tert-butylether (MTBE)	g/m^3	< 0.005	-	-	-	-
4-Methylpentan-2-one (MIBK)	g/m^3	< 0.005	-	-	-	-
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m^3	< 0.0005	-	-	-	-
Bromoform (tribromomethane)	g/m^3	< 0.0005	-	-	-	-
Chloroform (Trichloromethane)	g/m^3	< 0.0005	-	-	-	-
Dibromochloromethane	g/m^3	< 0.0005	-	-	-	-
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m^3	< 0.005	-	-	-	-
Naphthalene	g/m^3	< 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/m^3 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/m^3 at 25°C	1-11
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21st ed. 2005.	1.0 g/m^3 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/m^3	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/m^3	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/m^3	1-11
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m^3	1-11
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m^3	1-11
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m^3	1-11
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m^3	1-11
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m^3	1-11
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m^3	1-11
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m^3	1-11
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m^3	1-11
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0010 g/m^3	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/m^3	1-11
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO3- I (Modified) 21st ed. 2005.	0.002 g/m^3	1-11
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N.	0.002 g/m^3	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/m^3	1-11
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 21st ed. 2005.	0.5 g/m^3	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

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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/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Styrene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trimethylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trimethylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m^3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Methyl tert-butylether (MTBE)	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
4-Methylpentan-2-one (MIBK)	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Bromoform (tribromomethane)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroform (Trichloromethane)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dibromochloromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	g/m^3	< 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/m^3 as $CaCO_3$	144	-	-	-	-
Bicarbonate	g/m^3 at 25°C	175	-	-	-	-
Total Hardness	g/m^3 as $CaCO_3$	101	-	-	-	-
Electrical Conductivity (EC)	mS/m	32.1	-	-	-	-
Total Suspended Solids	g/m^3	9	-	-	-	-
Total Dissolved Solids (TDS)	g/m^3	230	-	-	-	-
Dissolved Cadmium	g/m^3	< 0.00005	-	-	-	-
Dissolved Calcium	g/m^3	22	-	-	-	-
Dissolved Copper	g/m^3	0.0005	-	-	-	-
Dissolved Iron	g/m^3	4.4	-	-	-	-
Dissolved Magnesium	g/m^3	11.0	-	-	-	-
Dissolved Manganese	g/m^3	0.162	-	-	-	-
Dissolved Nickel	g/m^3	0.0006	-	-	-	-
Dissolved Potassium	g/m^3	7.7	-	-	-	-
Dissolved Sodium	g/m^3	25	-	-	-	-
Dissolved Zinc	g/m^3	0.120	-	-	-	-
Chloride	g/m^3	19.0	-	-	-	-
Nitrite-N	g/m^3	< 0.002	-	-	-	-
Nitrate-N	g/m^3	0.009	-	-	-	-
Nitrate-N + Nitrite-N	g/m^3	0.009	-	-	-	-
Sulphate	g/m^3	< 0.5	-	-	-	-
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m^3	< 0.02	-	-	-	-
Gases in groundwater						
Ethane	g/m^3	< 0.003	-	-	-	-
Ethylene	g/m^3	< 0.004	-	-	-	-

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/m^3	< 0.0005	-	-	-	-
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m^3	< 0.0005	-	-	-	-
tert-Butylbenzene	g/m^3	< 0.0005	-	-	-	-
Isopropylbenzene (Cumene)	g/m^3	< 0.0005	-	-	-	-
4-Isopropyltoluene (p-Cymene)	g/m^3	< 0.0005	-	-	-	-
n-Propylbenzene	g/m^3	< 0.0005	-	-	-	-
sec-Butylbenzene	g/m^3	< 0.0005	-	-	-	-
Styrene	g/m^3	< 0.0005	-	-	-	-
1,2,4-Trimethylbenzene	g/m^3	< 0.0005	-	-	-	-
1,3,5-Trimethylbenzene	g/m^3	< 0.0005	-	-	-	-
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m^3	< 0.05	-	-	-	-
2-Butanone (MEK)	g/m^3	< 0.005	-	-	-	-
Methyl tert-butylether (MTBE)	g/m^3	< 0.005	-	-	-	-
4-Methylpentan-2-one (MIBK)	g/m^3	< 0.005	-	-	-	-
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m^3	< 0.0005	-	-	-	-
Bromoform (tribromomethane)	g/m^3	< 0.0005	-	-	-	-
Chloroform (Trichloromethane)	g/m^3	< 0.0005	-	-	-	-
Dibromochloromethane	g/m^3	< 0.0005	-	-	-	-
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m^3	< 0.005	-	-	-	-
Naphthalene	g/m^3	< 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/m^3 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/m^3 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/m^3 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/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
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.

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BETTER TESTING **BETTER RESULTS**

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/m^3 as $CaCO_3$	14.4	86	132	142	13.6
Bicarbonate	g/m^3 at 25°C	17.6	105	161	173	16.6
Total Hardness	g/m^3 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/m^3	82	171	210	210	77
Dissolved Barium	g/m^3	0.026	0.0167	0.021	0.021	0.0171
Dissolved Calcium	g/m^3	4.7	15.4	21	18.9	4.4
Dissolved Copper	g/m^3	0.0007	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dissolved Iron	g/m^3	< 0.02	5.4	5.3	8.3	0.06
Dissolved Magnesium	g/m^3	3.8	8.0	9.9	10.1	3.3
Dissolved Manganese	g/m^3	0.0083	0.25	0.163	0.20	0.0136
Dissolved Nickel	g/m^3	< 0.0005	0.0014	< 0.0005	< 0.0005	< 0.0005
Dissolved Potassium	g/m^3	3.6	2.3	7.1	5.3	2.2
Dissolved Sodium	g/m^3	13.0	15.9	24	30	10.4
Dissolved Zinc	g/m^3	0.0054	0.115	0.108	0.0140	0.0035
Bromide	g/m^3	0.10	0.11	< 0.05	0.07	0.11
Chloride	g/m^3	22	19.0	16.5	13.8	21
Nitrite-N	g/m^3	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Nitrate-N	g/m^3	1.25	< 0.002	< 0.002	< 0.002	0.26
Nitrate-N + Nitrite-N	g/m^3	1.25	< 0.002	< 0.002	0.002	0.26
Sulphate	g/m^3	6.1	< 0.5	< 0.5	0.5	5.2
Ethylene Glycol in Water						
Ethylene glycol*	g/m^3	< 4	< 4	< 4	< 4	< 4
Propylene Glycol in Water						
Propylene glycol*	g/m^3	< 4	< 4	< 4	< 4	< 4
Methanol in Water - Aqueous Solvents						
Methanol*	g/m^3	< 2	< 2	< 2	< 2	< 2
BTEX in Water by Headspace GC-MS						
Benzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Toluene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ethylbenzene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
m&p-Xylene	g/m^3	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
o-Xylene	g/m^3	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010

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/m^3	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Gases in groundwater						
Ethane	g/m^3	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Ethylene	g/m^3	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Methane	g/m^3	< 0.002	1.93	0.78	2.2	0.004
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
C10 - C14	g/m^3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
C15 - C36	g/m^3	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7

Sample Name:		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/m^3 as $CaCO_3$	9.2	-	-	-	-
Bicarbonate	g/m^3 at 25°C	11.2	-	-	-	-
Total Hardness	g/m^3 as $CaCO_3$	27	-	-	-	-
Electrical Conductivity (EC)	mS/m	12.9	-	-	-	-
Total Dissolved Solids (TDS)	g/m^3	95	-	-	-	-
Dissolved Barium	g/m^3	0.0196	-	-	-	-
Dissolved Calcium	g/m^3	5.2	-	-	-	-
Dissolved Copper	g/m^3	< 0.0005	-	-	-	-
Dissolved Iron	g/m^3	< 0.02	-	-	-	-
Dissolved Magnesium	g/m^3	3.4	-	-	-	-
Dissolved Manganese	g/m^3	0.0108	-	-	-	-
Dissolved Nickel	g/m^3	< 0.0005	-	-	-	-
Dissolved Potassium	g/m^3	2.2	-	-	-	-
Dissolved Sodium	g/m^3	10.4	-	-	-	-
Dissolved Zinc	g/m^3	0.0048	-	-	-	-
Bromide	g/m^3	0.10	-	-	-	-
Chloride	g/m^3	24	-	-	-	-
Nitrite-N	g/m^3	< 0.002	-	-	-	-
Nitrate-N	g/m^3	0.27	-	-	-	-
Nitrate-N + Nitrite-N	g/m^3	0.27	-	-	-	-
Sulphate	g/m^3	11.2	-	-	-	-
Ethylene Glycol in Water						
Ethylene glycol*	g/m^3	< 4	-	-	-	-
Propylene Glycol in Water						
Propylene glycol*	g/m^3	< 4	-	-	-	-
Methanol in Water - Aqueous Solvents						
Methanol*	g/m^3	< 2	-	-	-	-
BTEX in Water by Headspace GC-MS						
Benzene	g/m^3	< 0.0010	-	-	-	-
Toluene	g/m^3	< 0.0010	-	-	-	-
Ethylbenzene	g/m^3	< 0.0010	-	-	-	-
m&p-Xylene	g/m^3	< 0.002	-	-	-	-
o-Xylene	g/m^3	< 0.0010	-	-	-	-
Formaldehyde in Water by DNPH & LCMSMS						
Formaldehyde	g/m^3	< 0.02	-	-	-	-

Sample Type: Aqueous						
Sample Name:		GND2231 09-Nov-2012 11:45 am				
Lab Number:		1068206.6				
Gases in groundwater						
Ethane	g/m^3	< 0.003	-	-	-	-
Ethylene	g/m^3	< 0.004	-	-	-	-
Methane	g/m^3	< 0.002	-	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m^3	< 0.10	-	-	-	-
C10 - C14	g/m^3	< 0.2	-	-	-	-
C15 - C36	g/m^3	< 0.4	-	-	-	-
Total hydrocarbons (C7 - C36)	g/m^3	< 0.7	-	-	-	-

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 21^{st} 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) 21^{st} ed. 2005.	1.0 g/m^3 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 21^{st} ed. 2005.	1.0 g/m^3 at 25°C	1-6
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21st ed. 2005.	1.0 g/m^3 as $CaCO_3$	1-6
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21^{st} 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) 21^{st} ed. 2005.	10 g/m^3	1-6
Dissolved Barium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21^{st} ed. 2005.	0.00010 g/m^3	1-6
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21^{st} ed. 2005.	0.05 g/m^3	1-6
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 21^{st} ed. 2005.	0.0005 g/m^3	1-6
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 21^{st} ed. 2005.	0.02 g/m^3	1-6
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21^{st} ed. 2005.	0.02 g/m^3	1-6
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 21^{st} ed. 2005.	0.0005 g/m^3	1-6
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 21^{st} ed. 2005.	0.0005 g/m^3	1-6
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21^{st} ed. 2005.	0.05 g/m^3	1-6
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21^{st} ed. 2005.	0.02 g/m^3	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/m^3	1-6
Bromide	Filtered sample. Ion Chromatography. APHA 4110 B 21st ed. 2005.	0.05 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.

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Client Services Manager - Environmental Division

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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/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Toluene	g/m^3	0.0037	< 0.0010	0.0043	< 0.0010	< 0.0010
Ethylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
m&p-Xylene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
o-Xylene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane (Methyl Bromide)	g/m^3	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Carbon tetrachloride	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromo-3-chloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m^3	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Dibromomethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichlorodifluoromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloroethene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,2-Dichloroethene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,2-Dichloroethene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dichloromethane (methylene chloride)	g/m^3	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
1,2-Dichloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2,2-Dichloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1-Dichloropropene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
cis-1,3-Dichloropropene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
trans-1,3-Dichloropropene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Hexachlorobutadiene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1,2-Tetrachloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2,2-Tetrachloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Tetrachloroethene (tetrachloroethylene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,1-Trichloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichloroethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichloroethene (trichloroethylene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Trichlorofluoromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichloropropane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m^3	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Vinyl chloride	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Halogenated Aromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chlorobenzene (monochlorobenzene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
2-Chlorotoluene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Chlorotoluene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2-Dichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3-Dichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,4-Dichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,3-Trichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trichlorobenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
tert-Butylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Isopropylbenzene (Cumene)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
4-Isopropyltoluene (p-Cymene)	g/m^3	< 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/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
sec-Butylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Styrene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,2,4-Trimethylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
1,3,5-Trimethylbenzene	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m^3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
2-Butanone (MEK)	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Methyl tert-butylether (MTBE)	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
4-Methylpentan-2-one (MIBK)	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Bromoform (tribromomethane)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Chloroform (Trichloromethane)	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Dibromochloromethane	g/m^3	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m^3	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Naphthalene	g/m^3	< 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/m^3 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/m^3 at 25°C	1-5
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 21st ed. 2005.	1.0 g/m^3 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/m^3	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/m^3	1-5
Dissolved Cadmium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.00005 g/m^3	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/m^3	1-5
Dissolved Copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m^3	1-5
Dissolved Iron	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m^3	1-5
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m^3	1-5
Dissolved Manganese	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m^3	1-5
Dissolved Nickel	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0005 g/m^3	1-5
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.05 g/m^3	1-5
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.02 g/m^3	1-5
Dissolved Zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 21st ed. 2005.	0.0010 g/m^3	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/m^3	1-5
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO3- I (Modified) 21st ed. 2005.	0.002 g/m^3	1-5
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N.	0.002 g/m^3	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/m^3	1-5
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 21st ed. 2005.	0.5 g/m^3	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.

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