

Todd Energy Limited
Mangahewa-D Wellsite
Monitoring Programme Report
2014-2015

Technical Report 2015-115

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Executive summary

During 2014 the Todd Energy Limited Company (the Company) re-entered a hydrocarbon exploration site located on Rimutauteka Road at Waitui, in the Waitara catchment. The site is called Mangahewa-D wellsite. This report covers the period from August 2014 to December 2015. During this period, four wells (MHW-21, 22, 23, and 24) were drilled and tested. The hydraulic fracturing programme is ongoing. This report describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the Company's environmental performance in relation to drilling operations at the Mangahewa-D wellsite during the period under review, and the results and environmental effects of the Company's activities.

The Company holds six resource consents, which include a total of 88 conditions setting out the requirements that the Company must satisfy. The Company holds two consents to allow it to take and use water, two consents to discharge effluent / stormwater onto land or into an unnamed tributary of the Manganui River, one consent to discharge into land, and one consent to discharge emissions into the air at this site.

During the monitoring period, Todd Energy Ltd demonstrated an overall good level of environmental performance.

The Council's monitoring programme for the period under review included 28 inspections, and 29 water samples collected for physicochemical analysis. Furthermore, biomonitoring surveys of receiving waters were conducted prior to and following the commencement of drilling activities, which concluded that activities at the Mangahewa-D wellsite did not cause any impact on the macroinvertebrate communities within an unnamed tributary of the Manganui River.

The monitoring showed that all but one of the samples obtained were compliant. As in previous years, the monitoring indicated there was no effect on the receiving environment from the activities at the Mangahewa-D wellsite. There were no Unauthorised Incidents (UI/s) recording non-compliance in respect of this consent holder during the period under review.

The Company notified the Council of its intention to combust gas at the Mangahewa-D wellsite on 20 May 2015, 23 June 2015, and 23 July 2015. Following these dates, gas combustion occurred intermittently over the course of a few days in conjunction with well testing. There were no complaints associated with these activities. During routine inspections, no offensive or objectionable odours, smoke or dust associated with activities at the wellsite were observed. The drilling fluids and cuttings were disposed of at a consented off site facility.

The Company demonstrated a good level of environmental and a high level of administrative performance with the resource consents. During the period under review there were ongoing issues with sediment in the skimmer pit and ring drain system, but these were addressed by the Company in a satisfactory manner, and did not have any environmental effects of significance. In general the site was neat, tidy, and well-maintained. Site staff were cooperative with requests made by officers of the Council, with any required works being completed quickly and to a satisfactory standard.

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

This report includes recommendations for future drilling operations at the site.

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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 August 2014 to December 2015 by the Taranaki Regional Council (the Council) on the monitoring programme associated with resource consents held by Todd Energy Limited (the Company). The Company operates a hydrocarbon wellsite situated on Rimutauteka Road at Waitui, in the Waitara catchment.

The report includes the results and findings of the monitoring programme implemented by the Council in respect of the consents held by the Company that relate to abstractions and discharges of water within the Waitara catchment, and the air discharge permit held by Todd Energy Ltd to cover emissions to air from the site.

One of the intents of the *Resource Management Act 1991* (RMA) 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 Council generally implements integrated environmental monitoring programmes and reports the results of the programmes jointly. This report discusses the environmental effects of the Company's use of water, land and air, and is the second combined monitoring report by the Council for the Company.

1.1.2 Structure of this report

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

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites through annual programmes;
- the resource consents held by the Company 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 in the Company's site.

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

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

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

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

1.1.3 The Resource Management Act 1991 and monitoring

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

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

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

1.1.4 Evaluation of environmental and administrative performance

Besides discussing the various details of the performance and extent of compliance by the Company, this report also assigns them a rating for their environmental and administrative performance during the period under review.

Environmental performance is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year. **Administrative performance** is concerned with the Company's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

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

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

Environmental Performance

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

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

For example:

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

Administrative performance

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

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

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

1.2 Process description

Site description

Todd Energy Limited holds the 18 year Petroleum Mining Permit No. 38150 to prospect, explore, and mine for condensate, gas, LPG, oil and petroleum within an area of 44.36 Km². The Mangahewa-D wellsite is one of many sites within this area that have been established in order to explore, evaluate and produce hydrocarbons.

The Mangahewa-D wellsite is located approximately 9 km along Rimutauteka Road and approximately 5 km from Tikorangi, as per Figure 1. The Mangahewa-D wellsite was initially established for previous exploration efforts and has since had minor upgrades and boundaries extended to accommodate drilling and associated equipment. The establishment of the wellsite involved the removal of topsoil to create a firm level foundation on which to erect the drilling rig and house the associated equipment. Site establishment also involved the installation of:

- Wastewater control, treatment and disposal facilities;
- A system to collect and control stormwater and contaminants;
- A gas combustion system; and
- Other on-site facilities such as accommodation, parking and storage.

The nearest residence is approximately 640 m away from the wellsite. Bunding, earthworks and good site location helped minimise any potential for off-site effects for the neighbours.



Figure 1 Aerial view depicting the locality of the Mangahewa-D wellsite, with approximate regional location (inset)

Well development

The process of drilling a well can take a few weeks to several months, depending on the depth of the well, the geology of the area, and whether the well is vertical or horizontal.

Drilling fluids, more commonly known as 'drilling muds', are required in the drilling process for a number of reasons, including:

- As a safety measure to ensure that any pressurised liquids encountered in the rock formation are contained;
- To transport drill cuttings to the surface;
- To cool and lubricate the drilling bit;
- To provide information to the drillers about what is happening down hole and the actual geology being drilled; and
- To maintain well pressure and lubricate the borehole wall to control cave-ins and wash-outs.

The well is drilled progressively using different sized drill bits. The width of the well is widest at the surface as 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 country 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 packer is pressure tested to ensure it is sealed.

The construction aspects that are most important for a leak-free well include the correct composition and quality of the cement used, the installation method, and the setting time. The aim is to ensure that the cement binds tightly to the steel casing and the rock, and leaves no cavities through which liquids and gases could travel.

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.

Management of stormwater, wastewater and solid drilling waste

The Mangahewa-D wellsite is located approximately 20 m to the north west of the nearest waterbody which is an unnamed tributary of the Manganui River.

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 require appropriate management. These include:

- Stormwater from 'clean' areas of the site, e.g. parking areas, which 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 drilling mud;

- Produced water which flows from the producing formation and is separated from the gas and water phase at the surface; and
- Drill cuttings, mud and residual fluid which are separated from the liquid waste generated during drilling.

An important requirement of the site establishment is 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 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, and consequently into an unnamed tributary in the Waitara catchment.

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 is then reused for the drilling process. Cuttings were collected in bins located at the base of the shaker and disposed of offsite at a consented facility.

Hydraulic fracturing

In late 2012 the Parliamentary Commissioner for the Environment released an interim report on hydraulic fracturing within New Zealand. The purpose of this report is firstly to assess the environmental risks with hydraulic fracturing, and secondly to assess whether the policies, laws, regulations and institutions in New Zealand are adequate for managing these risks. The following discussion has been based upon this report.

The first known hydraulic fracturing operation was in 1989 at Petrocorp's Kaimiro-2 gas well in Taranaki. Since then, almost all of the hydraulic fracturing that has taken place in New Zealand has been done within the Taranaki region.

By the early 2000's New Zealand started exploring options for more unconventional ways of getting access to natural gas, and especially oil. These are considered to be more expensive than conventional drilling, but as the price of oil has risen and new technologies have been developed, these unconventional methods are growing.

The most common unconventional source of oil and gas in the Taranaki region has been extracting natural gas and oil from 'tight sands'. The boundary between tight sands and conventional reservoirs is ill-defined and generally based on whether the reservoir will have an economic production flow without hydraulic fracturing.

The process of hydraulic fracturing involves using a fracturing fluid, which is primarily water (typically made up of around 95-97% treated water). This fluid also contains various chemicals, including the three main components, which are:

- An inert proppant which keeps the induced fracture open when pumping is stopped, such as medium grained sand, or small ceramic pellets;
- A gelling substance to carry the proppant into the cracks; and
- A de-gelling substance to thin the gel to allow the fracturing fluid to return to the surface while leaving the proppant in the fractures.

The chemicals associated with the fracturing fluid are trucked to the site, stored in concentrated form, and mixed immediately before the hydraulic fracturing commences.

After the casing is perforated at the desired depth, the fracturing fluid is injected under high pressure into the well and is forced through the small holes into the rocks, creating cracks. This high downhole pressure is maintained for a brief period of time (approximately 1 hour) in order to exceed the fracture strength of the reservoir rock and cause artificial fractures.

Once a fracture has been initiated, the fracturing fluid and proppant are carried into the fracture. 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, trapped in the hydraulic fracture. With continued flow, formation hydrocarbon fluids should be drawn into the fracture, through the perforations into the wellbore and to the surface.

Flaring from exploration activities

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

- Well testing and clean-up;
- Production testing;
- Emergencies; and
- Maintenance and enhancement activities [well workovers].

1.3 Resource consents

1.3.1 Water abstraction permit (groundwater)

Section 14 of the RMA 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.

The Council determined that the application to take groundwater fell within Rule 49 of the Regional Freshwater Plan for Taranaki (RFP) as the rate and daily volume of the groundwater abstraction might exceed that of the permitted activity (Rule 48). Rule 49 provides for groundwater abstraction as a controlled activity, subject to certain conditions.

Todd Energy Limited holds water permit **7403-1** to take groundwater that may be encountered as produced water during exploration and production operations at the Mangahewa-D wellsite. This permit was issued by the Council on 19 November 2008 under Section 87(d) of the RMA. It is due to expire on 1 June 2021.

Conditions 1 and 2 impose limits upon the abstraction rate and significant potential contaminants.

Condition 3 requires submission of a summary well log.

Condition 4 requires the keeping of records related to abstraction and water quality reports, and provides for the supply of information to the Council.

The last two conditions are lapse and review provisions.

The permit is attached to this report in Appendix I.

1.3.2 Water abstraction permit (surface water)

Section 14 of the RMA 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.

The Council determined that the application to take surface water fell within Rule 16 of the Regional Freshwater Plan for Taranaki (RFP) as the rate and daily volume of the groundwater abstraction might exceed that of the permitted activity (Rule 15). Rule 15 provides for surface water abstraction as a permitted activity, subject to specific conditions.

The Company holds water permit **7404-1** to take water from the Manganui River for wellsite and well drilling activities during hydrocarbon exploration and production activities at the Mangahewa-D wellsite. This permit was issued by the Council on 19 November 2008 under Section 87(d) of the RMA. It is due to expire on 1 June 2021.

Condition 1 imposes limits upon the abstraction rate.

Conditions 2 and 3 require the use of an accurate flow measuring and recording device and provide for the supply of flow data to the Council

Condition 4 requires the keeping of records related to abstraction reports, and provides for the supply of information to the Council.

Condition 5 requires the consent holder to take all reasonable steps to prevent adverse effects on the environment.

Condition 6 requires fish screening of the intake structure.

The last two conditions are lapse and review provisions.

The permit is attached to this report in Appendix I.

1.3.3 Water discharge permit (treated stormwater and treated produced water)

Section 15(1)(a) of the RMA 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 Company holds water discharge permit **7407-1** to discharge treated stormwater, produced water, surplus drill water and water collected from the flare pit from hydrocarbon exploration and production operations at the Mangahewa-D wellsite into a manmade drain and then into an unnamed tributary of the Manganui River. This

permit was issued by the Council on 28 November 2008 under Section 87(e) of the RMA. A change to the consent commenced on 10 September 2015 and this is due to expire on 1 June 2027.

Condition 1 requires the consent holder to adopt the best practicable option.

Condition 2 sets limits on the discharge area.

Conditions 3 and 4 detail requirements for notification prior to works, and contingency plans.

Conditions 5, 6, 7, and 8 detail requirements of the stormwater and skimmer pit system.

Conditions 9 and 10 detail requirements for testing of water in, and notification of discharge from the vumu flare pit, and provide for the supply of information to the Council.

Conditions 11 and 12 detail requirements for site works and storage areas.

Conditions 13, 14, 15, and 16 detail requirements for the quality of the discharge and its effect on the receiving environment.

Condition 17 requires notification prior to reinstatement of the site.

The last two conditions are lapse and review provisions.

The permit is attached to this report in Appendix I.

1.3.4 Water discharge permit (stormwater and sediment – earthworks)

Section 15(1)(a) of the RMA 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 Company holds water discharge permit **7408-1** to discharge stormwater and sediment from earthworks associated with the construction of the Mangahewa-D wellsite onto and into land in the vicinity of an unnamed tributary of the Manganui River in the Waitara catchment. This permit was issued by the Council on 28 November 2008 under Section 87(e) of the RMA. It is due to expire on 1 June 2027.

Conditions 1 and 2 detail requirements of the earthworks and discharge, and the conditions regarding runoff.

Condition 3 requires the consent holder to take all reasonable steps to prevent effects on the environment.

Condition 4 requires notification prior to works.

Condition 5 imposes limits on suspended solids in the discharge.

Condition 6 details requirements for revegetation of earthworked areas.

The last two conditions are lapse and review provisions.

The permit is attached to this report in Appendix I.

1.3.5 Air discharge permit (exploration activities)

Section 15(1)(c) of the RMA 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.

The Company holds air discharge permit **7406-1** to discharge emissions to air from flaring of hydrocarbons and miscellaneous emissions associated with drill stem testing, well clean-up, well testing and production testing at the Mangahewa-D wellsite. This permit was issued by the Council on 5 February 2009 under Section 87(e) of the RMA. It is due to expire on 1 June 2027.

Condition 1 imposes limits on the duration of flaring.

Conditions 2 to 4 detail requirements regarding information and notification of flaring and changes to plant processes.

Conditions 5 to 12 detail requirements of flaring methods and require the consent holder to adopt the best practicable option.

Conditions 12 to 17 impose limits on the quality and effects of emissions from flaring.

Conditions 18 to 20 detail requirements for recording and reporting of information to the Council.

The last two conditions are lapse and review provisions.

The permit is attached to this report in Appendix I.

1.3.6 Discharges of wastes to land (mix-bury-cover)

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

The Company holds discharge permit **7410-1** to discharge solid drilling material (drilling cuttings and residual drilling fluids) from hydrocarbon exploration activities onto and into land via mix-bury-cover. This permit was issued by the Council on 5 February 2009 under Section 87(e) of the RMA. It is due to expire on 1 June 2027.

Conditions 1 and 2 require adherence to the consent conditions and the information submitted in the application, and adoption of the best practicable option at all times.

Conditions 3 and 4 relate to notification and reporting requirements prior to discharge.

Conditions 5 to 15 detail requirements of and impose limits on discharge methods.

Conditions 16 to 19 impose limits on the composition of the discharge.

Conditions 20 to 23 impose limits on the effects on the receiving environment.

The last two conditions are lapse and review provisions.

The permit is attached to this report in Appendix I.

1.4 Monitoring programme

1.4.1 Introduction

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

The Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations and seek information from consent holders.

The monitoring programme for the Mangahewa-D wellsite focused primarily on programme liaison and management, site inspections, chemical sampling, discharges to land and biomonitoring surveys. However, all seven components are discussed below.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council in:

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- in discussion over monitoring requirements;
- preparation for any reviews;
- renewals;
- new consents;
- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

1.4.3 Site inspections

The Mangahewa-D wellsite was visited 28 times during the monitoring period. Inspection and examination of wellsites is a fundamental and effective means of monitoring and are undertaken to ensure that good environmental practices are adhered to and resource consent special conditions complied with.

The inspections are based on internationally recognised and endorsed wellsite monitoring best-practice checklists developed by the Alberta Energy Resources Conservation Board and the USEPA, adapted for local application.

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 any potential receiving waters.

During each inspection the following are checked:

- 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;
- Site layout;
- Ring drains;
- Hazardous substance bunds;
- Treatment by skimmer pits/sedimentation pits;
- Drilling mud;
- Drill cuttings;
- Mud pit capacity and quantity contained in pit;
- Sewage treatment and disposal;
- Cementing waste disposal;
- Surface works;
- Gas combustion systems, whether flaring was in progress, and if there was a likelihood of flaring, whether the Council had been advised;
- Discharges;
- Surface waters in the vicinity for effects on colour and clarity, aquatic life and odour;
- Site records;
- General observations; and
- Odour (a marker for any hydrocarbon and hazardous chemical contamination).

1.4.4 Chemical sampling

The Council undertook sampling of both the discharges from the site and the water quality upstream and downstream of the discharge point and mixing zone.

The skimmer pit discharge was sampled on four occasions, and the sample analysed for hydrocarbons, chlorides, suspended solids, and pH. The unnamed tributary of the Manganui River was sampled on four occasions, and the sample analysed for the same parameters as well as conductivity.

1.4.5 Solid wastes

The Council monitors any disposal of drill cuttings on site via mix-bury cover to ensure compliance with resource consent conditions and to determine whether site activities were causing any adverse effects within the receiving environment.

In recent times consent holders have opted to remove drilling waste from the site by contractor and dispose of it at licensed disposal areas (landfarming), which are monitored separately.

1.4.6 Air quality monitoring

Air quality monitoring is carried out in association with the well testing and clean-up phase, where flaring can occur. The Council also undertook sampling of the ambient air quality in the neighbourhood.

Assessments are made by Inspecting Officers of the Council during site inspections to ensure that operators undertake all practicable steps to mitigate any effects from flaring gas.

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

It is also a requirement that the Council and immediate land owners are notified prior to any gas being flared when practicable. This requirement was checked to ensure compliance with consent conditions and to determine whether site activities were causing any adverse effects within the receiving environment.

1.4.7 Discharges to land (hydraulic fracturing)

Sampling and analysis of the hydraulic fracturing, return flow fluids, and nearby bores were carried out during the period under review. In addition, inspections of the site and surrounding land and water were carried out to ensure that no observable effects had occurred as a result of the discharge to land. Pre-hydraulic fracturing reports were submitted by the consent holder detailing among other things, the effectiveness of the mitigation measures put in place to protect the environment. The hydraulic fracturing campaign for the monitoring period under review is currently ongoing.

Analysis of the hydraulic fracturing sampling results and environmental performance will be discussed in a separate hydraulic fracturing report by the Council.

1.4.8 Biomonitoring surveys

A biological survey was performed on two occasions in an unnamed tributary of the Manganui River to determine whether or not the discharge of treated stormwater and treated produced water from the site had a detrimental effect upon the communities of the stream.

2. Results

2.1 Water

2.1.1 Inspections

27 August 2014

Site inspection was undertaken with Paul Barrett, site engineer. The stormwater systems were all in place and the contents of skimmer pits did not give rise to any concerns.

All the ring drains were in place and secure, and bunding was positioned as and where required. All necessary screening by way of bunding and planting had been undertaken. No odours were encountered and no flaring was being undertaken during the visit.

28 August 2014

Warner Construction Ltd. was onsite commencing the laying of buried pipes to the new drilling platform. Burgess Crowley Civil Ltd. (BCCL) was also onsite continuing to level the new drilling pad.

The northern section of the perimeter drain and a section of the eastern perimeter drain adjacent to the flare pit had been piped to a cellar adjacent to the skimmer pits. Surface drains were yet to have been put in place to divert surface water from the pad area (where perimeter drains had been piped) to the skimmer pit system.

Perimeter drain works were still required in the section of the pad adjacent to the security hut and production area.

The skimmer pits were not discharging during the inspection, and a visual inspection of receiving environment was carried out with no areas of concern observed. Samples were retrieved from the second skimmer pit near the outfall.

9 October 2014

Honnor Welldrillers Ltd. was onsite carrying out the drilling of the conductors. The camp extension had been completed and adequate silt controls were in place; heavy equipment was carrying out the delivery and placement of Portacoms.

Discharge of potable water from a holding tank to the perimeter drains was due be carried out prior to tank removal from site. The water was from town supply and had had sufficient time sitting for chlorine to dissipate. The discharge was to be controlled to avoid scouring and flooding of perimeter drain.

The top soil storage mound had been hydro seeded, as had other parts of the site, including bunds. The batter slope and proximity to the perimeter drain were of concern. Vigilant monitoring of slips and/or erosion was necessary until vegetation had established.

The second skimmer pit in the production facility had significant groundwater intrusion occurring.

The exploration skimmer pits were not discharging, and a visual inspection of the receiving environment showed that the in-stream vegetation was well established. The skimmers were sampled near the outflow.

The lower catchment area adjacent to the skimmer pits had been upgraded to a high standard.

12 November 2014

A pre-drill inspection and found that the drilling rig that was assembled above the conductor was undergoing minor works in anticipation of drilling.

Onsite chemicals were banded and stored under cover, and the earth bund had been seeded and vegetation was establishing.

A section of the perimeter drain adjacent to the security hut appeared to have stormwater ponding; this issue was discussed with the rig manager. It was agreed on that the onsite contractor had available machinery that would be utilised to ensure stormwater flows towards the skimmer system. Some additional time was allowed for should the stormwater system levels need to be reshot. The Company were informed of the issue also.

Additional works that had been undertaken were discussed with the rig manager including introduction of some rip rap under the camp storm water pipe where it enters the production perimeter drain. This was to avoid scouring of the drain.

Todd had enquired if drilling could proceed prior to the seven days as notified earlier in the week. The Council had undertaken all site pre-drilling inspections and agreed to allow the commencement of drilling activities prior to notice requirements.

28 November 2014

Drilling was underway on the top hole of the third well in the batch drilling campaign.

Remedial works to the perimeter drain near the security hut and production area had been started.

The site was clean and tidy with no signs of any recent spills. Onsite chemicals were stored under cover or in banded steel containers.

The skimmer pits were not discharging during the inspection, and samples were taken from the second skimmer pit near the outflow.

12 December 2014

At the time of inspection drilling was continuing on site with the Big Ben Rig. The top holes of wells MHW-21, 22 and 24 were complete with the cementing of an intermediate section taking place at the time of the inspection.

The inspection found that the site was clean and tidy, however recent rain had resulted in an excess of sediment entering the ring drain behind the rig offices. This was affecting water flow to the skimmer pits. It was requested that works be undertaken at the location to ensure that all stormwater was collected and directed to the skimmer pits for treatment prior to discharge.

The skimmer pits were inspected and found to be full but not discharging. A sample was taken from the second skimmer pit to ensure compliance with resource consent conditions should a discharge occur.

7 January 2015

The site was engaged in the drilling of the first of the production sections. The site was clean and tidy with no signs of recent spills. The skimmer pits were not discharging during the inspection, and samples were retrieved near the outfall.

Perimeter drain works near the security hut were still to be completed. The settling pit, within the perimeter drain and adjacent to the soil stock pile, was required to be filled in as it was no longer needed.

15 January 2015

A compliance monitoring inspection found that well MHW-22 had been drilled to total depth (TD), and Schlumberger were onsite carrying out logging of the production zone. The Big Ben Rig was scheduled to shift to MHW-21 to carry out production zone drilling.

BTW Company (BTW) staff were onsite carrying out works to the area where ponding had been occurring; this had been levelled and graded. The settling pit adjacent to the flare pit had been filled in.

The skimmer pits were not discharging during the inspection, and samples were retrieved from the second pit near the outfall.

21 January 2015

Management were involved in a site meeting at the time of inspection, and the drilling rig was still onsite.

No flaring was taking place, the chemical stores were under cover and surrounding area was clean and tidy.

The skimmer pits were not discharging and samples were retrieved from the second skimmer pit near outfall.

3 February 2015

A site inspection was undertaken as part of routine compliance monitoring. Batch drilling of the three wells onsite was ongoing with the rig currently completing the bottom hole sections of the wells.

Due to mechanical failure the rig was not in operation at the time of inspection, however it was anticipated that drilling would recommence later that day.

All chemicals on site were covered and protected from the elements. Containers with in-built bunds were in use onsite to store chemicals in a safe manner.

No flaring had been carried out onsite in association with the drilling programme.

All the ring drains were inspected and found to be in a good operational condition. The portion of bund that had previously been required to be built up had been completed

with a good bund established and subsequently concreted into place. This ensured the integrity of the bund and directed all stormwater to the ring drain on the northern edge of the site.

Honnor Drilling were onsite drilling the conductor for the fourth well to be completed in this operation. No concerns were held over their operation on site.

The skimmer pits were not discharging at the time of the inspection, however samples were taken to ensure compliance with consent conditions should a discharge occur. The receiving environment was inspected and no adverse effects were noted with grass growing throughout the small creek into which the skimmer pits discharge.

Staff were spoken to on site and asked to check the shut-off valve at the end of the skimmer pits to ensure that it was operational as it felt stiff on inspection. Overall the site appeared to be well managed with no issues noted on inspection.

23 February 2015

An investigation was undertaken after receiving a self-notified spill from the Company at the Mangahewa-D wellsite.

A Vac truck rear seal failed while transferring liquid contents from the liquids D-bin to the truck, which resulted in the contents of the truck spilling to the lease area. The total content spilled was estimated to be 8 m³, comprising of approximately 0.5 m³ synthetic-based muds (SBM) and approximately 7.5 m³ wash-up water from flushing the mud pits and cementing equipment.

As a result of the spill the rig was shut down and staff were re-assigned to clean up the spill. A majority of the material remained on the lease where it was discharged. A small volume of the liquid portion of the material entered the ring drain and travelled towards the skimmer pit treatment system. Some of the spill was contained within a concrete riser while, some passed through into the skimmer pits. The pits were not discharging at the time of the spill and the emergency shut-off valve was closed to prevent any likelihood of the spill reaching the receiving environment.

The lease was subsequently cleaned by placing sawdust over the spill to soak it up. A liquids vac system was used to remove any of the remaining liquid portion of the spill from the lease.

The sawdust and contaminated gravel was removed from site with a fresh layer of gravel brought in to place on the affected area. The Council was notified, and it appeared that the clean up was immediate, thorough and professional.

Samples were taken of the contents of the second skimmer pit and a downstream sample of the receiving environment was also taken. A visual inspection of the receiving environment found no visible adverse effects to the pasture growing throughout the stream drain.

12 March 2015

A site inspection found that the final well in the current batch drilling operation was nearing completion with a fourth well due to be drilled following completion of the current well activities.

The site was found to be in a clean and tidy order with good bunding in place about any area where potential spills may occur. The steel bunds placed under the coupling intersections leading to the tank storage were very good at containing any spills that may have occurred when changing hoses over.

The mud tanks and cuttings bins were found to be in a tidy order with no signs of spills about the area.

No flaring had been carried out on site as part of the well drilling operation.

The skimmer pits and ring drains were inspected and found to be in a good working order. The pits were full but not discharging and a visual inspection showed that the integrity of the liner appeared good. Samples were taken from the second skimmer pit to assess compliance should a discharge occur.

2 April 2015

An inspection was undertaken while drilling of the fourth well MHW-24 was underway. It was anticipated that drilling would be complete in approximately two weeks.

The site was clean and tidy with areas about the chemical store and cuttings tanks being maintained to a high standard.

Ring drains were in place and a visual inspection ascertained that they would work well during periods of wet weather, ensuring that all stormwater was captured and directed to the skimmer pits for treatment prior to discharge from site.

Skimmer pits were inspected and found to be full but not discharging. Samples were taken of the contents of the second skimmer pit to ensure compliance with Resource Consent conditions should a discharge occur.

28 April 2015

At the time of inspection the fourth well of the current batch drilling operation had been completed and the Big Ben drilling rig was being dis-assembled and removed from site.

A small amount of works were being undertaken to prepare the site for the installation of water storage (clip tanks) for the pending well stimulation programme.

No flaring had occurred onsite as part of this drilling operation.

A full site inspection was not undertaken due to health and safety issues associated with the movement of the rig and associated equipment on site; however a perimeter inspection was carried out.

It was found that the ring drain behind the mini-camp onsite had filled with gravel in places as a result of site erosion during the recent wet period. Although it was not preventing stormwater from reaching the skimmer pits at the time, it needed to be addressed. This issue was raised with staff onsite who were happy to address it prior to the establishment of the well entry team.

The skimmer pits were inspected and found to be turbid in colour. Samples were taken from the second skimmer pit. The receiving environment was inspected and the stream into which the skimmer pits discharge had vegetation growing throughout and stock access was excluded. The water within the stream was slow moving through the vegetation and found to be clean and clear.

15 May 2015

A site inspection was undertaken during a period of wet weather. Heavy rain was falling prior to the inspection with only light rain falling during the inspection.

All the equipment associated with the Big Ben rig had been removed from site and the well entry team were beginning to establish equipment on site. Schlumberger staff were on site completing cement bond logs of the recently drilled wells.

The flare pit was inspected and was found to be in order to be used when required. The skimmer pits were inspected and found to be discharging. Samples were taken of both the discharge and the receiving environment to ensure compliance with resource consent conditions.

The recent heavy rain had resulted in a section of the ring drain failing between the skimmer pits and the flare pit. This was resulting in stormwater flowing overland towards the first skimmer pit. The water was not discharging offsite at the time of the inspection; however the issue was identified to the well entry supervisor onsite who arranged for its immediate repair.

19 May 2015

A site meeting was carried out with Ian Hill, Hoani Graham and Geoff Bourke (Todd) and Nik Pyselman (BTW).

A conversation was held regarding the groundwater that was intruding under the liner of the skimmer pit at the production side of the wellsite. Options to resolve this issue included placing subsurface drainage under the liner; placing concrete over the base of the liner to prevent the liner lifting; or increasing the size of the discharge pipe to retain more water and increase the hydraulic pressure within the pits in the hope that it would exceed the pressure from the groundwater and subsequently prevent groundwater intrusion.

A conversation was also held regarding controlling the silt and sediment levels being discharged from site. It was suggested that emphasis should be placed on treating the stormwater within the ring drain system prior to entering into the skimmer pits. Options included installing filtering material; placing small weirs within the drain to retain solids; or hydroseeding or coconut matting within the drain to slow the water velocity where the water interacts with the base and sides of the drain and prevent scouring or re-mobilisation of sediment within the drain systems. Settling ponds and chemical treatment were also options that were considered.

It was also discussed with Geoff Bourke that the concentration of suspended solids in the discharge tended to increase with increased traffic movements or earthworks on site. This was often associated with the rig move and establishment of the well entry equipment. It was suggested that as the Company would be aware of when these type

of operations were planned that increased maintenance and instillation of silt controls could be undertaken on site immediately prior to such activities.

28 May 2015

A site inspection found that the well entry equipment had been established onsite. Work was being undertaken to establish a lined bund to contain the condensate tanks prior to commencement of the well hydraulic fracturing (HF) operation.

The flare pit contained some storm water in its base, however plenty of freeboard remained to contain any further storm water from rainfall events.

Work was ongoing to control silt and sediment levels in the site discharges. This involved stabilising the banks of a portion of the ring drain and installing further sediment treatment points throughout the ring drain. Expert assistance had been sought and was due to be received in the following week.

A sample was taken from the second skimmer pit as there was no discharge from the skimmer pits at the time. The sample appeared visually clear. Further work was being undertaken with the Company in regards to a previous high suspended solid reading in the discharge.

30 June 2015

The site was engaged in HF activities, with coil tubing underway in well MHW-22.

No flaring was occurring on site.

The northern perimeter drain had been concrete-lined to control erosion. The site was clean and tidy, and chemicals were stored undercover or within bunds to avoid stormwater contamination.

The skimmer system was not discharging during the inspection and a sample was retrieved from the second skimmer pit near the outfall.

A small section of the perimeter drain wall had been eroded by recent heavy rain, this section required remediation work to ensure all stormwater was directed to the treatment system. Site staff were alerted to the situation.

9 July 2015

The site was engaged with the HF of well MHW-23. The co-mingled flowing of MHW-22 was being undertaken and material was being flared. A light grey discharge was being emitted from the flare which quickly dissipated.

The site was clean and tidy with chemicals stored under cover or in banded steel tanks. Some minor hydrocarbon staining from heavy machinery in use was present and a spill trailer was observed on site.

The skimmer pits were discoloured from recent rainfall. Although the skimmer system was not discharging at the time of inspection it appeared to be close to doing so. A sample was retrieved from the second skimmer pit near the outfall.

17 July 2015

Wells 22 and 23 were flowing gas and produced water to the production station and small amounts of condensate were leaving the site via tankers.

The site was clean and tidy and onsite chemicals were being stored in bunded steel tanks or under cover.

HF and flow back samples were collected.

Hay bales that had previously been installed onsite were no longer providing filtration. The lower perimeter drain wall leading to the riser adjacent to the skimmer pits needed to be built up to ensure all stormwater was directed to the skimmer pit system.

The skimmer pits were not discharging at the time of inspection and samples were retrieved from the second skimmer pit near the outfall.

29 July 2015

Wellsite testing was underway to determine the requirements of contingent HF campaigns.

The site was clean and tidy with no evidence of recent spills. Good housekeeping practises were being carried out and chemicals were stored undercover.

Remedial works had been carried out adjacent to the sleeping block to ensure stormwater was directed to the perimeter drains and was not discharging from the site. The perimeter drain next to the skimmer pits had also been upgraded.

The skimmer pits were not discharging during the inspection, samples were retrieved from the second skimmer pit near the outfall.

13 August 2015

A site inspection found that Baker Hughes fracturing equipment remained onsite while the well stimulation programme was on-going.

The ring drains were inspected and found to be operating well. The concreted portion of the ring drain appeared to be maintaining its integrity and the sediment socks placed throughout the drain appeared to be slowing and treating the stormwater, but not holding it back at a level that would be considered ponding.

The skimmer pits on the well stimulation side of the site were visually inspected and although they appeared rather turbid, the sample collected from the second pit appeared reasonably clear. The skimmer pits were not discharging at the time of the inspection, however samples were taken to ensure compliance with resource consent conditions should a discharge occur.

Due to pressure testing signs about the site the inspection focused on the perimeter drains, skimmer pits and flaring activities. The inspection did not examine with bunding etc. within and around the Baker Hughes equipment due to H&S associated with the onsite testing.

No flaring was occurring onsite at the time of the inspection.

The skimmer pits on the production portion of the wellsite were visually inspected and although not discharging were found to be visually clean. The level in the first pit was slightly below the point of discharge while the stormwater level in the second pit was approximately 40 cm below the point of discharge. This could be due to stormwater being sucked out of the pit for use onsite or the integrity of the liner may be compromised.

The receiving environment was inspected and no adverse environmental effects were noted as a result of the wellsite activities. Photographs of the receiving environment (offsite) were taken to assist with the processing of stormwater consent variations recently lodged with Council.

24 August 2015

A site inspection found that the Baker Hughes equipment was still on site, and a HF of the MHW-24 well was occurring. This was the last planned fracture of the 'A' zone within that well for the time being.

Baker Hughes equipment was set up in the same position as per previous inspections with steel bunds placed under the chemical storage areas. Excess fluids were drained into these bunds and then removed from the site by sucker truck when required to maintain capacity.

No flaring was taking place within the flare pit at the time of the inspection, however flaring was anticipated to occur during the flow back and clean up phase of the current fracturing operation. The Company intended to keep all flaring to a minimum and place the gas through the installed pipeline to McKee production station as soon as the product was suitable to do so.

HF samples were collected from the previous HF's and sent away for analysis.

The ring drains were inspected and the recent upgrade works in this area appeared to be maintaining their integrity with no obvious failings identified. Sediment collected within the ring drains was being cleaned out on a regular basis to prevent it being re-suspended in subsequent rainfall events.

The skimmer pits were visually inspected and appeared to be turbid in colour. A sample was taken from near the discharge pipe in the second skimmer pit to ensure compliance with resource consent conditions should a discharge occur.

The receiving environments were inspected and no adverse environmental effect was detected as a result of the discharges.

2 September 2015

The fracturing operation was continuing with the Baker Hughes equipment still assembled onsite. At the time of inspection no actual fracturing operations were taking place.

The ring drains were inspected and found to be flowing well following a period of reasonable rainfall. There were no obvious signs of ponding or pooling within the drains.

The flare pit had been used during the fracturing operation with no complaints.

The skimmer pits were found to be discharging at the time of the inspection. Samples were taken of the discharge and receiving environment to ensure compliance with resource consent conditions.

24 September 2015

The Baker Hughes HF equipment was still established onsite, however it was not in use at the time of inspection.

Down hole work was currently being undertaken on the MHW-24 well. Further stimulation of the well was planned upon completion of this work.

The bunds that the Baker Hughes equipment was stored on were found to be near empty, allowing for plenty of freeboard to contain any contaminated stormwater during inclement weather conditions.

All ring drains were dry with no discharge occurring from the skimmer pits. Visually the skimmer pits appeared to be reasonably clear, however samples were taken of the contents of the second skimmer pit to ensure compliance with resource consent conditions should a discharge occur.

Flaring was not being undertaken at the time of the inspection, however it was taking place intermittently during the well stimulation programme. The flare pit was free of any solid or liquid material that may have originated from the well stream.

16 October 2015

Site activities were currently engaged with MHW-23, and all zones had been fractured. Complications with coil tubing had stalled work on flowing back all zones. Once the complications had been resolved, all remaining plugs were to be milled and then the well flowed back.

The well site was in a clean and tidy state even with the large amounts of equipment present for the current activities. No flaring was observed during inspection.

There were no signs of recent spills, and onsite chemicals were stored under cover or on bunded steel trays.

No discharge was occurring from the stormwater treatment system, and a sample was retrieved from the skimmer pit.

9 November 2015

The site was engaged with the milling of plugs in MHW-21 after 7 zones had been fractured. All zones were scheduled to be flowed back holistically.

Bio socks had been installed in the perimeter drains for filtration of suspended solids, and sorbent pads were in use around the site.

The flow line had been exposed in two places, one in the production area and the other in the carpark, and the exposed line was being checked for thermal expansion purposes.

Dry chemicals were stored under cover to prevent entrainment in the stormwater. Fuel tanks were stored in bunded steel tanks.

The skimmer pits were not discharging during inspection, and samples were retrieved from the second skimmer pit to monitor constituent concentrations. Frogs were observed in and around the skimmer pit system.

A visual inspection of the receiving environment showed no obvious impacts from recent discharges.

3 December 2015

A site inspection found that Baker Hughes equipment remained on site and well stimulation was ongoing. More fracturing was planned over the coming weeks.

A clip tank had been removed from site, and a snubbing unit was being brought onsite to work over one of the wells in the coming weeks. The unit was to be stacked on site until such time as the stimulation programme was completed.

The skimmer pits were not discharging at the time of the inspection and found to be clean and clear. Samples were taken from the second pit to assess compliance with resource consent conditions should a discharge occur.

2.1.2 Results of discharge monitoring

During the period under review a total of 25 stormwater samples were obtained. Stormwater was observed discharging from the skimmer pits located on the exploration section of the wellsite on four occasions; four samples were obtained in conjunction with this. The remaining 21 stormwater samples were obtained from the second skimmer pit located on the exploration section of the wellsite to ensure compliance with consent conditions in anticipation of potential discharges.

Analysis of the samples obtained showed that all but two of the discharges would have complied with resource consent conditions should a discharge have occurred. Results are detailed in Table 1 and sampling locations can be seen in Figure 2.

Table 1 Stormwater sampling results for Mangahewa-D wellsite 2014-2015

Date	Chloride g/m3	Hydrocarbons g/m3	pH pH	Suspended Solids g/m3	Sampling location
28 Aug 2014	10.8	<0.5	7.1	20	Second skimmer pit
09 Oct 2014	7.6	<0.5	7.5	71	Second skimmer pit
12 Nov 2014	8.4	<0.5	6.8	63	Skimmer pit discharge
28 Nov 2014	19.3	<0.5	9.1	44	Second skimmer pit
12 Dec 2014	15.6	0.6	6.8	49	Second skimmer pit
07 Jan 2015	12.0	<0.5	8.3	6	Second skimmer pit
15 Jan 2015	13.2	<0.5	8.0	4	Second skimmer pit
21 Jan 2015	13.0	<0.5	7.4	4.2	Second skimmer pit
03 Feb 2015	25.5	0.8	7.2	38	Second skimmer pit
23 Feb 2015	38.5	3.8	7.4	7	Skimmer pit discharge
12 Mar 2015	16.9	<0.5	7.2	7	Second skimmer pit

Date	Chloride g/m ³	Hydrocarbons g/m ³	pH pH	Suspended Solids g/m ³	Sampling location
02 Apr 2015	18.3	0.6	6.6	20	Second skimmer pit
28 Apr 2015	30.0	5.9	6.9	170	Second skimmer pit
15 May 2015	11.4	<0.5	6.4	200	Skimmer pit discharge
28 May 2015	8.6	<0.5	6.6	29	Second skimmer pit
30 Jun 2015	21.6	<0.5	6.9	6	Second skimmer pit
09 Jul 2015	48.1	<0.5	7.0	36	Second skimmer pit
17 Jul 2015	44.9	1.9	7.2	8	Second skimmer pit
13 Aug 2015	10.5	1.6	6.3	56	Second skimmer pit
24 Aug 2015	11.1	<0.5	6.8	110	Second skimmer pit
02 Sep 2015	21.2	<0.5	6.3	24	Skimmer pit discharge
24 Sep 2015	11.2	<0.5	7.2	13	Second skimmer pit
16 Oct 2015	53.2	<0.5	7.2	15	Second skimmer pit
09 Nov 2015	12.5	<0.5	7.3	12	Second skimmer pit
03 Dec 2015	30.7	<0.5	7.7	6	Second skimmer pit



Figure 2 Aerial view of the Mangahewa-D wellsite showing the location of the skimmer pits (in red) and the discharge and downstream sampling locations.

Samples obtained on 28 April 2015 and 24 August 2015 returned elevated levels of suspended solids (170 g/m³ and 110 g/m³ respectively). Although these values exceed condition 13 (100 g/m³) of consent 7407-1, no actual non-compliances occurred as these samples were obtained from the skimmer pits to ensure compliance with consent conditions in anticipation of potential discharges.

One discharge sample containing elevated levels of 200 g/m³ of suspended solids was collected on 15 May 2015. This sample was collected following a period of heavy rain,

and the inspection at the time also noted a section of the ring drain had failed due to the high flows of stormwater, although the runoff was still contained onsite. Wellsite staff arranged for the immediate repair of the drain, and after discussing proposed improvements to silt and sediment controls on the site with the Company and BTW staff a few days later, no further action was deemed necessary.

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

2.1.3 Results of receiving environment monitoring

2.1.3.1 Chemical sampling

During the period under review, samples were obtained from an unnamed tributary of the Manganui River in conjunction with discharges from the stormwater system on 12 November 2014, 23 February 2015, 15 May 2015, and 2 September 2015. No exceedances were recorded in relation to consent 7407-1. Results are detailed in Table 2 and sampling locations can be seen in Figure 2.

Table 2 Downstream surface water sampling results from the Mangahewa-D wellsite

Date	Chloride g/m ³	Conductivity mS/m@20C	Hydrocarbons g/m ³	pH pH	Suspended Solids g/m ³	Sampling location
12 Nov 2014	10.1	9.1	<0.5	6.6	31	Downstream
23 Feb 2015	23.4	19.2	-	6.5	26	Downstream
15 May 2015	10.7	13.5	0.7	6.5	120	Downstream
02 Sep 2015	19.5	15.8	<0.5	6.7	12	Downstream

2.1.3.2 Biomonitoring surveys

The Council's standard 'kick-sampling' technique was used at four established sites to collect streambed macroinvertebrates from an unnamed tributary of the Manganui River. Samples were processed to provide number of taxa (richness), taxa abundances, and MCI and SQMCI_s scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The SQMCI_s takes into account taxa abundance as well as sensitivity to pollution, and may reveal more subtle changes in communities. It may be the more appropriate index if non-organic impacts are occurring.

Significant differences in either the MCI or the SQMCI_s between sites indicate the degree of adverse effects (if any) of the discharges being monitored.

The macroinvertebrate survey conducted on 18 May 2015 indicated that the discharge of treated stormwater and treated production water from the Mangahewa-D wellsite was having an effect on the macroinvertebrate communities of the unnamed tributary of the Manganui River. The two impacted sites surveyed (sites 3 and 4, downstream of the discharge point) had substantially lower taxa richnesses compared with the control site. These low taxa richnesses were also far lower than previous results at the same

sites in 2014. This normally would suggest that wellsite discharges had a significant negative effect on the macroinvertebrate communities present in the unnamed tributary.

However, the control site and the two impacted sites had significant differences between them; and, in addition to this, prior to sampling there were eight separate flood peaks recorded in the Manganui River at Everett Park from the 8 April to 16 May 2015 with the three most recent floods close to or above 50 x median base flow indicating very high flood flows in the area. Therefore a combination of very high flows and habitat differences (the two impacted sites appeared more prone to scouring) may have produced the observed results which were the reason why an additional survey was conducted.

The additional survey on 28 May 2015 occurred 10 days after the last flood peak to allow a more representative macroinvertebrate community to be sampled. The second post-drill survey results showed an improvement in taxa richness at sites 3 and 4 but at levels that were still lower than the 'control' site. The results of the second post-drill survey, in conjunction with first post-drill survey, suggest macroinvertebrate communities that are recovering from a disturbance event rather than typical communities particularly when compared with previous results.

Low taxa richnesses at the two most downstream sites were probably the result of a combination of recent high flood flows and the topography of the sites. The additional 'impacted' site situated in the receiving tributary showed typical levels of taxa richness and abundances indicating that there was no toxic wellsite discharges. Analysis of all the available information suggests that Mangahewa-D wellsite discharges to the unnamed tributary of the Manganui River did not have any significant negative effects on the health of the macroinvertebrate communities present there.

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 for comments concerning site inspections.

2.2.2 Results of discharge monitoring

The Company notified the Council of its intention to combust gas at the Mangahewa-D wellsite on 20 May 2015, 23 June 2015 and 23 July 2015. Following these dates, gas combustion occurred intermittently over the course of a few days in conjunction with well testing. During this time a flare pit was largely employed for the combustion of gas and to maintain a pilot flare for emergency gas combustion / depressurisation.

During routine inspections, no offensive or objectionable odours, smoke or dust associated with activities at the Mangahewa-D wellsite were observed. From observations during site inspections, including the inspection of the flare log maintained by the Company, it appeared that special conditions relating to the control of emissions to air from the combustion of hydrocarbons were complied with, other than as noted above.

2.2.3 Results of receiving environment monitoring

No chemical monitoring of air quality was undertaken during the testing phase of the Mangahewa-D wellsite as gas combustion activities were minimal and the controls implemented by the Company did not give rise to any concerns with regard to air quality.

2.2.4 Other ambient monitoring

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

2.3 Contingency plan

The Company has provided a general contingency plan, as required by Condition 4 of resource consent 7407-1 with site specific maps. The contingency plan has been reviewed and approved by officers of the Council.

2.4 Investigations, interventions, and incidents

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

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

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

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

3. Discussion

3.1 Discussion of site performance

Monitoring of the Mangahewa-D wellsite during the period under review found that the site was generally well managed, although there were ongoing issues with silt and sediment controls that were addressed by the Company. Any minor actual or potential non-compliance with consent conditions were addressed during site inspections. The Company would quickly take steps to ensure that requests made by Council Inspecting Officers were adhered to without delay.

There were no incidents or complaints recorded, and it is considered that all resource consent conditions were complied with during the monitoring period, including the provision of various pieces of information (contingency plan, notifications etc.).

The discharge of solid drilling wastes (drilling cuttings and residual drilling fluids) from hydrocarbon exploration activities onto and into land via mix-bury-cover as permitted by resource consent 7410-1 was not exercised during the period under review. The drilling fluids and cuttings were disposed of at a consented off site facility.

Monitoring has shown that the management onsite ensured that no effects to the environment occurred during the monitoring period.

3.2 Environmental effects of exercise of consents

Results of stormwater discharge sampling were within the limits prescribed by the consent for the wellsite for all samples excluding one. No adverse effects were noted on the receiving environment as a result of this discharge.

Compliance with consent conditions during abstraction of surface water from the Manganui River ensured that this activity did not cause any adverse effects. Small amounts of groundwater may have been encountered as produced water during operations at the wellsite. It was anticipated that the abstraction of groundwater would not impact on any groundwater resource and that the groundwater would not be affected as it would be protected by the well casing, from contamination by drilling or fracturing activities.

There were no adverse effects on the environment resulting from discharges to air at the Mangahewa-D wellsite. Inspections showed that emissions from flaring were well controlled.

The Company implemented various mitigation measures to ensure the storage and use of hazardous substances onsite did not contaminate surface waters and soils. As a result, there were no issues or adverse effects noted as a result of the use of these substances.

3.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Table 3 to Table 8.

Table 3 Summary of performance for consent 7403-1 to take groundwater as 'produced water'

Purpose: To take groundwater that may be encountered as produced water during hydrocarbon exploration and production operations at the Mangahewa-D wellsite		
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	Sampling	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 1,000 m must be submitted to the Council	Well log to 1,000 m submitted	Yes
4. Consent holder shall maintain records of abstraction and make available to the Council	Information not requested	N/A
5. Consent shall lapse if not implemented by date specified	Confirmed by inspection	N/A
6. Notice of Council to review consent	Notice of intention not served	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

N/A = not applicable

Table 4 Summary of performance for consent 7404-1 to take water from the Manganui River

Purpose: To take water from the Manganui River for wellsite and well drilling activities during hydrocarbon exploration and production operations at the Mangahewa-D wellsite		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Volume of water abstracted shall not exceed 100 cubic metres per day, at a rate not exceeding 25 litres per second	Inspection of abstraction logs	Yes
2. Consent holder shall install and maintain a water meter	Inspection	Yes
3. Consent holder shall make available electronic records of water abstraction	Inspection	Yes
4. Consent holder shall maintain a record of abstractions and make available to the Council upon request	Inspection of abstraction logs	Yes

Purpose: To take water from the Manganui River for wellsite and well drilling activities during hydrocarbon exploration and production operations at the Mangahewa-D wellsite		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
5. Consent holder shall take all reasonable steps to avoid, remedy or mitigate any adverse effect on the environment arising from the exercise of this consent	Inspections	Yes
6. Intake structure must be appropriately screened to avoid the entrainment of fish	Inspection of structure	Yes
7. Consent shall lapse if not implemented by date specified	Confirmed by inspection	N/A
8. Notice of Council to review consent	Notice of intention not served	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

Table 5 Summary of performance for consent 7406-1 to discharge emissions to air

Purpose: To discharge emissions to air from flaring of hydrocarbons and miscellaneous emissions associated with drill stream testing, well clean-up, well testing and production testing at the Mangahewa-D wellsite		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent shall not be exercised for more than 15 days per zone for up to six zones per well, for up to eight wells	Inspection of records	Yes
2. Council must be notified 24hrs prior to initial flaring of each zone	Notification	Yes
3. At least 24hrs notice prior to flaring required to notify nearby residents when practicable	Notification	Yes
4. No alterations made to plant equipment that will alter the nature or quantity of flare emissions	Inspection, plant procedures and processes	Yes
5. Consent holder shall have regard to prevailing and predicted wind speed and direction with commencement of flaring	Inspection	Yes
6. Liquid and solid separation to occur before flaring to minimise smoke emissions	Inspection of flare pit	Yes
7. If separation could not be implemented / maintained, the consent holder shall notify the Council	Notification	Yes
8. No liquid or solid hydrocarbons shall be combusted within the flare pit	Inspection of flare pit	Yes
9. Gas shall be combusted so that emissions of smoke are minimised	Inspection	Yes

Purpose: To discharge emissions to air from flaring of hydrocarbons and miscellaneous emissions associated with drill stream testing, well clean-up, well testing and production testing at the Mangahewa-D wellsite		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
10. Best practicable option to be adopted	Inspections, procedures and processes	Yes
11. Only substances originating from the well stream shall be combusted in the flare pit	Inspection	Yes
12. No offensive odour or smoke beyond the boundary	Inspection	Yes
13. Opacity of smoke emissions shall not exceed level 1 on Ringelmann Scale	Inspection	Yes
14. Control of carbon monoxide	Inspection of company records	Yes
15. Control of nitrogen oxides	Inspection of company records	Yes
16. Consent holder shall not discharge any contaminant to air that is liable to be hazardous, toxic or noxious at or beyond the boundary of the wellsite	Inspections	Yes
17. Control of other emissions	Inspection of company records	Yes
18. Analysis of typical gas and condensate stream from field to be made available to the Council	Available upon request	N/A
19. The consent holder shall record the time, duration and cause of all smoke emitting incidents and submit to the Council	Inspection of company records	Yes
20. Log all flaring including time, duration, zone, volumes flared and smoke events	Inspection of company records	Yes
21. Consent shall lapse if not implemented	Consent exercised	N/A
22. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

Table 6 Summary of performance for consent 7407-1 to discharge treated stormwater

Purpose: To discharge treated stormwater; produced water; surplus drill water; and water collected from the flare pit; from hydrocarbon exploration and production operations at the Mangahewa-D wellsite into a manmade drain and then into an unnamed tributary of the Manganui River		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Consent holder to adopt best practicable option at all times	Inspections, procedures and processes	Yes
2. Maximum stormwater catchment area shall be no more than 19,000 m ²	Plans, procedures and processes	Yes

Purpose: To discharge treated stormwater; produced water; surplus drill water; and water collected from the flare pit; from hydrocarbon exploration and production operations at the Mangahewa-D wellsite into a manmade drain and then into an unnamed tributary of the Manganui River		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
3. 7 days written notice prior to site works and drilling	Notification received	Yes
4. Council to approve the contingency plan in relation to the wellsite prior to exercise of consent	Contingency plan approved	Yes
5. The stormwater system shall be designed, managed and maintained in accordance with information submitted	Comparative inspections in accordance with information submitted	Yes
6. All runoff from the site shall flow to a perimeter drain and skimmer pit without ponding	Inspection	No – instances of ponding and blockages in drains
7. Stormwater pits to be lined with impervious material	Inspection	Yes
8. Skimmer pits shall have a combined capacity of no less than 170 m ³	Inspection	Yes
9. Rainwater collected within the flare pit to be tested prior to discharge	Inspection of company records	Yes
10. Consent holder shall notify the Council 48hrs prior to the discharge of contaminated water from the flare pit through the skimmer pit system	Notification received	Yes
11. Perimeter drains and skimmer pits shall be installed prior to the commencement of any site works	Inspection	Yes
12. Hazardous substances storage areas shall be bunded with drainage to appropriate recovery systems	Inspection	Yes
13. Constituents in discharges shall meet the following standards: a) pH 6.0 – 9.0 b) Suspended solids <100 g/m ³ c) Hydrocarbon <15 g/m ³ d) Chloride 50 g/m ³	Physicochemical sampling	No – one exceedance of suspended solids on 15 May 2015
14. Following a mixing zone of 25 m , discharges shall not give rise to a temperature increase of more than 2°C	Physicochemical sampling	Yes
15. Following the mixing zone, the discharge shall not give rise to adverse effects in/on the receiving waters	Inspection and sampling	Yes
16. The Council shall be advised in writing 48 hrs prior to reinstatement of the site	Site still occupied / in use	N/A

Purpose: To discharge treated stormwater; produced water; surplus drill water; and water collected from the flare pit; from hydrocarbon exploration and production operations at the Mangahewa-D wellsite into a manmade drain and then into an unnamed tributary of the Manganui River		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
17. Consent shall lapse if not implemented	Exercise of consent confirmed by inspection	N/A
18. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		Good
Overall assessment of administrative performance in respect of this consent		High

Table 7 Summary of performance for consent 7408-1 to discharge stormwater and sediment from earthworks

Purpose: To discharge stormwater and sediment from earthworks associated with the construction of the Mangahewa-D wellsite onto and into land in the vicinity of an unnamed tributary of the Manganui River in the Waitara catchment		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Definitions	-	N/A
2. Runoff derived from exposed soil shall pass through settlement ponds or traps	Inspection	Yes
3. The consent holder shall mitigate and minimise the amount of sediment discharged / suspended in the Manganui River or its tributaries as a result of activities at site	Inspection	Yes
4. 7 days written notice prior to site earthworks commencing	Notification received	Yes
5. Concentration of suspended solids in the discharge shall not exceed 100gm ³	Physicochemical sampling	Yes
6. All earth worked areas shall be stabilised as soon as practicable	Inspection	Yes
7. Consent shall lapse if not implemented	Exercise of consent confirmed by inspection	N/A
8. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		High
Overall assessment of administrative performance in respect of this consent		High

Table 8 Summary of performance for consent 7410-1 to discharge solid drilling wastes

Purpose: To discharge solid drilling wastes (drilling cuttings and residual drilling fluids) from hydrocarbon exploration activities onto and into land via mix-bury-cover		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Discharges are to take place in accordance with information submitted in support of application	Confirming discharges were undertaken in accordance with information submitted	N/A
2. Consent holder to adopt best practicable option at all times	Inspection, procedures and processes	Yes
3. The Council to be notified 48hrs prior to and completion of each mix-bury-cover discharge	Notification received	N/A
4. Records of composition, volumes and quantities of material to be discharged shall be kept and supplied to the Council	Inspection of Company records	N/A
5. Volume of solid drilling wastes discharged shall not exceed 1500 m ³ per well from up to 8 wells	Inspection, procedures and processes	N/A
6. Discharge areas for waste from individual wells are to be kept separate and distinct	Inspection of company records	N/A
7. No discharges shall occur within 12 months of any previous mix-bury-cover discharge at the site	Inspection of company records	N/A
8. As far as practicable, all fluids shall be removed from the drilling wastes	Inspection, procedures and processes	N/A
9. All sumps are to be permeable	Inspection	N/A
10. Drilling waste to be mixed with uncontaminated soil	Sampling soil prior to mixing	N/A
11. The mixture of solid drilling wastes and uncontaminated soil shall be covered by at least one metre of uncontaminated soil	Inspection, procedures and processes	N/A
12. Each mix-bury-cover discharge shall be re-vegetated and maintained with pasture cover	Inspection	N/A
13. The cover material is to be compacted and contoured so that stormwater is directed away from the mix-bury-cover site.	Inspection	N/A
14. Mix-bury-cover discharge sites are to be as far above the groundwater table as practicable	Inspection	N/A

Purpose: To discharge solid drilling wastes (drilling cuttings and residual drilling fluids) from hydrocarbon exploration activities onto and into land via mix-bury-cover		
Condition requirement	Means of monitoring during period under review	Compliance achieved?
15. Mix-bury-cover discharge sites must be 30m from any water body, spring or bore	Inspection	N/A
16. The total loading of trace elements in waste is not to exceed Alberta Energy and Utilities Board, 1996, G-50 guidelines	Inspection of company records	N/A
17. Chloride levels in each mix-bury-cover shall not exceed 1,600kg	Physicochemical sampling	N/A
18. Nitrogen levels in each mix-bury-cover shall not exceed 400kg	Physicochemical sampling	N/A
19. The hydrocarbon content of solid drilling waste shall not exceed 15mg/kg	Physicochemical sampling	N/A
20. Various parameters in the soil covering the mix-bury-cover to be below agreed limits	Physicochemical sampling	N/A
21. Various metals in the soil covering the mix-bury-cover to be below agreed limits	Physicochemical sampling	N/A
22. Hydrocarbon concentrations in the soil covering the mix-bury-cover shall comply with agreed guideline values	Physicochemical sampling	N/A
23. Level of salts in surface & ground water not to exceed 2,500g/m ³	Physicochemical sampling	N/A
24. Consent shall lapse if not implemented by date specified	Exercise of consent confirmed by inspection	N/A
25. Notice of Council to review consent	No provision for review during period	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		N/A
Overall assessment of administrative performance in respect of this consent		N/A

During the year, the Company demonstrated a good level of environmental and high level of administrative performance with the resource consents as defined in Section 1.1.4. During the year under review there were ongoing issues with silt and sediment controls in the stormwater system, but these were dealt with quickly and efficiently by Company staff. There were no registered incidents or complaints related to the Company's activities at the site.

The Company demonstrated a high level of administrative performance, as shown by the timely and satisfactory manner with which they provided required information and responded to requests from Council officers.

Ratings are as defined in Section 1.1.4

3.4 Recommendations from the 2013-2014 Annual Report

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

1. THAT this report be forwarded to the Company, and to any interested parties upon request;
2. THAT the monitoring of future consented activities at Mangahewa-D wellsite continue to include biomonitoring surveys;
3. THAT the monitoring of future consented activities continue to include sampling and extensive analysis of both groundwater and surface waters in the general vicinity of the Mangahewa-D wellsite where hydraulic fracturing occurs;
4. THAT, subject to the findings of monitoring of any further activities at the Mangahewa-D wellsite consents 7403-1, 7404-1, 7405-1, 7406-1, 7407-1, 7408-1, 7410-1 and 7912-1 shall not be reviewed in 2015.

These recommendations were implemented.

3.5 Alterations to monitoring programmes for 2015-2016

In designing and implementing the monitoring programmes for air/water discharges in the region, the Council has taken into account:

- the extent of information made available by previous authorities;
- its relevance under the RMA;
- its obligations to monitor emissions/ discharges and effects under the RMA; and
- to report to the regional community.

The Council also takes into account the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki emitting to the atmosphere/ discharging to the environment.

It is proposed that for 2015-2016 the monitoring of consented activities at the Mangahewa-D wellsite continue at the same level as in 2014-2015. A recommendation to this effect is attached to this report.

3.6 Exercise of optional review of consent

Each resource consent includes a condition which allows the Council to review the consent, 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 were not foreseen at the time the application was considered or which it was not appropriate to deal with at the time. The next provisions for review are in June 2015.

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 for any of the consents. A recommendation to this effect is presented in section 4.

4. Recommendations

1. THAT this report be forwarded to the Company, and to any interested parties upon request;
2. THAT the monitoring of future consented activities at Mangahewa-D wellsite continue to include biomonitoring surveys;
3. THAT the monitoring of future consented activities continue to include sampling and analysis of both groundwater and surface waters in the general vicinity of the Mangahewa-D wellsite where hydraulic fracturing occurs.

Glossary of common terms and abbreviations

The following abbreviations and terms may be 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.
Conductivity	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	Grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.

Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.
IR	The Incident Register contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
L/s	Litres per second.
m ²	Square Metres.
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	<i>Resource Management Act 1991</i> and including all subsequent amendments.
SS	Suspended solids.
SQMCI	Semi quantitative macroinvertebrate community index.
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.
Zn*	Zinc.

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

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

Bibliography and references

Taranaki Regional Council (2014): *Todd Energy Limited Mangahewa-D Wellsite Report*. Technical Report 2014-54

Appendix I

Resource consents held by Todd Energy Ltd

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

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

Name of
Consent Holder: Todd Energy Limited
P O Box 802
NEW PLYMOUTH 4340

Decision Date: 19 November 2008

Commencement Date: 19 November 2008

Conditions of Consent

Consent Granted: To take groundwater that may be encountered as produced water during hydrocarbon exploration and production operations at the Mangahewa-D wellsite at or about (NZTM) 1711141E-5673516N

Expiry Date: 1 June 2021

Review Date(s): June 2015

Site Location: Mangahewa-D wellsite, Rimutauteka Road, Inglewood
[Property owner: KV & SJ Collins]

Legal Description: Rimutauteka 1A Blk X Waitara SD

Catchment: Waitara

Tributary: Manganui

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

General conditions

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

Special conditions

1. The consent holder shall 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, or cross-contamination with salt water into any freshwater aquifer.
3. The consent holder shall submit, to the written satisfaction of the Chief Executive, Taranaki Regional Council, a summary well log to a depth of 1000 metres. 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. The consent holder shall maintain records of abstraction including date, volume of groundwater abstracted per day, water quality reports and shall make these records available to the Chief Executive, Taranaki Regional Council, upon request.
5. This consent shall lapse on the expiry of five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

Consent 7403-1

6. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 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 15 November 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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

Name of
Consent Holder: Todd Energy Limited
P O Box 802
NEW PLYMOUTH 4340

Decision Date: 19 November 2008

Commencement Date: 19 November 2008

Conditions of Consent

Consent Granted: To take water from the Manganui River for wellsite and well drilling activities during hydrocarbon exploration and production operations at the Mangahewa-D wellsite at or about (NZTM) 1711141E-5673516N

Expiry Date: 1 June 2021

Review Date(s): June 2015

Site Location: Mangahewa-D wellsite, Rimutauteka Road, Inglewood
[Property owner: KV & SJ Collins]

Legal Description: Rimutauteka 1A Blk X Waitara SD

Catchment: Waitara

Tributary: Manganui

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

General conditions

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

Special conditions

1. The volume of water taken shall not exceed 100 cubic metres per day, at a rate not exceeding 25 litres per second.
2. Before exercising this consent the consent holder shall install, and thereafter maintain, a water meter. The water meter shall be tamper-proof and shall measure and record the rate and volume of water taken to an accuracy of $\pm 5\%$.
3. The consent holder shall make available electronic records of water taken to the Council at a frequency and in a format to be advised by the Chief Executive Taranaki Regional Council.
4. The consent holder shall maintain a record of the abstraction including date, pumping hours and daily volume abstracted and make these records available to the Chief Executive, Taranaki Regional Council, no later than 31 July of each year, or earlier upon request.
5. Notwithstanding the terms and conditions of this consent the consent holder shall take all reasonable steps to avoid, remedy or mitigate any adverse effect on the environment arising from the exercise of this consent, including, but not limited to, the efficient and conservative use of water.
6. The consent holder shall ensure that the intake structure is appropriately screened to avoid the entrainment of fish.
7. This consent shall lapse five years after the date of issue of this consent, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

Consent 7404-1

8. 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 15 November 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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

Name of
Consent Holder: Todd Energy Limited
P O Box 802
NEW PLYMOUTH 4340

Decision Date: 5 February 2009

Commencement Date: 5 February 2009

Conditions of Consent

Consent Granted: To discharge emissions to air from flaring of hydrocarbons and miscellaneous emissions associated with drill stem testing, well clean-up, well testing and production testing at the Mangahewa-D wellsite at or about (NZTM)
1711146E-5673511N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Mangahewa-D wellsite, Rimutauteka Road, Inglewood
[Property owners: KV & SJ Collins]

Legal Description: Rimutauteka 1A Blk X Waitara SD

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

General conditions

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

Special conditions

Exercise of consent

1. Flaring shall not occur on more than 15 days per zone for up to six zones per well, for up to eight wells.

Information and notification

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. Notification by fax or post is acceptable if the consent holder does not have access to email.
3. At least 24 hours before any flaring, the consent holder shall provide notification to all residents within 1000 metres of the wellsite of the commencement of flaring. 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. No alteration shall be made to plant equipment or processes which may substantially alter the nature or quantity of flare emissions or other wellsite emissions, including but not limited to the recovery of produced gas, other than as authorised by this consent, without prior consultation with the Chief Executive, Taranaki Regional Council.

Flaring

5. Other than for the maintenance of a pilot flare flame, the consent holder shall have 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.
6. All gas that is flared during well clean-up, drill stem testing, initial testing, well workovers, or production testing, or at any other time, must first be treated by effective liquid and solid separation and recovery, to ensure that smoke emission during flaring is minimised.
7. If separation required by condition 6 cannot be implemented or maintained at any time while there is a flow from the well, whether natural or induced, then the consent holder shall immediately advise the Compliance Manager, Taranaki Regional Council, and shall in any case re-establish liquid separation and recovery within three hours.
8. Subject to special condition 7, no liquid or solid hydrocarbons shall be combusted through the gas flare system.
9. The gas shall be combusted so that emissions of smoke are minimised.
10. Notwithstanding any other condition of this consent 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 or any other emissions to air from the Mangahewa-D wellsite [including use of a separator during well clean-up].
11. Only substances originating from the well stream and treated as outlined by conditions 6, 7, 8, 9, and 10 shall be combusted within the flare pit.
12. There shall not be any offensive odour or smoke at or beyond the boundary of the property where the wellsite is located.
13. The opacity of any smoke emissions shall not exceed a level of 1 as measured on the Ringelmann Scale.
14. 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.

Consent 7406-1

15. 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 [$\mu\text{g}/\text{m}^3$] [24-hour average exposure], or 200 $\mu\text{g}/\text{m}^3$ [1-hour average exposure] at or beyond the boundary of the property where the wellsite is located.
16. The consent holder shall control emissions to the atmosphere, from the production station and flare, of contaminants other than carbon dioxide, carbon monoxide, and nitrogen oxides so that, whether alone or in conjunction with any other emissions from the production station, is not hazardous or toxic or noxious at or beyond the boundary of the property.
17. 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].

Recording and reporting information

18. 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.
19. Each time there is visible smoke as a result of the exercise of this consent, the consent holder shall record the time, duration and cause. The consent holder shall make the record available to the Chief Executive, Taranaki Regional Council, upon request.
20. The consent holder shall record and make available to the Chief Executive, Taranaki Regional Council, logs of all flaring, including time, duration, zone, and volumes of substances flared.

Lapse and Review

21. This consent shall lapse on 31 March 2014, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.
22. 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 2014 and/or June 2020, 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;
 - b) requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment caused by the discharge;
 - c) to alter, add or delete limits on mass discharge quantities or discharge or ambient concentrations of any contaminant;
 - d) taking into account any Act of Parliament, regulation, national policy statement or national environmental standard which relates to limiting, recording, or mitigating emissions of gases which are products of combustion, and which is relevant to the air discharge from the Mangahewa-D wellsite.

Signed at Stratford on 15 November 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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

Name of
Consent Holder: Todd Energy Limited
PO Box 802
New Plymouth 4340

Decision Date
(Change): 10 September 2015

Commencement Date
(Change): 10 September 2015 (Granted Date: 28 November 2008)

Conditions of Consent

Consent Granted: To discharge treated:
• stormwater;
• surplus drill water; and
• water collected from the vumu flare pit;
from hydrocarbon exploration and production operations at
the Mangahewa-D wellsite into a manmade drain and then
into an unnamed tributary of the Manganui River

Expiry Date: 1 June 2027

Review Date(s): June 2021

Site Location: Mangahewa-D wellsite, 674 Rimutauteka Road, Inglewood
(Property owner: KV & SJ Collins)

Legal Description: Pt Rimutauteka 1A Blk X Waitara SD
(Discharge source & site)

Grid Reference (NZTM) 1711186E-5673665N (Skimmer pit discharge)
1711219E-5673706N (Final discharge)

Catchment: Waitara

Tributary: Manganui

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

General conditions

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

Special conditions

1. Notwithstanding any other condition of this consent, 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 19,000 m².
3. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 7 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. Notification by fax or post is acceptable if the consent holder does not have access to email.
4. The consent holder shall prepare and maintain a contingency plan that details measures and procedures to be undertaken that will, to the satisfaction of the Chief Executive, Taranaki Regional Council, prevent spillage or accidental discharge of contaminants not authorised by this consent and avoid, remedy or mitigate the environmental effects of such a spillage or discharge.
5. Subject to the other conditions of this consent, the design, construction, management and maintenance of the stormwater system shall be undertaken in accordance with the information submitted in support of application 7595, and in particular, Drawing No. 13285-01, Sheets 1-5, prepared by BTW Company Limited, dated August 2013.
6. All runoff from the site flow to a perimeter drain and skimmer pits. Perimeter drains shall be designed, including by having a positive grade and low permeability, to ensure that stormwater runoff flows directly to the skimmer pits without ponding.
7. All skimmer pits and any other stormwater retention areas shall be lined with an impervious material to prevent seepage through the bed and sidewalls.

Consent 7407-1.4

8. Skimmer pits shall have a combined capacity of no less than 170 m³ before being discharged.
9. Before being discharged, rainwater collected in the vumu flare pit shall be tested and test results shall be provided to the Chief Executive, Taranaki Regional Council. If contaminant levels do not meet the standards specified in condition 13 of this consent, the water shall be trucked off site for appropriate disposal.
10. The consent holder shall notify the Chief Executive, Taranaki Regional Council, in writing at least 48 hours, prior to the discharge of contaminated water from the vumu flare pit through the skimmer pit system. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz.
11. Perimeter drains and skimmer pits necessary to comply with the conditions of this consent shall be installed before any site works commences. Site works includes the introduction of a drilling rig, drilling equipment or any other associated equipment or facilities to the site for any purpose other than for the construction of the site.
12. Any above ground hazardous substances storage areas shall be bunded with drainage to sumps, or other appropriate recovery systems, and not to the stormwater catchment.
13. Constituents in the discharge shall meet the standards shown at the locations described in the following table.

Constituent	Standard	Discharge Location
pH	Within the range 6.0 to 9.0	Scruffy dome in paddock adjacent to skimmer pits at or about 1711186E-5673665N.
total recoverable hydrocarbons	Concentration not greater than 15 gm ⁻³ (as determined by infrared spectroscopic technique)	
Chloride	Concentration not greater than 230 gm ⁻³	After final treatment within farm drain at or about 1711219E-5673706N.
suspended solids	Concentration not greater than 100 gm ⁻³	

14. In order for the final treatment to continually provide effective filtration, it shall be left undisturbed (including by excluding stock) and shall not be sprayed.
15. After allowing for a mixing zone of 25 metres, the discharge shall not cause any of the following effects in the receiving water:
 - a. an increase in temperature of more than 2 degrees Celsius; or
 - b. the chloride concentration to exceed 50 gm⁻³.
16. After allowing for a mixing zone of 25 metres, the discharge shall not give rise to any of the following effects in the receiving water:
 - a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
 - b) any conspicuous change in the colour or visual clarity;
 - c) any emission of objectionable odour;
 - d) the rendering of fresh water unsuitable for consumption by farm animals;
 - e) any significant adverse effects on aquatic life.

Consent 7407-1.4

17. 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 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. Notification by fax or post is acceptable if the consent holder does not have access to email.
18. This consent shall lapse on 31 December 2013, 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.
19. 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 2009, 2010, 2011, 2012, 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 10 September 2015

For and on behalf of
Taranaki Regional Council

A D McLay
Director - Resource Management

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

Name of Consent Holder: Todd Energy Limited
P O Box 802
NEW PLYMOUTH 4340

Decision Date: 28 November 2008

Commencement Date: 28 November 2008

Conditions of Consent

Consent Granted: To discharge stormwater and sediment from earthworks associated with the construction of the Mangahewa-D wellsite onto and into land in the vicinity of an unnamed tributary of the Manganui River in the Waitara catchment at or about (NZTM) 1711146E-5673511N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Mangahewa-D wellsite, Rimutauteka Road, Inglewood
[Property owner: KV & SJ Collins]

Legal Description: Rimutauteka 1A Blk X Waitara SD

Catchment: Waitara

Tributary: Manganui

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

General conditions

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

Special conditions

1. This consent authorises the discharge of stormwater and sediment from earthworks associated with the construction of a 100 metres x 80 metres wellsite and a 1 kilometre long access track.
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 50 cubic metres.
3. The consent holder shall take all reasonable steps to:
 - a. minimise the amount of sediment discharged to the Manganui River or its tributaries;
 - b. minimise the amount of sediment that becomes suspended in the Manganui River or its tributaries; and
 - c. mitigate the effects of any sediment in the Manganui River or its tributaries.

Subject to condition 1, undertaking work in accordance with *Guidelines for Earthworks in the Taranaki region [2006]*, by the Taranaki Regional Council, will achieve compliance with this condition.

4. At least 7 working days prior to the commencement of works the consent holder shall notify the Taranaki Regional Council of the proposed start date for the work. Notification shall include the consent number and a brief description of the activity consented and shall be emailed to worknotification@trc.govt.nz. Notification by fax or post is acceptable only if the consent holder does not have access to email.
5. The concentration of suspended solids in the discharge shall not exceed 100 gm⁻³. This condition shall apply prior to the entry of the stormwater into water at a designated sampling point approved by the Chief Executive, Taranaki Regional Council.
6. All earthwork areas shall be stabilised vegetatively or otherwise as soon as is practicable immediately following completion of soil disturbance activities.

Consent 7408-1

7. This consent shall lapse on 31 December 2013, 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.
8. 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 15 November 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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

Name of
Consent Holder: Todd Energy Limited
P O Box 802
NEW PLYMOUTH 4340

Decision Date: 5 February 2009

Commencement Date: 5 February 2009

Conditions of Consent

Consent Granted: To discharge solid drilling wastes [drilling cuttings and residual drilling fluids] from hydrocarbon exploration activities onto and into land via mix-bury-cover at or about (NZTM) 1711146E-5673511N

Expiry Date: 1 June 2027

Review Date(s): June 2015, June 2021

Site Location: Mangahewa-D wellsite, Rimutauteka Road, Inglewood
[Property owner: KV & SJ Collins]

Legal Description: Rimutauteka 1A Blk X Waitara SD

Catchment: Waitara

Tributary: Manganui

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

General conditions

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

Special conditions

1. The exercise of this consent shall be undertaken substantially in accordance with the documentation submitted in support of application 6126. In the case of any contradiction between the documentation submitted in support of application 6126 and the conditions of this consent, the conditions of this consent shall prevail.
2. Notwithstanding any other condition of this consent, 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, including but not limited to effects on any water body or soil.

Notification and reporting requirements prior to discharge

3. The consent holder shall notify the Taranaki Regional Council at least 48 hours prior to commencement, and upon completion of each mix-bury-cover discharge. Notification shall include the consent number and a brief description of the activity consented and be emailed to worknotification@trc.govt.nz. Notification by fax or post is acceptable if the consent holder does not have access to email.
4. For each mix-bury-cover discharge, the consent holder shall provide a record of the volume, composition [including concentrations of nitrogen, chloride, hydrocarbons, and trace elements to show that the discharge complies with conditions 16 to 19], types of drilling fluids used, and the location of the discharge area, to the Chief Executive, Taranaki Regional Council, prior to the discharge.

Discharge methods and limits

5. The volume of solid drilling wastes discharged shall not exceed 1500 m³ per well from up to 8 wells.

Consent 7410-1

6. Mix-bury-cover discharge areas for wastes from individual wells shall be kept separate and distinct.
7. No mix-bury-cover discharge shall occur within 12 months of any previous mix-bury-cover discharge at the site.
8. As far as practicable, all fluids shall be removed from the drilling wastes prior to discharge.
9. If sumps are used as drilling waste holding receptacles on the site, and the sump is to be used for a disposal area, the impermeable liner shall be perforated, and where possible removed, so that it no longer encloses the solid drilling wastes.
10. The solid drilling wastes shall be mixed with uncontaminated soil in a mixing ratio of 1 part solid drilling wastes to a minimum of 3 parts uncontaminated soil.
11. The mixture of solid drilling wastes and uncontaminated soil shall be covered by at least one metre of uncontaminated soil.
12. Each mix-bury-cover discharge area shall be revegetated, and thereafter maintained with pasture cover:
 - a) within 6 months of the completion of the discharge, or
 - b) if the discharge area is part of the active wellsite area, upon reinstatement of the site.
13. The consent holder shall compact, contour, and maintain the soil overlying the mix-bury-cover discharge to ensure that at all times all surface stormwater is directed away from the mix-bury-cover discharge area.
14. The mix-bury-cover discharge shall, as far as practicable, occur above the groundwater table.
15. The edges of the mix-bury-cover discharge area shall be at least 30 metres from any surface water body, spring, or any pre-existing groundwater supply bore.
16. The total loading of trace elements in the solid drilling wastes for each distinct mix-bury-cover discharge area shall not exceed the limits shown below:

Trace element	Total loading limit
boron	10 kg
cadmium	3 kg
chromium	200 kg
copper	400 kg
lead	200 kg
nickel	50 kg
vanadium	200 kg
zinc	600 kg

Consent 7410-1

17. The loading of chloride shall not exceed 1,600 kg for each distinct mix-bury-cover discharge area.
18. The loading of nitrogen shall not exceed 400 kg for each distinct mix-bury-cover discharge area.
19. The hydrocarbon content of the solid drilling waste shall not exceed 0.0015% [15 mg/kg] on a dry weight basis.

Receiving environment limits

20. At all times, parameters in the soil overlying the mix-bury-cover discharge area [less than 0.5 metre depth] shall not exceed the limits shown below:

Parameter	Limit
Conductivity	290 mSm ⁻¹
Total dissolved salts	2500 gm ⁻³
Sodium	460 gm ⁻³
Chloride	700 gm ⁻³

21. At all times the levels of metals in the soil overlying the mix-bury-cover discharge area [less than 0.5 metre depth] shall comply with the limits shown below:

Metal	Limit
arsenic	20 mg kg ⁻¹
cadmium	1 mg kg ⁻¹
chromium	600 mg kg ⁻¹
copper	100 mg kg ⁻¹
lead	300 mg kg ⁻¹
mercury	1 mg kg ⁻¹
nickel	60 mg kg ⁻¹
zinc	300 mg kg ⁻¹

22. At all times the levels of hydrocarbons in the soil covering the mix-bury-cover discharge area [less than 0.5 metre depth] shall comply with the guideline values for the designated soil type in the surface layer set out in Tables 4.12 and 4.15 of the Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand [Ministry for the Environment, 1999], appended to this consent.
23. The exercise of this consent shall not cause the level of total dissolved salts within any surface water or ground water to exceed more than 2500 gm⁻³.

Lapse and review

24. This consent shall lapse on 31 March 2014, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

Consent 7410-1

25. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month following each mix-bury-cover discharge, and/or 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 15 November 2013

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Consent 7410-1

Appendix 1

Tables 4.12 and 4.15 of the Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand [Ministry for the Environment, 1999].

**Table 4.12 Tier 1 soil acceptance criteria *Agricultural use* ^(1,3,6) ALL PATHWAYS
(all values mg/kg)**

Soil Type/ Contaminant	Depth of contamination		
	Surface (<1m)	1m - 4m	> 4m
SAND			
MAHs			
Benzene	1.1 ^(v)	1.9 ^(7,v)	2.4 ^(7,v)
Toluene	(68) ^(4,v)	(94) ^(4,m)	(230) ^(4,v)
Ethylbenzene	(53) ^(4,v)	(92) ^(4,7,v)	(120) ^(4,v)
Xylenes	(48) ^(4,v)	(130) ^(4,7,v)	(180) ^(4,v)
PAHs			
Naphthalene	7.2 ^(p)	70 ^(v)	80 ^(v)
Non-carc. (Pyrene)	(160) ^(4,p)	NA ⁽²⁾	NA ⁽²⁾
Benzo(a)pyrene eq. ⁽⁵⁾	0.027 ^(p)	(25) ^(4,m)	NA ⁽²⁾
SANDY SILT			
MAHs			
Benzene	1.1 ^(v)	1.9 ^(v)	2.4 ^(v)
Toluene	(82) ^(4,v)	(170) ^(4,v)	(240) ^(4,v)
Ethylbenzene	(59) ^(4,v)	(92) ^(4,v)	(140) ^(4,v)
Xylenes	(59) ^(4,v)	(130) ^(4,v)	(180) ^(4,v)
PAHs			
Naphthalene	7.2 ^(p)	83 ^(v)	(130) ^(4,v)
Non-carc. (Pyrene)	(160) ^(4,p)	NA ⁽²⁾	NA ⁽²⁾
Benzo(a)pyrene eq. ⁽⁵⁾	0.027 ^(p)	(25) ^(4,m)	NA ⁽²⁾
SILTY CLAY			
MAHs			
Benzene	1.7 ^(v)	4.6 ^(v)	12 ^(v)
Toluene	(210) ^(4,v)	(950) ^(4,v)	(3,000) ^(4,v)
Ethylbenzene	(110) ^(4,v)	(800) ^(4,v)	(2,800) ^(4,v)
Xylenes	(160) ^(4,v)	(710) ^(4,v)	(2,200) ^(4,v)
PAHs			
Naphthalene	7.2 ^(p)	(330) ^(4,v)	(1,100) ^(4,v)
Non-carc. (Pyrene)	(160) ^(4,p)	NA ⁽²⁾	NA ⁽²⁾
Benzo(a)pyrene eq. ⁽⁵⁾	0.027 ^(p)	(25) ^(4,m)	NA ⁽²⁾

NOTES:

1. Based on protection of human health. Refer to Table 4.20 for protection of groundwater. Site-specific consideration of aesthetic and ecological impacts is required.
2. NA indicates contaminant not limiting as estimated health-based criterion is significantly higher than that likely to be encountered on site.
3. Surface soil acceptance criteria are based on the lower value of volatilisation criteria (Table 4.16), other pathway criteria (Table 4.18) and criteria for the protection of maintenance workers (Table 4.19). Criteria for soils at 1 m are based on the lower value of those arising from volatilisation and maintenance criteria. Criteria for soils at 4 m are based on volatilisation only.
4. Brackets denote values exceed threshold likely to correspond to formation of residual separate phase hydrocarbons. For further explanation refer to Appendix 4M.
5. Risk associated with mixture of carcinogenic PAHs assessed by comparison with criteria based on benzo(a)pyrene equivalent concentration. Refer to Section 4.4.3 for details of the calculation of Benzo(a)pyrene equivalent concentrations.
6. The following notes indicate the limiting pathway for each criterion: v - Volatilisation, s - Soil Ingestion, d - Dermal, p - Produce, m - Maintenance/Excavation
7. Due to the nature of boundary conditions in volatilisation model, calculated criteria for sandy soils are higher than that for silt soil type. Therefore, the criteria for sand are set equal to the criteria for silt. Refer Appendix 4D for details.

Table 4.12 (CONTINUED)
Tier 1 soil acceptance criteria *Agricultural use* ^(1,3,6) ALL PATHWAYS
(all values mg/kg)

Soil Type/ Contaminant	Depth of contamination		
	Surface (<1m)	1m - 4m	> 4m
CLAY			
MAHs			
Benzene	2.7 ^(v)	8.8 ^(v)	(26) ^(4,v)
Toluene	(320) ^(4,v)	(2,400) ^(4,v)	(8,500) ^(4,v)
Ethylbenzene	(160) ^(4,v)	NA ⁽²⁾	NA ⁽²⁾
Xylenes	(250) ^(4,v)	(1,800) ^(4,v)	(6,500) ^(4,v)
PAHs			
Naphthalene	7.2 ^(p)	(360) ^(4,v)	(1,200) ^(4,v)
Non-carc. (Pyrene)	(160) ^(4,p)	NA ⁽²⁾	NA ⁽²⁾
Benzo(a)pyrene eq. ⁽⁵⁾	0.027 ^(p)	(25) ^(4,m)	NA ⁽²⁾
PUMICE			
MAHs			
Benzene	1.2 ^(v)	2.4 ^(v)	3.1 ^(v)
Toluene	(73) ^(4,v)	(240) ^(4,v)	(350) ^(4,v)
Ethylbenzene	(48) ^(4,v)	(140) ^(4,v)	(220) ^(4,v)
Xylenes	(53) ^(4,v)	(180) ^(4,v)	(260) ^(4,v)
PAHs			
Naphthalene	7.2 ^(p)	140 ^(v)	(220) ^(4,v)
Non-carc. (Pyrene)	(160) ^(4,p)	NA ⁽²⁾	NA ⁽²⁾
Benzo(a)pyrene eq. ⁽⁵⁾	0.027 ^(p)	(25) ^(4,m)	NA ⁽²⁾
PEATS AND HIGHLY ORGANIC SOILS			
MAHs			
Benzene	5.7 ^(v)	10 ^(v)	13 ^(v)
Toluene	(2,500) ^(4,v)	(2,900) ^(4,v)	(3,800) ^(4,v)
Ethylbenzene	(2,200) ^(4,v)	(2,500) ^(4,v)	(3,200) ^(4,v)
Xylenes	(1,700) ^(4,v)	(2,000) ^(4,v)	(2,600) ^(4,v)
PAHs			
Naphthalene	7.2 ^(p)	(2,700) ^(4,v)	(3,500) ^(4,v)
Non-carc. (Pyrene)	(160) ^(4,p)	NA ⁽²⁾	NA ⁽²⁾
Benzo(a)pyrene eq. ⁽⁵⁾	0.027 ^(p)	(25) ^(4,m)	NA ⁽²⁾

NOTES:

1. Based on protection of human health. Refer to Table 4.20 for protection of groundwater. Site-specific consideration of aesthetic and ecological impacts is required.
2. NA indicates contaminant not limiting as estimated health-based criterion is significantly higher than that likely to be encountered on site.
3. Surface soil acceptance criteria are based on the lower value of volatilisation criteria (Table 4.16), other pathway criteria (Table 4.18) and criteria for the protection of maintenance workers (Table 4.19). Criteria for soils at 1 m are based on the lower value of those arising from volatilisation and maintenance criteria. Criteria for soils at 4 m are based on volatilisation only.
4. Brackets denote values exceed threshold likely to correspond to formation of residual separate phase hydrocarbons. For further explanation refer to Appendix 4M.
5. Risk associated with mixture of carcinogenic PAHs assessed by comparison with criteria based on benzo(a)pyrene equivalent concentration. Refer to Section 4.4.3 for details of the calculation of Benzo(a)pyrene equivalent concentrations.
6. The following notes indicate the limiting pathway for each criterion: v - Volatilisation, s - Soil Ingestion, d - Dermal, p - Produce, m - Maintenance/Excavation

Appendix II

Biomonitoring reports

To Job Manager; Callum MacKenzie
From Freshwater Biologist; Darin Sutherland
Report No DS011
Document 1517920
Date 4 June 2015

Biomonitoring of two unnamed tributaries of the Manganui River in relation to drilling by Todd Energy Ltd at the Mangahewa-D wellsite, May 2015

Introduction

Macroinvertebrate surveys were performed at the Mangahewa-D wellsite to determine whether drilling discharges had a detrimental effect upon macroinvertebrate communities of two unnamed tributaries of the Manganui River. The wellsite treated stormwater, uncontaminated site water, and production water were discharged from a skimmer pit into an unnamed tributary of the Manganui River (Figure 1). A pre-drill and a post-drill survey had been completed at the site on 15 April and 28 August 2014 respectively due to previous drilling at the site. No substantial decreases in taxa richnesses and no significant changes in MCI or SQMCI_s scores occurred between the pre-drill and post-drill surveys (Thomas, 2014).

There were two post-drill surveys completed in May 2015 only eight days apart due to the first post-drill survey results which suggested that the primary and secondary impacted sites may have been negatively affected by wellsite discharges. However, the first survey was completed two days after heavy rain and high streams flows which may have confounded results. Furthermore, physiochemical data from the skimmer pits had found no evidence of elevated toxic chemicals (chloride or total recoverable hydrocarbons) present although there had been two instances of non-compliance prior to the first post-drill survey due to elevated levels of suspended sediment exceeding the 100 gm⁻³ resource consent limit on 28/04/15 (170 gm⁻³; NTU 230) and 15/05/15 (200 gm⁻³; NTU 190). Suspended sediment at those levels would not cause any acute toxic affects to the macroinvertebrates present in the tributaries (Rowe et al. 2002) but deposited sediment can smother cobbles and gravels and thus reduce the quality of macroinvertebrate habitat. The second survey was completed ten days after the last heavy rain event (7 times median flow). The second survey also included an additional impacted site within the unnamed tributary which directly received wellsite discharges and thus could be expected to be most affected by any discharges. This additional site was also less likely to be influenced by high flows due to its very small catchment area. Both sets of results are reported here for succinctness.

Methods

The first post-drill survey was undertaken on 18 May 2015 at three sites and the second post-drill survey was undertaken on 26 May 2015 at four sites (Table 1). Site 1 was the 'control' site while site 2 was the 'primary impacted' site, site 3 the 'secondary impacted', and site 4 the 'tertiary impacted' site. The altitude of the four sites was approximately 60 m asl.

Two different sampling techniques were used to collect macroinvertebrates in the unnamed tributaries of the Manganui River: the Council's standard 'kick-sampling' and 'vegetation sweep' techniques and a combination of both (Table 1). The 'kick-sampling' and 'vegetation

sweep' techniques are very similar to Protocol C1 (hard-bottomed, semi-quantitative) and C2 (soft-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001). The two techniques are used depending on the situation and a combination of techniques may be used when different conditions are encountered in the same reach of stream.

Table 1 Biomonitoring sites in two unnamed tributaries of the Manganui River in relation to the Mangahewa-D wellsite.

Site No.	Site code	Grid reference (NZTM)	Location	Sampling method	
				First post-drill	Second post-drill
1	MGN000489	1711359E-5673793N	55 m upstream of drain confluence from Mangahewa-D wellsite discharge	Sweep	Kick-Sweep
2	MGN000491	1711322E-5673832N	90m downstream of Mangahewa-D wellsite discharge point and 10m upstream of tributary confluence	NA	Kick-Sweep
3	MGN000492	1711376E-5673894N	60m downstream of drain confluence from Mangahewa-D wellsite	Kick	Kick-Sweep
4	MGN000493	1711392E-5673936N	100m downstream of drain confluence from Mangahewa-D wellsite.	Kick	Kick-Sweep

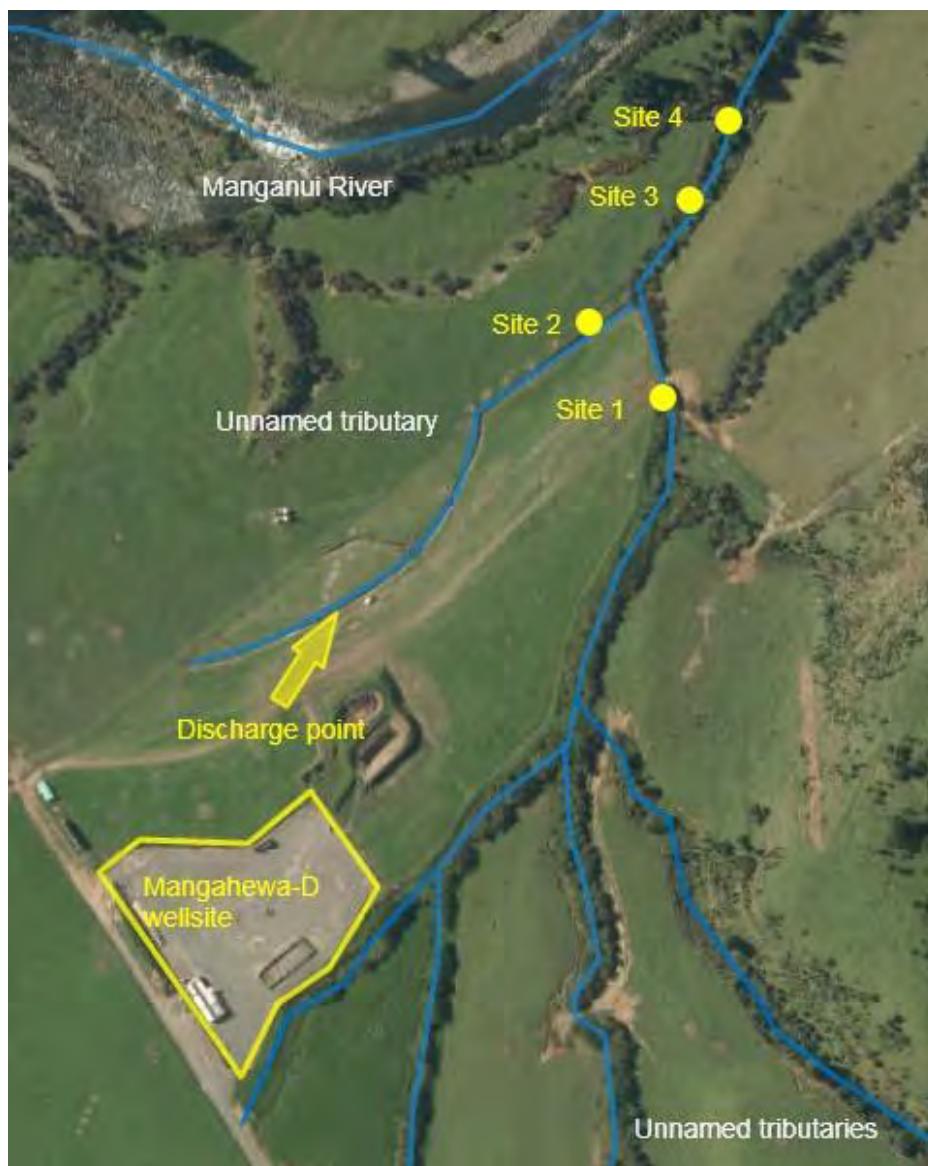


Figure 1 Biomonitoring sites in two unnamed tributaries of the Manganui River in relation to the Mangahewa-D wellsite

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology which uses Protocol P1 of NZMWG protocols of sampling macroinvertebrates in wadeable streams (Stark et al, 2001). Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	= less than 5 individuals;
C (common)	= 5-19 individuals;
A (abundant)	= estimated 20-99 individuals;
VA (very abundant)	= estimated 100-499 individuals;
XA (extremely abundant)	= estimated 500 individuals or more.

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience.

By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

A semi-quantitative MCI value (SQMCI_s) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark, 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the SQMCI_s is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower. A difference of 0.9 units or more in SQMCI_s is considered significantly different (Stark, 1998).

Results

Site habitat characteristics

The water temperatures during the first post-drill survey were cool (range 13.0-13.1 °C) and were comparatively warmer for the same sites surveyed during the second post-drill survey (10.6-11.0 °C). The additional site (site 2) was noticeably warmer with a temperature of 14.1 °C. Water levels were moderate for all sites during both surveys except for site 2 during the second survey which had low flow and water speed. Water was uncoloured and clear for all sites. The substrate for site 1 (both post-drill surveys) and site 2 (second post-drill survey) was mainly silt while sites 3 and 4 had a substrate composition dominated by silt, sand and fine gravel (Table 2).

No algal mats and filamentous algae were present during both surveys. Moss, leaves and wood were absent from all sites during the first post-drill survey. Site 1 had macrophytes on the stream bed while sites 3 and 4 did not have any macrophytes. Moss, leaves and wood were absent from sites 1 and 2 during the second post-drill survey and both sites had

macrophytes present on the stream bed. Sites 3 and 4 had patchy leaves and wood and macrophytes present on the edge of the stream. Site 1 had no shading during the first post-drill survey but a larger area was sampled during the second post-drill survey which incorporated streambed with overhanging vegetation and thus the site did have partial shading during the second post-drill survey. Site 2 had no shading and sites 3 and 4 were partially shaded from overhanging vegetation.

Table 2 Summary of time of sampling and some water variables collected at each site.

Site code	Time (NZST)		Temperature (°C)		Water Colour		Water Clarity		Flow Conditions		Water Speed	
	First post-drill	Second post-drill	First post-drill	Second post-drill	First post-drill	Second post-drill	First post-drill	Second post-drill	First post-drill	Second post-drill	First post-drill	Second post-drill
MGN000489	1310	1155	13.3	11.0	Uncoloured	Uncoloured	Clear	Clear	Moderate	Moderate	Swift	Steady
MGN000491	NA	1145	NA	14.1	NA	Uncoloured	NA	Clear	NA	Low	NA	Slow
MGN000492	1250	1120	13.1	10.8	Uncoloured	Uncoloured	Clear	Clear	Moderate	Moderate	Steady	Steady
MGN000493	1230	1045	13.0	10.6	Uncoloured	Uncoloured	Clear	Clear	Moderate	Moderate	Steady	Steady

Macroinvertebrate communities

Comparative data for similar sites (TRC, 2015) are summarised in Table 3. Data from the two previous surveys completed in relation to the Mangahewa-D wellsite are summarised in Table 4. Results of the first post-drill and second post-drill survey macroinvertebrate faunal data are summarised in (Table 5).

Table 3 Range and median number of taxa, MCI values and SQMCI_s scores for 'control' sites (lowland coastal streams) at altitudes between 50 and 79 m asl (TRC, 2015).

	No. of taxa	MCI	SQMCI _s
No. Samples	98	98	69
Range	19-30	60-100	1.4-6.2
Median	20	78	4.0

Table 4 Summary of the two previous biomonitoring surveys completed on 15/04/14 (pre-drill) and 28/08/14 (post-drill) at the Mangahewa-D wellsite.

Site code	Site code	No. of taxa		MCI		SQMCI _s	
		15/04/14	28/08/14	15/04/14	28/08/14	15/04/14	28/08/14
1	MGN000489	19	20	66	71	3.3	3.6
3	MGN000492	16	15	69	77	3.3	3.5
4	MGN000493	13	27	78	85	3.7	3.5

Table 5 Macroinvertebrate fauna of two unnamed tributaries of the Manganui River in relation to the Mangahewa-D wellsite surveys sampled 18 May 2015 (first post-drill) and 26 May, 2015 (second post-drill).

Taxa List	Survey	MCI score	First Post-Drill			Second Post-Drill			
	Site Code		MGN000489	MGN000492	MGN000493	MGN000489	MGN000491	MGN000492	MGN000493
	Site Number		1	3	4	1	2	3	4
PLATYHELMINTHES	<i>Cura</i>	3	C	R	-	-	-	-	-
NEMERTEA	Nemertea	3	C	-	-	-	-	-	-
ANNELIDA	Oligochaeta	1	VA	A	C	C	XA	C	A
	Lumbricidae	5	-	-	-	R	C	R	-
HIRUDINEA	Hirudinea	3	R	-	R	R	-	R	-
MOLLUSCA	Lymnaeidae	3	-	-	-	-	C	-	-
	<i>Physa</i>	3	A	-	-	-	-	-	R
	<i>Potamopyrgus</i>	4	VA	A	VA	XA	VA	XA	VA
	Sphaeriidae	3	R	-	-	-	-	-	-
CRUSTACEA	Copepoda	5	C	-	-	-	R	-	-
	Ostracoda	1	VA	-	-	-	XA	-	R
	Isopoda	5	-	-	-	-	R	-	-
	<i>Paracalliope</i>	5	C	-	-	R	-	R	C
	Talitridae	5	-	-	-	-	R	-	-
	<i>Paratya</i>	3	-	-	-	R	-	R	R
EPHEMEROPTERA	<i>Zephlebia group</i>	7	-	-	-	-	-	-	-
ODONATA	<i>Austrolestes</i>	4	R	-	-	-	C	-	-
	<i>Xanthocnemis</i>	4	C	-	-	R	-	R	C
	<i>Hemicordulia</i>	5	-	-	-	-	-	-	-
HEMIPTERA	<i>Microvelia</i>	3	-	-	-	-	R	-	-
COLEOPTERA	Dytiscidae	5	-	-	-	-	R	-	-
	Hydrophilidae	5	-	-	-	-	R	-	-
	Ptilodactylidae	8	-	-	R	-	-	-	-
	TRICHOPTERA	Ecnomidae/Psychomyiidae	6	-	-	-	R	-	R
	<i>Hydrobiosis</i>	5	-	-	-	R	-	R	-
	<i>Plectrocnemia</i>	8	R	-	-	-	-	-	-
	<i>Polypsectropus</i>	6	-	-	-	-	-	-	-
	<i>Psilochorema</i>	6	C	-	-	R	-	R	R
	<i>Oxyethira</i>	2	C	-	-	R	VA	R	C
	<i>Triplectides</i>	5	-	-	R	C	-	C	R
DIPTERA	Orthoclaadiinae	2	R	-	-	-	C	-	-
	Tanypodinae	5	C	-	-	-	R	-	R
	Ceratopogonidae	3	R	-	-	-	-	-	-
	<i>Paradixa</i>	4	-	-	-	-	C	-	-
	Empididae	3	-	-	-	-	C	-	-
	Ephydriidae	4	-	-	-	-	R	-	-
	<i>Austrosimulium</i>	3	VA	R	C	C	-	C	A
	Stratiomyidae	5	-	-	-	-	R	-	-
ACARINA	Acarina	5	R	-	-	-	C	-	-
No of taxa			20	4	6	21	20	13	12
MCI			73	55	80	74	76	80	70
SQMCIs			2.5	2.5	3.9	3.8	1.4	4	3.5
EPT (taxa)			2	0	1	4	0	4	2
%EPT (taxa)			10	0	17	19	0	31	17
'Tolerant' taxa		'Moderately sensitive'		'Highly sensitive' taxa					

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Site 1. 55 m upstream of drain confluence from Mangahewa-D wellsite discharge

A moderate macroinvertebrate community richness of 20 taxa was found at site 1 ('control' site) at the time of the first post-drill survey and similar taxa richness was found in the second post-drill survey of 21 taxa. Site 1 also had the same/similar taxa richness compared with numbers found at other sites in similar streams in the Taranaki region within the same altitudinal band (median taxa richness of 20 taxa; Table 3). Site 1 taxa richness was also similar to results found at both the previous 2014 surveys (19 and 20 taxa; Table 4).

The first post-drill survey MCI score of 73 units and the second post-drill survey MCI score of 74 units indicated a community of 'poor' biological health. Both the post-drill survey MCI scores were not significantly different (Stark, 1998) to the median MCI score found at other sites in similar streams in the Taranaki region within the same altitudinal band (median MCI score of 78; Table 3). Site 1 MCI scores were also not significantly different to results found by both of the previous surveys (66 and 71 units; Table 4).

The first post-drill survey SQMCI_s score of 2.5 units was significantly lower than the second post-drill score of 3.8 units (Stark, 1998) and streams in the Taranaki region within the same altitudinal band (median SQMCI_s score of 4.0 units; Table 3). The first post-drill survey SQMCI_s score of 2.5 was also significantly lower than what had been found previously but the second post-drill survey SQMCI_s score was not significantly different (Stark, 1998) to results found at both the previous surveys (3.3 and 3.6 units; Table 4).

The first post-drill survey community was characterised by four 'tolerant' taxa, [oligochaete worms, snail (*Potamopygus*), ostracod seed shrimps and sandfly (*Austrosimulium*)]. The second post-drill survey community was characterised by five 'tolerant' taxa, [oligochaete worms, snail (*Potamopygus*), ostracod seed shrimps, damselfly (*Xanthocnemis*) and sandfly (*Austrosimulium*)], and one 'moderately sensitive' taxon, [amphipods (*Paracalliope*)] (Table 5).

Site 2. 90m downstream of Mangahewa-D wellsite discharge point and 10m upstream of tributary confluence

A moderate macroinvertebrate community richness of 20 taxa was found at site 2 ('primary impacted' site) at the time of the second post-drill survey. Site 2 also had the same taxa richness compared with the median number found at other sites in similar streams in the Taranaki region within the same altitudinal band (median taxa richness of 20 taxa; Table 3).

The second post-drill survey MCI score of 76 units indicated a community of 'poor' biological health. The second post-drill survey MCI score was not significantly different (Stark, 1998) than the median MCI score found at other sites in similar streams in the Taranaki region within the same altitudinal band (median MCI score of 78 units; Table 3).

The second post-drill survey SQMCI_s score of 1.4 units was significantly lower (Stark, 1998) than other sites in similar streams in the Taranaki region within the same altitudinal band (median SQMCI_s score of 4.0 units; Table 3).

The second post-drill survey community was characterised by four 'tolerant' taxa, [oligochaete worms and snail (*Potamopygus*), ostracod seed shrimps and caddisfly (*Oxyethira*)] (Table 5).

Site 3. 60m downstream of drain confluence from Mangahewa-D wellsite

A very low macroinvertebrate community richness of only four taxa was found at site 3 ('secondary impacted' site) at the time of the first post-drill survey and a far higher taxa richness of 13 taxa was found in the second post-drill survey. Site 3 had far lower taxa richness compared with numbers found at other sites in similar streams in the Taranaki region within the same altitudinal band (median taxa richness of 20 taxa; Table 3). Site 3 taxa richnesses, especially for the first post-drill survey were also lower than what was found at both the previous surveys (16 and 15 taxa; Thomas 2014).

The first post-drill survey MCI score of 55 units indicated a community of 'very poor' biological health and the second post-drill survey MCI score of 80 units indicated a community of 'fair' biological health. The first post-drill survey but not the second post-drill survey was significantly lower (Stark, 1998) than the median MCI score found at other sites in similar streams in the Taranaki region within the same altitudinal band (median MCI score of 78 units; Table 3). The first post-drill survey MCI score was significantly lower than what have been found previously while the second post-drill survey was not significantly different previous surveys (66 and 71 units; Table 4).

The first post-drill survey SQMCI_s score of 2.5 units was significantly lower than the second post-drill score of 3.8 units (Stark, 1998) and the median score at other sites in similar streams in the Taranaki region within the same altitudinal band (median SQMCI_s score of 4.0 units; Table 3). The first post-drill survey SQMCI_s score of 2.5 units was not significantly lower than the April 2014 pre-drill survey (SQMCI_s score 3.3 units; Table 4) but was significantly lower than August 2014 post-drill (3.6 taxa richness; Table 4). The second post-drill survey SQMCI_s score of 3.5 units was not significantly different (Stark, 1998) to results found at both the previous 2014 surveys (3.3 and 3.6 units; Table 4).

The first post-drill survey community was characterised by two 'tolerant' taxa, [oligochaete worms, snail (*Potamopygus*)]. The second post-drill survey community was characterised by one 'tolerant' taxon [snail (*Potamopygus*)] (Table 5).

Site 4. 100m downstream of drain confluence from Mangahewa-D wellsite

A very low macroinvertebrate community richness of only six taxa was found at site 4 ('tertiary impacted' site) at the time of the first post-drill survey and a higher taxa richness of 12 taxa was found in the second post-drill survey. Site 4 had far lower taxa richness compared with numbers found at other sites in similar streams in the Taranaki region within the same altitudinal band (median taxa richness of 20 taxa; Table 3). Site 4 taxa richnesses, especially for the first post-drill survey, were also lower than what was found at both the previous 2014 surveys (13 and 27 taxa; Table 4).

The first post-drill survey MCI score of 80 units indicated a community of 'fair' biological health and the second post-drill survey MCI score of 70 units indicated a community of 'poor' biological health. The first post-drill and second post-drill surveys were not significantly lower (Stark, 1998) than the median MCI score found at other sites in similar streams in the Taranaki region within the same altitudinal band (median MCI score of 78 units; Table 3). The first post-drill and second post-drill survey MCI scores were not significantly lower (Stark, 1998) than what have been found previously (78 and 85 units; Table 4).

The first post-drill survey SQMCI_s score of 3.9 units was not significantly different to the second post-drill score of 3.5 units (Stark, 1998) and both surveys were not significantly

different to other sites in similar streams in the Taranaki region within the same altitudinal band (median SQMCI₅ score of 4.0 units; Table 3). Both surveys SQMCI₅ scores were also not significantly different (Stark, 1998) to results found at both the previous 2014 surveys (3.7 and 3.5 units; Table 4).

The first post-drill survey community was characterised by one 'tolerant' taxon [snail (*Potamopygus*)]. The second post-drill survey community was characterised by three 'tolerant' taxa [oligochaete worms, snail (*Potamopygus*), and sandfly (*Austrosimulium*)] (Table 5).

Discussion and Conclusions

The Councils 'kick-sampling' and 'vegetation sweep' techniques and a combination of both techniques were used to collect streambed macroinvertebrates from two unnamed tributaries of the Manganui River following drilling at the Mangahewa-D wellsite. This has provided data to assess impacts of skimmer pit discharge effects from the Mangahewa-D wellsite on the macroinvertebrate communities of the immediate receiving drain, but principally the unnamed tributary to which the drain discharges into. Samples were processed to provide number of taxa (richness), taxa abundances, MCI, and SQMCI₅ scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to acutely toxic discharges. Macroinvertebrates when exposed to toxic chemicals may die and be swept downstream or deliberately drift downstream. The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The SQMCI₅ takes into account taxa abundances as well as sensitivity to organic pollution. It may indicate subtle changes in communities, and therefore be a more relevant index if non-organic impacts are occurring than the MCI. Large differences in either taxa richness, taxa abundances, MCI or the SQMCI₅ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

The first post-drill survey results showed that the two impacted sites surveyed (sites 3 and 4) had substantially lower taxa richnesses compared with the control site. These low taxa richnesses were also far lower than previous results at the same sites in 2014. This normally would suggest that wellsite discharges had a significant negative effect on the macroinvertebrate communities present in the unnamed tributary. However, the control site and the two impacted sites had significant differences between them; the control site was in a wider, more open area with shallower more stable banks with a bed dominated by macrophytes whereas the two impacted sites were in a more incised section of the stream with high unstable banks, shading and predominately bare gravels, sand and silt. If differences in habitat were solely the reason for differences in taxa richness then the previous surveys would show the same trend which was not the case. In addition to habitat variation prior to sampling there were eight separate flood peaks (> 7 x median flow) recorded in the Manganui River at Everett Park from the 8 April to 16 May 2015 with the three most recent floods close to or above 50 x median base flow indicating very high flood flows in the area. Therefore a combination of very high flows and habitat differences (the two impacted sites appeared more prone to scouring) may have produced the observed results which were the reason why an additional survey was instigated. The additional survey occurred 10 days after the last flood peak to allow a more representative macroinvertebrate community to be sampled.

The standard protocol for macroinvertebrate sampling for state of the environment reporting and general compliance monitoring is for a 10 day stand down period after 7 x median flows or a 7 day stand down period after 3 x median flows. With wellsite monitoring there is a more urgent need to survey after any potential discharges and therefore though complying with the standard stand down periods after heavy rain is highly desirable sampling should be carried out within two weeks of cessation of drilling or hydraulic fracturing if it can be done so safely regardless of the time after the stand down period.

The second post-drill survey results showed an improvement in taxa richness at sites 3 and 4 but at levels that were still lower than the 'control' site. At all sites during the second post-drill survey a large area of stream was sampled to minimise habitat or stochastic effects. The numbers of individuals for several taxa were generally low. Site 3 had nine out of the 13 taxa recorded in the 'rare' category (1-4 individuals found) and three other taxa recorded in the next lowest 'common' abundance category (5-19 individuals found). Site 4 had slightly higher abundances with six of the 12 taxa in the 'rare' category and three taxa in the 'common' category. The results of the second post-drill survey, in conjunction with first post-drill survey, suggest macroinvertebrate communities that are recovering from a disturbance event rather than typical communities particularly when compared with previous results.

The preferred sampling design for wellsite monitoring is to have one 'control' upstream of the discharge and two 'impacted' sites downstream of the discharge and all sites on the same tributary as the discharge. In some cases this design is not possible, for instance when it is not possible to place a 'control' upstream of a discharge due to low flows/ no stream or if a tributary being discharged to is too small to allow for sample collection. The Mangahewa-D survey sites were set up during a low flow period and it appears that the small tributary which was directly discharged to was not considered sufficiently large for samples to be collected. However, the tributary does have conspicuous macrophyte growth indicating a permanent waterbody and there was sufficient water to sample the tributary at the time of the second post-drill survey. There were three advantages to sampling the tributary where discharges were directed to: 1) the impacts of the discharges were maximised in the immediate receiving waters and thus it would be expected to cause a more severe impact on the macroinvertebrate communities present if any toxic discharges were released, 2) the very small size of the tributary and its catchment should prevent most impacts from flood flows as though the channel is small even in heavy rainfall events comparatively little water will enter it and water velocities will not be as high as in larger waterbodies with large catchments, and 3) longer term impacts would likely occur as there is only a very small amount of upstream habitat above the discharge point which would limit provision for re-colonisation.

Site 2, which was situated in the tributary where discharges occurred, was only surveyed at the time of the second post-drill survey and showed a macroinvertebrate community typical of a very small low altitude stream in pasture grassland. There was no evidence of any significant impacts of wellsite discharges. The low taxa numbers and low abundances found at sites 3 and 4 would therefore be most likely caused by a combination of floods partially denuding the community as well as from animals withdrawing from the surface to seek refuge in the sub-surface zone and not having returned to the surface at the time of sampling.

Summary

- A post-drill macroinvertebrate survey was completed at three sites near the Mangahewa-D wellsite to determine if any wellsite discharges had impacted on the health of macroinvertebrate communities in an unnamed tributary of the Manganui River. A second post-drill survey was completed eight days after the first survey as the results were suggestive of there having been a toxic wellsite discharge. An additional sampling site in the receiving waters water also included.
- Taxa richnesses for the two impacted sites for the first post-drill survey were very low compared to the control site and previous surveys at the sites. The second post-drill survey produced higher taxa richnesses but still indicated that the two most downstream 'impacted' sites had lower than expected taxa numbers and abundances.
- The additional 'impacted' site situated in the receiving tributary showed typical levels of taxa richness and abundances indicating that there was no toxic wellsite discharges.
- Low taxa richnesses at the two most downstream sites were probably the result of a combination of recent high flood flows and the topology of the sites. Analysis of all the available information suggests that Mangahewa-D wellsite discharges to two unnamed tributaries of the Manganui River did not have any significant negative effects on the health of the macroinvertebrate communities present there.

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