CD Boyd Drilling Waste Stockpiling and Landfarm/Landspread Monitoring Programme Annual Report 2014-2015

Technical Report 2015-86

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Executive summary

Colin Boyd (the consent holder), in conjunction with operator Mi Swaco, operates two drilling waste stockpiling facilities and a landspreading operation on his property, near Inglewood, within the Waitara catchment, Taranaki. These sites are located on adjoining properties off Derby Road North and Surrey Road respectively. Analytically quantified drilling waste consisting of water based and synthetic based muds are stockpiled at each facility prior to application across defined paddocks at specific, conditional concentrations.

This report for the period July 2014 to June 2015 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess the consent holders' environmental performance during the period under review, and the results and environmental effects of the activities.

The consent holder holds four resource consents, one of which is through a subsidiary company which is owned by the consent holder; Surrey Road landfarms. These consents include a total of 64 conditions which set out the requirements that the consent holder must satisfy. The consent holder holds one consent to discharge stormwater into the Managawhete stream, and three consents to stockpile and discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading/landfarming.

During the monitoring period, the consent holder demonstrated an overall good level of environmental performance.

The Council's monitoring programme for the year under review included 32 inspections, 45 water samples, six composite soil samples collected for physicochemical analysis and four biomonitoring surveys of receiving waters.

The monitoring indicated that the now closed Derby Road facility did not have any significant adverse effect on the environment; it also indicated that the landspreading operation was inline with the Derby Road facility. Conversely, the Surrey Road facility did affect the stream species abundance of the Mangatengehu Stream adversely in the beginning of the monitoring period. However, an engineering control in line with best practicable option mitigated this effect, and by the end of the monitoring period the biomonitoring indicated the species had begun to recover and should continue to improve.

This event resulted in one unauthorised Incident/s (UI/s) recording non-compliance. There were no other incidents recorded pertaining to this monitoring programme for this period.

Overall the consent holder demonstrated a good level of both environmental and administrative performance.

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

This report includes recommendations for the 2015-2016 year.

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period July 2014-June 2015 by the Taranaki Regional Council (hereafter the Council), describing the monitoring programme associated with resource consents held by Colin Boyd (hereafter the consent holder) and his subsidiary company, Surrey Road Landfarms Limited. The consent holder operates two stockpiling facilities; Derby Road stockpiling facility and Surrey Road stockpiling facility respectively while Surrey Road Landfarms holds consent for the application of the material to land.

Mi Swaco Company operates the Surrey Road stockpiling facility on behalf of the consent holder. Within this monitoring period Mi Swaco moved to relinquish its management responsibilities from the Derby Road stockpiling facility which was handed over for direct control to the consent holder. The stockpiling facilities are located in two locations; one on Surrey Road and the other in close proximity to Derby Road North respectively. The application areas, in terms of where material is landfarmed/landspread is located between these two stockpiling facilities (indicated as the red area in Figure 1), these locations are detailed in Figure 1.

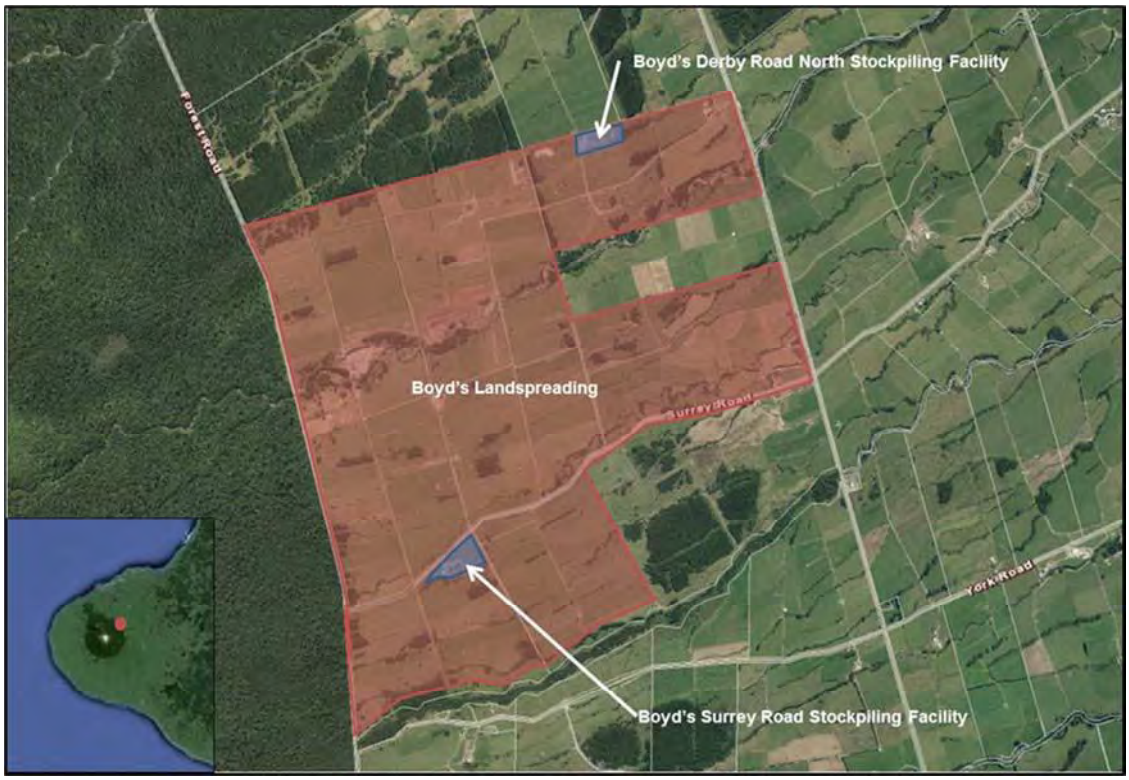

Figure 1 Aerial photograph detailing the location and extent of the landfarming application area and the stockpiling facilities with the approximate regional inset

This report covers the results and findings of the three monitoring programmes implemented by the Council in respect of the consents held by the consent holder. These relate to the application of drilling muds to land within the Waitara catchment.

This is the sixth annual report to be prepared by the Council to cover the consent holder's operations and it is specifically focused on understanding the environmental effects which may have occurred in association with activities around the exercising of these consents.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the RMA and the Council's obligations and general approach to monitoring sites though annual programmes, the resource consents held by the consent holder 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 catchment.

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

Section 3 discusses incidents, investigations and interventions.

Section 4 discusses the results, their interpretations, and their significance for the environment.

Section 5 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.

The appendices contain the resource consents held by the consent holder, the biomonitoring reports and the Mi Swaco supplied annual report

1.1.3 The Resource Management Act 1991 and monitoring

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

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

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each activity. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the RMA to assess the effects of the exercise of consents. In accordance with Section 35 of the RMA,

the Council undertakes compliance monitoring for consents and rules in regional plans, and maintains an overview of the performance of resource users and consent holders. Compliance monitoring, including both activity and impact monitoring, enables the Council to continually re-evaluate its approach and that of consent holders to resource management and, ultimately, through the refinement of methods and considered responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and administrative performance

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

Environmental performance is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year. **Administrative performance** is concerned with the consent holder'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 2014-2015 REPORTS For reference, in the 2014-2015 year, 75% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 22% demonstrated a good level of environmental performance and compliance with their consents.

1.2 Process description

1.2.1 Hydrocarbon exploration and production wastes

For the purposes of disposal to land, waste from the petroleum industry can be divided into two broad categories; exploration (drilling) wastes, and production wastes. The wastes disposed of through the consent holder's operations are primarily drilling waste. Fracture return fluids are not disposed of at these sites.

1.2.1.1 Drilling wastes

Waste drilling material is produced during well drilling for hydrocarbon exploration. The primary components of this waste are drilling fluids (muds) and rock cuttings.

1.2.1.2 Drilling fluids

Drilling fluids are engineered to perform several crucial tasks in the drilling of a hydrocarbon well. These include: transporting cuttings from the drill bit to the well surface for disposal; controlling hydrostatic pressure in the well; supporting the sides of the hole and preventing the ingress of formation fluids; and lubricating and cooling the drill bit and drill pipe in the hole. Oil and gas wells may be drilled with either synthetic based mud (SBM) or water based mud (WBM). As the names suggest, these are fluids with either water (fresh or saline) or synthetic oil as a base material, to which further compounds are added to modify the physical characteristics of the mud (for example mud weight or viscosity).

More than one type of fluid may be used to drill an individual well. In the past, oil based muds (diesel/crude oil based) have also been used. Their use has declined since the 1980s due to their ecotoxicity; they have been replaced by SBM. SBM use olefins, paraffins or esters as a base material. While this is technically still a form of oil based fluid, these fluids have been engineered to remove polynuclear aromatic hydrocarbons, reduce the potential for bioaccumulation and accelerate biodegradation compared with OBM.

Common constituents of WBM and SBM include weighting agents, viscosifiers, thinners, lost circulation materials (LCM), pH control additives, dispersants, corrosion inhibitors, bactericides, filtrate reducers, flocculants and lubricants. Of these, the naturally occurring clay mineral barite (barium sulphate) is generally the most common additive. It is added to most drilling muds as a wetting and weighting agent.

Drilling fluids may be intentionally discharged in bulk for changes to the drilling fluid programme or at the completion of drilling. Depending on operational requirements and fluid type and properties, fluids may be re-used in multiple wells.

1.2.1.3 Cuttings

Cuttings are produced as the drill bit penetrates the underlying geological formations. They are brought to the surface in the drilling fluid where they pass over a shaker screen that separates the cuttings and drilling fluids. The drilling fluids are recycled for reuse within the drilling process, but small quantities of drilling fluids remain adhered to the cuttings. The cuttings and smaller particle material from the drill fluid treatment

units drain into sumps. If sumps cannot be constructed, corrals or special bins are used. During drilling, this material is the only continuous discharge.

1.2.2 Landfarming process description

Basic steps in the landfarming process include:

1. Drilling waste is transported from a specific wellsite by truck (cuttings) or tanker (liquids). It is placed in a dedicate, fit for purpose, lined storage cell. At the consent holder's facilities cuttings arrive from site in metal 'D' bins directly collected from the wellsite. Material is subjected to an analytical screen undertaken in a registered laboratory. The analysis is dictated by specific consent conditions.
2. The required area is prepared by scraping back and stockpiling existing pasture/topsoil and leveling out uneven ground.
3. Waste is transferred to the prepared area by excavator and truck and spread out with a bulldozer. Liquids may be discharged by tanker or a spray system.
4. Waste is allowed to dry sufficiently before being tilled into the soil to the required depth with a tractor and discs.
5. The disposal area is leveled with chains or harrows.
6. Stockpiled or brought in topsoil/clay is applied to aid stability and assist in grass establishment.
7. Fertiliser may be applied and the area is sown in crop or pasture at a suitable time of year.

Consents 6900-2 and 7559-1 allow for the disposal of drilling waste from hydrocarbon exploration activities with WBM and SBM via the landfarming process outlined above.

Of note 6900-2 is directly concerned with stockpiling of material prior to application to land. Initial landfarming at the site revealed difficulties working with soils with higher baseline moisture content. As a result, consent 7591-1 was issued to allow for disposal via the process of landspreading.

1.2.3 Landspreading process description

The preferred method for the treatment and disposal of drilling material at the consent holders property is via landspreading (under consent 7591-1). A large muck spreader, detailed in Photograph 1, is used for this purpose.

Photo 1 The unit utilised for landspreading operations at the consent holders facility

An auger in the base of the spreader conveys material back and through an opening (where the size is controlled by a sliding plate) where it contacts two rapidly rotating augers and is applied up to 10 meters on either side. The deposition rate is controlled by the size of the opening at the rear of the unit and the speed of forward travel by the tractor. The waste is deposited onto existing pasture in small fragments, which are allowed some time to dry out before chain harrows and roman discs are used to till and break-up the waste which is dispersed back into the soil, shown in Photograph 2.

Photo 2 Tilling of the soil post application of the landspreading unit.

1.3 Resource consents

1.3.1 Discharges of wastes to land

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.

Colin Boyd holds discharge permit **6900-2** (supersedes expired consent 6900-1), to discharge drilling wastes (consisting of drilling cuttings and drilling fluids from water based muds and synthetic based muds), onto and into land for the purpose of temporary stockpiling prior to disposal. This permit was issued by the Council on 16 February 2011 under Section 87(e) of the RMA. It is due to expire on 1 June 2027. Site location Derby Road North.

Condition 1 requires adoption of the best practicable option.

Conditions 2 to 4 detail notification, record keeping, and reporting requirements.

Conditions 5 and 6 are operational requirements.

Conditions 7 and 8 set limits on contaminants in groundwater and surface water.

Conditions 9 and 10 set limits on certain parameters in the soil of the previously landfarmed areas, to be met prior to surrender.

Condition 11 is a review condition.

Colin Boyd holds discharge permit **7559-1**, to discharge drilling wastes (consisting of drilling cuttings and drilling fluids) from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into land via landfarming. This permit was issued by the Taranaki Regional Council on 20 November 2009 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2027. Site Location Surrey Road.

Condition 1 sets out definitions of stockpiling and landfarming.

Condition 2 requires adoption of the best practicable option.

Conditions 3 and 4 require the installation of groundwater monitoring wells and provision of a management plan, prior to exercise of the consent.

Conditions 5 and 6 detail notification and sampling requirements prior to discharge.

Conditions 9 and 11 to 13 specify discharge limits and loading rates.

Conditions 7, 8, 10, 14 and 15 are operational requirements.

Conditions 16 to 20 set limits on certain parameters in the soil.

Conditions 20 and 22 relate to effects on groundwater and surface water.

Conditions 23 and 24 concern monitoring and reporting.

Conditions 25 and 26 relate to lapse and review of the consent.

Surrey Road Landfarms Limited holds discharge permit **7591-1**, to discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading This permit was issued by the Taranaki Regional Council on 21 January 2010 under Section 87(e) of the Resource Management Act. It is due to expire on 1 June 2027. Site location Surrey Road.

Condition 1 and 2 concern adoption of the best practicable option and notifications.

Conditions 3 and 7 to 9 are operational requirements.

Conditions 4 to 6 specify discharge limits and loading rates.

Conditions 10 to 14 set limits on certain parameters in the soil.

Conditions 15 and 16 relate to effects on groundwater and surface water.

Conditions 17 and 18 concern monitoring and reporting.

Conditions 19 and 20 relate to lapse and review of the consent.

These permits are attached to this report in Appendix I.

1.3.2 Water discharge permit

Colin Boyd holds discharge permit **7911-1**, to discharge stormwater from a drilling waste storage site into an unnamed tributary of the Mangamawhete Stream in the Waitara River. This permit was issued by the Council on 27 September 2011 under Section 87(e) of the RMA. It is due to expire on 1 June 2027. Site location Derby Road North.

Condition 1 concerns adoption of the best practicable option.

Conditions 2 through to 4 specify discharge limits and operational requirements.

Condition 5 relates to effects on surface water.

Condition 6 relates to the implementation and maintenance of a contingency plan.

Condition 7 relates to the lapse and review of the consent.

The permit is attached to this report in Appendix I.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets out obligations upon the Council to gather information, monitor, and conduct research on the exercise of resource consents. This is aimed at monitoring the potential effects arising from the ratification of their consents which may occur within the Taranaki region and report upon these.

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 the consent holder.

The monitoring programmes associated with the consents which govern Surrey, Derby Road and the landspreading operation respectively consist of five primary components.

- Programme liaison and management
- Site inspections
- Chemical sampling
- Biomonitoring surveys; and
- Review of the analytical results

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 two stockpiling facilities and the landspread areas were inspected a combined total of 32 times during the monitoring period. With regard to consents for the abstraction of or discharge to water, the main points of interest were plant processes with potential or actual discharges to receiving watercourses, including contaminated stormwater and process wastewaters. Sources of data being collected by the consent holder were identified and accessed, so that performance in respect of operation, internal monitoring, and supervision could be reviewed by the Council. The neighbourhood was surveyed for environmental effects.

1.4.4 Chemical sampling

The Council collects samples of the mediums of soil and water through out the monitoring period. This is to check the compliance of the consent holder with the

consented conditions and to make sure that no adverse effects are emitted from the facilities as an exercise of their consents.

1.4.4.1 Soil

In total, six composite soil samples from specific disposal areas were collected by Council staff. The methodology utilised is adapted from the Guidelines for the Safe Application of Biosolids to Land in New Zealand (2003). This is undertaken through the compositing of 10 soil cores (Photo 3) (500 mm+/- depth to encompass the zone of application) taken at 10 m intervals along transects through an application area.

Photo 3 An example of a soil core

The samples were analysed for the following: ammoniacal nitrogen, calcium, chloride, conductivity, total hydrocarbons, pH, potassium, magnesium, nitrite/nitrate nitrogen, sodium absorption ration, sodium and total soluble salts.

Of note, the metal analysis and speciation of petroleum hydrocarbons as required by the consent is provided by the consent holder. This is discussed in the following section.

1.4.4.2 Water

Water analysis is undertaken across the following mediums:

- Surface water ;
- Stormwater discharge; and
- Groundwater

Surface water samples were collected on three separate occasions along the unnamed tributary of the Mangamawhete Stream (Figure 2) in close proximity to the Derby Road North stockpiling facilities.

Surface water samples were also obtained on three separate occasions along the unnamed tributary of the Mangatengehu Stream (Figure 4) in relation to stormwater discharges from the Surrey Road stockpiling facilities. These samples were analysed for barium, BOD, chloride, conductivity, hydrocarbons, pH and total dissolved solids.

Stormwater discharge samples were also obtained on two separate occasions in relation to both the Derby Road North and Surrey Road stockpiling facilities. These samples were analysed for ammonia, barium, BOD, chloride, conductivity, hydrocarbons, pH, suspended solids and total dissolved solids.

Groundwater analysis results were obtained through the purpose built groundwater monitoring bore network. Derby and Surrey Road facilities each have three groundwater monitoring bores. These bore were installed to quantify the quality of the groundwater and specifically to understand if any adverse effects were permeating from either facility. Locations of each monitoring well are detailed in the following section respectively.

1.4.5 Biomonitoring surveys

Four biological surveys were performed during the monitoring period under review. These four were split evenly across the two stockpiling facilities at Derby and Surrey Roads respective unnamed tributaries.

The Surrey Road stockpiling facility is located in close proximity to the unnamed tributary of the Mangatengehu Stream. A Council Officer undertook a spring and a late summer survey of four specific monitoring sites on this tributary.

The Derby Road stockpiling facility is also located in close proximity to an unnamed tributary of the Mangamawhete Stream. In similarity to the Surrey Road assessment, the Derby Road facility is assessed across four specific monitoring sites on the unamed tributary of the Mangamawhete Stream.

The analysis results of the biomonitoring surveys are discussed in more detail in Section 2.

1.4.6 Review of analyical data

Inline with the consent conditions the consent holder must supply the Council with an annual report to satisfy the following condition.

'The consent holder shall keep records of the following:

a) Wastes from each individual well
b) Composition of wastes
c) Stockpiling area
d) Volumes of material stockpiled
e) Landfarming areas, including maps
f) Volumes and weights of wastes landfarmed
g) Dated of commencement and completion of stockpiling and landfarming events
h) Treatments applied

i) Details of monitoring, including sampling locations, sampling methods and the results of the analysis

And shall make the records available to the Chief Executive, Taranaki Regional Council'

Mi Swaco acts as the managers for both stockpiling facilties within this monitoring period. As previously discussed in the earlier sections of this report they moved to relinquish control of the now inactive stockpiling facility of Derby Road, however this was not until the end of the monitoring period of this report.

Mi Swaco undertook pre screening analysis of the material which they received on site. They provided the Council with representative samples of the material and it was analysed by an IANZ accredited independent laboratory (Hills laboratory in Hamilton).

Mi Swaco also undertook post spreading soil sampling of the paddocks to which material is applied through the practice of landfarming or landspreading. The chemical parameters which they analyse are provided below:

- Dry matter;
- Density;
- Total recoverable barium;
- Total recoverable sodium ;
- Arsenic;
- Cadmium;
- Chromium;
- Copper;
- Lead;
- Mercury;
- Nickel ;
- Zinc;
- Phosphorous;
- Potassium;
- Calcium;
- Chloride;
- Magnesium;
- Sodium absorption ratio;
- Electrical conductivity;
- Benzene;
- Toluene;
- Ethylbenzene;
- M&p xylene;
- 0-xylene;
- Polycyclic aromatic hydrocarbons; and
- Total petroleum hydrocarbon speciation.

The analysis of the paddocks which were utilised for the practice of landfarming/spreading is provided in the consent holder supplied annual report in Appendix III.

2. Results: Annual site monitoring and inspection

2.1 Derby Road North stockpiling facility

2.1.1 Site description

Derby Road North stockpiling facility is located on the Taranaki ring plain bordering the Egmont National Park near Inglewood (Figure 1). In previous monitoring years this was the primary stockpiling site for muds and cuttings. At the beginning of the 2011-2012 monitoring year activity slowed at the site. During the 2012-2013 monitoring year the Surrey Road site became the primary site, the Derby Road site remained unused and on standby to receive waste as a contingency or secondary site if required. While the site remained unused in the current monitoring period (2014-15) it still contained 100 m^3 +/- of residual drilling material which must be landfarmed before the Council considers the site for surrender.

The consent holder undertook a cleaning out operation towards the end of the monitoring period, whereby the remaining drilling muds were consolidated into one cell. The site is now to be utilised by the consent holder for the storage of water treatment sludge.

The unnamed tributary of the Mangamawhete Stream flows adjacent to the Derby Road North stockpiling facility. The proximity of the site to this surface water body had been taken into account in the setting of buffer distances and location of the stockpiling facilities.

The predominant soil type has been identified as gravelly sand and the vegetation cover is pasture, recently converted from native bush. Average annual rainfall for the site is 1,942 mm (taken from the nearby 'Stratford' monitoring station).

No consents were initially held to discharge stormwater from this stockpiling site, as it was expected to comply with the permitted activity criteria in Rule 23 of the Regional Freshwater Plan. However, a stormwater discharge consent was issued for the Derby Road North site (7911-1, 27 September 2011). The Derby Road facility also holds a discharge permit (6900-2) which permits the temporary stockpiling of blended waste prior to landfarm deployment.

Figure 2 Aerial photograph of the Derby Road North stockpiling facility, it details the storage cells, sampling sites and the approximate regional location (inset)

2.1.1.1 Site data

Location

Word descriptor:	Derby Road North, Inglewood, Taranaki
Map reference:	E 1702545
(NZTM)	N 5653650
Mean annual rainfall:	1,942 mm
Mean annual soil temperature:	-
Mean annual soil moisture:	-
Elevation:	~500 MASL
Geomorphic position:	Ring plain
Erosion / deposition:	Negligible
Vegetation:	Transitional – native bush to pasture
Parent material:	Tephra / volcaniclastic
Drainage class:	Free / well draining

2.1.2 Results

2.1.2.1 Inspections

22 August 2014

No site activity, deliveries or changes to the site had occurred. The level of cell 3 was low and expected to fill with storm water, the liquid inside was turbid. All other cells were full of storm water with a minor discharge observed from the skimmer pipes to the receiving drain. All cells were free of surface oils except a small amount in cell 6. The residual muds within the cell appeared to be increasing in volume due to gas pockets and organic growth. Discharge from final settling pond was estimated to be <0.1 l/s. No adverse effects were found in the receiving waters.

01 October 2014
An inspection was conducted in conjunction with groundwater sampling at the Derby Road North stockpiling site. The site remained unused. All cells and ponds were fairly full with clean rainwater. The site looked good. Ducklings were observed swimming in the final cell. Three samples were taken with a peristaltic pump. The samples were clear, iron oxide was present in the two down gradient samples. No issues were noted at the site.

05 November 2014
No recent storage activities had occurred. The site was quiet and all cells were observed to be at discharge level with stormwater only. Organic growth had occurred in some of the cells, no skimmer pipes were discharging. Receiving ponds appeared clear and free of hydrocarbons with lots of ducks on both ponds. No discharge to receiving waters was occurring at the time, although the, tributary was running slightly turbid with iron oxide prevalent throughout. No objectionable odours or visible emissions were found during the inspection

06 January 2015
No recent stockpiling of drilling wastes had occurred. The discharge from the final settling pond was clear, receiving waters were slightly turbid with no detrimental effects observed. The settling ponds were clear of any hydrocarbon sheen. Cell 3 recently had residual muds removed and discharged onto land adjacent to quarry area. The muds had been incorporated into the soil; although further works are required around the spreading area to fully incorporate the muds into the soil profile, machinery was on-site but no activity had occurred. No objectionable odours or visible emissions were found during the inspection.

All other cells contained storm water with lots of tadpoles throughout the cells, some algal growth also, minor amount of hydrocarbon sheen in small areas around the surface of cells 6 and 7. The historic area where muds were applied too thickly on the mountain side of the Derby Road storage site was being rolled during the inspection. Works have been undertaken to rip the material into the soil. The area looked good and pasture was yet to be sown.

28 January 2015
An inspection conducted at the Derby and Surrey Road stockpile sites in conjunction with surface water sampling. The Derby Road stockpile was inactive as per the inspection report for groundwater sampling the previous day.

05 March 2015
Derby Road storage site remained inactive. Some residual muds remained in cells 6 and 7. No discharge had occurred from the final settling pond while the inspection was undertaken. An inspection of the landfarmed areas was undertaken with the consent holder. All pasture appeared healthy, some muds remained at the surface in small patches across several paddocks but pasture cover was essentially complete. The most recent spreading area which received residual muds from Derby Road, had been worked over and rock raked, no pasture had been sown due to weather conditions.

13 May 2015
The inspection was undertaken with an MI Swaco representative to discuss the possibility of using the current storage cells at the site of Derby Road to temporarily store water treatment sludge. Storage cells 1-7, excluding cell 3 all contained residual drilling muds in varying volumes. It was outlined that if the cells are to be used, then they would need to be scraped completely clean prior to being utilised, to contain the sludge as the resource consents are explicit for each type of waste. Cells 6 and 7 were observed to contain some surface hydrocarbons and all cells contained algae. It was suggested that due to the bad weather and the need to use the cells it would be possible to clean the residual muds and stockpile them in one cell until weather permits land-farming activities. The discharge from the final storm water treatment pond was minor and clear. No effects were observed in the receiving waters which were in high flow. MI Swaco indicated that they would like to relinquish their involvement with the site once all drilling mud material had been land-farmed.

In the inspection notice it was instructed that the consent holder must clean out residual muds prior to using the cells to store sludges and to inform the Council when works are completed prior to the discharge of sludges in order for it be confirmed that the wastes are kept separate.

15 May 2015
An inspection was undertaken to quantify the volumes of residual drilling muds present within the cells after the storm water had been removed. Mi Swaco representative was met on-site at the time. Preliminary investigations found that cell 2 had approximately 40 m^3 present in the first 5 metres at the northern end; cell 4 was found to have a significant volume of mud present, which ran the length of the cell on the western side; and the other cells also contained muds but due to storm water ingress after recent heavy rains it was not possible to determine quantities. It was noted that Mi Swaco are looking to relinquish responsibility for the site, it was outlined that all materials will need to be land-farmed prior to consent surrender. As the site would likely be used to store water treatment sludge it was agreed that all cells would be scraped completely clean and the materials stockpiled into one cell in preparation for land-farming when the weather improved. The discharge from the final treatment pond was inspected and found to be clear, no effects were observed in the receiving waters.

It was noted that the following action was to be taken: Consolidate the residual muds into one cell. Spread the muds in accordance with resource consent conditions when the weather improved.

25 May 2015
Works had begun to consolidate residual drilling muds. A long-reach digger was on-site, but no activity had occurred. The first eight metres of cell 2, at the load-in end had been transferred into cell 1, the mud profile was approximately 1 meter deep, but the base of the pit had yet to be reached as the material was quite solid. Cell 5 residuals from all areas of the cell had been transferred into cell 4, but plenty remained within cell 5. No works had occurred in cells 6 or 7. Cell 7 had a small amount remaining but cell 6 had quite a considerable volume. Storm water ponds were slightly turbid, the discharge from final pond was approximately 2 l/minute and was essentially clear. No effects were observed within the receiving waters. Samples were taken.

It was noted that the following action was to be taken: Continue to consolidate the residual muds, spreading the material in accordance with resource consent conditions when the weather permitted.

23 June 2015
Residual drilling muds from cell 8 (western end of the site) had been cleaned out into a smaller cell adjacent to cell 8 which had been newly created, however on the western half of the cell, approximately 6 inches of muds remained in the bottom as the digger on-site was too short to reach the muds. The storm water from the cell had been pumped into the wash-pad, which had discharged into the storm water ponds. A new cell had also been dug on the eastern side of cell 8 to accommodate deliveries of water treatment sludge from Rowan Road. The newly dug cell had filled with water during a recent storm event. The storm water was being pumped into the wash-pad and discharged into the final storm water pond during the inspection. The discharge from the final pond was inspected and found to have created a foaming effect in the receiving waters. The foaming effect was observed down stream at the culvert on Derby Road North and beyond. The pump in the new cell was stopped to prevent further discharges from the final storm water ponds. A digger was used to bury the outlet pipe to cease the discharge from the final storm water pond.

It was outlined to the consent holder that the storm water ponds would need to be discharged onto land to prevent the detrimental effect on the receiving waters. The paddocks were too wet to use a tanker. In addition the tractor was being repaired. It was agreed that the only practical solution was to dig a bund down gradient of the final storm water pond and discharge the liquid into it in a controlled manner which would allow it to soak into the pasture.

A sample of the discharge was collected, photos and video of the effects on the receiving waters were also taken. Discussions were held with the consent holder regarding the cause of the effect, it was theorised that the storm water from cell 8 contained detergent/surfactants from rig cleaning activities and because the liquid was all pumped into the storm water ponds the concentration of the detergent/surfactant was high enough to create a visual effect on the receiving waters. All other cells at the site were full of storm water. No works had occurred to land-farm the residual muds which were recently consolidated.

The following action was to be taken: To undertake works to discharge the storm water ponds onto/into pasture to prevent detrimental effects on the adjacent unnamed tributary. To ensure all discharges from the site comply with resource consent conditions. To undertake works to land-farm the residual muds at the site in accordance with resource consent conditions.

2.1.2.2 Results of abstraction and discharge monitoring

Drilling material

No deliveries of drilling muds or cuttings were received by the stockpiling facility at Derby Road during this monitoring period. The site is now closed with the Surrey Road facility presently serving as the primary site. Residual drilling muds estimated to be 100 m^3 +/- are now consolidated to one storage cell and as outlined by the inspecting officer now require to be landfarmed.

Council stormwater results

The Council undertook stormwater discharge sampling on two occasions throughout the monitoring year, they were collected from the location IND001064 (Figure 2). The results are presented in Table 1. The rationale for the collection of stormwater discharge samples is to confirm compliance with the stormwater discharge consent 7911-1; the limits of which are detailed in the table below.

Table 1 Council stormwater 7911-1

Parameter	Unit	Consent 7911-1	Date	
			10 April 2015	25 May 2015
Benzene	g/m³		<0.0010	-
Toluene	g/m³		<0.0010	-
Ethylbenzene	g/m³		<0.0010	-
meta-Xylene	g/m³		<0.0010	-
ortha-Xylene	g/m³		<0.002	-
Hydrocarbons	g/m³	15	<0.7	-
C7-C9	g/m³		<0.10	-
C10-C14	g/m³		<0.7	-
C15-C36	g/m³		<0.4	-
Barium (acid soluble)	g/m³		0.29	-
Biochemical oxygen demand	g/m³	2	1.1	-
Chloride	g/m³	50	19.8	37.2
Conductivity	mS/m@20°C		10.6	18.6
pH	pH	6.0-9.0	7	7.4
Suspended solids	g/m³	100	4	-
Temperature	°C		16.6	11.6
Total dissolved solids	g/m³		82.0	-

No exceedance was detected on either occasion for the two stormwater monitoring rounds at location IND001604.

2.1.2.3 Results of receiving environment monitoring

The Council collects samples of soil and water throughout the monitoring period. This is to check the compliance of the consent holder with the consented conditions and to make sure that no adverse effects are leaving the facilities as an exercise of their consents.

Council groundwater results

Three groundwater monitoring wells were installed in late 2008, prior to the first delivery of drilling material to the site. The wells are located up-gradient (GND2060), adjacent to the cells (GND2061) and down gradient of the storage cells (GND2062), the locations of these wells are detailed in Figure 2.

Table 2 Annual groundwater monitoring results for GND2060 from Derby Road North during the 2014-2015 year.

Parameter	Unit	01 Oct 2014	27 Jan 2015	31 Mar 2015	26 Jun 2015
Barium (Acid Soluble)	g/m³	0.015	0.031	0.020	0.018
Barium (Dissolved)	g/m³	0.015	0.021	0.020	0.018
Benzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Chloride	g/m³	5.9	8.2	8.3	7.1
Conductivity	mS/m@20°C	6.0	5.8	6.7	6.3
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Total Hydrocarbons	g/m³	<0.7	<0.7	<0.7	<0.7
C7-C9	g/m³	<0.10	<0.10	<0.10	<0.10
C10-C14	g/m³	<0.2	<0.2	<0.2	<0.2
C15-C36	g/m³	<0.4	<0.4	<0.4	<0.4
Static Water Level	m	2.504	2.781	2.561	2.530
Sodium	g/m³	4.3	6.0	6.0	4.6
Nitrite/ Nitrate Nitrogen	g/m3 N	<0.01	0.01	0.06	0.15
pH	pH	6.1	6.0	5.9	6.1
Total dissolved solids	g/m³	46.4	44.9	51.8	48.7
Temperature	°C	11.8	14.5	14.4	11.5
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m³	<0.002	<0.002	<0.0010	<0.002
ortha-Xylene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010

Table 3 Annual groundwater monitoring results for GND2061 from Derby Road North during the 2014- 2015 year.

Parameter	Unit	01 Oct 2014	27 Jan 2015	31 Mar 2015	26 Jun 2015
Barium (Acid Soluble)	g/m³	0.034	0.137	0.017	0.060
Barium (Dissolved)	g/m³	0.034	0.133	0.017	0.058
Benzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Chloride	g/m³	23.6	77.9	7.6	43.3
Conductivity	mS/m@20°C	16.2	40.9	10.6	26.1
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Total Hydrocarbons	g/m³	<0.10	<0.10	<0.10	<0.10
C7-C9	g/m³	<0.2	<0.2	<0.2	<0.2
C10-C14	g/m³	<0.4	<0.4	<0.4	<0.4
C15-C36	g/m³	<0.7	<0.7	<0.7	<0.7
Static Water Level	m	1.290	1.936	1.338	1.323
Sodium	g/m³	6.6	13.4	5.4	8.7
Nitrite/ Nitrate Nitrogen	g/m3 N	0.02	<0.01	0.10	0.03
pH	pH	6.0	6.0	6.0	6.0
Total dissolved	g/m³	125.3	316.4	82.0	201.9

Parameter	Unit	01 Oct 2014	27 Jan 2015	31 Mar 2015	26 Jun 2015
solids					
Temperature	°C	12.2	14.7	17.5	12.5
Toluene	g/m3	<0.0010	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m3	<0.002	<0.002	<0.002	<0.002
ortha-Xylene	g/m3	<0.0010	<0.0010	<0.0010	<0.0010

Table 4 Annual groundwater monitoring results for GND2062 from Derby Road North during the 2014- 2015 year.

Parameter	Unit	01 Oct 2014	27 Jan 2015	31 Mar 2015	26 Jun 2015
Barium (Acid Soluble)	g/m3	0.023	0.030	0.031	0.044
Barium (Dissolved)	g/m3	0.023	0.023	0.029	0.039
Benzene	g/m3	<0.0010	<0.0010	<0.0010	<0.0010
Chloride	g/m3	6.4	9.2	7.2	13.9
Conductivity	mS/m@20°C	5.4	8.1	5.8	7.2
Ethylbenzene	g/m3	<0.0010	<0.0010	<0.0010	<0.0010
Total Hydrocarbons	g/m3	<0.10	<0.10	<0.10	<0.10
C7-C9	g/m3	<0.2	<0.2	<0.2	<0.2
C10-C14	g/m3	<0.4	<0.4	<0.4	<0.4
C15-C36	g/m3	<0.7	<0.7	<0.7	<0.7
Static Water Level	m	0.805	1.570	0.667	0.671
Sodium	g/m3	3.8	4.0	4.2	4.8
Nitrite/ Nitrate Nitrogen	g/m3 N	<0.01	<0.01	<0.01	<0.01
pH	pH	5.5	5.7	5.5	5.7
Total dissolved solids	g/m3	41.8	62.7	44.9	55.7
Temperature	°C	14.1	15.5	17.5	11.8
Toluene	g/m3	<0.0010	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m3	<0.002	<0.002	<0.002	<0.0010
ortha-Xylene	g/m3	<0.0010	<0.0010	<0.0010	<0.0010

The annual groundwater analysis results conducted by the Council of the operational monitoring well network at the Derby Road stockpiling facility, are detailed in the above tables (Table 2, 3 and 4). The wells were each sampled four times during the year. No adverse effect in terms of specific contaminate analysis were recorded.

Council surface water results

An unnamed tributary of the Mangamawhete Stream flows adjacent to the southern boundary of the site (Figure 2). The Council has three established monitoring sites located on this stretch of the unnamed tributary:

MMW000161 Upstream
MMW000162 Midstream
MMW000163 Downstream

These three sites were monitored three times throughout the monitoring period, the results are provided in the following tables (Tables 5, 6 and 7). Note that the data is presented per sample run to ascertain any effect from the facility.

Table 5 Results from surface water assessment of the unnamed tributary of the Mangamawhete Stream 08 December 2014

Parameter	Unit	MMW000161 8 Dec 2014	MMW000162 08 Dec 2014	MMW000163 08 Dec 2014
Barium (acid soluble)	g/m³	0.034	0.015	0.017
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Biochemical Oxygen Demand	g/m³	-	<0.5	<0.5
Chloride	g/m³	6.6	6.8	7.6
Conductivity	mS/m@20°C	10.3	10.2	10.5
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
Total Petroleum Hydrocarbon	g/m³	<0.7	<0.7	<0.7
HC C7-C9	g/m³	<0.10	<0.10	<0.10
HC C10-C14	g/m³	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4
pH	pH	7.5	7.3	7.5
Total Dissolved Solids	g/m³	79.7	78.9	81.2
Temperature	°C	17.4	17.1	16.6
Toluene	g/m³	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m³	<0.002	<0.002	<0.002
ortha-Xylene	g/m³	<0.0010	<0.0010	<0.0010

Table 6 Results from surface water assessment of the unnamed tributary of the Mangamawhete Stream 28 January 2015

Parameter	Unit	MMW000161 28 Jan 2015	MMW000162 28 Jan 2015	MMW000163 28 Jan 2015
Barium (acid soluble)	g/m³	0.009	0.012	0.019
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Biochemical Oxygen Demand	g/m³	-	1.5	0.7
Chloride	g/m³	6.7	6.9	7.7
Conductivity	mS/m@20°C	10.5	10.5	10.7
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
Total Petroleum Hydrocarbon	g/m³	<0.10	<0.10	<0.10
HC C7-C9	g/m³	<0.2	<0.2	<0.2
HC C10-C14	g/m³	<0.4	<0.4	<0.4
HC C15-C36	g/m³	<0.7	<0.7	<0.7
pH	pH	7.3	7.2	7.4
Total	g/m³	81.2	81.2	82.8

Parameter	Unit	MMW000161 28 Jan 2015	MMW000162 28 Jan 2015	MMW000163 28 Jan 2015
Dissolved Solids				
Temperature	°C	18.7	19.7	20.7
Toluene	g/m^3	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m^3	<0.002	<0.002	<0.002
ortha-Xylene	g/m^3	<0.0010	<0.0010	<0.0010

Table 7 Results from surface water assessment of the unnamed tributary of the Mangamawhete Stream 10 April 2015

Parameter	Unit	MMW000161 10 Apr 2015	MMW000162 10 Apr 2015	MMW000163 10 Apr 2015
Barium (acid soluble)	g/m^3	0.040	0.041	0.120
Benzene	g/m^3	<0.0010	<0.0010	<0.0010
Biochemical Oxygen Demand	g/m^3	-	<0.5	0.6
Chloride	g/m^3	5.1	4.9	9.2
Conductivity	mS/m@20°C	6.4	6.1	7.6
Ethylbenzene	g/m^3	<0.0010	<0.0010	<0.0010
Total Petroleum Hydrocarbon	g/m^3	<0.10	<0.10	<0.10
HC C7-C9	g/m^3	<0.2	<0.2	<0.2
HC C10-C14	g/m^3	<0.4	<0.4	<0.4
HC C15-C36	g/m^3	<0.7	<0.7	<0.7
pH	pH	6.7	6.8	6.9
Total Dissolved Solids	g/m^3	49.5	47.2	58.8
Temperature	°C	15.7	15.8	16.0
Toluene	g/m^3	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m^3	<0.002	<0.002	<0.002
ortha-Xylene	g/m^3	<0.0010	<0.0010	<0.0010

Annual analysis on the surface waters of the unnamed tributary of the Mangamawhete Stream did not detail any significant variation between sample locations. This indicated that there is a minimal impact on the tributary from the activities of the Derby Road stockpiling facility within this monitoring period.

Council biomonitoring results

A macroinvertebrate survey was performed in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land within its vicinity. The survey was conducted in spring and was one of two scheduled surveys for the site in the 2014-15 year.

A baseline survey was undertaken in April 2009, prior to any receipt of drilling wastes at the site. At the time of the baseline survey the communities at the downstream sites had experienced significant habitat deterioration due to the realignment of the

tributary, and also the discharge of significant amounts of sediment through associated land disturbance. However, the upstream control site was relatively unaffected.

The previous survey performed in February 2014 (Thomas, 2014) found that the activities at the drilling waste stockpiling site and landfarming area had not had any impacts on the macroinvertebrate communities although some impacts caused by habitat variability were noted.

2.1.2.4 Method

Four sites were sampled in this survey. The 'control' site (site 1) was established in the unnamed tributary, alongside the upstream boundary of the land treatment area. Site 2 was established between the land treatment area and the storage pits, and site 3 was established just downstream of the skimmer pit discharge point. A fourth site was established approximately 200m downstream of the skimmer pit discharge. This fourth site provides comparative information, should deterioration be recorded at sites 2 or 3. The sampling site locations are presented in Table 8 and Figure 4.

Either the Council's standard 'vegetation-sweep' (site 1) or 'kick-sampling' (sites 2, 3, and 4) sampling techniques were used at these four sites (Table 8) to collect streambed macroinvertebrates on 16 October 2014. 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).

Table 8 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling activities

Site number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MMW000161	E1702317 N5653463	Upstream of drilling waste stockpiling site	450
2	MMW000162	E1702508 N5653560	Downstream of land spreading area	440
3	MMW000163	E1702734 N5653676	Downstream of skimmer pit discharge	435
4	MMW000165	E1702900 N5653750	200m downstream of skimmer pit discharge	430

Figure 3 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling activities

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Council methodology using Protocol P1 of NZMWG protocols for 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)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 500 individuals or more.

2.1.2.5 Summary results

There was no indication from any of the macroinvertebrate indices examined that stockpiling and discharge of drilling waste to land has had any significant effect on the health of the macroinvertebrate communities present in the unnamed tributary of the Mangamawhete Stream.

The above information is extracted from the full biomonitoring reports. Note that the full reports including taxa and richness are provided in Appendix II.

2.3 Surrey Road stockpiling facility

2.3.1 Site description

The Surrey Road stockpiling facility is located on the Taranaki ring plain bordering the Egmont National Park near Inglewood. The Mangatengehu Stream flows adjacent to the facility. The proximity of the site to this recognised ecosystem has been taken into account in the setting of buffer distances and location of the stockpiling facilities.

The predominant soil type has been identified as gravelly sand and vegetation growth consists of native bush which transitions into pasture. Average annual rainfall for the site is 1942 mm (taken from the nearby 'Stratford' monitoring station).

The stockpiling facility located at Surrey Road is operated under one consent (7559-1), this consent directs the consent holder to discharge detailed quantities of drilling related material (consisting of drilling cuttings, drilling fluids and muds, both water based and synthetic based) onto land for the propose of land farming. No consents are held to discharge stormwater from this stockpiling site; it is expected to comply with the permitted activity criteria detailed by Rule 23 of the RFWP.

Figure 4 Aerial photograph of the Surrey Road stockpiling facility, storage cells as well as sample locations are detailed, including the regional location

2.3.1.1 Site data

Location	
Word descriptor:	Surrey Road, Inglewood, Taranaki
Map reference:	E 1701847
(NZTM)	N 5651476
Mean annual rainfall:	1,942 mm
Mean annual soil temperature:	-
Mean annual soil moisture:	-
Elevation:	~500 MASL
Geomorphic position:	Ring plain
Erosion / deposition:	Negligible
Vegetation:	Transitional – native bush to pasture
Parent material:	Tephra / volcaniclastic
Drainage class:	Free / well draining

2.3.2 Results

2.3.2.1 Inspections

26 August 2014
Follow up biomonitoring was conducted in the Mangatengehu Stream in relation to a previous incident (UI 30942). Chemical sampling was also conducted, with samples taken from upstream and downstream of the site, the novaflo pipe that was discharging contaminants from the pit base to the perimeter drain, and the final pond next to the final discharge pipe. The novaflo pipe was discharging at 0.5 L/S into the perimeter drain. The discharge contained visible hydrocarbons, and a hydrocarbon odour was strong in both the samples and the drain. Oil was built up in the drain, but the final pond was free of significant oil build up. No hydrocarbons were evident in either stream sample, and the stream water appeared clean and clear. The substrate was covered in iron oxide and algae. Other than the perimeter drain, the site was generally tidy and looked well managed. It was discussed and agreed with the site management that the site would be a no-discharge site.

19 September 2014
No objectionable odours or visible emissions were found during the inspection. Work was underway on cleaning out IBC's while the inspection was undertaken. The wash-pad was not in use, its discharge was directed to cell 1. Cell 1 was at the time, full with muds and storm water, cell 2 contained a small volume of muds while cell 3 was found to be discharging into the receiving drain. The liquid within the cell was turbid with a small volume of emulsified surface oil present.

Staff outlined that the cell had been emptied regularly onto pasture but the tanker used was being repaired so the cell had filled from the recent heavy rains and had begun to discharge overnight. The nova flow was discharging visible hydrocarbon sheen during the inspection. Emulsified hydrocarbons were also present further down the drain at the culvert. The final settling pond discharge was clear and no effects were found within the receiving waters. The mud storage tanks were secure, some algae appeared to be growing in the liquid within the bund. The adjacent lined pit had a very minor hydrocarbon sheen. Discussions held with site occupier regarding installing a cut-off

drain above the pits to redirect the liquid moving through the nova-flow pipe below the pits/wash-pad.

In the inspection notice it was noted that the following action was to be taken: To ensure all liquid originating from the storage cells, bunds and the washpad were irrigated onto pasture to ensure compliance with 'best practicable option' resource consent condition as discussed on 21 August 2014 with the consent holder.

30 September 2014
The inspection was conducted in conjunction with groundwater sampling at the Surrey Road landfarm site. The site was tidy and appeared well managed; the ponds were not discharging at the time of inspection. Three bores were sampled using the new peristaltic pump. All samples were clean and clear. No odours or sheens were observed in the samples.

1 October 2014
No objectionable odours or visible emissions were found during the inspection. No site activity was occurring at the time of inspection, the tracks had been re-metalled and drains cleaned out. Cell 3 was being managed so as not to discharge to the receiving ponds and the tanker was on-site. Plenty of capacity was available within the cell. Cell 1 was full of mud and storm water. The liner of cell 2 had been completely torn along the eastern wall during heavy winds on 27/28 September 2014, the rip was above the mud line but below the storm water line. The liquid within the cell was clear and free of hydrocarbon sheen. The nova-flow discharge from below the cell was clear of any hydrocarbon sheen, although emulsified hydrocarbons were present within the drain at the first down stream drain culvert.

The receiving ponds were clear of hydrocarbons and were found to be turbid. The discharge was clear and no effects were observed within the receiving waters. IBC's containing residues remained on-site. The tank bund contained clear water only. The officer called the consent holder and outlined the cell 2 liner issue. He agreed to lower the cell fluid level and investigate repair options immediately.

It was noted that the following action was to be undertaken: To undertake works to lower the cell level to below the tear, and ensure the cell does not fill until sufficient repairs have been made or the liner replaced.

5 November 2014
No objectionable odours or visible emissions were found during the inspection. No site was activity occurring at the time of inspection, the wash-pad and cell 1 were full with stormwater on the surface, cell 2 was being kept below the liner tear level and stabilisation measures had been put in place. It was planned that the liner would be repaired in the near future. Cell 3 had approximately 1 metre of freeboard. The nova flow pipe was discharging a barely visible rainbow sheen was noted. The receiving ponds were slightly turbid brown with organic growth throughout, final discharge to receiving waters were clear and no effects were observed.

14 November 2014
The inspecting officer spoke with the consent holder and outlined three areas identified which required further works to incorporate muds into the soil profile and establish

pasture cover,. The consent holder agreed to investigate the proposition and develop timeframes for the works.

5 January 2015
No objectionable odours or visible emissions were found during the inspection. Works had commenced on digging a cut-off drain up-stream of the storage cells immediately adjacent to cell 1. The drain was to be cut to below cell floor level, nova-flow installed and the drain was backfilled with large metal. Approximately 4 metres had been installed and this was picking up ground water and discharging it into the receiving drain. Cell 1 was found to be full with mud and storm water, very little surface hydrocarbons were present in cell 1. Cell 2 liner had been repaired using silicon and battens screwed through into wood below the liner. Initial repair works failed to get the new liner material to adhere due to a change in material properties from when the current liner was new.

The level of the storm water in the cell was above the repair level and the lack of tide-line on the liner wall indicated the seal was holding. Cell 3 contained clear liquid and was completely free of surface hydrocarbons. Plenty of freeboard was available and the cell was being irrigated onto pasture.

Discussions were held regarding requirement to keep records of where the liquid was irrigated to ensure soil loading is accurately assessed. The nova flow originating from below the cells was inspected and found to be satisfactory. No foaming or rainbow sheen was identified during the inspection. The receiving pond was free of surface hydrocarbons. The final discharge into the receiving waters was approximately 1/2 L/S. The discharge was clear and no effects were observed within the receiving waters. The mud tanks remained on-site, the lined bund contained clear water only, and the adjacent lined cell had a minor amount of surface hydrocarbons with approximately 1/3 metre freeboard. No recent material deliveries had occurred and no muds had recently been spread from the storage site.

28 January 2015
Surrey Road was inactive, the cells contained stormwater and plenty of freeboard. A small amount of hydrocarbon was visible as a sheen in some of the cells. Recent earthworks (early Jan 2015) had been undertaken to capture and divert the underground spring away from the washdown pit and into the stormwater system.

Earthworks had realigned stream at sampling site MTH000060 and a revised sampling site was established at the head of the small pool just before the culvert. Streambank and surrounding area were still bare, with vegetative cover yet to be established. No suspended sediment was noticeable in sample.

30 January 2015
The inspection was conducted in conjunction with groundwater sampling, following surface water sampling a few days previous. Bore GND2165 was dry, possibly as a result of recent work to divert nearby underground spring away from the washdown pit. Bore GND2166 was sampled for the groundwater nitrate programme in conjunction with landfarm monitoring. Discussion held with site management (Mi Swaco). The site was inactive, with no upcoming work.

18 February 2015
The inspection was conducted in conjunction with surface water and discharge sampling. The recently earthworked area at MTH000060 was slowly establishing vegetating cover. Pasture growth was establishing well considering the current drought. Stormwater within cell 3 was not discharging into the drain, however the nova flow pipe from the base of the cell was. A sample was collected from this point. Trucks carrying drilling muds from OMV's offshore campaign were being unloaded at the Surrey Road site during the visit; this material was to be stored in the silos.

5 March 2015
Noticeable hydrocarbon and mud odours were found down wind of cells at both storage sites. The Surrey road site had received a mud delivery which had been introduced into cell 1. Three IBC's which contained muds were also stored adjacent to the washpad. Washpad liquid was turbid with some surface oils. Cell 1 was essentially full, cell 2 had plenty of freeboard available, and the liner repair appeared to be holding. The unlined receiving cell 3 had a slight turbid appearance. The recently installed cut-off nova flow upstream of the storage cells was discharging approximately 1 L/S and the liquid was clear. No discharge was occurring from the nova-flow under the storage cells. The receiving drain was flowing clear. Iron oxide was prevalent throughout its length. The discharge from the final settling pond was clear and free of hydrocarbons, no effects were evident in the receiving waters. No site activity was occurring at the time of inspection.

30 March 2015
The inspection conducted in conjunction with groundwater sampling. All samples were clear and colourless with no odour, sheen or foaming. A phone conversation was held with the consent holder earlier that morning informing him of intention to visit site and conduct groundwater sampling. No activity onsite during visit. Talked to farm manager informed him what we were doing.

10 April 2015
The inspection was conducted in conjunction with surface water and discharge sampling. The weather was overcast and raining. The stream volume was high. Some odour and foaming was noted in the samples, however, no sheen. Surface ponding on access tracks around the storage cells showed a hydrocarbon sheen, some sheen apparent on the cells themselves. Cells were discharging into stormwater system, between 0.5 and 1m freeboard was available in all.

6 May 2015
Localised drilling mud and hydrocarbon odours were present down wind of the cells, but no objectionable odours were found beyond the site boundary. Lined cell 1 was full and discharging storm water into unlined cell 3, lined cell 2 had approximately 50cm free board until discharge would occur; cell 3 had plenty of free-board available to cope with forecasted rain event. A pump was in place but not operating and no irrigation was occurring. The cell was to be lined in the near future, the liquid inside was clear. The receiving drain's nova coil's flow discharge from under cells had a minor rainbow sheen. The first receiving pond and all other treatment ponds were clear of hydrocarbons. The mud tanks bund was empty. Programmed deliveries occurred throughout the day. The wash pad pond was turbid, but the final discharge to

receiving waters was clear and no effects were observed. All pasture inspected where muds have been spread appeared healthy and had good cover.

23 June 2016
A council officer met with the consent holder at Inglewood Loader Parts prior to the site visit. He informed me that work was currently being undertaken at Derby Road stockpiling site. Trucks were onsite sucking stormwater out of the pits and trucks would be bringing in water treatment sludge for storage onsite over the next two weeks.

Met with site management (Mi Swaco) at Surrey Road stockpiling site, and was told that the remaining waste material at Derby Road had been combined in two of the cells prior to spreading, and the remaining cells were intended to be used for water treatment sludge storage.

Surrey Road site inspection was conducted in conjunction with compliance monitoring groundwater and soil sampling, following heavy rain three days previous. All three groundwater bores were sampled. No odour, sheen or foaming was encountered in any bores. An additional sample was collected from novaflow discharge into stormwater drain below cell 2. Odour and sheen were present and there was a noticeable foaming. Operators were onsite at Surrey Road, cleaning mud tanks in washdown area, following recent arrival of new muds to the site. All cells had adequate freeboard. There was no discharge to stormwater system at the time of inspection.

Composite soil sample transects were collected in paddocks 34, 18 and 142. 12 cores collected per transect, sampled to an approximate depth of 250 mm. Some drilling muds were evident on the surface in paddocks 18 and 142, but this was weathered and no odour noticeable. Dark brown, moist clays and small gravels were noted. Mature pasture established in all paddocks, however there were noticeable lines where spreading had occurred.

2.3.2.2 Results of abstraction and discharge monitoring

Drilling material

During the monitoring period the Surrey Road Facility received deliveries from two locations. The quantity of material received is detailed below:

1: 1,3996 m^3 from the 107 Maari MR7A5 OMV
2: 1 m^3 from KA-20 STOS

Council stormwater results

The site at Surrey Road does not hold stormwater discharge consent; as such it has to meet the RFWP Rule 23. The Council undertook the collection and analysis from the final discharge pond (IND00167 Figure 4) in relation to stormwater discharges. On both occasions, the analysis did not return any exceedances in comparison to the parameters specified in the by the RFP Rule 23. In addition none of the analysis returned any concentrations above background concentrations.

			IND001067	IND001067
		Rule 23 RFP	18 Feb 2015	10 Apr 2015
Parameter	Unit		13:45	12:10
Barium (acid soluble)	g/m3		0.09	0.15
Benzene	g/m3		<0.0010	<0.0010
Biochemical Oxygen Demand	g/m3	5	2.5	3.1
Chloride	g/m3		22.2	9.0
Conductivity	mS/m@20C		16.5	7.1
Ethylbenzene	g/m3		<0.0010	<0.0010
Total Hydrocarbon	g/m3	15	<0.7	<0.7
HC C7-C9	g/m3		<0.10	<0.10
HC C10-C14	g/m3		<0.2	<0.2
HC C15-C36	g/m3		<0.4	<0.4
pH	pH	6-9	7.4	6.6
Suspended solids	g/m3	100	5	8
Total dissolved salts	g/m3		127.7	54.9
TEMP-1	Deg.C		22.5	15.8
TOL-1	g/m3		<0.0010	<0.0010
XYLENE-2	g/m3		<0.002	<0.002
XYLENE-1	g/m3		<0.0010	<0.0010

In comparison to the previous year's stormwater analysis we have seen an improvement in the biochemical oxygen demand, last year's ranges were between 24-5.8g/m^3 which were partly caused by heavy rainfall events, but also represented a breech in the RFP Rule 23 on all three occasions within the 2013-14 monitoring.

This period saw the adoption of a new technique where by the site is now deemed a non discharge facility. Thus the breeches which were seen in the beginning of this period and in the previous monitoring period should be suitably mitigated.

Mi Swaco supplied storm water results

As discussed in the previous section, the facility at Surrey Road does not hold a storm water discharge permit, as such it must comply with the Regional Fresh Water Plan Rule 23 which states the following:

Discharge that will, or is liable to enter surface water, shall not exceed the following:

pH	*6.0-9.0*
oil and grease	*15 gm^3*
Suspended solids	*100 gm^3*
Bio-chemical oxygen demand	*5 gm^3*
Unionised ammonia	*0.025 gm^3*
Free chlorine	*0.2g/m^3*

The discharge shall not give rise to any of the following effects in the receiving waters after reasonable mixing:

a) production of any conspicuous oil or grease films, scums or foams, or floatable or suspended material;
b) any conspicuous change in the colour or visual clarity;
c) any emission of objectionable odour;
d) the rendering of freshwater unsuitable for consumption by farm animals; and
e) any significant adverse effects on aquatic life.

The analysis provided by Mi Swaco is provided in the following three tables:

Table 9 Mi Swaco supplied surface water sample results undertaken 19 September 2014

Mi Swaco		Surrey Road Upstream	Surrey Road outlet	Surrey Road Downstream
		19-Sep-14	19-Sep-14	19-Sep-14
Total Kjedahl nitrogen	g/m^3	-	0.6	-
Bio-chemical oxygen demand	gO2/m^3	<2	-	<2
Chemical oxygen demand	gO2/m^3	-	**14**	-
Oil and grease	g/m^3	-	<5	-

Table 10 Mi Swaco supplied surface water sample results undertaken 19 February 2015

Mi Swaco		Surrey Road Upstream	Surrey Road outlet	Surrey Road Downstream
		19-Feb-15	19-Feb-15	19-Feb-15
Free ammonia	g/m^3	-	<0.010	-
pH	pH	-	6.9	-
Total suspended solids	g/m^3	-	7	-
Total ammoniacal nitrogen	g/m^3	-	<0.010	-
Biochemical oxygen demand	gO2/m^3	<2	<2	<2
oil and grease	g/m^3	-	<4	-
free chlorine	g/m^3	-	0.15	-
combined chlorine	g/m^3	-	<0.08	-

Table 11 Mi Swaco supplied surface water sample results undertaken 08 July 2015

Mi Swaco		Surrey Road Upstream	Surrey Road Outlet
		08-Jul-15	08-Jul-15
Free ammonia	g/m^3	-	<0.010
pH	pH	-	7.3
Total suspended solids	g/m^3	-	4
Total ammoniacal nitrogen	g/m^3	-	0.39
Biochemical oxygen demand	gO2/m^3	<2	<2
oil and grease	g/m^3	-	<5
free chlorine	g/m^3	-	<0.05
combined chlorine	g/m^3	-	<0.08

Surface waters samples provided by Mi Swaco in this monitoring period are detailed in Tables 15, 16 and 17 respectively. Ideally it would have been best practice to undertake the same analysis across all three locations, rather than primarily focussing on the storm water outlet. However, the outlet storm water discharge was sampled on all three occasions. It is this analysis that the Council is most interested in.

The September analysis omission of bio-chemical oxygen demand is concerning considering the high degree of corresponding chemical oxygen demand (14g/m^3) in the sample collected on the same day.However, the remainder of the analysis did not reveal anything significant to suggest any likely adverse effects had occurred whilst these samples were collected.

The laboratory results which correspond with theses analyses are provided in the consent holder provided report which is available in Appendix III.

Mi Swaco Pre landfarm Storage Cell Analysis

Pre landfarm storage cell analysis is provided by Mi Swaco. This analysis is included in their supplied annual report located in Appendix III.

2.3.2.3 Results of receiving environmental monitoring

The Council collected soil and water (groundwater and surface water) samples through out the monitoring period. The soil analysis is provided in the landspreading section of this report.

Groundwater monitoring

Three groundwater monitoring wells were installed at the site in late 2009, these wells were fixed prior to the delivery of any drilling related material to the facility. The well positioning is detailed in Figure 4, one well is located up gradient (GND2165) this is to measure the quality of the groundwater preceding the site, the other two wells (GND2165 and 2166) are located down gradient to encapsulate any potential effects permeating from the facility. The results of the annual monitoring of the Surrey Road facility are detailed in Tables 12-14

Table 12 Groundwater monitoring analysis from well GND 2165 Surrey Road 2014-2015

		GND2165	GND2165	GND2165
		30 Sep 2014	30 Mar 2015	23 Jun 2015
Barium (acid soluble)	g/m^3	0.008	0.035	0.009
Barium Dissolved	g/m^3	0.008	0.034	0.009
Benzene	g/m^3	<0.0010	<0.0010	<0.0010
Chloride	g/m^3	5.6	11.8	8.1
Conductivity	mS/m@20°C	5.8	15.1	6.7
Ethylbenzene	g/m^3	<0.0010	<0.0010	<0.0010
Total Hydrocarbon	g/m^3	<0.7	<0.7	<0.7
HC C7-C9	g/m^3	<0.10	<0.10	<0.10
HC C10-C14	g/m^3	<0.2	<0.2	<0.2
HC C15-C36	g/m^3	<0.4	<0.4	<0.4
Static water level	m	1.884	3.236	2.173
Sodium	g/m^3	3.3	6.8	4.7
Nitrite/Nitrate nitrogen	g/m^3 N	0.38	0.43	0.51
pH	pH	6.4	6.3	6.3
Total dissolved salts	g/m^3	44.9	116.8	51.8
Temperature	°C	12.8	13.3	10.5
Toluene	g/m^3	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m^3	<0.002	<0.002	<0.002
ortha-Xylene	g/m^3	<0.0010	<0.0010	<0.0010

Table 13 Groundwater monitoring analysis from well GND 2166 Surrey Road 2014-2015

		GND2166	GND2166	GND2166	GND2166
		30 Sep 2014	30 Jan 2015	30 Mar 2015	23 Jun 2015
Barium (acid soluble)	g/m^3	0.022	0.035	0.088	0.026
Barium Dissolved	g/m^3	0.022	0.027	0.087	0.026
Benzene	g/m^3	<0.0010	<0.0010	<0.0010	<0.0010
Chloride	g/m^3	5.8	8.6	15.5	9.0
Conductivity	mS/m@20°C	5.3	7.0	14.4	7.2
Ethylbenzene	g/m^3	<0.0010	<0.0010	<0.0010	<0.0010
Total Hydrocarbon	g/m^3	<0.7	<0.7	<0.7	<0.7

		GND2166	GND2166	GND2166	GND2166
		30 Sep 2014	30 Jan 2015	30 Mar 2015	23 Jun 2015
HC C7-C9	g/m³	<0.10	<0.10	<0.10	<0.10
HC C10-C14	g/m³	<0.2	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.2	<0.4
Static water level	m	2.240	2.251	1.304	1.152
Sodium	g/m³	3.9	5.6	8.4	5.1
Nitrite/Nitrate nitrogen	g/m³ N	2.61	1.08	**9.30**	4.77
pH	pH	5.5	6.0	5.6	5.3
Total dissolved salts	g/m³	41.0	54.2	111.4	55.7
Temperature	°C	13.1	14.5	15.5	10.7
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m³	<0.002	<0.002	<0.002	<0.002
ortha-Xylene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010

Table 14 Groundwater monitoring analysis from well GND 2167 Surrey Road 2014-2015

		GND2167	GND2167	GND2167	GND2167
		30 Sep 2014	30 Jan 2015	30 Mar 2015	23 Jun 2015
Barium (acid soluble)	g/m³	0.030	0.044	0.027	0.042
Barium Dissolved	g/m³	0.030	0.044	0.026	0.042
Benzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Chloride	g/m³	6.0	19.8	7.6	11.4
Conductivity	mS/m@20°C	6.9	15.0	6.6	9.4
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
Total Hydrocarbon	g/m³	<0.7	<0.7	<0.7	<0.7
HC C7-C9	g/m³	<0.10	<0.10	0.10	<0.10
HC C10-C14	g/m³	<0.2	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4	<0.4
Static water level	m	1.872	2.577	1.831	1.817
Sodium	g/m³	5.8	7.6	5.1	6.9
Nitrite/Nitrate nitrogen	g/m³ N	0.09	0.01	0.21	1.83
pH	pH	5.7	6.0	5.7	5.5
Total dissolved salts	g/m³	53.4	116.1	51.1	72.7
Temperature	°C	14.0	14.8	14.9	12.4
Toluene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m³	<0.002	<0.002	<0.002	<0.002
ortha-Xylene	g/m³	<0.0010	<0.0010	<0.0010	<0.0010

The Council undertook groundwater sampling across the operational monitoring well network at the Surrey Road stockpiling facility on four separate occasions throughout the monitoring year. On one occasion the upgradient monitoring well (GND2165) was not sampled due to insufficient water in the well (January 2015).

The results returned one significant reading in this period. The level of nitrate increased dramatically in monitoring well GND2165, whereby it peaked at 9.30 g/m^3 N in March 2015 before falling to 4.77 g/m^3 N. Analysis of samples collected in the following monitoring year suggests that this concentration has returned to baseline levels when taking into account the overall record.

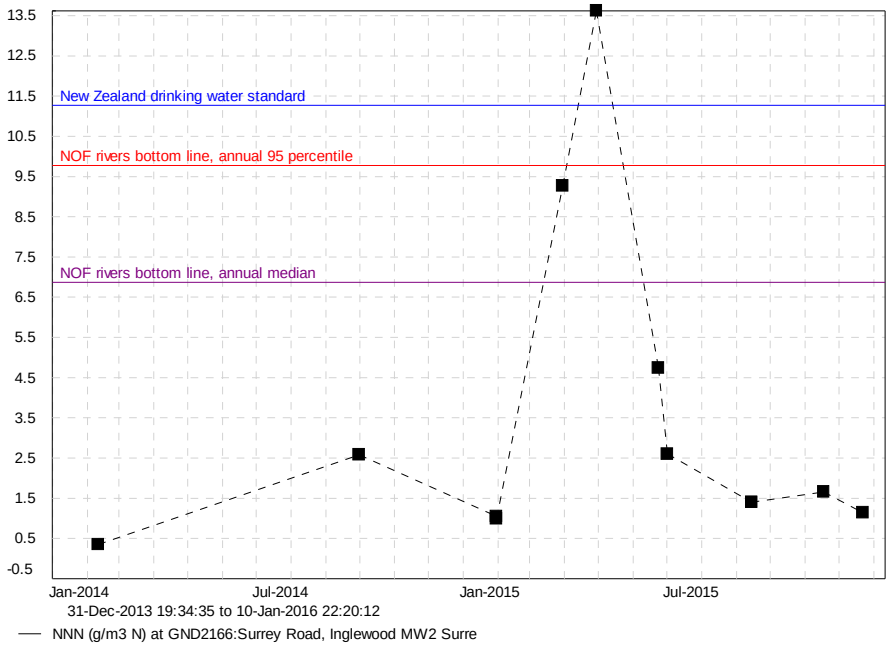

Figure 5 Nitrite/ nitrate nitrogen in groundwater GND2166

Discussion with the site manager suggested that this peak in nitrate (Figure 5) could be a result of fertiliser application of urea in the vicinity of the monitoring well (Figure 4). The farm manager had been contacted and the source was confirmed. Neither of the other two monitoring wells picked up this peak, as such it is most likely the result of a localised application of urea fertiliser, as have been seen on other landfarming facilities.

Council surface water results

An unnamed tributary of the Managtenghu Stream runs along the southern boundary of the Surrey Road facility. On three occasions samples were collected upstream (MTH000060), midstream (MTH000062) and downstream (MTH000064) of the site (Figure 4). The results of the surface water sampling are detailed in the following tables.

Table 15 Surface water analysis obtained from the unnamed tributary of the Managtengehu Stream on the 28 January 2015

		MTH000060 Upstream	MTH000062 Midstream	MTH000064 Downstream
		28 Jan 2015	28 Jan 2015	28 Jan 2015
Barium Acid Soluble	g/m^3	0.012	0.014	0.020
Benzene	g/m^3	<0.0010	<0.0010	<0.0010

		MTH000060 Upstream	MTH000062 Midstream	MTH000064 Downstream
		28 Jan 2015	28 Jan 2015	28 Jan 2015
Bio-chemical Oxygen Demand	g/m³	-	0.9	1.3
Chloride	g/m³	5.6	5.7	8.8
Conductivity	mS/m@20°C	8.8	9.0	10.3
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
Total Hydrocarbon	g/m³	<0.7	<0.7	<0.7
HC C7-C9	g/m³	<0.10	<0.10	<0.10
HC C10-C14	g/m³	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4
pH	pH	7.3	7.4	7.3
Suspended Solids	g/m³	2	<2	3
Total Dissolved Salts	g/m³	68.1	69.6	79.7
Temperature	°C	16.2	15.9	15.6
Toluene	g/m³	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m³	<0.002	<0.002	<0.002
ortha-Xylene	g/m³	<0.0010	<0.0010	<0.0010

Table 16 Surface water analysis obtained from the unnamed tributary of the Managtengehu Stream on the 18 February 2015

		MTH000060 Upstream	MTH000062 Midstream	MTH000064 Downstream
		18 Feb 2015	18 Feb 2015	18 Feb 2015
Barium Acid Soluble	g/m³	0.016	0.015	0.018
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Bio-chemical Oxygen Demand	g/m³	-	<0.5	<0.5
Chloride	g/m³	5.8	5.9	8.9
Conductivity	mS/m@20°C	9.0	9.0	10.4
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
Total Hydrocarbon	g/m³	<0.7	<0.7	<0.7
HC C7-C9	g/m³	<0.10	<0.10	<0.10
HC C10-C14	g/m³	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4
pH	pH	7.4	7.3	7.2
Suspended Solids	g/m³	4	7	3
Total Dissolved Salts	g/m³	69.6	69.6	80.5

		MTH000060 Upstream	MTH000062 Midstream	MTH000064 Downstream
		18 Feb 2015	18 Feb 2015	18 Feb 2015
Temperature	°C	15.2	14.1	13.8
Toluene	g/m³	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m³	<0.002	<0.002	<0.002
ortha-Xylene	g/m³	<0.0010	<0.0010	<0.0010

Table 17 Surface water analysis obtained from the unnamed tributary of the Managtengehu Stream on the 10 April 2015

		MTH000060 Upstream	MTH000062 Midstream	MTH000064 Downstream
		10 Apr 2015	10 Apr 2015	10 Apr 2015
Barium Acid Soluble	g/m³	0.020	0.020	0.040
Benzene	g/m³	<0.0010	<0.0010	<0.0010
Bio-chemical Oxygen Demand	g/m³		0.8	0.7
Chloride	g/m³	5.6	5.5	5.9
Conductivity	mS/m@20°C	3.7	3.7	4.1
Ethylbenzene	g/m³	<0.0010	<0.0010	<0.0010
Total Hydrocarbon	g/m³	<0.7	<0.7	<0.7
HC C7-C9	g/m³	0.10	<0.10	<0.10
HC C10-C14	g/m³	<0.2	<0.2	<0.2
HC C15-C36	g/m³	<0.4	<0.4	<0.4
pH	pH	6.6	6.6	6.6
Suspended Solids	g/m³	15	16	26
Total Dissolved Salts	g/m³	28.6	28.6	31.7
Temperature	°C	14.3	14.3	14.8
Toluene	g/m³	<0.0010	<0.0010	<0.0010
meta-Xylene	g/m³	<0.002	<0.002	<0.002
ortha-Xylene	g/m³	<0.0010	<0.0010	<0.0010

The results indicated that at the time of sample collection and subsequent analysis there were no significant variations across the sample sites. The analysis indicated that the site, at the time of sample collection, had minimal impact on the unnamed tributary of the Mangatenghu Stream. Of note there is a slight elevation in terms of salt concentration, detailed by the TDS, chloride and conductivity; however it is minimal and typical of regional values.

Council biomonitoring results

The Councils undertook two biomonitoring surveys of the unnamed tributary of the Managatenghu Stream throughout the monitoring year. These were performed in October 2014 and March 2015. The aim of the surveys is to assess the macroinvertebrate communities in terms of species composition and number to ascertain if the exercise of the consent is adversely effecting the biological life in the waterways.

Method

This scheduled biomonitoring survey was undertaken at four sites on 16 October 2014 (Table 18 and Figure 6). At the time of the initial survey undertaken in April 2010, site 1 was established as a 'control site', upstream of the drilling stockpile area and sites 2 and 3 were established downstream of the skimmer pit discharge. During an inspection of the site in mid-2010, an unauthorised discharge of hydrocarbons was observed entering the stream. As a consequence of this inspection, changes were made to the on site drainage. These changes were made between the April 2010 and November 2010 surveys. The result was that site 2 was located upstream of any discharge from the sites, and site 3 became the primary impact site. The stormwater discharge from the site now enters the unnamed tributary immediately upstream of the race crossing, approximately 35 metres upstream of site 3. A new, secondary impact site (site 4) was established 100 metres downstream of the stormwater discharge during the May 2012 survey.

The Council's standard '400ml kick-sampling' technique was used at sites 2, 3 and 4 and the 'vegetation sweep' sampling technique was used at site 1 (Table 18). 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).

Table 18 Biomonitoring sites at the unnamed tributary of the Managatengehu Stream in relation to the Surrey Road facility

Site Number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MTH000060	E1701830 N5651430	Upstream of drilling waste stockpiling site	495
2	MTH000062	E1701954 N5651468	Approximately 85 metres upstream of the spring and skimmer pit discharge	495
3	MTH000064	E1702050 N5651525	Approximately 35 metres downstream of the skimmer pit discharge	490
4	MTH000066	E1702102 N5651582	Approximately 100 metres downstream, of the skimmer pit discharge	485

Background

Surveys undertaken in December 2013 (Thomas, 2014a) and February 2014 (Thomas, 2014b) indicated that activities at the drilling waste stockpiling site and landfarming area had resulted in significant impacts on the macroinvertebrate communities through the lower section of the Mangatengehu Stream surveyed. As a result of the suspected impacts an additional survey was completed in winter on the 26 August 2014. Its results suggested that the activities at the drilling waste stockpiling site and landfarming area may have impacted on the macroinvertebrate communities through the lower section of the reach surveyed, although it is likely that such impacts have been compounded by habitat variability (Thomas, 2014c).

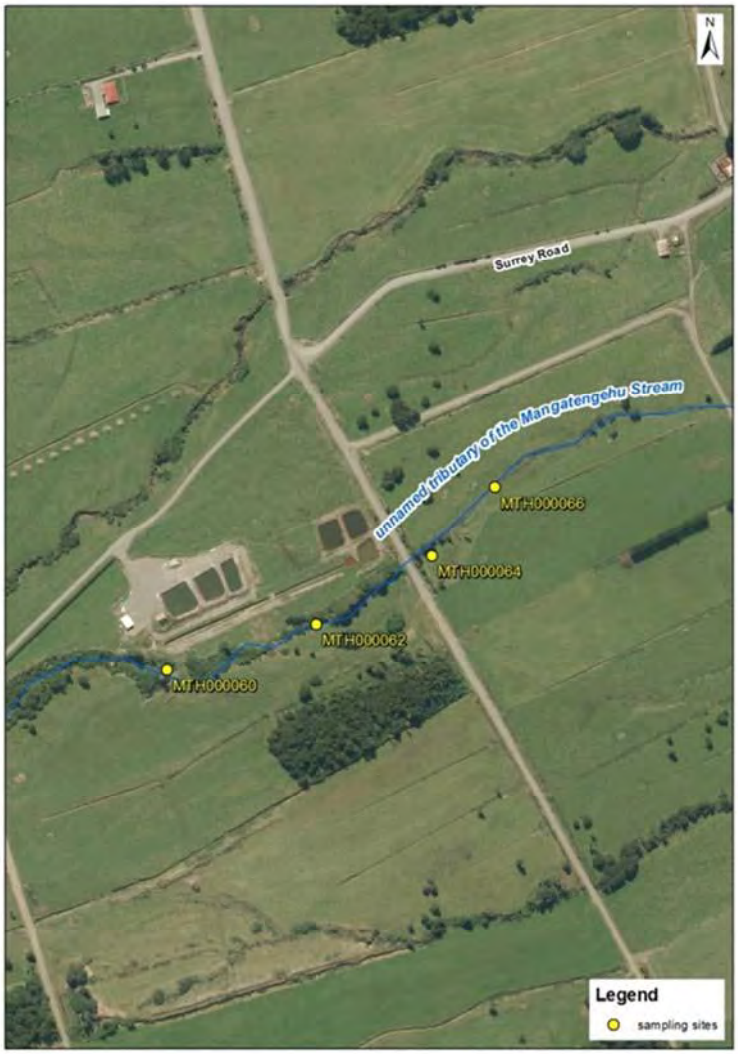

Figure 6 Biomonitoring sites at the unnamed tributary of the Managatengehu Stream in relation to the Surrey Road facility

Summary of biomonitoring results October 2014

- A macroinvertebrate survey was performed at four sites in an unnamed tributary of the Mangatengehu Stream in relation to the stockpiling and discharge of drilling waste to land at the Surrey Road landfarm.

- There were some significant differences in the macroinvertebrate indices examined between the 'control' and 'impacted' sites at the time of the survey with the 'control' sites having higher macroinvertebrate indices than the 'impacted' sites.

- The two 'control' sites showed improvements in their taxa richnesses and MCI scores since the last survey in August 2014 whereas the two 'impacted' sites had decreases. However, the differences were not significant except for site 3 which showed a significant decrease in MCI score.

- There was substantial habitat variation (riparian cover, substrate type etc) among sites which makes discrimination between any impacts from landfarming activities and habitat effects difficult.

- There was some evidence from the macroinvertebrate indices examined that stockpiling and discharge of drilling waste to land had some effects on the health of the macroinvertebrate communities but habitat variation makes any conclusions about the extent or existence of impacts tenuous.

Summary of biomonitoring results March 2015

- A macroinvertebrate survey was performed at four sites in an unnamed tributary of the Mangatengehu Stream in relation to the stockpiling and discharge of drilling waste to land at the Surrey Road landfarm.

- There were mostly insignificant differences in the macroinvertebrate indices examined between the 'control' and 'impacted' sites at the time of the survey.

- The two 'impacted' sites showed improvements in their taxa richnesses and MCI scores since the last survey whereas there was little change in these indices at the two 'control' sites.

- There was no evidence for landfarming activities having had significant impact on the macroinvertebrate communities in the unnamed tributary of the Mangatengehu Stream.

2.4 Landspreading activities

Surrey Road Landfarms Limited holds discharge permit 7591-1, to discharge waste from hydrocarbon exploration activities onto and into land via landspreading. This permit was issued by the Council on 21 January 2010 under Section 87 (e) of the RMA. It is due to expire on the 1 June 2027.

This consent encompasses the paddocks which are utilised by the consent holder to discharge drilling material to land, note that it allows for landspreading which stipulates that the consent holder may spread material to paddocks in the form of liquid fraction of drilling material. The Surrey Road stockpiling facility also utilises the same areas however, their specific consent 7559-1 deals with landfarming.

Of note, no piece of land may be reused for the practice of landspreading or landfarming without meeting specific conditions required by the Consents, a description of either process is provided earlier in the report, Section 1.2.

2.4.1 Inspections

22 July 2014

No recent spreading or land-farming activities had occurred. The muds recently spread in paddock 18 were inspected. The muds were identifiable throughout the area and no pasture had been sown. The area was too wet for machinery to access the site during the inspection. The injection spreader trial areas were inspected. Lines were still visible in the pasture where the mud was thickly applied, material within the incisions

wasweathering and broke apart easily throughout all areas where muds were identified. Historic application areas had good pasture cover which appeared healthy.

05 November 2014
Areas where muds have been applied were inspected and found to be mostly in good condition. The pasture appeared healthy and muds difficult to identify within the soil profile. The area on the mountain side of Derby Road storage, where muds were originally applied, was still bare of pasture and the muds at the surface had in places formed a pan dispersed across approximately 80 x 40 metres.

Paddock 34 where the spreader trial occurred had applied muds too thickly, with linear mud patches visible at the surface in places. Other areas where the spreader was trialled were found to have good pasture cover and no visible lines. Transects across the areas found that the mud was remaining near the surface in defined lines, although roots were observed to be growing through the material. The area adjacent to the quarry, where the Derby Road muds were recently spread, has had no further works undertaken to incorporate or blend the material which is still in clumps at the surface.

It was noted that the following action was to be undertaken: The area on the mountain side of Derby Road storage site had to be ripped and re-sown to establish pasture. The patches of mud in paddock 34 also needed to be incorporated into the soil. The area adjacent to the quarry was to have further works undertaken to incorporate and blend the muds and establish pasture as soon as practicable.

14 November 2014
A council officer spoke with the consent holder and outlined three areas identified, which needed to have further works undertaken to incorporate muds into the soil profile and establish pasture cover.

06 January 2015
Muds had been incorporated into the soil, however further works were required around the spreading area to fully incorporate the muds into the soil profile. Machinery was present on-site but no activity was occurring. The historic area where muds were applied too thickly on the mountain side of the Derby Road storage site was being rolled during the inspection. Works had been undertaken to rip the material into the soil, the area looked good, pasture was yet to be sown.

13 January 2015
An inspection was conducted in conjunction with soil sampling in paddocks 18, 34, and 142. The site manager was onsite at Surrey Road following completion of recent earthwork. Soil cores were dry with minor drilling mud encountered in paddocks 18 and 142. Pasture establishment looked good. Paddock 142 was the most recently spread. Some fencing was still to be installed. Council officer met with the consent holder, he had requested that prior to sampling, officers were to call into his Inglewood Loader Parts office and give notice before visiting the site.

05 March 2015
The most recent spreading area which received residual muds from Derby Road had been worked over and rock raked. No pasture has as yet been sown due to weather conditions.

23 June 2015
Composite soil sample transects were collected from paddocks 34, 18 and 142. 12 cores were collected per transect, each sampled to an approximate depth of 250 mm. Some drilling muds evident on the surface in paddocks 18 and 142, but material had weathered and no odour was noticeable. Soil was described as dark brown, moist clays and small gravels. Mature pasture had established in all paddocks, however there were noticeable lines where spreading had occurred.

2.4.2 Results of the discharge monitoring

Applications of material to land within this monitoring period were limited to two locations; paddocks 21 and 34 were utilised to farm material originating from STOS's operations at the KA-20 wellsite, Figure 4.

Table 19 Quantities of material landfarmed/ landspread 2014-15 monitoring period

Paddock	Mud type	Well name	Application date	Solid m^3	Liquid m^3	Easting	Northing	Area/ Ha
21	SBM/WBM	KA-20	31/07/2014	220	110	1701740.825	5651675.584	2.74
34	SBM/WBM	KA-20	01/08/2014	175	-	1701432.5514	5651561.478	3.10

Note: The Surrey Road stockpiling facility received material from OMV's offshore operations (1,399 m^3) within this monitoring period; however this material would not be landfarmed until the following monitoring period 2015-16.

2.4.2.1 Council soil results

Six composite soil samples were collected from three specific application areas (P 18, 24 and 142) during the 2014-15 monitoring year (Figure 6). The rationale for re-sampling of each paddock within a year was to ascertain the bio-remediation rates.

Table 20 Council compliance soil results collected from specific application areas throughout the monitoring year

Parameter	Unit	Consent Conditions	P 34	P 34	P 142	P 142	P 18	P18
			13 Jan 2015	23 Jun 2015	13 Jan 2015	23 Jun 2015	13 Jan 2015	23 Jun 2015
Calcium	mg/kg		22.0	21.0	49.6	23.2	35.4	34.1
Chloride	mg/kg	700	46.0	25.3	16.0	37.7	25.3	31.8
Conductivity	mS/m@20°C	290	45.1	25.3	42.6	29	42.2	43.2
Total Hydrocarbon	mg/kg	20,000	54	50	1,089	216	236	205
Potassium	mg/kg		26.0	11.1	18.8	15.7	30.6	22.2
Moisture factor	nil		1.475	1.749	1.473	1.636	1.593	1.734
Magnesium	mg/kg		2.0	1.2	3.5	1.7	2.7	2.3
Sodium	mg/kg	460	35.1	26.6	17.1	12.2	18.2	18.2
Ammoniacal Nitrogen	mgN/kg		16.93	8.52	6.00	5.27	13.61	17.49
Nitrate/Nitrite Nitrogen	mgN/kg		2.27	2.22	0.16	1.39	0.05	3.52
pH	pH		6.0	6.4	6.1	6.5	5.9	6.4
Sodium Absorption Ratio	None	8	1.92184	1.52817	0.63286	0.65887	0.79396	0.81423
Total soluble	mg/kg	2,500	353.0	198.0	333.4	227	330.3	338.1

Parameter	Unit	Consent Conditions	P 34	P 34	P 142	P 142	P 18	P18
			13 Jan 2015	23 Jun 2015	13 Jan 2015	23 Jun 2015	13 Jan 2015	23 Jun 2015
salts								

The analysis of soils within this period did not result in any exceedance of parameters set in the consent conditions[1]. Of note the reduction in concentration of total hydrocarbon can be seen across all the paddocks sampled within this period (Table 21, 22 and 23). Locations of the paddocks are detailed in the below Figure 7, this figure also contains historical information in terms of application to land dates.

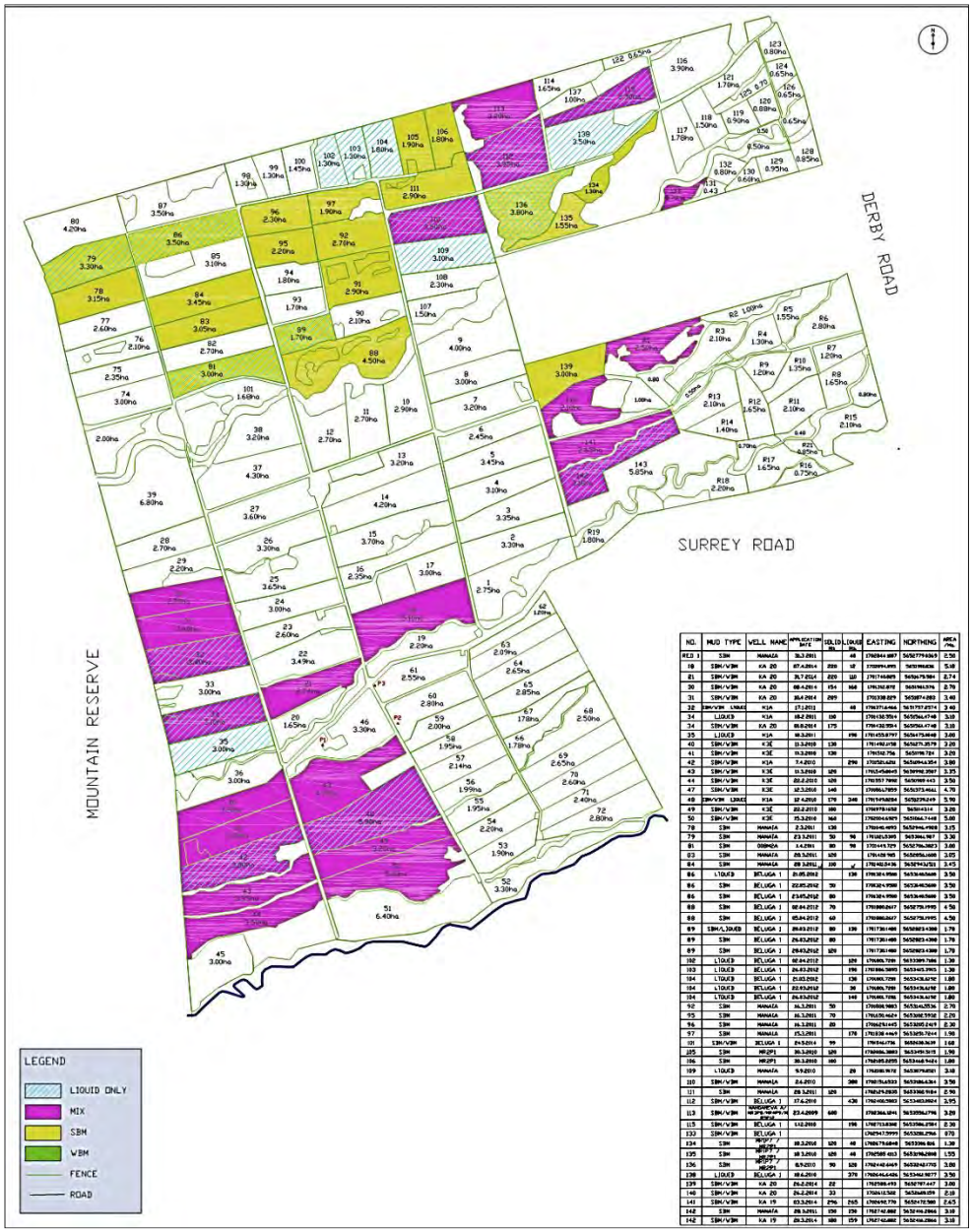

Figure 7 Paddock locations and application dates[2]

[1] Consent 7591-1.1 Condition 11
[2] A larger copy of this map is included in the consent holder supplied monitoring report- Appendix III

2.4.2.2 Mi Swaco post spread soil analysis

During the monitoring period Mi Swaco undertook the collection and analysis of six soil samples from specific paddocks which had been utilised for the application of drilling material to land. Of note these sampled paddocks were originally tested in the 2013-14 monitoring year. The soils were analysed by a IANZ accredited laboratory.

Table 21 Mi Swaco supplied postspread soil analysis 2014-2015

	Sample Name:	Paddock 18	Paddock 18	Paddock 30	Paddock 30	Paddock 31	Paddock 31
		30-Jun-14	02-Jul-15	30-Jun-14	02-Jul-15	30-Jun-14	02-Jul-15
Dry Matter	g/100g as rcvd	63	50	61	57	59	57
Density	g/mL at 20°C	0.72	0.75	0.81	0.66	0.8	0.78
Total Recoverable Barium	mg/kg dry wt	1,930	2,600	2,000	930	3,000	3,200
Total Recoverable Sodium	mg/kg dry wt	740	530	640	670	500	490
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg							
Total Recoverable Arsenic	mg/kg dry wt	< 2	2	< 2	2	< 2	3
Total Recoverable Cadmium	mg/kg dry wt	0.16	0.29	0.17	0.49	0.16	0.31
Total Recoverable Chromium	mg/kg dry wt	7	8	7	9	7	9
Total Recoverable Copper	mg/kg dry wt	50	40	40	32	41	37
Total Recoverable Lead	mg/kg dry wt	3.4	5.4	6.8	9.7	6.1	5.8
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Nickel	mg/kg dry wt	2	3	2	4	3	5
Total Recoverable Zinc	mg/kg dry wt	34	35	30	37	29	34
BTEX in Soil by Headspace GC-MS							
Benzene	mg/kg dry wt	< 0.13	< 0.11	< 0.13	< 0.09	< 0.14	< 0.09
Toluene	mg/kg dry wt	< 0.13	< 0.11	< 0.13	< 0.09	< 0.14	< 0.09
Ethylbenzene	mg/kg dry wt	< 0.13	< 0.11	< 0.13	< 0.09	< 0.14	< 0.09
m&p-Xylene	mg/kg dry wt	< 0.3	< 0.3	< 0.3	< 0.17	< 0.3	< 0.17
o-Xylene	mg/kg dry wt	< 0.13	< 0.11	< 0.13	< 0.09	< 0.14	< 0.09
Polycyclic Aromatic Hydrocarbons Screening in Soil							
Acenaphthene	mg/kg dry wt	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04
Acenaphthylene	mg/kg dry wt	< 0.04	0.06	< 0.04	< 0.04	< 0.04	< 0.04
Anthracene	mg/kg dry wt	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04
Benzo[a]anthracene	mg/kg dry wt	< 0.04	0.07	< 0.04	< 0.04	0.04	< 0.04
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.04	0.08	< 0.04	< 0.04	< 0.04	< 0.04
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	0.04	0.18	0.04	0.04	0.06	< 0.04
Benzo[g,h,i]perylene	mg/kg dry wt	0.07	0.24	0.08	< 0.04	0.12	< 0.04
Benzo[k]fluoranthene	mg/kg dry wt	< 0.04	0.07	< 0.04	< 0.04	< 0.04	< 0.04
Chrysene	mg/kg dry wt	0.05	0.11	0.06	< 0.04	0.08	< 0.04

	Sample Name:	Paddock 18	Paddock 18	Paddock 30	Paddock 30	Paddock 31	Paddock 31
		30-Jun-14	02-Jul-15	30-Jun-14	02-Jul-15	30-Jun-14	02-Jul-15
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04
Fluoranthene	mg/kg dry wt	0.08	0.11	0.09	< 0.04	0.13	< 0.04
Fluorene	mg/kg dry wt	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.04	0.1	< 0.04	< 0.04	< 0.04	< 0.04
Naphthalene	mg/kg dry wt	< 0.18	< 0.3	< 0.19	< 0.19	< 0.18	< 0.19
Phenanthrene	mg/kg dry wt	0.04	0.07	0.07	< 0.04	0.07	< 0.04
Pyrene	mg/kg dry wt	0.16	0.11	0.18	< 0.04	0.25	< 0.04
Total Petroleum Hydrocarbons							
C7 - C9	mg/kg dry wt	< 11	< 13	< 11	< 12	< 11	< 12
C10 - C14	mg/kg dry wt	30	< 30	64	< 30	142	< 30
C15 - C36	mg/kg dry wt	1,290	500	1,750	134	2,200	133
Total hydrocarbons (C7 - C36)	mg/kg dry wt	1,320	500	1,820	134	2,400	133

Table 22 Mi Swaco supplied post spread soil analysis 2014-2015

	Sample Name:	Paddock 34	Paddock 141	Paddock 142 (Prior 141) 02-Jul-2014	Paddock 142	Paddock 143 (Prior 142) 02-Jul-2014
		02-Jul-15	30-Jun-14	02-Jul-15	30-Jun-14	02-Jul-15
Dry Matter	g/100g as rcvd	52	60	68	61	61
Density	g/mL at 20°C	0.77	0.8	1.08	0.88	0.87
Total Recoverable Barium	mg/kg dry wt	4,600	4,600	4,700	3,500	2,100
Total Recoverable Sodium	mg/kg dry wt	590	620	580	560	500
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	< 2	2	2	2	3
Total Recoverable Cadmium	mg/kg dry wt	0.32	0.21	0.12	0.17	0.37
Total Recoverable Chromium	mg/kg dry wt	9	10	7	7	8
Total Recoverable Copper	mg/kg dry wt	38	33	37	44	40
Total Recoverable Lead	mg/kg dry wt	9	9.8	8.9	6.5	6.6
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Nickel	mg/kg dry wt	3	7	4	3	3
Total Recoverable Zinc	mg/kg dry wt	40	40	39	34	29
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.10	< 0.13	< 0.07	< 0.13	< 0.08
Toluene	mg/kg dry wt	< 0.10	< 0.13	< 0.07	< 0.13	< 0.08
Ethylbenzene	mg/kg dry wt	< 0.10	< 0.13	< 0.07	< 0.13	< 0.08

	Sample Name:	Paddock 34	Paddock 141	Paddock 142 (Prior 141) 02-Jul-2014	Paddock 142	Paddock 143 (Prior 142) 02-Jul-2014
		02-Jul-15	30-Jun-14	02-Jul-15	30-Jun-14	02-Jul-15
m&p-Xylene	mg/kg dry wt	< 0.2	< 0.3	< 0.13	< 0.3	< 0.16
o-Xylene	mg/kg dry wt	< 0.10	< 0.13	< 0.07	< 0.13	< 0.08
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04
Acenaphthylene	mg/kg dry wt	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04
Anthracene	mg/kg dry wt	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04
Benzo[a]anthracene	mg/kg dry wt	< 0.05	0.05	0.03	0.05	< 0.04
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.05	< 0.04	0.04	< 0.04	< 0.04
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	0.05	0.07	0.08	0.09	0.06
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.05	0.14	0.13	0.19	0.08
Benzo[k]fluoranthene	mg/kg dry wt	< 0.05	< 0.04	0.04	< 0.04	< 0.04
Chrysene	mg/kg dry wt	< 0.05	0.11	0.07	0.11	0.05
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04
Fluoranthene	mg/kg dry wt	< 0.05	0.17	0.06	0.18	0.04
Fluorene	mg/kg dry wt	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.05	< 0.04	0.03	0.04	< 0.04
Naphthalene	mg/kg dry wt	< 0.3	< 0.18	< 0.16	< 0.18	< 0.18
Phenanthrene	mg/kg dry wt	< 0.05	0.16	< 0.04	0.1	< 0.04
Pyrene	mg/kg dry wt	< 0.05	0.32	0.06	0.37	0.07
Total Petroleum Hydrocarbons						
C7 - C9	mg/kg dry wt	< 13	< 11	< 10	< 11	< 11
C10 - C14	mg/kg dry wt	< 30	690	32	83	< 30
C15 - C36	mg/kg dry wt	122	10,800	1,770	2,300	380
Total hydrocarbons (C7 - C36)	mg/kg dry wt	122	11,500	1,800	2,400	380

The tabulated results from Table 21 and 22 provide an extensive list of chemical parameters. Of note is the remediation of hydrocarbons species throughout the year. This also mirrors the analysis which was undertaken by the Council, one of a reduction to almost 10%of the initial concentrations. Heavy metal screen detailed low concentrations of the target metals. While at the time of analysis, sodium concentrations remained above their re-application or surrenderedable concentration of 460 mg/kg.

3. Investigations, interventions, and incidents

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

The Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The Incident Register (IR) includes events where the consent holder 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 2014-15 period, the Council was required to record one incident associated the consent holders conditions.

Incident IN/30942
During routine compliance/biological monitoring it was found that the abundance of biological life within an unnamed tributary of the Mangatengehu Stream had reduced at two sites downstream of a drilling mud storage area at Surrey Road, Tariki.

Bio-monitoring samples undertaken during December 2013 and reported during August 2014 had shown that there had been a decline in sensitive taxa at two sites immediately downstream of a drilling mud storage site. Further bio-monitoring and physiochemical sampling was undertaken during August 2014. The results found that the in-stream communities remained stable and the discharges from the site were compliant and had no adverse effect on the receiving waters.

The management of stormwater at the site had been adapted to focus on the irrigation of storm water onto pasture in accordance with best practicable option, to prevent ongoing and minor cumulative pressures on the in-stream communities.

As such with the follow up bio-monitoring samples undertaken in March 2015, it was found that the once impacted communities of the lower two sample sites had made a recovery.

4. Discussion

4.1 Discussion of site performance

The initial discussion will focus on each individual facility:

- Derby Road stockpiling Facility;
- Surrey Road stockpiling Facility; and
- Landfarming operations

4.1.1 Derby Road Stockpiling Facility

The Derby Road facility remained closed during this monitoring period. The site did not receive any deliveries of landfarmable material. The consent holder began to consolidate the remaining residual drilling muds into one cell, whereby he intends to landfarm this material in the 2015-16 monitoring year. The volume of material is estimated to be in the region of 100m^3. The consent holder must be mindful of the consent conditions which stipulate that material brought to the facility must be applied to land with the specified time frame.

Once this material has been landfarmed and the cells cleaned out as far as practicable (the Council's investigating officer will be informed when the clean out has occurred to confirm) the consent holder will seek to relinquish the consent through the application for surrender which will be assessed at the time of lodgment.

The consent holder had been pro-active in the consolidation of material. This was partly due to the need to utilise the cells for the storage of water treatment sludge and due to the fact the site is no longer required as the Surrey Road facility is now the primary stockpiling facility.

4.1.2 Surrey Road Stockpiling Facility

As in the previous monitoring period, the Surrey Road facility was the primary site in terms of stockpiling land farmable material in its purpose built, fit for purpose, lined storage cells. This monitoring period lead to three significant improvement measures in terms of the site performance. These were as follows:

- Irrigation of stormwater to paddocks;
- The installation of the a fit for purpose liner in cell 3; and
- The use of an irrigator to spread stormwater.

As previously discussed in Section 3, an incident occurred on the cusp of the monitoring period whereby the species diversity and abundance had suffered as a result of stormwater discharges from the Surrey Road facility into the unnamed tributary of the Managamwhete Stream. Analysis provided by the proponent in Table 9 detailed a high chemical oxygen deficit which could have had the potential to impact the macroinvertebrate species in the unnamed tributary.

The route forward was to irrigate the stormwater directly from the storage cells onto a specific paddock, thus treating the paddock as a spread area. This was initially undertaken through the use of a tanker, however this was modified on request of the

site management late on in the monitoring period. The modification was to fit and utilise an irrigator to spread the liquid stormwater from the cells.

Originally the Surrey Road stockpiling facility contained two fit for purpose lined storage cells, the third cell which was clay lined was outlined by the Council to be fitted with a similar fit for purpose liner. This was undertaken in this period and this marked the last dedicated unlined drilling mud storage cell in Taranaki. Now all active stockpiling facilities are fitted with the requisite liner in line with best practicable option.

Although 2014-15 marked a slower year when compared to previous years, the site operator was prepared to undertake significant investment in the site by adding the three improvement measures to improve the site's performance. The installation of a cut off drain to remove the possibility of spring generated water from flowing beneath the storage cells was also a site improvement.

The site operator was requested to undertake additional sample analysis in terms of metal and speciation of hydrocarbons, both in the pre landfarming analysis of the cell contents and the soil, post application of the material. The additional pre-spread cells analysis has been undertaken for the recent deliveries of material, however it is not provided in this report as this material has not be applied to land in this monitoring period.

The consent holder has shown commitment to implementing the best practicable option this monitoring period. The proceeding monitoring year (2015-16) will mark the application to land of more material than was sequestered in this period.

4.1.3 Landspreading activities

In comparison to previous monitoring years, 2014-15 was quiet in terms of material sequestered to land. As detailed in Table 20, two applications were undertaken in this monitoring period.

The consent holder in some cases, utilised the method of an injection spreader to apply material to land. While the initial inclusion of the drilling muds resulted in injected lines of clay, subsequent follow up by Council inspectorate staff detailed that the clays once weathered, broke down easily and were found to have grass rootlets growing through them. The clays will aid with water holding capacity during the drier months of the year. However, the consent holder should be mindful of the application rates and not to apply lines too thickly.

At certain times the consent holder had been prompted to undertake extra inclusion works to certain areas and the Council has encouraged the consent holder to not leave orphan piles of mud for a period of time. Some areas had been left for a period of up to two months and this is not inline with the consent conditions.

Paddocks which had been utilised for the application of material to land require to be listed and recorded. Additional encouragement was required in this period in prompting the site management to keep on top of their record keeping.

Conversely however, pasture strike has been successful moving forward, the degree of bio remediation stipulated in Sections 2.3.2.1 and 2.3.2.2 state that the process of landfarming is effective when conducted in the correct manner. As discussed in last year's report, the evolution of landfarming is occurring with this consent holder by different application methods of landfarming, landspreading, injection spreading and irrigation.

While this monitoring period has included less activity in comparison to previous years, the advent of two large drilling campaigns at the end of this current period (OMV's Maari Field and TODD's Tere Kiri North) will dictate how the process will evolve moving forward.

4.2 Environmental effects of exercise of consents

The Council undertakes significant chemical compliance sampling across the mediums of water (surface water, groundwater and discharge) and soils (receiving environment) as well as biological monitoring of the invertebrate communities of both tributaries of the Managmawhete and the Mangatenghu streams. In addition, the Council's investigating officers conduct frequent inspections of the sites throughout the year.

The rationale is centred on ascertaining the quality of the consent holders practice and to monitor for any potential environmental effects which may have been caused by the exercise of the resource consent.

The **Derby Road** facility is now closed as a drilling waste stockpile facility. The consent holder is in the process of consolidating the remaining residual drilling muds into one cell prior to finally farming this material. The site is also being utilised for the storage of water treatment sludge which will be spread across consented paddocks along with the residual muds.

Throughout the year the council undertook monitoring of the operational groundwater monitoring bore network, whereby the three wells were monitored four times. The rationale was to ascertain seasonal variation. To date no adverse effects have been observed in any of the three wells.

Surface water analysis as well as discharge sampling was also undertaken. The site at Derby Road holds a discharge permit which allows the facility to discharge storm water at a consented rate. In this period, neither the discharge sampling nor the surface water results retuned any analysis which would detail an adverse effect.

This was similarly echoed by the bio-monitoring reports conducted for the same period, whereby it stated the following:

> 'There was no indication from any of the macroinvertebrate indices examined that stockpiling and discharge of drilling waste to land has had any significant effect on the health of the macroinvertebrate communities present in the unnamed tributary of the Mangamawhete Stream.'

The **Surrey Road** facility is now the primary site for stockpiling drilling muds prior to sequestration to land for this consent holder. Like the Derby Road facility; it contains an operation groundwater monitoring bore network. However, conversely to the Derby

road facility, it does not contain a stormwater discharge permit, therefore the activities of this site must comply with RFWP Rule 23.

At the end of the last monitoring period it was ascertained that at certain periods of intense precipitation the storm water discharge had the potential to adversely affect the instream communities of macroinvertebrates. This was observed by the biannual biomonitoring, whereby the in stream communities had suffered a decrease in population. Further details of this were previously described in Section 3.

As already discussed in the previous section, the site was deemed a non discharge facility, this occurred in September 2014, whereby storm water which would fall into the storage cells would be irrigated to a certain paddock and therefore the paddock would then be treated as a spread area.

The initial bio-monitoring undertaken in October 2014 found a decline in species, although by the time of the follow up bio-monitoring survey was conducted in March of 2015, the species had begun to recover which led our biologist to state the following:

> 'the two 'impacted' sites showed improvements in their taxa richnesses and MCI scores since the last survey whereas there was little change in these indices at the two 'control' sites. There was no evidence for landfarming activities having had significant impact on the macroinvertebrate communities in the unnamed tributary of the Mangatengehu Stream.'

While there had been a measured adverse effect, it was not catastrophic and with careful site management of the storm water by the consent holder, the populations have continued to improve.

The operational groundwater network did observe a peak of nitrate in April 2015. This peak was due to the localised application of urea fertiliser and the consent holder has been asked to be mindful with the application as it was not linked to the facility. Apart from the nitrate spike the network did not return any additional observations of concern.

The analysis of the surface water sampling conducted by the Council did not return any analysis of concern, while the Company provided storm water results did return a slightly high reading of chemical oxygen deficit (September 2014), however this was prior to the facility becoming a non discharge facility. Moving forward this issue should be resolved.

The **Landspreading** activities did not return any results of concern in this period. There were no adverse effects due to the applications of drilling muds to land. The bio remediation rates as already stipulated, are apparent and the system is working.

Moving forward the consent holder will be mindful to the application rates and buffer distances considering the upcoming period which will include the landfarming from two different sources.

4.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Tables 24-27.

Table 23 Summary of performance for Consent 6900-2 Derby Road stockpiling facility

Purpose: ***To discharge drilling waste [consisting of drill9ing cuttings and drilling fluids from water based muds and synthetic based muds], onto and into land for the purpose of temporary stockpiling prior to disposal***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Adoption of the best practicable option	Inspection, sampling and liaison with consent holder	Mostly
2. Notify TRC 48 hours prior receiving waste onto site for stockpiling	No material received in relation to this consent	N/A
3. Records to be kept by consent holder and made available to the Council	Records received	Not applicable in this period
4. Consent holder to report to Council by 31 August each year on records specified in SC3	Report received	Yes
5. No discharge within 25 m of surface water or property boundaries	Inspection	Yes
6. Stockpiled material to be landspread under consent 7591-1 within 12 months of arrival on site	Inspection and consent holders records	No Residual material still in-situ. Stockpiles left in paddocks.
7. Total dissolved solids in any fresh water body not to exceed 2500 g/m^3	Sampling	Yes
8. No contamination of groundwater or surface water to exceed background concentrations	Sampling	Yes
9. Concentrations in soil to be met prior to expiry	Not applicable in this monitoring period	N/A
10. Consent may not be surrendered until compliance with SC9	Not applicable	N/A
11. Optional review provision re environmental effects	Not to be undertaken	N/A
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		**Good** **High**

The consent holder in relation to consent 6900-2 demonstrated a **Good** degree of environmental compliance and a **High** degree of administrative performance within this monitoring period. The mark down to a good in terms of administrative performance was due to the residual muds not being farmed out within 12 months and the material which was farmed out was left in stockpiles rather than landfarmed. There were no assessed adverse environmental effects throughout the year from this facility.

Table 24 Summary of performance for 7559-1 Surrey Road stockpiling facility

Purpose: ***To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into land via landfarming.***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Definitions of stockpiling and landfarming	N/A	N/A
2. Adoption of the best practicable option	Inspection	For the most part
3. Install groundwater monitoring wells prior to exercise of consent	Inspection	Yes
4. Approved management plan to be reviewed annually		N/A
5. Notify Council 48 hours prior to stockpiling wastes	Informed	Yes
6. Notify Council 48 hours prior to landfarming wastes	Informed	Yes
7. Limited to wastes generated in Taranaki	Including offshore region	Yes
8. Maximum stockpiling volume of 2,000 m^3 to be landfarmed/spread within nine months	Records	Yes
9. Maximum application thickness for wastes: a) 100 mm TPH < 5% b) 50 mm TPH > 5% c) no ponded liquids 1 hr after application	Sample	Yes
10. Landfarmed areas to be used once only	Re-spread areas actioned under separate consent	N/A
11. Incorporate wastes into the soil so that the surface 250mm contains less than 5% hydrocarbons	Sampling	Yes
12. Maximum chloride loading 800 kg/ha	Sampling	N/A
13. Maximum nitrogen loading 1,000 kg/5yrs	Sampling	N/A
14. Discharge area shall be resown to pasture/crop as soon as practicable	Inspection	Mostly
15. No discharge within 25 m of a water body (includes farm drains)	Not applicable. Waste landspread under consent 7591-1	N/A
16. Conductivity must be less than 400 mS/m. If background soil conductivity greater than 400 mS/m, then waste application shall not increase conductivity by more than 100 mS/m	Sampling	Yes
17. Concentration of metals in soil must	Sampling	Yes

Purpose: ***To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into land via landfarming.***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
comply with MfE/NZWWA guidelines		
18. Sodium absorption ratio [SAR] must be less than 18. If background soil SAR is greater than 18, then waste application shall not increase SAR by more than 1	Sampling	Yes
19. At time of expiry/cancellation/ surrender, soil hydrocarbon concentrations must comply with MfE guidelines	Not applicable in this period	N/A
20. Prior to expiry/cancellation/surrender, soil parameters shall not exceed: a) conductivity 290 mS/m b) dissolved salts 2,500 g/m^3 c) sodium 460 g/m^3 d) chloride 700 g/m^3	Sampling	Yes
21. Total dissolved solids in surface water or groundwater shall not exceed 2,500 g/m^3	Sampling	Yes
22. No contamination of groundwater or surface water to exceed background concentrations	Sampling	Yes, some fertiliser concentration, though not linked to the facility
23. Records to be kept by consent holder and made available to the Council	Provided	Yes
24. Consent holder to report to Council by 31 August each year on records specified in SC23	Provided	Yes, but late
25. Consent shall lapse on 31 Dec 2014 unless exercised		Exercised
26. Optional review provision re environmental effects	Undertaken just after the monitoring period of this report	Exercised
Overall assessment of environmental performance and compliance in respect of this consent		**Good**
Overall assessment of administrative performance in respect of this consent		**Good**

The consent 7559-1 was graded as **good** for environmental performance and a **good** for administrative performance. The reason for the down grading from High was due to the following issues: The storm water system had adversely affected the species in the stream. This was remedied throughout the monitoring year by best practicable option, however it was still an effect, hence environmental downgrade to Good. The annual report was late and the paddock listings were incorrect, as such the administration performance was downgraded.

Table 25 Summary of performance for Consent 7591-1 Landspreading

Purpose: ***To discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading.***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Adoption of the best practicable option	Inspection, sampling and liaison with consent holder	Mostly
2. Notify Council 48 hours prior to landspreading	Notifications received	Yes
3. Limited to wastes generated in Taranaki	Consent holders records	Yes
4. Discharge rate shall not exceed 100 m^3/ha/yr and no ponded liquids shall remain after 1 hr	Inspection and consent holders records	Yes
5. Maximum chloride loading 800 kg/ha	Not calculated during period under review	N/A
6. Maximum nitrogen loading 1,000 kg/5yrs	Consent holders records	Yes
7. Pasture cover to be maintained at all times	Inspections	Yes
8. No waste shall be applied within: a) 12 m of boundaries b) 12 m of named streams c) 6 m of other water courses	Inspection	Yes
9. Liquid wastes which may flow overland shall not be discharged within 25 m of boundaries or water courses	Inspection	Yes
10. Soil hydrocarbon concentrations must comply with MfE guidelines: a) prior to areas being reused for landspreading b) at the time of expiry/cancellation/surrender	Sampling	Yes
11. Concentration of metals in soil must comply with MfE/NZWWA guidelines	Sampling	Yes
12. Conductivity must be less than 400 mS/m. If background soil conductivity greater than 400 mS/m, then waste application shall not increase conductivity by more than 100 mS/m	Sampling	Yes
13. Sodium absorption ratio [SAR] must be less than 18. If background soil SAR is greater than 18, then waste application shall not increase SAR by more than 1	Sampling	N/A
14. Soil parameters shall not exceed: a) conductivity 290 mS/m b) dissolved salts 2500 g/m^3 c) sodium 460 g/m^3 d) chloride 700 g/m^3 prior to areas being reused for landspreading, and at the time of	Sampling	Yes

Purpose: *To discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
expiry/cancellation/surrender		
15. Total dissolved solids in surface water or groundwater shall not exceed 2,500 g/m^3	Sampling	Yes
16. No contamination of groundwater or surface water to exceed background concentrations	Sampling	Yes
17. Records to be kept by consent holder and made available to the Council	Report provided	Yes, later than planned and required updating due to inconsistent paddock listing
18. Consent holder to report to Council by 31 August each year on records specified in SC17	Provided	Yes later than planned
19. Consent shall lapse on 1 June 2027 unless exercised	-	N/A
20. Optional review provision re environmental effects	Undertaken in the following period	Exercised
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative performance in respect of this consent		**High** **Good**

The environmental performance with respect to consent 7591-1 was **high**, the material landfarmed in this period was undertaken to an acceptable standard.

The administrative performance was rated as **good**, however, the Council prompted the consent holder to provide accurate mapping information as the original paddocks supplied did not correspond with what was undertaken. The consent holder has rectified the issue.

Table 26 Summary of performance for Consent 7911-1 Stormwater discharge permit

Purpose: *To discharge storm water from a drilling waste storage site into an unnamed tributary of the Managawhete Stream in the Waitara River.*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Adoption of the best practicable option	Inspection and liaison with consent holder	Yes
2. Stormwater discharged shall be from a catchment area not exceeding 1.5 hectares	Inspection and liaison with consent holder	Yes
3. Discharges shall meet the following: a. pH 6.0 – 9.0 b. Suspended solids <100 gm^{-3} c. Total recoverable hydrocarbons <15 gm^{-3}	Sampling	Yes

Purpose: ***To discharge storm water from a drilling waste storage site into an unnamed tributary of the Managawhete Stream in the Waitara River.***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
4. 25m downstream of the initial discharge point, discharges shall not exceed: a. BOD_5 <2 gm^{-3} b. Chloride <50 gm^{-3}	Sampling, no annual report for the storm water supplied	Yes
5. After allowing for reasonable mixing, within a mixing zone extending twenty five metres downstream of the discharge point, the discharge shall not, either by itself or in combination with other discharges, give rise to any or all 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.	Inspection and sampling	Mostly
f. Consent holder shall maintain a contingency plan	Inspection and liaison with consent holder	Yes
g. Optional review provision re environmental effects	Next option for review in June 2015	Yes
Overall assessment of environmental performance and compliance in respect of this consent Overall assessment of administrative compliance in respect of this consent		**High** **Need improvement**

The environmental performance in relation to stormwater discharge consent 6900-2 of the Derby Road facility was rated as **high**, no issues environmentally were observed during this monitoring period. This site is in the process of decommissioning.

The administrative performance of the facility however was rated as **needs improvement** as no analysis results were undertaken by the consent holder, as were supplied last year. The Council understands the facility is in the process of consolidation and decommissioning, however as the site still contains residual material and discharges as permitted, the analysis must be supplied.

Overall the consent holder achieved a good environmental and good administrative performance in the 2014-2015 monitoring year.

Ratings are as defined in Section 1.1.4

4.4 Recommendations from the 2013-2014 Annual Report

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

1. THAT monitoring of consented activities at the locations of Derby Road stockpiling facility in the 2014-2015 year continues at the same level as in 2013-2014 with the inclusion of TPH and BTEX to all water samples collected. *Undertaken.*

2. THAT monitoring of consented activities at the locations of Surrey Road stockpiling facility in the 2014-2015 year continues at the same level as in 2013-2014 with the inclusion of TPH, BTEX and dissolved nutrients (total nitrogen, total phosphorus, and dissolved reactive phosphorus) from both the site discharge, and also from the stream upstream and downstream of the discharge point. *Undertaken, however the nutrient sampling was not required in the discharge sampling as the site has been deemed a non discharge facility.*

3. THAT the monitoring programme for landspreading activities in 2014-2015 continue at the same level as in 2013-2014, unless the level of site activity changes.

4. THAT the consent holder must address the breaches to the RFP Rule 23 in relation to the Surrey Road Stockpiling facility. *Site is now a non discharge site with storm water discharged to land via an irrigator.*

5. THAT the option for a review of resource consent 7559-1 in June 2014, as set out in condition 25 of the consent, not be exercised, on the grounds that that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of the consents. However, recommendation 4 must be satisfied. *No review was necessary.*

4.5 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 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.

No alterations to the Derby Road facility monitoring programme are required until the final consolidated muds are removed and farmed as per consent 6900-2.

No alterations to the Surrey Road facility monitoring programme are required.

No alterations to Landspreading monitoring programme are required unless the number of paddocks utilised by the consent holder numbers more than the specified number of samples.

4.6 Exercise of optional review of consent

Resource consents 7591-1 and 7559-1 provided for an optional review of the consent in June 2015. Both consents will be reviewed to allow for the update and implication of best practical option, inline with international best practice.

At the time of writing this report, both consents have been reviewed. They are provided in the Company supplied annual report. Note that the resource consents attached in Appendix I are the consents which applied to the 2014-2015 monitoring period.

5. Recommendations

1. THAT monitoring of consented activities at the Derby Road stockpiling facility in the 2015-2016 year continues at the same level as in 2014-2015.

2. THAT monitoring of consented activities at Surrey Road stockpiling facility in the 2015-2016 year continues at the same level as in 2014-2015.

3. That the monitoring programme for landspreading activities in 2015-16 year continue at the same level as in 2014-15.

4. THAT the option for a review of resource consent(s) in June 2015, as set out in condition 26 of consent 7559-1 and condition 20 of consent 7591-1, be exercised, on the grounds of the following:

    - Modified application concentrations for specific parameters within the receiving environment soils, inline with international best practice and expert opinion;

    - Allowance to include material from outside the 12 nautical mile maritime limit, within the Taranaki basin;

    - A reduction in allowable sodium absorption ratio within the receiving environmental soils;

    - Condition requiring the lining of all waste storage cells/pits with fit for purpose liners;

    - An expansion to the initial screen of pre-landfarmable material;

    - Adjustment to the method utilised by the consent holder to apply the landspreadble fluid component of the storage cells;

    - The inclusion of an injection spreader to the method of application to soil;

    - An increase to allow for more material to be stockpiled; and

    - An adjustment to the specific hydrocarbon speciation with regard to surrender criteria.

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.
Cumec	A volumetric measure of flow- 1 cubic metre per second (1 m^3s^{-1}).
DO	Dissolved oxygen.
DRP	Dissolved reactive phosphorus.
E.coli	Escherichia coli, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample.
F	Fluoride.
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
$g/m^2/day$	grams/$metre^2$/day.
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	*Resource Management Act* 1991 and including all subsequent amendments.
SS	Suspended solids.
SQMCI	Semi quantitative macroinvertebrate community index.
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.

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.

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Appendix I

Resource consents held by the Consent Holder

(For a copy of the resource consent/s please contact the TRC consent department)

Discharge Permit

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

Name of Consent Holder:	Colin David Boyd P O Box 44 INGLEWOOD 4347
Decision Date:	16 February 2011
Commencement Date:	16 February 2011

Conditions of Consent

Consent Granted:	To discharge drilling wastes [consisting of drilling cuttings and drilling fluids from water based muds and synthetic based muds], onto and into land for the purpose of temporary stockpiling prior to disposal at or about (NZTM) 1702545E-5653650N
Expiry Date:	1 June 2027
Review Date(s):	June 2015, June 2021
Site Location:	Derby Road North, Inglewood
Legal Description:	Lot 2 DP 344156 [Discharge site]
Catchment:	Waitara
Tributary:	Manganui Mangamawhete

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

General condition

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

Special conditions

1. The consent holder shall adopt the best practicable option [as defined section 2 of the Resource Management Act 1991] to prevent or minimise any actual or potential effects on the environment arising from the discharge.

Notifications, monitoring and reporting

2. The consent holder shall notify the Chief Executive, Taranaki Regional Council, [by emailing worknotification@trc.govt.nz.] at least 48 hours prior to permitting drilling wastes onto the site for stockpiling, from each well drilled. Notification shall include the following information:

    a) the consent number;
    b) the name of the well[s] from which the waste was generated;
    c) the type of waste to be stockpiled; and
    d) the volume of waste to be stockpiled.

3. The consent holder shall keep records of the following:

    a) wastes from each individual well;
    b) composition of wastes [including concentrations of chloride, nitrogen and total petroleum hydrocarbons];
    c) stockpiling area[s];
    d) volumes and weights of material stockpiled;
    e) dates of commencement and completion of stockpiling events;
    f) the results of analysis;

    and shall make the records available to the Chief Executive, Taranaki Regional Council.

4. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, by 31 August of each year, a report on all records required to be kept in accordance with condition 3, for the period of the previous 12 months, 1 July to 30 June.

Operational requirements

5. There shall be no discharge of drilling waste to land, within 25 metres of surface water or of property boundaries.

6. All material must be spread on to land in accordance with consent 7591-1 as soon as practicable, but no later than twelve months after being brought onto the site.

Receiving environment limits - water

7. The exercise of this consent shall not result in the concentration of total dissolved salts in any fresh water body exceeding 2500 g/m^3.

8. Other than as provided for in condition 7, the exercise of this consent shall not result in any contaminant concentration, within surface water or groundwater, which after reasonable mixing, exceeds the background concentration for that particular contaminant.

Receiving environment limits - soil

9. From 1 March 2027 [three months prior to the consent expiry date], constituents in the soil of previously landfarmed areas shall not exceed the standards shown in the following table:

Constituent	Standard
conductivity	290 mS/m
chloride	700 mg/kg
sodium	460 mg/kg
total soluble salts	2500 mg/kg
MAHs PAHs TPH	Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand [Ministry for the Environment, 1999]. Tables 4.12 and 4.15, for soil type sand.

MAHs - benzene, toluene, ethylbenzene, xylenes
PAHs - napthalene, non-carc. [pyrene], benzo(a)pyrene eq.
TPH - total petroleum hydrocarbons [C_7-C_9, C_{10}-C_{14}, C_{15}-C_{36}]

The requirement to meet these standards shall not apply if, before 1 March 2027, the consent holder applies for a new consent to replace this consent when it expires.

10. This consent may not be surrendered at any time until the standards in condition 9 have been met.

Review

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

Signed at Stratford on 16 February 2011

For and on behalf of
Taranaki Regional Council

_____

Director-Resource Management

Discharge Permit

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

Name of Consent Holder:	Colin David Boyd P O Box 44 INGLEWOOD 4347
Consent Granted Date:	20 November 2009

Conditions of Consent

Consent Granted:	To discharge drilling wastes [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into land via landfarming at or about (NZTM) 1701847E-5651476N
Expiry Date:	1 June 2027
Review Date(s):	June 2010, June 2011, June 2012, June 2013, June 2014, June 2015, June 2021
Site Location:	Surrey Road, Inglewood
Legal Description:	Sec 17 & 18 Blk XIV Egmont SD
Catchment:	Waitara
Tributary:	Mangamawhete Mangatengehu

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. For the purposes of this consent the following definitions shall apply:

   a) stockpiling means a discharge of drilling wastes from vehicles, tanks, or other containers onto land, but without subsequently spreading, or incorporating into the soil within 24 hours of such discharge; and
   b) landfarming means the discharge of drilling waste onto land, subsequent spreading, incorporation into the soil and re-sowing into pasture or crop.

2. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent. For the purpose of this consent, the best practicable option will include undertaking the landfarming of drilling waste during extended periods of dry weather.

Requirements prior to exercise of consent

3. Prior to the exercise of this consent, the consent holder shall install a minimum of three groundwater monitoring wells. The wells shall be at locations and to depths, that enable the collection of groundwater samples [to assess any changes in groundwater quality] to the satisfaction of the Chief Executive, Taranaki Regional Council. The wells shall be installed in accordance with NZS 4411:2001 and all associated costs shall be met by the consent holder.

4. Prior to the exercise of this consent, the consent holder shall provide, to the written satisfaction of the Chief Executive, Taranaki Regional Council, a landfarming and stockpiling management plan to demonstrate the activity will be conducted to comply with all of the conditions of this consent. The management plan shall be reviewed annually and shall include as a minimum:

   a) control of site access;
   b) procedures for notification to Council of disposal activities;
   c) procedures for the receipt and stockpiling of drilling wastes onto the site;
   d) procedures for the management of stormwater recovered from, or discharging from, the drilling waste stockpiling area;
   e) methods used for the mixing and testing of different waste types;
   f) procedures for landfarming drilling wastes [including means of transfer from stockpiling area, means of spreading, and incorporation into the soil];
   g) contingency procedures;
   h) sampling regime and methodology; and
   i) post-landfarming management, monitoring and site reinstatement.

Notification and sampling requirements prior to discharge

5. The consent holder shall notify the Chief Executive, Taranaki Regional Council, [by emailing worknotification@trc.govt.nz.] at least 48 hours prior to permitting drilling wastes onto the site for stockpiling, from each well drilled. Notification shall include the following information:

   a) the consent number;
   b) the name of the well[s] from which the waste was generated;
   c) the type of waste to be stockpiled; and
   d) the volume of waste to be stockpiled.

6. The consent holder shall notify the Chief Executive, Taranaki Regional Council, [by emailing worknotification@trc.govt.nz.] at least 48 hours prior to landfarming stockpiled material. Notification shall include the following information:

   a) the consent number;
   b) the name of the well[s] from which the waste was generated;
   c) the type of waste to be landfarmed;
   d) the volume and weight of the waste to be landfarmed;
   e) the concentration of chlorides, nitrogen and hydrocarbons in the waste; and
   f) the specific location and area over which the waste will be landfarmed.

   In order to demonstrate compliance with conditions 9, 12 and 13 of this consent.

Discharge limits

7. The exercise of this consent is limited to wastes generated within the Taranaki region.

8. The stockpiling of material authorised by this consent shall be limited to a maximum volume of 2,000 cubic metres at any one time on the site. All stockpiled material must be landfarmed within nine months of being brought onto the site.

9. For the purposes of landfarming, drilling wastes shall be applied to land in a layer not exceeding:

   a) 100 mm thick for wastes with a hydrocarbon concentration less than 50,000 mg/kg dry weight; or
   b) 50 mm thick for wastes with a hydrocarbon concentration equal to or greater than 50,000 mg/kg dry weight; and
   c) in a rate and manner such that no ponded liquids remain after one hour, for all wastes;

   prior to incorporation into the soil.

10. An area of land used for the landfarming of drilling wastes in accordance with condition 9 of this consent shall not be used for any subsequent discharges of drilling waste.

11. As soon as practicable following the application of drilling wastes to land, the consent holder shall incorporate the material into the soil to a depth of at least 250 mm so that the hydrocarbon concentration at any point in the soil/waste mix is less than 50,000 mg/kg dry weight.

12. The exercise of this consent shall not result in a chloride loading exceeding 800 kg/ha.

13. The nitrogen loading [including that from any application of nitrogen fertiliser] over any area where drilling wastes are applied, shall not exceed 1000 kilograms per hectare over any 5 year period.

14. As soon as practicable following the landfarming of drilling wastes the discharge area shall be re-sown into pasture [or into crop]. If revegetation cannot be established within two months of the discharge, the consent holder shall undertake appropriate land stabilisation measures to minimise wind and/or stormwater erosion.

15. No discharge shall take place within 25 metres of a water body [including farm drains], or property boundary.

Receiving environment limits for soil

16. The conductivity of the soil layer containing the discharge shall be less than 400 mS/m, or alternatively, if the background soil conductivity exceeds 400 mS/m, the application of waste shall not increase the soil conductivity by more than 100 mS/m.

17. The concentration of metals in the soil layer containing the discharge shall comply with the guidelines for heavy metals in soil set out in Table 7.1, Section 7 of the "Guidelines for the safe application of biosolids to land in New Zealand" [MfE and NZWWA 2003].

18. The sodium absorption ratio [SAR] of the soil layer containing the discharge shall be less than 18, or alternatively if the background soil SAR exceeds 18, the application of waste shall not increase the SAR by more than 1.

19. At the time of expiry, cancellation, or surrender of this consent the concentrations of hydrocarbons in the soil shall comply with the guideline values for sandy silt set out in Tables 4.12 and 4.15 of the "Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand" [MfE, 1999].

20. At the time of expiry, cancellation, or surrender of this consent soil parameters shall not exceed the following limits: chloride, 700 mg/kg; conductivity, 290 mS/m; sodium, 460 mg/kg; and total soluble salts, 2500 mg/kg.

Receiving environment limits for water

21. The exercise of this consent shall not result in a level of total dissolved salts within any surface water or groundwater of more than 2500 g/m^3.

22. The exercise of this consent shall not result in any contaminant concentration, within surface water or groundwater, which exceeds the background concentration for that particular contaminant, as determined by the Chief Executive, Taranaki Regional Council.

Monitoring and reporting

23. The consent holder shall keep records of the following:

    a) wastes from each individual well [including records of all additives used at the wellsite during the drilling process]
    b) composition of wastes, including concentrations of chloride, nitrogen and total hydrocarbons
    c) stockpiling area[s]
    d) volumes of material stockpiled
    e) landfarming area[s], including a map showing each individual disposal area and GPS co-ordinates
    f) volumes and weights of wastes landfarmed
    g) dates of commencement and completion of stockpiling and landfarming events
    h) treatments applied
    i) details of monitoring, including sampling locations, sampling methods and the results of analysis

    and shall make the records available to the Chief Executive, Taranaki Regional Council.

24. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, by 31 August of each year, a report on all records required to be kept in accordance with condition 23, for the period of the previous 1 July to 30 June.

Lapse and review

25. This consent shall lapse on the 31 December 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.

26. 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 2010 and/or June 2011 and/or June 2012 and/or June 2013 and/or June 2014 and/or 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, or to take into account any Act of Parliament, regulations, national policy statement, and national environmental standard which is relevant to this consent.

Signed at Stratford on 20 November 2009

For and on behalf of
Taranaki Regional Council

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Chief Executive

Discharge Permit

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

Name of Consent Holder:	Surrey Road Landfarms Limited P O Box 44 INGLEWOOD
Consent Granted Date:	21 January 2010

Conditions of Consent

Consent Granted:	To discharge drilling waste from hydrocarbon exploration activities onto and into land via landspreading at or about (NZTM) 1701750E-5652370N
Expiry Date:	1 June 2027
Review Date(s):	June 2011, June 2012, June 2015, June 2021
Site Location:	Surrey Road, Inglewood
Legal Description:	Lot 2 DP 344156, Secs 9, 10 , & Pt Sec 13 Blk XII Egmont SD, Secs 17 & 18 Blk XVI Egmont SD
Catchment:	Waitara
Tributary:	Mangamawhete Mangatengehu Waipuku

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

General conditions

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

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent. For the purpose of this consent, the best practicable option will include undertaking the landspreading of drilling waste during extended periods of dry weather.

2. The consent holder shall notify the Chief Executive, Taranaki Regional Council, [by emailing worknotification@trc.govt.nz.] at least 48 hours prior to landspreading waste from each separate storage cell. Notification shall include the following information:

    a) the consent number;
    b) the name of the well[s] from which the waste was generated;
    c) the type of waste to be landspread;
    d) the volume and weight of the waste to be landspread;
    e) the concentration of chlorides, nitrogen and hydrocarbons in the waste; and
    f) the specific location and area over which the waste will be landspread.

    In order to demonstrate compliance with conditions 4, 5 and 6 of this consent.

3. The exercise of this consent is limited to wastes generated within the Taranaki region.

Discharge limits

4. Drilling waste shall be applied to land at a rate not exceeding 100 m^3/ha/yr, and in a rate and manner such that no ponded liquids remain after one hour.

5. The exercise of this consent shall not result in a chloride loading exceeding 800 kg/ha.

6. The nitrogen loading [including that from any application of nitrogen fertiliser] over any area where drilling wastes are applied, shall not exceed 1000 kilograms per hectare over any 5 year period.

7. The consent holder shall maintain pasture cover at all times in areas used for the landspreading of drilling waste.

8. No drilling waste shall be discharged within:

    a) 12 metres of property boundaries; or
    b) 12 metres of the Mangamawhete, Mangatengehu and Waipuku Streams; or
    c) 6 metres of any other surface water course [including farm drains].

9. Any liquid drilling waste which may flow overland, shall not be discharged within 25 metres of property boundaries or surface water courses [including farm drains].

Receiving environment limits for soil

10. The concentration of hydrocarbons in the soil shall comply with the guideline values for sandy silt set out in Tables 4.12 and 4.15 of the "Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand" [MfE, 1999]. This condition shall apply:

    a) prior to drilling wastes being discharged onto an area that has previously been used for the disposal of drilling wastes via landspreading; and
    b) at the time of expiry, cancellation, or surrender of this consent.

11. The concentration of metals in the soil layer containing the discharge shall comply with the guidelines for heavy metals in soil set out in Table 7.1, Section 7 of the "Guidelines for the safe application of biosolids to land in New Zealand" [MfE and NZWWA 2003].

12. The conductivity of the soil layer containing the discharge shall be less than 400 mS/m, or alternatively, if the background soil conductivity exceeds 400 mS/m, the application of waste shall not increase the soil conductivity by more than 100 mS/m.

13. The sodium absorption ratio [SAR] of the soil layer containing the discharge shall be less than 18, or alternatively if the background soil SAR exceeds 18, the application of waste shall not increase the SAR by more than 1.

14. Soil parameters shall not exceed the following limits: chloride, 700 mg/kg; conductivity, 290 mS/m; sodium, 460 mg/kg; and total soluble salts, 2500 mg/kg. This condition shall apply:

    a) prior to drilling wastes being discharged onto an area that has previously been used for the disposal of drilling wastes via landspreading; and
    b) at the time of expiry, cancellation, or surrender of this consent.

Receiving environment limits for water

15. The exercise of this consent shall not result in a level of total dissolved salts within any surface water or groundwater of more than 2500 g/m^3.

16. The exercise of this consent shall not result in any contaminant concentration, within surface water or groundwater, which exceeds the background concentration for that particular contaminant, as determined by the Chief Executive, Taranaki Regional Council.

Monitoring and reporting

17. The consent holder shall keep records of the following:

    a) wastes from each individual well
    b) composition of wastes, including concentrations of chloride, nitrogen and total hydrocarbons
    c) landspreading areas, including a map showing individual disposal areas with GPS co-ordinates
    d) volumes and weights of wastes landspread
    e) dates of commencement and completion of landspreading events
    f) details of monitoring, including sampling locations, sampling methods and the results of analysis

    and shall make the records available to the Chief Executive, Taranaki Regional Council.

18. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, by 31 August of each year, a report on all records required to be kept in accordance with condition 17, for the period of the previous 1 July to 30 June.

Lapse and review

19. This consent shall lapse on the 31 March 2015, unless the consent is given effect to before the end of that period or the Taranaki Regional Council fixes a longer period pursuant to section 125(1)(b) of the Resource Management Act 1991.

20. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2011 and/or June 2012 and/or June 2013 and/or June 2014 and/or 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, or to take into account any Act of Parliament, regulations, national policy statement, and national environmental standard which is relevant to this consent.

Signed at Stratford on 21 January 2010

For and on behalf of
Taranaki Regional Council

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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:	Colin David Boyd P O Box 44 INGLEWOOD 4347
Decision Date:	27 September 2011
Commencement Date:	27 September 2011

Conditions of Consent

Consent Granted:	To discharge stormwater from a drilling waste storage site into an unnamed tributary of the Mangamawhete Stream in the Waitara River at or about (NZTM) 1702717E-5653665N
Expiry Date:	1 June 2027
Review Date(s):	June 2013, June 2015, June 2021
Site Location:	Derby Road North, Inglewood
Legal Description:	Lot 2 DP 344156 [Discharge source & site]
Catchment:	Waitara
Tributary:	Manganui Mangamawhete

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

General condition

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

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent.

2. The stormwater discharged shall be from a catchment area not exceeding 1.5 hectares.

3. Constituents of the discharge shall meet the standards shown in the following table.

Constituent	Standard
pH	Within the range 6.0 to 9.0
suspended solids	Concentration not greater than 100 gm^{-3}
total recoverable hydrocarbons	Concentration not greater than 15 gm^{-3}

This condition shall apply before entry of the treated stormwater into the receiving waters at a designated sampling point approved by the Chief Executive, Taranaki Regional Council.

4. After allowing for reasonable mixing, within a mixing zone extending twenty five metres downstream of the discharge point to the unnamed tributary of the Mangamawhete Stream, the discharge shall not, either by itself or in combination with other discharges, cause the following:

   a) the carbonaceous filtered biochemical oxygen demand [BOD_5] to exceed 2 gm^{-3}, or
   b) the chloride concentration to exceed 50 gm^{-3}.

5. After allowing for reasonable mixing, within a mixing zone extending twenty five metres downstream of the discharge point, the discharge shall not, either by itself or in combination with other discharges, give rise to any or all 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.

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

7. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month 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 27 September 2011

For and on behalf of
Taranaki Regional Council

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Director-Resource Management

Appendix II

Biomonitoring reports

To	Job Manager, Nathan Crook
From	Scientific Officer, Darin Sutherland
Document	1523824
Report No	DS014
Date	June 2015

Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, October 2014

Introduction

A macroinvertebrate survey was performed in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land within its vicinity. The survey was conducted in spring and was one of two scheduled surveys for the site in the 2014-15 year. The site receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits where it is either pumped out for removal, or discharged to the unnamed tributary. No consent was held to discharge to the tributary from the skimmer pits, as it was intended that no discharges to surface water would occur unless they complied with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that any discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life. However, during the 2010-2011 monitoring period several non-compliance discharge events were recorded (TRC, 2012) culminating in the requirement for a consent to discharge which was issued in September 2011. This consent to discharge stormwater (7911-1) provided for a 25 metre mixing zone in the tributary.

A baseline survey was undertaken in April 2009, prior to any receipt of drilling wastes at the site. At the time of the baseline survey the communities at the downstream sites had experienced significant habitat deterioration due to the realignment of the tributary, and also the discharge of significant amounts of sediment through associated land disturbance. However, the upstream control site was relatively unaffected.

The previous survey performed in February 2014 (Thomas, 2014) found that the activities at the drilling waste stockpiling site and landfarming area had not had any impacts on the macroinvertebrate communities although some impacts caused by habitat variability were noted.

Methods

Four sites were sampled in this survey. The 'control' site (site 1) was established in the unnamed tributary, alongside the upstream boundary of the land treatment area. Site 2 was established between the land treatment area and the storage pits, and site 3 was established just downstream of the skimmer pit discharge point. A fourth site was established approximately 200m downstream of the skimmer pit discharge. This fourth site provides comparative information, should deterioration be recorded at sites 2 or 3. The sampling site locations are presented in Table 1 and Figure 1.

Either the Council's standard 'vegetation-sweep' (site 1) or 'kick-sampling' (sites 2, 3, and 4) sampling techniques were used at these four sites (Table 1) to collect streambed macroinvertebrates on 16 October 2014. 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).

Table 1 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling activities

Site number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MMW000161	E1702317 N5653463	Upstream of drilling waste stockpiling site	450
2	MMW000162	E1702508 N5653560	Downstream of land spreading area	440
3	MMW000163	E1702734 N5653676	Downstream of skimmer pit discharge	435
4	MMW000165	E1702900 N5653750	200m downstream of skimmer pit discharge	430

Figure 1 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream, sampled in relation to the Derby Rd drilling waste stockpiling site

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols for 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)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 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 and hydrology

This October 2014 survey followed a period of 10 days since a fresh in excess of three times median flow, and 17 days since a fresh in excess of seven times median flow. In the month prior to this survey, there had been nine fresh events, three of which exceeded the 3 times median flow and four which exceeded 7 times median flow.

The water temperatures were cool. Water levels were low and water speeds were slow or steady. Water was uncoloured and clear for all sites during the survey (Table 2). Substrate composition for site 1 was a mixture of sand, fine and course gravel, and cobbles, for site 2 it was predominately fine and course gravel, cobble and boulder, for site 3 it was coarse gravel, cobble and boulder and for site 4 it was coarse gravel and cobbles.

There were patchy periphyton mats at sites 1, 2 and 3 but none at site 4 and widespread filamentous algae at sites 1 and 2, patchy filamentous at site 3 and no filamentous algae at site 4. Moss was absent from all site except site 3 where it was patchy. Leaves were patchy for all sites except site 3 where none were present. Wood was absent from all sites except site 4 where it was patch. No macrophytes were present on the bed of any of the sites. Sites 1 and 2 had no overhanging vegetation or shading while sites 3 and 4 and overhanging vegetation and complete shading.

Table 2 Summary of time of sampling and some water variables collected at four sites in the unnamed tributary of the Mangamawhete Stream, sampled in relation to the Derby Rd landfarm on 16 October 2014.

Site	Time (NZST)	Temperature (°C)	Water Colour	Water Clarity	Flow Conditions	Water Speed
1	1100	11.9	Uncoloured	Clear	Low	Slow
2	1045	11.8	Uncoloured	Clear	Low	Steady
3	1015	11.7	Uncoloured	Clear	Low	Steady
4	0950	10.8	Uncoloured	Clear	Low	Slow

Macroinvertebrate communities

Table 3 provides a summary of the results from previous surveys sampled in relation to the Derby Rd drilling waste stockpiling site along with current survey results.

Table 3 Number of taxa, MCI and $SQMCI_s$ values for an unnamed tributary of the Mangamawhete Stream, sampled in relation to the Derby Rd drilling waste stockpiling site on 16 October 2014 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Oct 2014	Median	Range	Oct 2014	Median	Range	Oct 2014
1	10	23	12-33	18	106	87-114	101	5.4	3.2-7.4	5.0
2	10	15	6-30	13	100	80-109	95	3.3	2.0-7.4	3.9
3	10	16	5-19	17	100	88-109	108	4.2	2.5-5.9	5.9
4	10	17	6-24	23	92	73-104	110	4.3	2.1-6.8	5.7

Table **4** provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park.

Table 4 Range and median number of taxa, MCI values and SQMCIs scores for 'control' sites (ring plain rivers/streams with sources outside the National Park) at altitudes greater than 400 m asl (TRC, 2015).

	No. of taxa	MCI value	$SQMCI_s$ value
No. Samples	33	33	31
Range	8-36	82-127	2.0-7.5
Median	20	109	5.0

The full results from the current survey are presented in Table 5.

Table 5 Macroinvertebrate fauna of an unnamed tributary of the Mangamawhete Stream, sampled on 16 October 2014 in relation to the Derby Rd Landfarm.

Taxa List	Site Number	MCI score	Site 1	Site 2	Site 3	Site 4
	Site Code		MMW000161	MMW000162	MMW000163	MMW000165
	Sample Number		FWB14306	FWB14307	FWB14308	FWB14309
NEMERTEA	Nemertea	3	-	R	R	-
NEMATODA	Nematoda	3	-	-	-	R
ANNELIDA (WORMS)	Oligochaeta	1	-	R	R	A
MOLLUSCA	*Potamopyrgus*	4	C	R	C	C
CRUSTACEA	Ostracoda	1	R	R	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	R	-	A
	Deleatidium	8	A	C	A	A
	Neozephlebia	7	R	-	-	C
	Nesameletus	9	-	-	R	-
	Zephlebia group	7	R	R	C	A
PLECOPTERA (STONEFLIES)	*Acroperla*	5	R	-	-	-
	Zelandobius	5	R	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	C	-	R	C
	Ptilodactylidae	8	R	R	R	R
	Staphylinidae	5	-	-	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	-	R	R
TRICHOPTERA (CADDISFLIES)	*Costachorema*	7	-	-	-	R
	Hydrobiosis	5	R	R	-	-
	Hydrochorema	9	-	-	R	-
	Hydropsyche (Orthopsyche)	9	-	-	-	R
	Plectrocnemia	8	-	R	R	-
	Polyplectropus	6	-	-	-	A
	Psilochorema	6	R	-	R	C
	Oxyethira	2	C	-	-	-
	Triplectides	5	-	-	-	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C	R	-
	Eriopterini	5	R	-	R	C
	Hexatomini	5	-	-	-	R
	Harrisius	6	-	-	-	R
	Orthocladiinae	2	A	A	C	R
	Tanypodinae	5	R	-	-	R
	Austrosimulium	3	R	R	C	R
ACARINA (MITES)	Acarina	5	-	-	-	R
		No of taxa	18	13	17	23
		MCI	101	95	108	110
		SQMCIs	5.0	3.8	5.9	5.7
		EPT (taxa)	8	5	6	9
		%EPT (taxa)	44	38	35	39

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

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

Site 1

A moderate macroinvertebrate community richness of 18 taxa was found at site 1 (' control' site) at the time of the survey which was five taxa less than the median number recorded for the site and nine taxa less than the previous sample (median taxa richness 23; Table 3). Overall there was a positive trend over time for taxa richness but considerable fluctuations occurred around the line of best fit (Figure 2).

The MCI score of 101 units indicated a community of 'good' biological health. The survey was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 106; Table 3). Overall there was a negative trend over time for MCI but considerable fluctuations occurred around the line of best fit (Figure 2). The $SQMCI_s$ score of 5.0 units was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 5.4 units; Table 3).

The community was characterised by one 'tolerant' taxon [midge (Orthocladiinae)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 5).

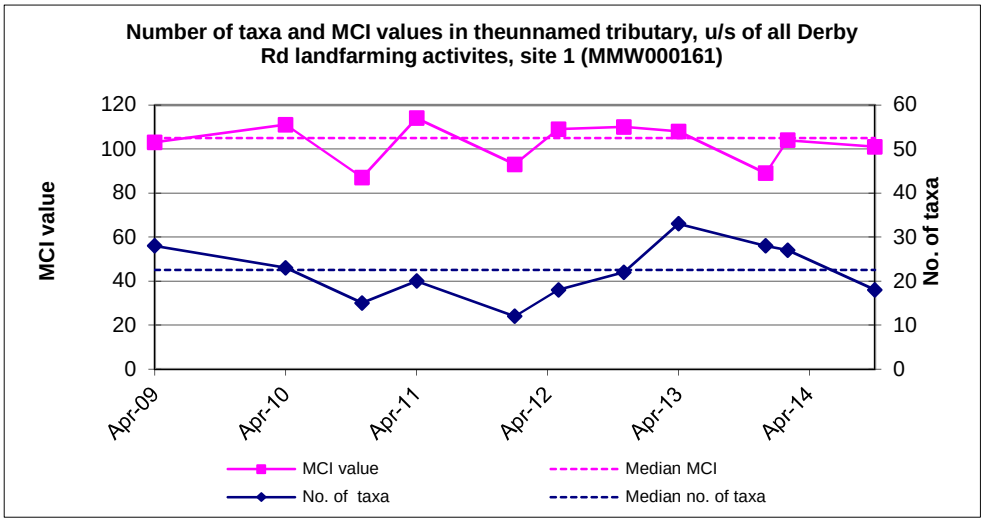

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderately low macroinvertebrate community richness of 13 taxa was found at site 2 at the time of the survey which was ten taxa less that the median number recorded for the site and six taxa less than the previous sample (median taxa richness 23; Table 3). Overall there was a positive trend over time for taxa richness but considerable fluctuations occurred around the line of best fit (Figure 3).

The MCI score of 95 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 100; Table 3). Overall there was a positive trend over time for MCI value but considerable fluctuations occurred around the line of best fit (Figure 2). The $SQMCI_s$ score of 3.3 units was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 3.9 units; Table 3).

The community was characterised by one ‘tolerant’ taxon [midge (Orthocladiinae)] (Table 5).

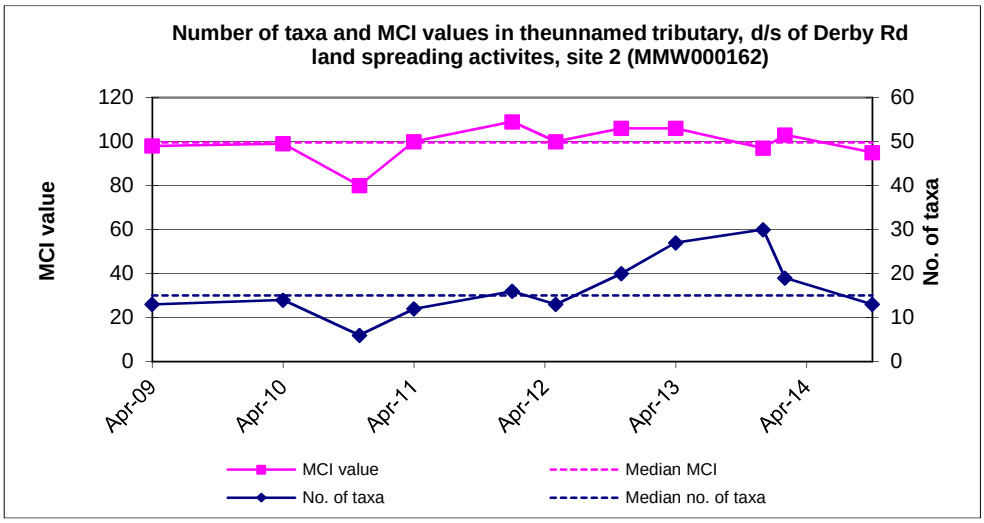

Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangamawhete Stream.

Site 3

A moderate macroinvertebrate community richness of 17 taxa was found at site 3 at the time of the survey which was one taxa less than the median number recorded for the site and two taxa less than the previous sample (median taxa richness 16; Table 3). Overall there was a positive trend over time for taxa richness but considerable fluctuations occurred around the line of best fit (Figure 4).

The MCI score of108 units indicated a community of ‘good’ biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 100; Table 3). Overall there was a positive trend over time for MCI value but considerable fluctuations occurred around the line of best fit (Figure 2). The $SQMCI_s$ score of 5.9 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 4.2 units; Table 3).

The community was characterised by one ‘highly sensitive’ taxon [mayfly (*Deleatidium*)] (Table 5).

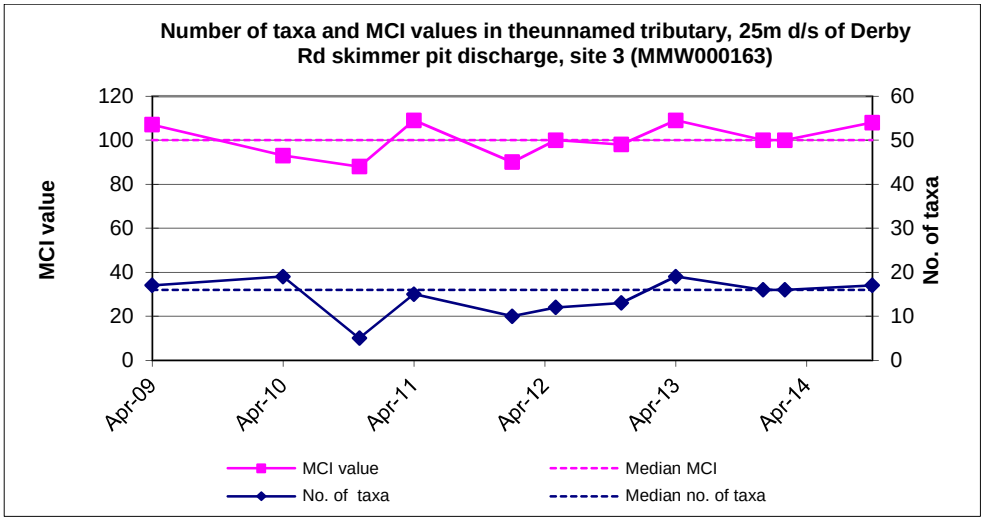

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangamawhete Stream.

Site 4

A moderate macroinvertebrate community richness of 23 taxa was found at site 4 at the time of the survey which was six taxa more than the median number recorded for the site and eight taxa more than the previous sample (median taxa richness 17; Table 3). Overall there was a positive trend over time for taxa richness but considerable fluctuations occurred around the line of best fit (Figure 5).

The MCI score of110 units indicated a community of 'good' biological health which was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median MCI score 92; Table 3). Overall there was a positive trend over time for MCI value but considerable fluctuations occurred around the line of best fit (Figure 2). The $SQMCI_s$ score of 5.7 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 4.3 units; Table 3).

The community was characterised by one 'tolerant' taxon (oligochaete worms) and two 'moderately sensitive' taxa [mayfly (*Zephlebia* group) and caddisfly (*Polyplectropus*)] (Table 5).

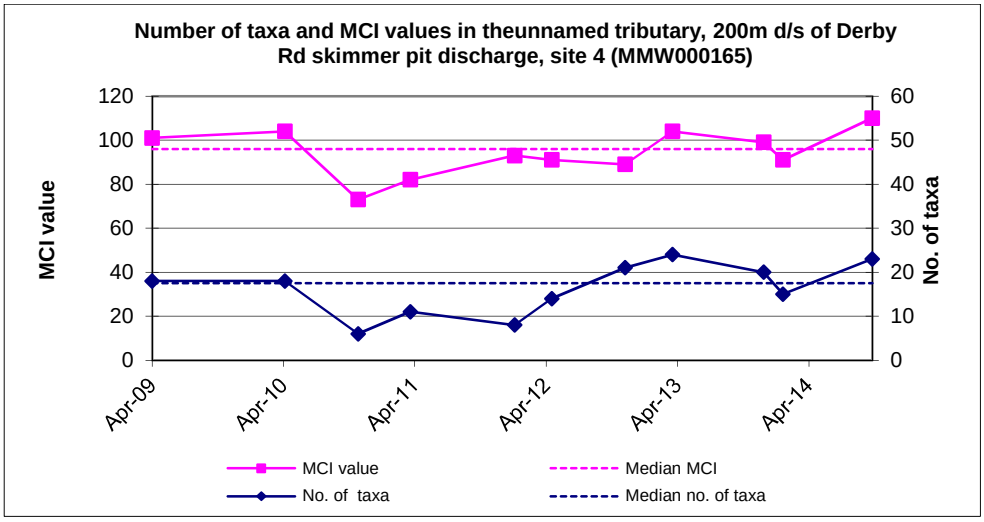

Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangamawhete Stream.

Discussion and Conclusions

The Council's 'kick-sampling' or 'vegetation sweep' techniques were used at four sites to collect streambed macroinvertebrates from an unnamed tributary of the Mangamawhete Stream in relation to the storage of drilling waste within its vicinity and the consented discharge of stormwater to the stream. This has provided data to assess any potential impacts the consented activities have had on the macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (richness), MCI, and $SQMCI_s$ scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges. Macroinvertebrates when exposed to toxic chemicals may die and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). 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 abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_s$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

Overall there was little significant variation among sites at the time of the survey. There were only minor non-significant differences in taxa richness, MCI, $SQMCI_s$ scores among sites 1, 3 and 4. There were also no significant differences between sites 1, 3 and 4 and the median taxa richness, MCI and $SQMCI_s$ scores for other similar sites in the same altitudinal band (TRC, 2015). Site 2 did have a significantly lower MCI score compared with sites 3 and 4 and a significantly lower $SQMCI_s$ score compared with the other sites. Site 2 also had the lowest taxa richness. Given site 2 is upstream of sites 3 and 4 and any discharges or leachate that would effect site 2 is also likely to effect sites 3 and 4 the most likely explanation for the macroinvertebrate community at site 2 having the worst health was likely poorer habitat quality at site 2 compared with the other sites.

Sites 1 and 2 both had substantial decreases in taxa richness. Both sites were more similar in nature to each other than sites 3 and 4, having a streambed which was more confined and with no overhanging vegetation. Filamentous algae were very abundant at both sites but

only had a patchy distribution at site 3 and were not present in site 4. As site 1 is the 'control' site, and thus unaffected by landfarming activities, the decrease in taxa richness at sites 1 and 2 was most likely due to differences in site characteristics in combination with temporal variation rather than from landfarming activities.

The results of the spring survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any significant impacts on the macroinvertebrate communities in the unnamed tributary of the Mangamawhete Stream since the last survey.

Summary

- A macroinvertebrate survey was performed at four sites in an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land at the Derby Rd landfarm.

- Taxa richnesses, MCI and $SQMCI_s$ scores for sites 1, 3 and 4 were all similar to each other and similar to other similar sites in Taranaki. Site 2 had lower macroinvertebrate community indices which were probably due to poorer habitat quality.

- There was no indication from any of the macroinvertebrate indices examined that stockpiling and discharge of drilling waste to land had had any significant effects on the health of the macroinvertebrate communities present in an unnamed tributary of the Mangamawhete Stream.

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To Job Manager, Nathan Crook
From Scientific Officer, Darin Sutherland
Document 1530092
Report No DS016
Date June 2015

Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road landfarm, October 2014

Introduction

A macroinvertebrate survey was performed in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangatengehu Stream in relation to the disposal of drilling waste to land within its vicinity at the Surrey Road land farm. The site located off Surrey Road, receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits. From here it is either pumped out for removal, or discharged to the land in the vicinity of the unnamed tributary. No consent is held to discharge to the tributary from the skimmer pits, as this discharge was considered to comply with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that the discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life.

Surveys undertaken in December 2013 (Thomas, 2014a) and February 2014 (Thomas, 2014b) indicated that activities at the drilling waste stockpiling site and landfarming area had resulted in significant impacts on the macroinvertebrate communities through the lower section of the Mangatengehu Stream surveyed. As a result of the suspected impacts an additional survey was completed in winter on the 26 August 2014. Its results suggested that the activities at the drilling waste stockpiling site and landfarming area may have impacted on the macroinvertebrate communities through the lower section of the reach surveyed, although it is likely that such impacts have been compounded by habitat variability (Thomas, 2014c).

Methods

This scheduled biomonitoring survey was undertaken at four sites on 16 October 2014 (Table 1 and Figure 1). At the time of the initial survey undertaken in April 2010, site 1 was established as a 'control site', upstream of the drilling stockpile area and sites 2 and 3 were established downstream of the skimmer pit discharge. During an inspection of the site in mid-2010, an unauthorised discharge of hydrocarbons was observed entering the stream. As a consequence of this inspection, changes were made to the on site drainage. These changes were made between the April 2010 and November 2010 surveys. The result was that site 2 was located upstream of any discharge from the sites, and site 3 became the primary impact site. The stormwater discharge from the site now enters the unnamed tributary immediately upstream of the race crossing, approximately 35 metres upstream of site 3. A new, secondary impact site

(site 4) was established 100 metres downstream of the stormwater discharge during the May 2012 survey.

The Council's standard '400ml kick-sampling' technique was used at sites 2, 3 and 4 and the 'vegetation sweep' sampling technique was used at site 1 (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).

Table 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road drilling waste stockpiling activities

Site Number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MTH000060	E1701830 N5651430	Upstream of drilling waste stockpiling site	495
2	MTH000062	E1701954 N5651468	Approximately 85 metres upstream of the spring and skimmer pit discharge	495
3	MTH000064	E1702050 N5651525	Approximately 35 metres downstream of the skimmer pit discharge	490
4	MTH000066	E1702102 N5651582	Approximately 100 metres downstream, of the skimmer pit discharge	485

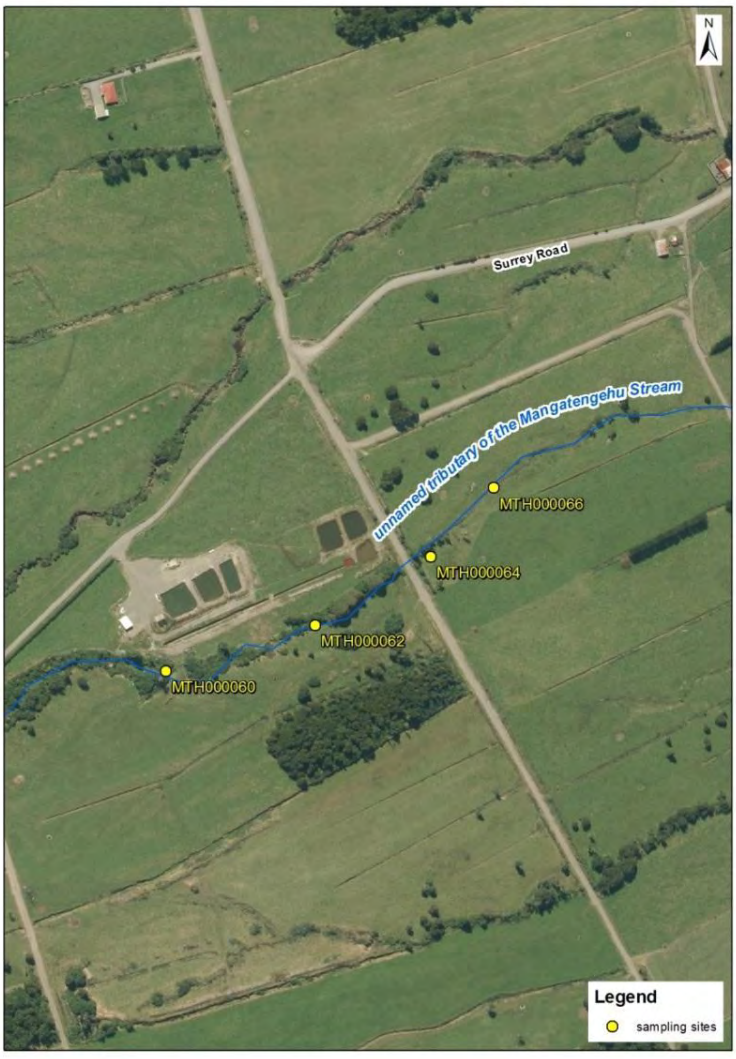

Figure 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols for 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)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 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, 19 98 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 and hydrology

This October 2014 survey followed a period of 11 days since a fresh in excess of three times median flow, and 67 days since a fresh in excess of seven times median flow. In the month prior to this survey, there had been eight fresh events, two of which exceeded the 3 times median flow.

The water temperatures were cool (9.5-10.0 °C). Water levels were low and water speeds either slow or steady. Water was uncoloured and clear for all sites during the survey (Table 2). Site 1 had a silt substrate, site 2 substrate composition was mainly course gravel and cobbles, site 3 and 4 had predominately cobble substrates with some course gravel.

There were no slippery periphyton mats at site 1, patchy periphyton mats at site 2 and widespread periphyton mats at sites 3 and 4. There was no moss or leaves at sites 1, 3 and 4 while site 2 had patchy moss and leaves. There was no wood at any of the sites. Macrophytes were present on the stream bed at site 1 but absent from sites 2, 3 and 4. Sites 1, 3 and 4 had

no shade and overhanging vegetation while site 2 did have partial shading and overhanging vegetation.

Table 2 Summary of time of sampling and some water variables collected at four sites in the unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Rd landfarm on 16 October 2014.

Site	Time (NZST)	Temperature (°C)	Water Colour	Water Clarity	Flow Conditions	Water Speed
1	0900	9.8	Uncoloured	Clear	Low	Slow
2	0825	9.5	Uncoloured	Clear	Low	Slow
3	0815	9.9	Uncoloured	Clear	Low	Steady
4	0805	10.0	Uncoloured	Clear	Low	Steady

Macroinvertebrate communities

Table 3 provides a summary of the results from previous surveys sampled in relation to the Surrey Rd drilling waste stockpiling site along with current survey results.

Table 3 Number of taxa, MCI and $SQMCI_s$ values for an unnamed tributary of the Mangatangehu Stream, sampled in relation to the Surrey Rd landfarm drilling waste stockpiling site on 16 October 2014 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Oct 2014	Median	Range	Oct 2014	Median	Range	Oct 2014
1	10	20	15-36	20	114	89-127	98	4.7	2.0-5.6	5.2
2	10	20	5-30	24	118	80-128	125	5.4	1.6-6.9	6.6
3	10	12	6-18	9	103	77-121	89	2.1	1.4-3.9	3.1
4	6	13	7-24	11	94	77-109	87	2.5	1.8-4.3	1.4

Table 4 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park.

Table 4 Range and median number of taxa, MCI values and SQMCIs scores for 'control' sites (Taranaki ring plain rivers/streams with sources outside Egmont National Park) at altitudes greater than 400 m asl (TRC, 2015).

	No. of taxa	MCI value	$SQMCI_s$ value
No. Samples	33	33	31
Range	8-36	82-127	2.0-7.5
Median	20	109	5.0

The full results from the current survey are presented in Table 5**Error! Reference source not found.**.

Table 5 Macroinvertebrate fauna of an unnamed tributary of the Mangatengehu Stream, sampled on 16 October 2014

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MTH000060	MTH000062	MTH000064	MTH000066
	Sample Number		FWB14316	FWB14317	FWB14318	FWB14319
ANNELIDA (WORMS)	Oligochaeta	1	A	A	C	VA
MOLLUSCA	*Potamopyrgus*	4	R	-	-	R
CRUSTACEA	Ostracoda	1	C	-	-	-
	Paranephrops	5	-	R	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	A	R	-
	Deleatidium	8	R	VA	-	R
	Nesameletus	9	A	R	-	-
	Zephlebia group	7	A	A	-	-
PLECOPTERA (STONEFLIES)	*Acroperla*	5	-	R	R	R
	Austroperla	9	-	R	R	-
	Spaniocerca	8	-	R	-	-
	Stenoperla	10	-	R	-	-
	Zelandoperla	8	-	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	-	R	-	-
	Hydraenidae	8	-	R	-	-
	Ptilodactylidae	8	-	R	-	-
	Scirtidae	8	-	C	-	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	R	R	-	-
	Hydrochorema	9	-	R	-	-
	Polyplectropus	6	A	-	-	-
	Psilochorema	6	R	R	-	-
	Oxyethira	2	-	-	R	-
	Triplectides	5	R	-	-	-
DIPTERA (TRUE FLIES)	Eriopterini	5	R	C	R	R
	Hexatomini	5	R	R	-	-
	Paralimnophila	6	-	-	-	R
	Zelandotipula	6	R	-	R	-
	Orthocladiinae	2	C	C	C	C
	Polypedilum	3	C	C	R	R
	Tanypodinae	5	C	R	-	-
	Ceratopogonidae	3	R	-	-	-
	Paradixa	4	-	-	-	R
	Austrosimulium	3	-	C	-	-
	Stratiomyidae	5	R	-	-	R
ACARINA (MITES)	Acarina	5	R	-	-	-
		No of taxa	20	24	9	11
		MCI	98	125	89	87
		SQMCIs	5.2	6.6	3.1	1.4
		EPT (taxa)	8	12	3	2
		%EPT (taxa)	40	50	33	18

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

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

Site 1

A moderate macroinvertebrate community richness of 20 taxa was found at site 1 (' control' site) at the time of the survey which was the same number as the median number recorded for similar sites and five more than the previous survey (median taxa richness 20; Table 3). Taxa richness was the same as the median calculated from similar sites (Table 4).

The MCI score of 98 units indicated a community of 'fair' biological health which was significantly lower (Stark, 1998) than the median value calculated from previous surveys at the same site (median MCI score 114; Table 3). The $SQMCI_s$ score of 5.2 units was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 4.7 units; Table 3).

The community was characterised by one 'tolerant' taxon [oligochaete worms], two 'moderately sensitive' taxa [mayfly (*Austroclima*) and caddisfly (*Polyplectropus*)], and one 'highly sensitive' taxon [mayfly (*Nesameletus*)] (Table 5).

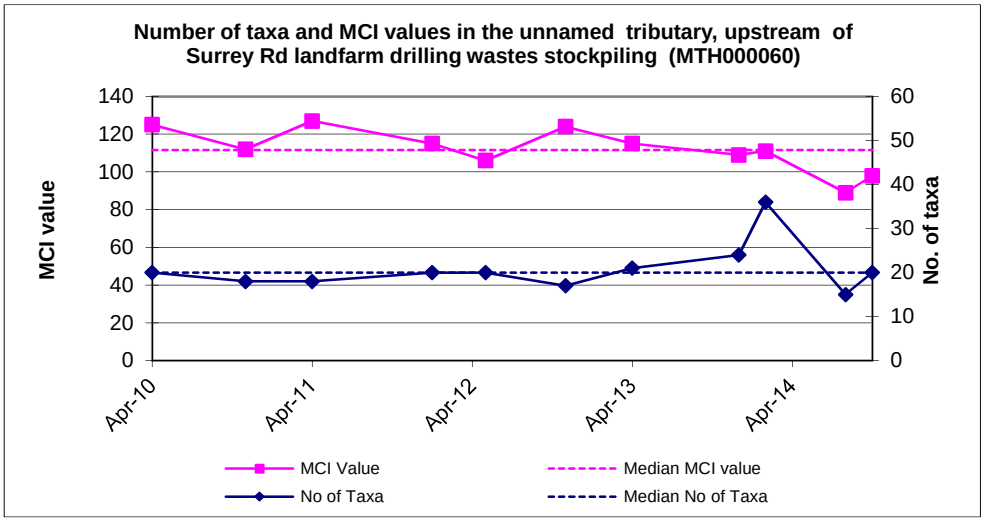

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderate macroinvertebrate community richness of 24 taxa was found at site 2 at the time of the survey which was four taxa more than the median number recorded for the site and for the previous survey (median taxa richness 21; Table 3). Taxa richness was also four taxa more than the median calculated from similar sites (Table 4).

The MCI score of 125 units indicated a community of 'very good' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 118; Table 3). The $SQMCI_s$ score of 6.6 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 5.4 units; Table 3).

The community was characterised by one 'tolerant' taxon [oligochaete worms], two 'moderately sensitive' taxa [mayflies (*Austroclima*) and (*Zephlebia* group)], and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 5).

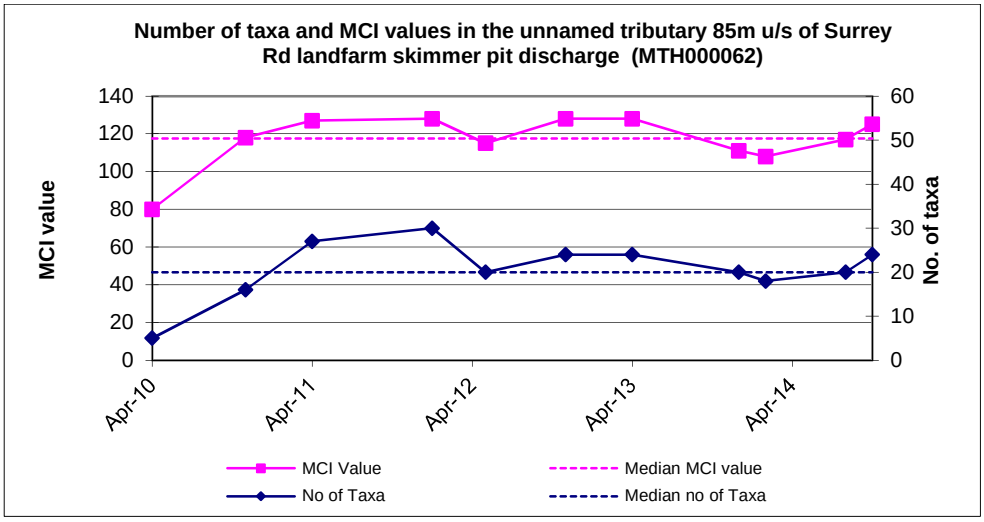

Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangatengehu Stream.

Site 3

A low macroinvertebrate community richness of nine taxa was found at site 3 at the time of the survey which was three taxa less than the median number recorded for the site and six taxa less than the previous survey (median taxa richness 12; Table 3). Taxa richness was also 11 taxa lower than the median calculated from similar sites (Table 4).

The MCI score of 89 units indicated a community of 'fair' biological health which was significantly lower (Stark, 1998) than the median value calculated from previous surveys at the same site (median MCI score 103; Table 3). The $SQMCI_s$ score of 3.1 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 2.1 units; Table 3).

The macroinvertebrate community had no abundant taxa with the nine taxa present at the site comprised of two 'common' taxa and seven 'rare' taxa (Table 5).

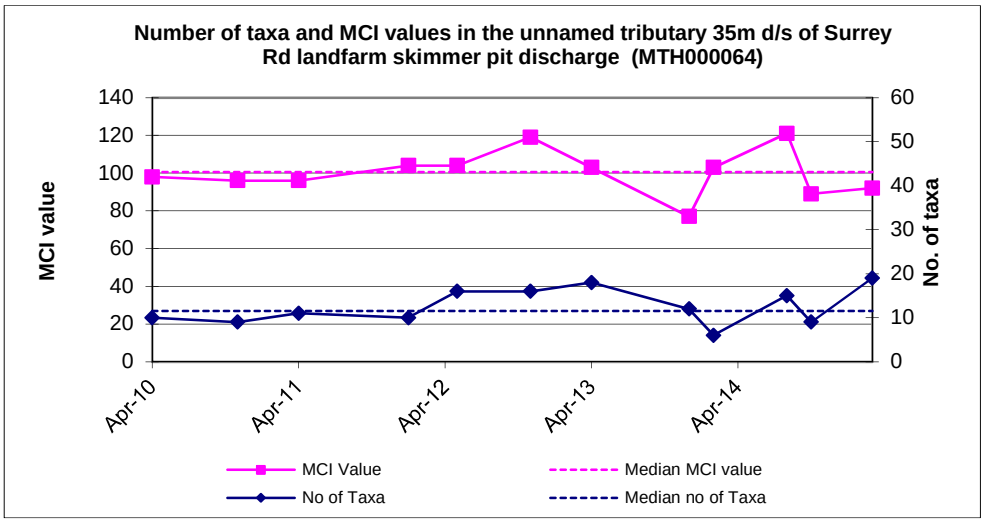

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangatengehu Stream.

Site 4

A low macroinvertebrate community richness of 11 taxa was found at site 4 at the time of the survey which was two taxa less than the median number recorded for the site and three taxa less than the previous survey (median taxa richness 13; Table 3). Taxa richness was also nine taxa lower than the median calculated from similar sites (Table 4).

The MCI score of 87 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 94; Table 3). The $SQMCI_s$ score of 1.4 units was significantly lower (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 2.5 units; Table 3).

The community was characterised by one 'tolerant' taxon (oligochaete worms) (Table 5).

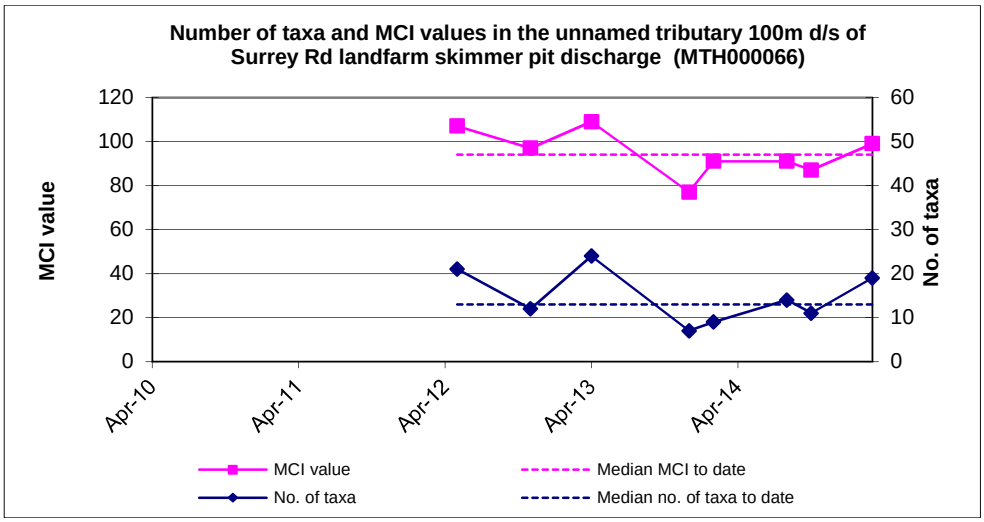

Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangatengehu Stream.

Discussion and Conclusions

The Council's 'kick-sampling' and 'vegetation sweep' techniques were used at four sites to collect streambed macroinvertebrates from an unnamed tributary of the Mangatengehu Stream in relation to the storage of drilling waste within its vicinity and the discharge of stormwater to land or to the stream. This has provided data to assess any potential impacts the consented activities have had on the macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (richness), MCI, and $SQMCI_s$ scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges. Macroinvertebrates when exposed to toxic chemicals may die and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). 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 abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_s$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

There were significant differences between sites 1 and 2 which both act as 'control' sites for the current survey and sites 3 and 4 which are the two 'impacted' sites for the macroinvertebrate indices examined. The 'control' sites macroinvertebrate indices were all higher than the 'impacted' sites whereas that the quality of the macroinvertebrate communities at the two 'impacted' sites was significantly lower. In particular taxa richness, a key indicator of toxic discharges, was substantially lower at the two impacted sites

However, there was significant habitat variability among the four sites with site 2 appearing to be the most favourable site for macroinvertebrates (mostly native riparian cover with partial bed shading and a course gravel and cobble substrate), which is borne out by it possessing higher macroinvertebrate indices than site 1, the other 'control' site. Site 1 also had silt buildup at the edge of the stream which was likely caused by previous stock damage (Thomas 2014c) which would lower habitat quality. Sites 1, 3 and 4 were more similar to each other in that they had no shading but site 1 had a substantially different substrate type, silt with macrophytes on the bed, compared with sites 3 and 4 which were mostly cobbles with some course gravel. Therefore, comparisons among sites have to be viewed with some caution as site and habitat differences can confound attempts to determine impacts caused by discharges.

Comparison of the macroinvertebrate indices of the four sites surveyed with the median value for similar sites occurring at the same altitudinal band reveals that the 'control' sites had either similar or higher macroinvertebrate indices apart from the site 1 MCI score which was just significantly lower. The 'impacted' sites had significantly lower macroinvertebrate health indices which provide further evidence of potential impacts at the sites.

In relation to the previous survey the two 'control' sites showed improvements in their taxa richnesses and MCI scores whereas the two 'impacted' sites showed deterioration. However, the MCI scores were not significantly different (Stark, 1998) between the August 2014 and October 2014 surveys except for site 3 which showed a large decrease of 32 units. This may suggest that there have been further impacts from landfarming discharges but may also be due to seasonal variation. Macroinvertebrate samples will typically show higher abundances and taxa richnesses in summer and lower abundances and taxa richnesses in winter but factors such as very low flows, high water temperatures and excessive periphyton growth may all contribute to lowering the health of macroinvertebrate communities. Sites 3 and 4 both had thick mats of *Phormidium* sp (potentially toxic cyanobacteria) and widespread long green filamentous algae. They also had a thick coasting of iron oxide which would also reduce the quality of macroinvertebrate habitat. Sites 1 and 2 also had less prevalent iron oxide silt coatings.

Overall, the two potentially 'impacted' sites showed significant differences in the macroinvertebrate indices examined compared with the 'control' sites at the time of the survey with the 'control' sites having higher macroinvertebrate indices than the 'impacted' sites. There was some significant habitat variation among sites which makes discrimination between impacts from landfarming activities and habitat effects difficult. Overall, the results of the spring survey suggest that the activities at the drilling waste stockpiling site and landfarming area may have had an impact on the macroinvertebrate communities in the unnamed tributary of the Mangatengehu Stream but the degree of this impact cannot be determined as they may also have been affected by habitat variability and/or seasonal effects.

Summary

- A macroinvertebrate survey was performed at four sites in an unnamed tributary of the Mangatengehu Stream in relation to the stockpiling and discharge of drilling waste to land at the Surrey Rd landfarm.

- There were some significant differences in the macroinvertebrate indices examined between the 'control' and 'impacted' sites at the time of the survey with the 'control' sites having higher macroinvertebrate indices than the 'impacted' sites.

- The two 'control' sites showed improvements in their taxa richnesses and MCI scores since the last survey in August 2014 whereas the two 'impacted' sites had decreases but the differences were not significant except for site 3 which showed a significant decrease in MCI score.

- There was substantial habitat variation (riparian cover, substrate type etc) among sites which makes discrimination between any impacts from landfarming activities and habitat effects difficult.

- There was some evidence from the macroinvertebrate indices examined that stockpiling and discharge of drilling waste to land had some effects on the health of the macroinvertebrate communities but habitat variation makes any conclusions about the extent or existence of impacts tenuous.

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To	Job Manager, Nathan Crook
From	Scientific Officer, Darin Sutherland
Document	1532412
Report No	DS017
Date	June 2015

Biomonitoring of an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road landfarm, March 2015

Introduction

A macroinvertebrate survey was performed on 2 March 2015 in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangatengehu Stream in relation to the disposal of drilling waste to land within its vicinity at the Surrey Road land farm. The site located off Surrey Road, receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits. From here it is either pumped out for removal, or discharges to the land in the vicinity of the unnamed tributary. No consent is held to discharge to the tributary from the skimmer pits, as this discharge was considered to comply with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that the discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life.

Surveys undertaken in December 2013 (Thomas, 2014a), February 2014 (Thomas, 2014b), August 2014 (Thomas, 2014c) and October 2014 (Sutherland, 2015) indicated that activities at the drilling waste stockpiling site and landfarming area may have resulted in impacts on the macroinvertebrate communities in the lower section of the tributary of the Mangatengehu Stream.

Methods

This scheduled biomonitoring survey was undertaken at four sites on 2 March 2015 (Table 1 and Figure 1). At the time of the initial survey undertaken in April 2010, site 1 was established as a 'control site', upstream of the drilling stockpile area and sites 2 and 3 were established downstream of the skimmer pit discharge. During an inspection of the site in mid-2010, an unauthorised discharge of hydrocarbons was observed entering the stream. As a consequence of this inspection, changes were made to the on site drainage. These changes were made between the April 2010 and November 2010 surveys. The result was that site 2 was located upstream of any discharge from the sites, and site 3 became the primary impact site. The stormwater discharge from the site now enters the unnamed tributary immediately upstream of the race crossing, approximately 35 metres upstream of site 3. A new, secondary impact site (site 4) was established 100 metres downstream of the stormwater discharge during the May 2012 survey.

The Council's standard '400ml kick-sampling' technique was used at sites 2, 3 and 4 and a combination of the 'kick-sampling' and 'vegetation sweep' sampling techniques was used at site 1 (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).

Table 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream in relation to the Surrey Road drilling waste stockpiling activities

Site Number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MTH000060	E1701830 N5651430	Upstream of drilling waste stockpiling site	495
2	MTH000062	E1701954 N5651468	Approximately 85 metres upstream of the spring and skimmer pit discharge	495
3	MTH000064	E1702050 N5651525	Approximately 35 metres downstream of the skimmer pit discharge	490
4	MTH000066	E1702102 N5651582	Approximately 100 metres downstream, of the skimmer pit discharge	485

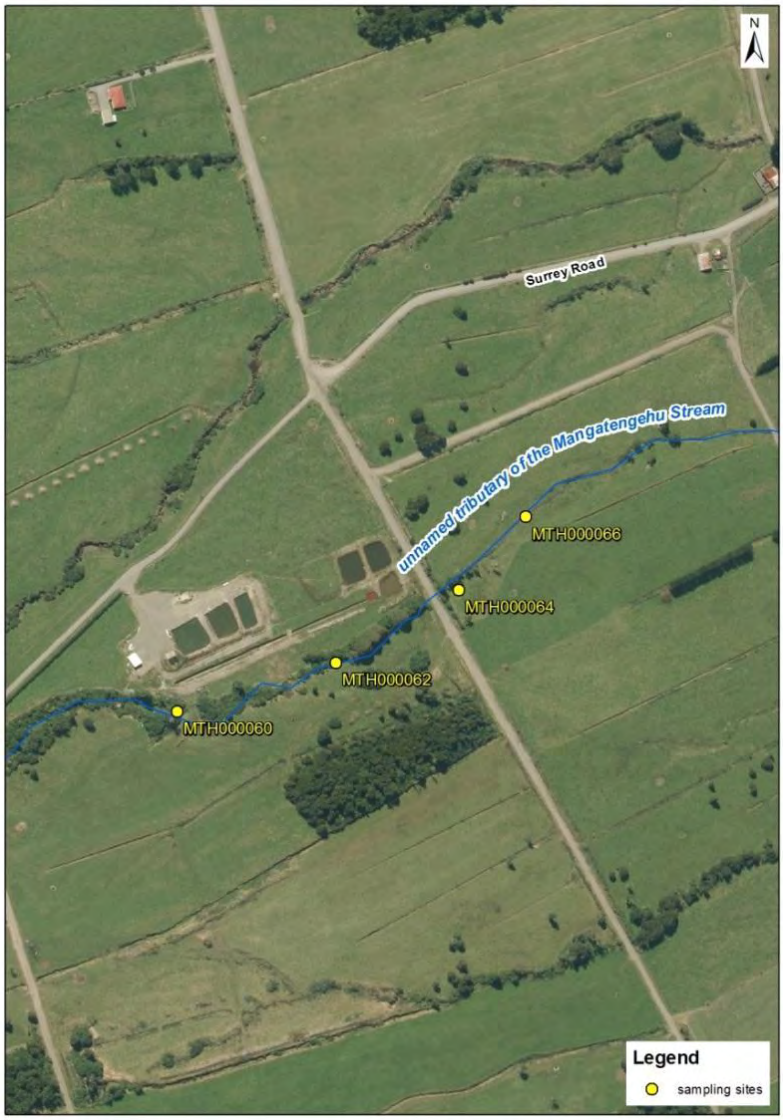

Figure 1 Biomonitoring sites in an unnamed tributary of the Mangatengehu Stream, sampled in relation to the Surrey Road drilling waste stockpiling site

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols for 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)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 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, 19 98 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 and hydrology

This March 2015 survey followed a period of 28 days since a fresh in excess of three times median flow, and 29 days since a fresh in excess of seven times median flow. The majority of flows during the last month were close to the 7 day mean annual low flow (MALF).

The water temperatures were relatively cool (12.7-13.0 °C). Water levels were very low and water speeds either slow or steady. Water was uncoloured and clear for all sites during the survey (Table 2). Site 1 had a silt substrate, site 2 had a substrate composition which was mainly silt and cobbles, site 3 and 4 had predominately cobble substrates with some course gravel and silt.

There were no periphyton mats at sites 1 and 2 and slippery periphyton mats at sites 3 and 4. There were no filamentous algae at sites 1 and 2, site 3 had patchy filamentous algae and site 4 had widespread filamentous algae. There was no moss at sites 1, 3 and 4 while site 2 had patchy moss. Sites 1 and 3 had patchy leaves, site 2 had widespread leaves and site 4 had no leaves. There was no wood at sites 1, 3 and 4 while site 2 had patchy wood. Macrophytes were

present on the stream bed at site 1 but absent from sites 2, 3 and 4. Sites 1, 3 and 4 had no shade and overhanging vegetation while site 2 did have partial shading and overhanging vegetation.

Table 2 Summary of time of sampling and some water variables collected at four sites in the unnamed tributary of the Mangatengehu Stream sampled in relation to the Surrey Rd landfarm on 2 March 2015.

Site	Time (NZST)	Temperature (°C)	Water Colour	Water Clarity	Flow Conditions	Water Speed
1	1000	12.7	Uncoloured	Clear	Very low	Slow
2	0925	12.7	Uncoloured	Clear	Very low	Slow
3	0900	13.0	Uncoloured	Clear	Very low	Steady
4	0835	13.0	Uncoloured	Clear	Very low	Steady

Macroinvertebrate communities

Table 3 provides a summary of the results from previous surveys sampled in relation to the Surrey Rd drilling waste stockpiling site along with current survey results.

Table 3 Number of taxa, MCI and $SQMCI_s$ values for an unnamed tributary of the Mangatangehu Stream, sampled in relation to the Surrey Rd landfarm drilling waste stockpiling site on 2 March 2015 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Mar 2015	Median	Range	Mar 2015	Median	Range	Mar 2015
1	11	20	15-36	20	112	89-127	96	4.9	2.0-5.6	5.1
2	11	20	5-30	19	118	80-128	113	5.5	1.6-6.9	4.1
3	11	11	6-18	19	103	77-121	92	2.1	1.4-3.9	3.5
4	7	12	7-24	19	91	77-109	99	2.1	1.4-4.3	4.2

Table 4 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park.

Table 4 Range and median number of taxa, MCI values and SQMCIs scores for 'control' sites (Taranaki ring plain rivers/streams with sources outside Egmont National Park) at altitudes greater than 400 m asl (TRC, 2015).

	No. of taxa	MCI value	$SQMCI_s$ value
No. Samples	33	33	31
Range	8-36	82-127	2.0-7.5
Median	20	109	5.0

The full results from the current survey are presented in Table 5.

Table 5 Macroinvertebrate fauna of an unnamed tributary of the Mangatengehu Stream, sampled on 2 March 2015.

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MTH000060	MTH000062	MTH000064	MTH000066
	Sample Number		FWB15192	FWB15193	FWB15194	FWB15195
NEMERTEA	Nemertea	3	R	-	-	-
ANNELIDA (WORMS)	Oligochaeta	1	A	C	A	A
	Lumbricidae	5	-	-	R	R
MOLLUSCA	*Gyraulus*	3	R	-	-	-
	Potamopyrgus	4	C	-	R	-
CRUSTACEA	Ostracoda	1	R	-	R	-
	Talitridae	5	R	-	-	-
	Paranephrops	5	-	R	C	R
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	-	R	-	-
	Austroclima	7	-	C	R	-
	Deleatidium	8	-	A	-	A
	Neozephlebia	7	C	-	-	-
	Nesameletus	9	A	R	-	-
	Zephlebia group	7	A	C	R	R
PLECOPTERA (STONEFLIES)	*Austroperla*	9	R	R	-	-
	Zelandoperla	8	-	-	R	R
COLEOPTERA (BEETLES)	Hydrophilidae	5	-	-	-	R
	Ptilodactylidae	8	R	R	-	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	-	-	-	C
	Polyplectropus	6	A	R	A	C
	Psilochorema	6	C	C	R	C
	Triplectides	5	-	-	-	R
DIPTERA (TRUE FLIES)	Eriopterini	5	-	R	-	-
	Hexatomini	5	-	R	-	R
	Limonia	6	-	-	R	-
	Zelandotipula	6	-	-	R	R
	Orthocladiinae	2	-	C	A	A
	Polypedilum	3	A	VA	C	A
	Tanypodinae	5	A	R	R	R
	Culicidae	3	-	-	R	-
	Paradixa	4	R	-	R	R
	Empididae	3	R	C	R	R
	Ephydridae	4	R	-	-	-
	Austrosimulium	3	C	C	-	-
ACARINA (MITES)	Acarina	5	R	R	C	A
		No of taxa	20	19	19	19
		MCI	96	113	92	99
		SQMCIs	5.1	4.1	3.5	4.2
		EPT (taxa)	6	8	5	7
		%EPT (taxa)	30	42	26	37

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

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

Site 1

A moderate macroinvertebrate community richness of 20 taxa was found at site 1 ('control' site) at the time of the survey which was the same number as the median number recorded for similar sites and for the previous sample (median taxa richness 20; Table 3). Taxa richness was the same as the median calculated from similar sites (Table 4).

The MCI score of 96 units indicated a community of 'fair' biological health which was significantly lower (Stark, 1998) than the median value calculated from previous surveys at the same site (median MCI score 112; Table 3). The $SQMCI_s$ score of 5.1 units was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 4.9 units; Table 3).

The community was characterised by two 'tolerant' taxa [oligochaete worms and midge (*Polypedilum*)], three 'moderately sensitive' taxa [mayfly (*Zephlebia* group), caddisfly (*Polyplectropus*), and midges (Tanypodinae)], and one 'highly sensitive' taxon [mayfly (*Nesameletus*)] (Table 5).

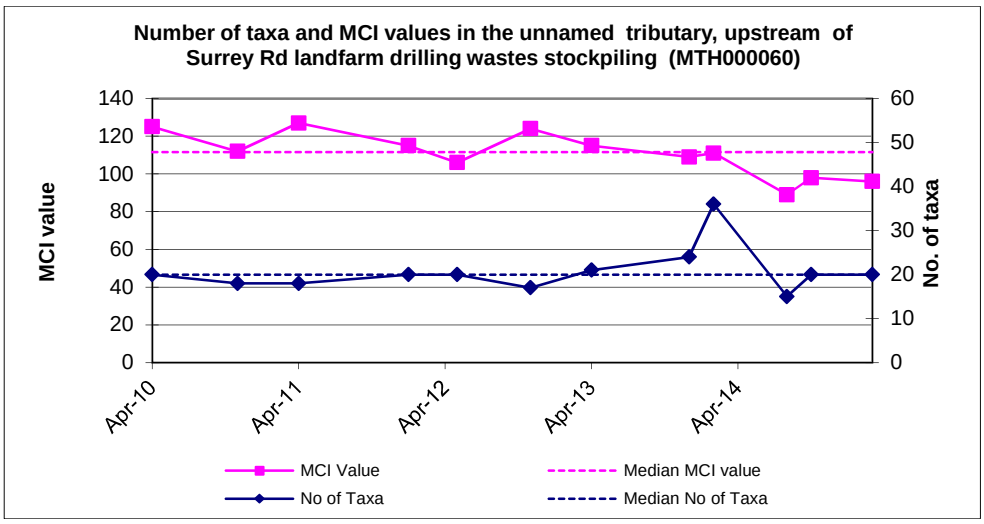

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderate macroinvertebrate community richness of 20 taxa was found at site 2 at the time of the survey which was the same as the median number recorded for the site and for the median number calculated from similar sites (median taxa richness 20; Table 3; Table 4). Taxa richness had decreased by four since the previous survey.

The MCI score of 113 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 118; Table 3). The $SQMCI_s$ score of 4.1 units was significantly lower (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 5.4 units; Table 3).

The community was characterised by one 'tolerant' taxon [midge (*Polypedilum*)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 5).

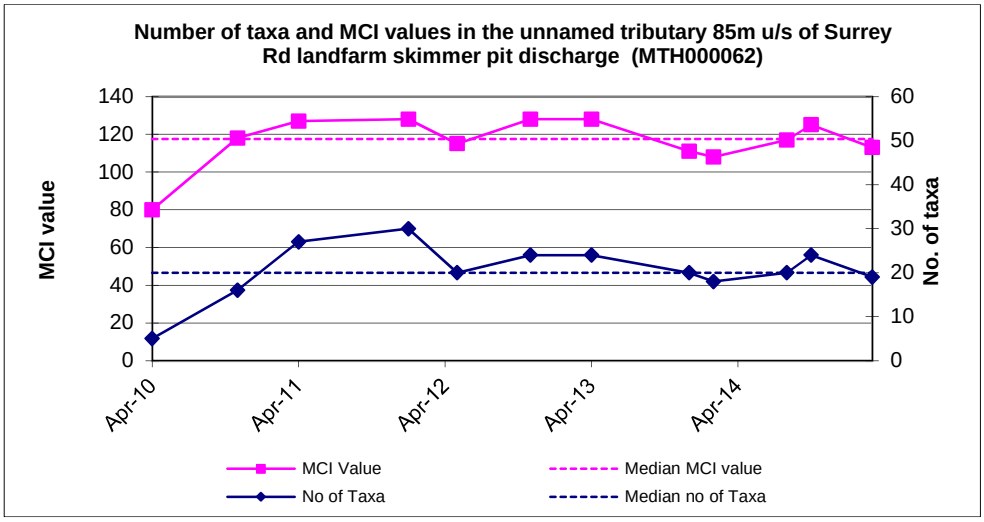

Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangatengehu Stream.

Site 3

A moderate macroinvertebrate community richness of 19 taxa was found at site 3 at the time of the survey which was eight taxa more than the median number recorded for the site and 10 taxa more than the previous survey (median taxa richness 11; Table 3). Taxa richness was one taxon lower than the median calculated from similar sites (Table 4).

The MCI score of 92 units indicated a community of 'fair' biological health which was significantly lower (Stark, 1998) than the median value calculated from previous surveys at the same site (median MCI score 103; Table 3). The $SQMCI_s$ score of 3.5 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 2.1 units; Table 3).

The community was characterised by two 'tolerant' taxa [oligochaete worms and midge (Orthocladiinae)] and one 'moderately sensitive' taxon [caddisfly (*Polyplectropus*)] (Table 5).

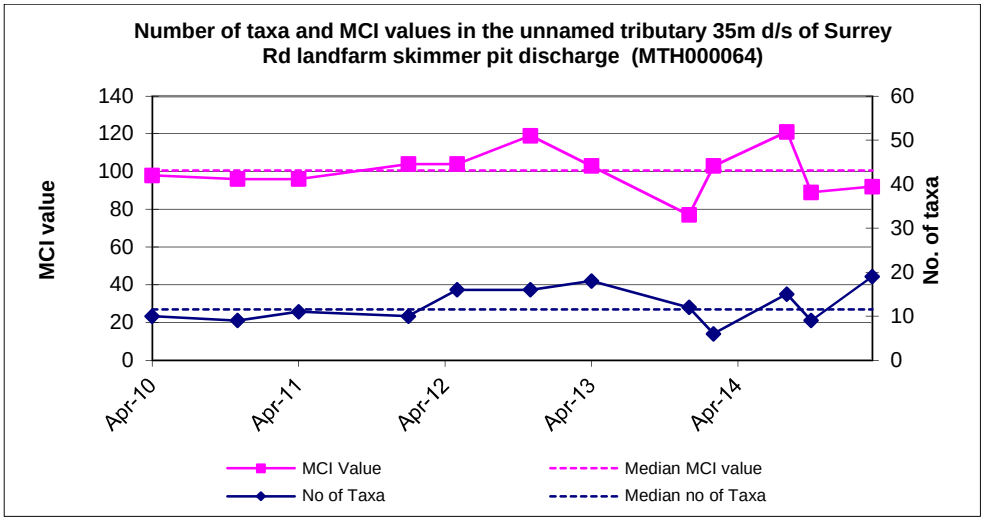

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangatengehu Stream.

Site 4

A moderate macroinvertebrate community richness of 19 taxa was found at site 4 at the time of the survey which was seven taxa more than the median number recorded for the site and eight taxa more than the previous survey (median taxa richness 12; Table 3). Taxa richness was one taxon lower than the median calculated from similar sites (Table 4).

The MCI score of 99 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 94; Table 3). The $SQMCI_s$ score of 4.2 units was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 2.1 units; Table 3).

The community was characterised by three 'tolerant' taxa [oligochaete worms and midges (Orthocladiinae and *Polypedilum*)], one 'moderately sensitive' taxon [mites (Acarina)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 5).

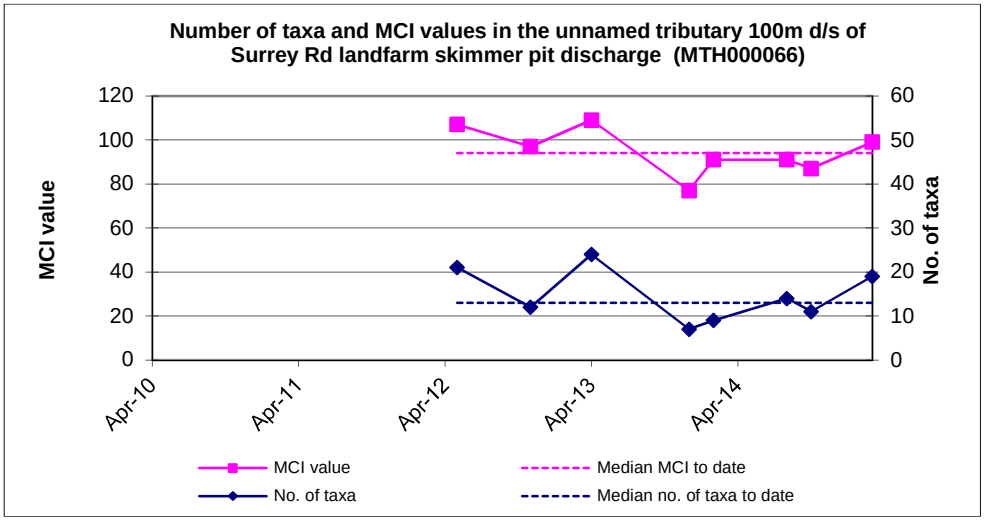

Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangatengehu Stream.

Discussion and Conclusions

The Council's 'kick-sampling' and 'vegetation sweep' techniques were used at four sites to collect streambed macroinvertebrates from an unnamed tributary of the Mangatengehu Stream in relation to the storage of drilling waste within its vicinity and the discharge of stormwater to land or to the stream. This has provided data to assess any potential impacts the consented activities have had on the macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (richness), MCI, and $SQMCI_s$ scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges. Macroinvertebrates when exposed to toxic chemicals may die and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). 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 abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_s$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

In general there were insignificant differences in the macroinvertebrate indices between sites 1 and 2 which both act as 'control' sites for the current survey and sites 3 and 4 which are the two 'impacted' sites for the macroinvertebrate indices examined. The 'control' sites taxa richnesses were nearly identical to the 'impacted' sites taxa richnesses. MCI scores for site 1 were not significantly different to the two 'impacted' sites but site 2 had a significantly higher MCI score than at the other three sites which would be a reflection of the different site characteristics between the riparian planted and shaded site 2 and the unshaded sites 1, 3 and 4.

SQMCIs scores for sites 2, 3 and 4 were also not significantly different to each other but site 1 had a significantly higher score compared with the other sites as a result of it containing three abundant 'moderately sensitive' taxa and one abundant 'highly sensitive' taxon. The SQMCIs scores for sites 1 and 2 would be identical if site 2 recorded the chironomid genus *Polypedilum* as abundant instead of very abundant. This emphasised the sensitivity of the SQMCIs to changes in abundance of taxa (particularly highly abundant taxa) and it therefore should be used with caution.

Comparison of the macroinvertebrate indices of the four sites surveyed with the median value for similar sites occurring at the same altitudinal band reveals that both the 'control' sites and the 'impacted' sites had very similar or identical taxa richnesses. MCI scores for sites 1 and 3 but not sites 2 and 4 were significantly lower compared with the median value at similar sites in the same altitudinal band which is due to habitat variability.

In relation to the previous survey the two 'control' sites showed little change in their taxa richnesses but site 2 had a significant decrease in MCI score which is likely related to the very low water levels encountered when sampling was undertaken at the site. The 'impacted' sites showed improvements in taxa richness and site 4 had a significant increase in MCI score. This may have been due to improvements in water quality caused by a lack of any significantly harmful discharges. Sites 3 and 4 also had decreases in nuisance periphyton levels with no cyanobacteria (*Phormidium* sp) noted in the survey compared with the thick mats found by previous surveys at the site and filamentous algae which was still

widespread was not as abundant as the previous survey.

Overall, the two potentially 'impacted' sites showed insignificant differences in the macroinvertebrate indices examined compared with the 'control' sites at the time of the survey indicating that there was no evidence for landfarming activities having had significant impacts on the macroinvertebrate communities in the unnamed tributary of the Mangatengehu Stream.

Summary

- A macroinvertebrate survey was performed at four sites in an unnamed tributary of the Mangatengehu Stream in relation to the stockpiling and discharge of drilling waste to land at the Surrey Rd landfarm.

- There were mostly insignificant differences in the macroinvertebrate indices examined between the 'control' and 'impacted' sites at the time of the survey.

- The two 'impacted' sites showed improvements in their taxa richnesses and MCI scores since the last survey whereas there was little change in these indices at the two 'control' sites.

- There was no evidence for landfarming activities having had significant impact on the macroinvertebrate communities in the unnamed tributary of the Mangatengehu Stream.

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To	Job Manager, Nathan Crook
From	Scientific Officer, Darin Sutherland
Document	1528813
Report No	DS015
Date	June 2015

Biomonitoring of an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road land farm, March 2015

Introduction

A macroinvertebrate survey was performed in order to monitor the health of the macroinvertebrate communities of an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land within its vicinity. The survey was conducted in spring and was one of two scheduled surveys for the site in the 2014-15 year. The site receives drilling wastes, which are stored on site, and then eventually spread over land. Drainage of water from the storage pits flows through at least two skimmer pits where it is either pumped out for removal, or discharged to the unnamed tributary. No consent was held to discharge to the tributary from the skimmer pits, as it was intended that no discharges to surface water would occur unless they complied with permitted activity rule 23 of the Regional Fresh Water Plan for Taranaki. A condition of this permitted activity rule is that any discharge shall not give rise to (amongst other effects), any significant adverse effects on aquatic life. However, during the 2010-2011 monitoring period several non-compliance discharge events were recorded (TRC, 2012) culminating in the requirement for a consent to discharge which was issued in September 2011. This consent to discharge stormwater (7911-1) provided for a 25 metre mixing zone in the tributary.

A baseline survey was undertaken in April 2009, prior to any receipt of drilling wastes at the site. At the time of the baseline survey the communities at the downstream sites had experienced significant habitat deterioration due to the realignment of the tributary, and also the discharge of significant amounts of sediment through associated land disturbance. However, the upstream control site was relatively unaffected.

The previous survey performed in October 2014 (Sutherland, 2015) found that the activities at the drilling waste stockpiling site and landfarming area had not had any significant impacts on the macroinvertebrate communities present in the unnamed tributary of the Mangamawhete Stream.

Methods

Four sites were sampled in this survey. The 'control' site (site 1) was established in the unnamed tributary, alongside the upstream boundary of the land treatment area. Site 2 was established between the land treatment area and the storage pits, and site 3 was established just downstream of the skimmer pit discharge point. A fourth site was established approximately 200m downstream of the skimmer pit discharge. This fourth site provides comparative information, should deterioration be recorded at sites 2 or 3. The sampling site locations are presented in Table 1 and Figure 1.

The Council's standard 'kick-sampling' sampling technique was used at these four sites (Table 1) to collect streambed macroinvertebrates on 2 March 2015. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Table 1 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream in relation to the Derby Road drilling waste stockpiling activities

Site number	Site code	Grid reference (NZTM)	Location	Altitude (masl)
1	MMW000161	E1702317 N5653463	Upstream of drilling waste stockpiling site	450
2	MMW000162	E1702508 N5653560	Downstream of land spreading area	440
3	MMW000163	E1702734 N5653676	Downstream of skimmer pit discharge	435
4	MMW000165	E1702900 N5653750	200m downstream of skimmer pit discharge	430

Figure 1 Biomonitoring sites in an unnamed tributary of the Mangamawhete Stream, sampled in relation to the Derby Rd drilling waste stockpiling site

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using Protocol P1 of NZMWG protocols for 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)	= 20-99 individuals;
VA (very abundant)	= 100-499 individuals;
XA (extremely abundant)	= 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 and hydrology

This March 2015 survey followed a period of 28 days since a fresh in excess of three times median flow, and 29 days since a fresh in excess of seven times median flow. The majority of flows during the last month were close to the 7 day mean annual low flow (MALF).

The water temperatures were moderate. Water levels were very low and water speeds swift in the riffles. Water was uncoloured and clear for all sites during the survey (Table 2). Substrate composition for site 1 was mostly composed of a mixture of sand, course gravel, and cobble, for site 2 it was predominately silt, cobble and boulder, for site 3 it was silt, cobble and boulder and for site 4 it was silt, coarse gravel and cobble.

There were slippery periphyton mats at sites 2 and 3 but none at sites 1 and 4 and widespread filamentous algae at sites 2. Moss and macrophytes were absent from all sites. Leaves were widespread in sites 1, 3 and 4 but absent at site 2 and wood was patchy at sites 1, 3 and 4 but absent at site 2. Sites 1, 3 and 4 had shade and overhanging vegetation while site 2 did not have any shade or overhanging vegetation.

Table 2 Summary of time of sampling and some water variables collected at four sites in the unnamed tributary of the Mangamawhete Stream, sampled in relation to the Derby Rd landfarm on 2 March 2015.

Site	Time (NZST)	Temperature (°C)	Water Colour	Water Clarity	Flow Conditions	Water Speed
1	1235	16.7	Uncoloured	Clear	Very low	Steady
2	1210	17.3	Uncoloured	Clear	Very low	Steady
3	1145	18.9	Uncoloured	Clear	Very low	Steady
4	1105	14.5	Uncoloured	Clear	Very low	Steady

Macroinvertebrate communities

Table 3 provides a summary of the results from previous surveys sampled in relation to the Derby Rd drilling waste stockpiling site along with current survey results.

Table 3 Number of taxa, MCI and $SQMCI_S$ values for an unnamed tributary of the Mangamawhete Stream, sampled in relation to the Derby Rd drilling waste stockpiling site on 2 March 2015 and a summary of historical data for these sites.

Site No.	N	No of taxa			MCI value			$SQMCI_S$ value		
		Median	Range	Mar 2015	Median	Range	Mar 2015	Median	Range	Mar 2015
1	11	22	12-33	25	104	87-114	106	5.0	3.2-7.4	5.1
2	11	14	6-30	21	100	80-109	98	3.4	2.0-7.4	2.5
3	11	16	5-19	18	100	88-109	103	4.4	2.5-5.9	2.5
4	11	18	6-24	17	93	73-110	105	4.6	2.1-6.8	4.0

Table 4 provides a summary of various macroinvertebrate indices within a specific altitudinal band for 'control' sites situated in Taranaki ring plain streams arising outside of Egmont National Park.

Table 4 Range and median number of taxa, MCI values and SQMCIs scores for 'control' sites (ring plain rivers/streams with sources outside the National Park) at altitudes greater than 400 m asl (TRC, 2015).

	No. of taxa	MCI value	$SQMCI_S$ value
No. Samples	33	33	31
Range	8-36	82-127	2.0-7.5
Median	20	109	5.0

The full results from the current survey are presented in Table 5.

Table 5 Macroinvertebrate fauna of an unnamed tributary of the Mangamawhete Stream, sampled on 2 March 2015 in relation to the Derby Rd Landfarm.

Taxa List	Site Number	MCI score	1	2	3	4
	Site Code		MMW000161	MMW000162	MMW000163	MMW000165
	Sample Number		FWB15196	FWB15197	FWB15198	FWB15199
NEMERTEA	Nemertea	3	R	R	R	-
ANNELIDA (WORMS)	Oligochaeta	1	C	R	A	R
	Lumbricidae	5	C	-	-	-
MOLLUSCA	*Potamopyrgus*	4	A	C	C	C
	Sphaeriidae	3	R	-	-	-
CRUSTACEA	Ostracoda	1	R	VA	A	-
EPHEMEROPTERA (MAYFLIES)	*Acanthophlebia*	9	-	-	R	-
	Ameletopsis	10	R	-	-	-
	Austroclima	7	C	R	R	C
	Coloburiscus	7	-	-	-	R
	Deleatidium	8	C	C	R	C
	Nesameletus	9	-	R	-	-
	Zephlebia group	7	R	-	-	R
COLEOPTERA (BEETLES)	Elmidae	6	-	C	-	-
	Ptilodactylidae	8	C	-	R	R
	Scirtidae	8	-	R	-	-
	Staphylinidae	5	R	-	-	-
NEUROPTERA	*Kempynus*	8	-	-	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	R	R	-
TRICHOPTERA (CADDISFLIES)	*Hydrobiosis*	5	-	R	-	R
	Hydrochorema	9	C	-	-	-
	Hydropsyche (Orthopsyche)	9	R	-	R	R
	Polyplectropus	6	C	C	R	-
	Psilochorema	6	C	C	R	R
	Oxyethira	2	-	A	-	-
	Pycnocentria	7	R	-	-	C
DIPTERA (TRUE FLIES)	*Aphrophila*	5	-	R	-	-
	Eriopterini	5	R	R	R	-
	Hexatomini	5	R	R	R	-
	Harrisius	6	R	-	R	-
	Orthocladiinae	2	C	A	R	A
	Polypedilum	3	R	-	R	A
	Tanypodinae	5	R	A	-	-
	Dolichopodidae	3	-	R	-	-
	Empididae	3	-	-	-	R
	Psychodidae	1	-	-	-	R
	Austrosimulium	3	C	-	R	C
	Tanyderidae	4	R	-	-	-
ACARINA (MITES)	Acarina	5	-	R	-	-
		No of taxa	25	21	18	17
		MCI	106	98	103	105
		SQMCIs	5.1	2.5	2.5	4.0
		EPT (taxa)	9	6	6	8
		%EPT (taxa)	36	29	33	47

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

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

Site 1

A moderate macroinvertebrate community richness of 25 taxa was found at site 1 (‘ control’ site) at the time of the survey which was three taxa more than the median number recorded for the site and seven more than the previous sample (median taxa richness 22; Table 3).

The MCI score of 106 units indicated a community of ‘good’ biological health which was the same as the median value calculated from previous surveys at the same site (median MCI score 106; Table 3). The $SQMCI_s$ score of 5.1 units was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 5.1 units; Table 3).

The community was characterised by one ‘tolerant’ taxon [snail (*Potampyrgus*)] (Table 5).

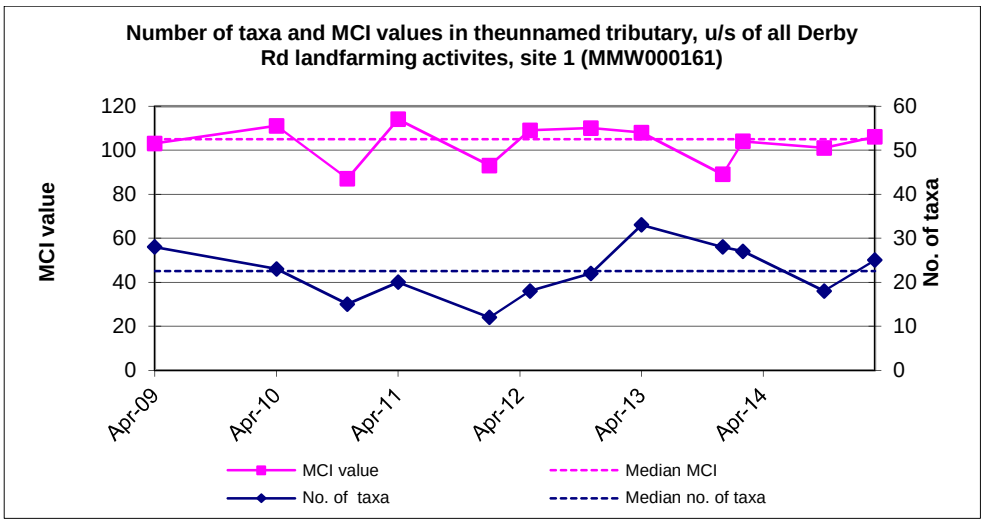

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded at site 1 in the unnamed tributary.

Site 2

A moderately low macroinvertebrate community richness of 14 taxa was found at site 2 at the time of the survey which was seven taxa less that the median number recorded for the site and one taxon more than the previous sample (median taxa richness 21; Table 3).

The MCI score of 98 units indicated a community of ‘fair’ biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 100; Table 3). The $SQMCI_s$ score of 2.5 units was significantly lower (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 3.8 units; Table 3).

The community was characterised by two ‘tolerant’ taxa [ostracod seed shrimp and midge (Orthocladiinae)] and one ‘moderately sensitive’ taxon [midge (Tanypodinae)] (Table 5).

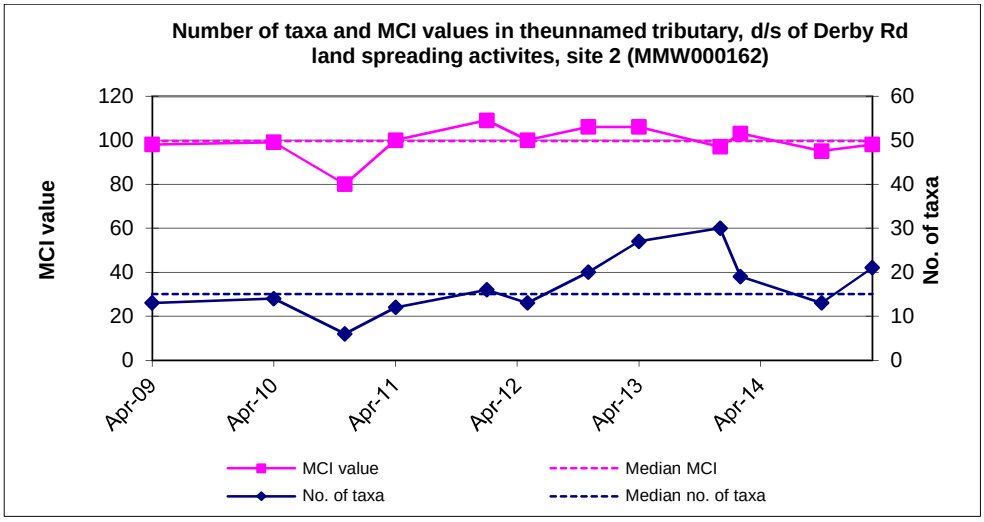

Figure 3 Numbers of macroinvertebrate taxa and MCI values recorded at site 2 in an unnamed tributary of Mangamawhete Stream.

Site 3

A moderate macroinvertebrate community richness of 18 taxa was found at site 3 at the time of the survey which was two taxa more than the median number recorded for the site and one taxon more than the previous sample (median taxa richness 16; Table 3).

The MCI score of103 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median MCI score 100; Table 3). The $SQMCI_s$ score of 2.5 units was significantly lower (Stark, 1998) than the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 4.4 units; Table 3).

The community was characterised by two 'tolerant' taxa (oligochaete worms and ostracod seed shrimp) (Table 5).

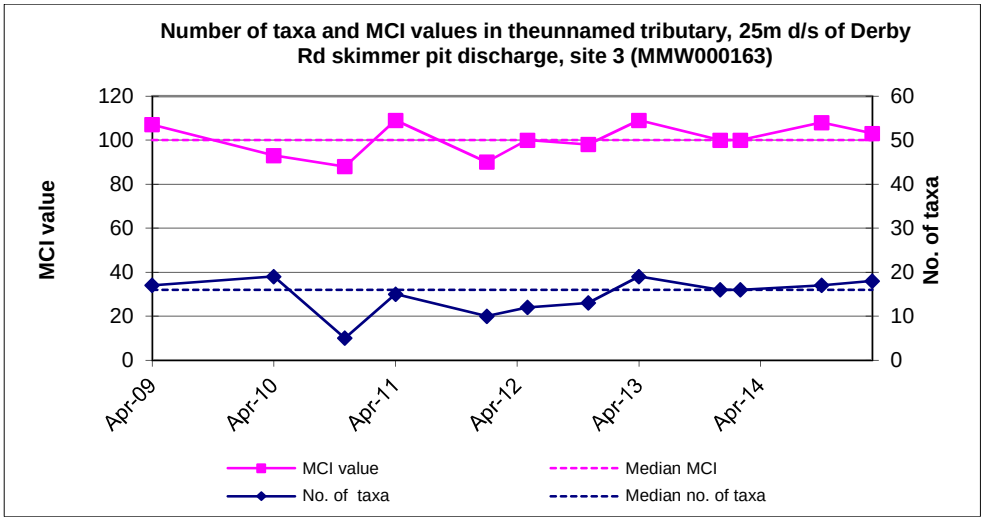

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded at site 3 in an unnamed tributary of Mangamawhete Stream.

Site 4

A moderate macroinvertebrate community richness of 17 taxa was found at site 4 at the time of the survey which was one taxon less than the median number recorded for the site and six taxa less than the previous sample (median taxa richness 18; Table 3).

The MCI score of105 units indicated a community of 'good' biological health which was significantly higher (Stark, 1998) than the median value calculated from previous surveys at the same site (median MCI score 93; Table 3). The $SQMCI_s$ score of 4.0 units was not significantly different (Stark, 1998) to the median value calculated from previous surveys at the same site (median $SQMCI_s$ score of 4.6 units; Table 3).

The community was characterised by two 'tolerant' taxa [midges (Orthocladiinae and *Polypedium*)] (Table 5).

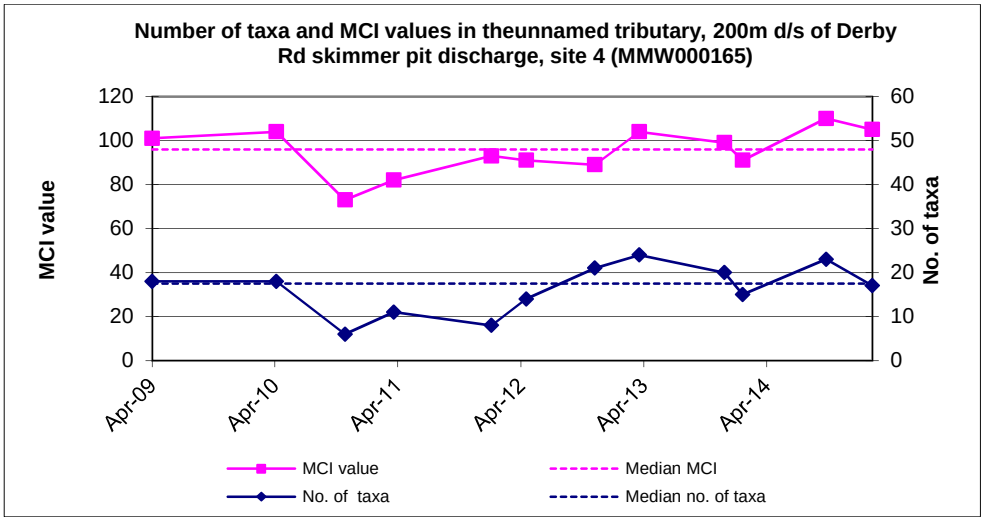

Figure 5 Numbers of macroinvertebrate taxa and MCI values recorded at site 4 in an unnamed tributary of Mangamawhete Stream.

Discussion and Conclusions

The Council's 'kick-sampling' technique was used at four sites to collect streambed macroinvertebrates from an unnamed tributary of the Mangamawhete Stream in relation to the storage of drilling waste within its vicinity and the consented discharge of stormwater to the stream. This has provided data to assess any potential impacts the consented activities have had on the macroinvertebrate communities of the stream. Samples were processed to provide number of taxa (richness), MCI, and $SQMCI_s$ scores for each site.

Taxa richness is the most robust index when ascertaining whether a macroinvertebrate community has been exposed to toxic discharges. Macroinvertebrates when exposed to toxic chemicals may die and be swept downstream or deliberately drift downstream as an avoidance mechanism (catastrophic drift). 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 abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_s$ between sites may indicate the degree of adverse effects (if any) of the discharge being monitored.

Overall there was little significant variation among sites at the time of the survey. There were only minor non-significant differences in taxa richnesses and MCI scores among all the sites surveyed. The 'control' site had a significantly higher $SQMCI_s$ score compared with the three 'impacted' sites and the most downstream site (site 4) also had a significantly higher $SQMCI_s$ score compared with sites 2 and 3. The low $SQMCI_s$ scores at sites 2 and 3 were largely the result of high numbers of two very low scoring taxa, site 2 had very abundant ostracod seed shrimp and site 3 had abundant ostracod seed shrimp oligochaete worms. These taxa are usually associated with organic enrichment, silt substrates and slow flows.

There were no marked differences between the four sites surveyed and the median taxa richness for other similar sites in the same altitudinal band (TRC, 2015). Sites 1, 3 and 4 MCI scores were also not significantly different to the median MCI score for other similar sites in the same altitudinal band (TRC, 2015) but site 2 did have a marginally significant lower MCI score (Stark, 1998). This was the same pattern which occurred in the previous survey (Sutherland, 2015) and is probably related to habitat differences; specifically the site is very open with no shading and had large amounts of filamentous green algae.

There were no significant differences in MCI scores at any of the sites compared with the results of the previous survey and taxa richnesses were higher at sites 1, 2 and 3 compared with the previous survey but were lower at site 4. Overall, the results of the summer survey suggest that the activities at the drilling waste stockpiling site and landfarming area have not had any significant impacts on the macroinvertebrate communities in the unnamed tributary of the Mangamawhete Stream since the last survey.

Summary

- A macroinvertebrate survey was performed at four sites in an unnamed tributary of the Mangamawhete Stream in relation to the stockpiling and discharge of drilling waste to land at the Derby Rd landfarm.

- There were minor non-significant differences in taxa richnesses and MCI scores among sites at the time of the survey and between the current survey and the previous survey.

- $SQMCI_s$ scores were lower for the three 'impacted' sites compared with the previous surveys scores and the median for similar sites which was probably as a result of seasonal effects.

- There was no indication from any of the macroinvertebrate indices examined that stockpiling and discharge of drilling waste to land had had any significant effects on the health of the macroinvertebrate communities present in an unnamed tributary of the Mangamawhete Stream.

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Appendix III

Company Supplied Annual Report

MiSWACO

A Schlumberger Company

ANNUAL REPORT FOR

CONSENT# 6900-1

CONSENT# 7591-1

COLIN BOYD LAND FARMS

SURREY ROAD

DERBY ROAD

INGLEWOOD

TARANAKI

31 JULY 2015

Status of Derby Rd and Surrey Rd Land Farm Facilities:

Derby Road.

The Derby Rd Land Farm has been closed due to the Surrey Rd facility being able to accept all drilling waste produced by current drilling programs.

The cells are gradually being fully cleaned out with an excavator, and the contents stockpiled on site. We estimate that 100 cubic metres of this product was removed from cell 3 in May 2013 and land farmed into paddock 101 from the Beluga 1 well. Further cleanings will be spread in the future with due notification.

Surrey Road.

There is currently 1,399.6 cubic metres of drilling waste stored in cell 1 at the Surrey Rd land farm. This is to be spread November 2015. The waste was from the OMV Maari field (107 Maari MR7A5).
In August 2014, 1 cubic metre of SBM/cement arrived from KA-20 STOS.

This waste will be spread using the direct injection system trialled in 2014 under the new consents.

In October 2014, a small tear in the liner of cell 2 was ripped open by strong wind. This cell was deemed to be empty at that time. A plastic welding specialist was engaged to perform repairs. The plastic in the liner was more brittle than when installed, and the welding was not successful. Consequently, a repair was done using silicone and wooden clamps. This repair has been very successful, and alleviated the need to replace the entire liner.

After discussions with Taranaki Regional Council scientific officers, it was noted that underground streams flowing under the site were washing old hydrocarbon beneath the cells into the south perimeter drain. Although the novaflow has a collection drum and skim pipe, it was decided to install a deep drain on the northern side of the site to divert this water. This drain was done in January 2015. The quantity of hydrocarbon entering the catchment drum has since considerably decreased.

In 2013, three vertical silos were placed in a bunded area within the land farm. 650 barrels of SBM/WBM were stored in these silos.

In January 2015, 150 barrels were taken from the silos. A photograph of the silos is included in this report.

The large number of used IBC's stored on site, many containing drilling mud have been emptied and removed from the site.

Irrigation system.

The Surrey Rd land farm is now deemed to be a non-discharge site, whereas previously the storm water from the site was filtered through three ponds with skimmer pipes and then into the nearby stream.

Storm water that now collects from rainfall into the storage cells has now been diverted into the empty cell 3. This cell will also have a plastic liner fitted in the future. The accumulated storm water stored in this cell was previously pumped into a tanker and spread into paddocks. This was time consuming, costly and difficult during wet weather. In April/May 2015, a trial was done using a spreader/irrigator system whereby the water was pumped several hundred metres to an adjacent paddock. This system has proven to work very efficiently, and has now been included in the new resource consent.

A photograph of the spreader is included in this report.

To monitor the quantity of water pumped, a graduated measure has been installed near the skimmer pipe.

A rain gauge has also been installed to monitor rainfall on site.

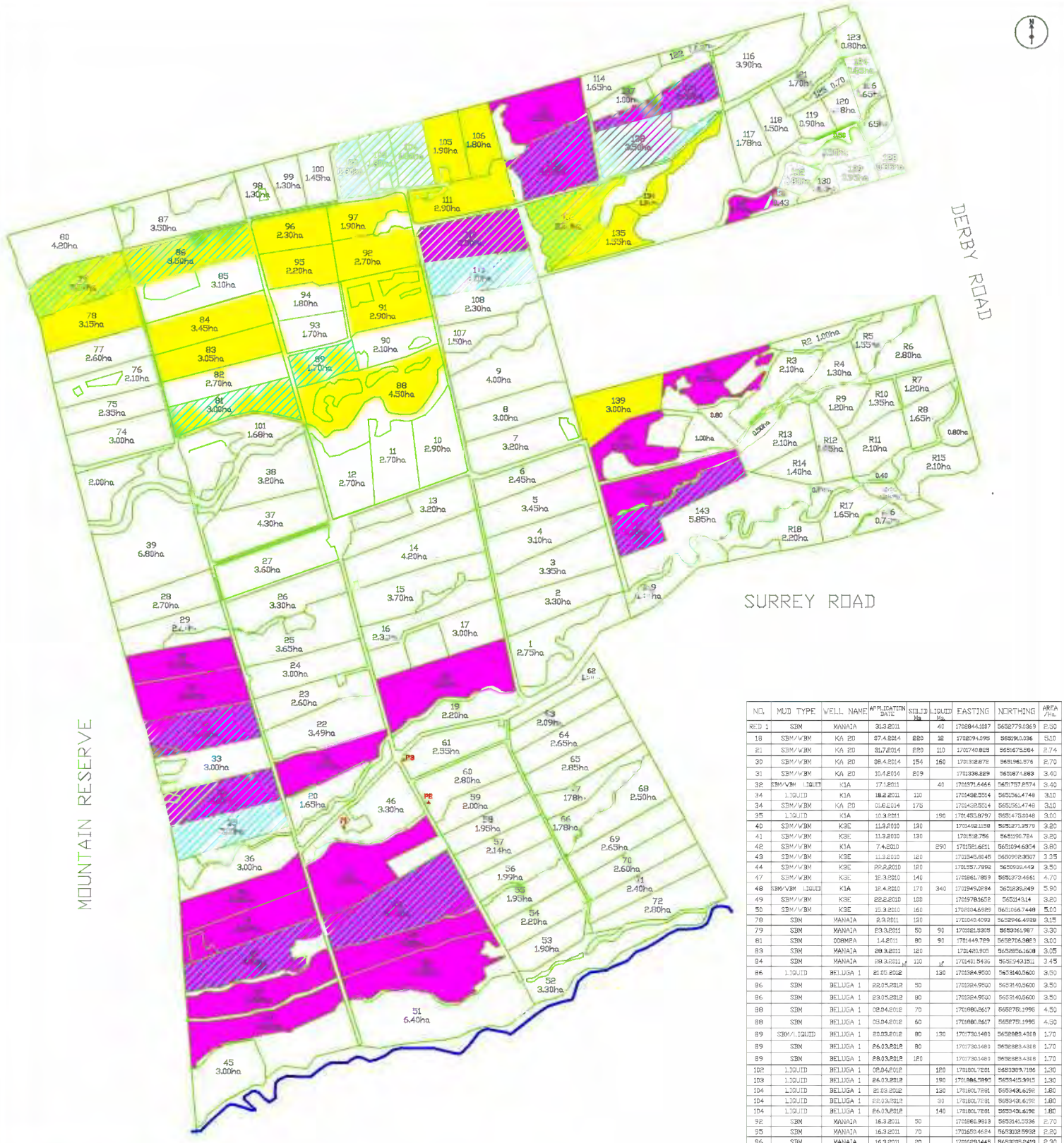
Non-discharge status.

As a result of our non-discharge status, the downstream laboratory results for the Surrey Rd Storm water 3 outlet (SW3) have shown a marked improvement even over the last 12 months. We expect even better results in the future. We particularly note the huge improvement in the Chemical Oxygen Demand (COD). These results are included in this report.

2014 Direct Drilling Trial.

The 2014 direct drilling trial appears to have worked very well. Further soil testing has been done this year on the affected paddocks, the results of which are included in this report. When taking the cross-sectional soil samples, it was found that there is a small mark indicating where the initial lines were placed. However, upon excavation the drilling waste seems to have broken down via bio-remediation and brown soil has resulted. We consider this to be a good result and the resource consent has been changed to accommodate this new method for future spreading.

Note :- Due to a new fencing program, the paddock formerly known as 141 is now 142; 142 is now known as 143.



NO.	MUD TYPE	WELL NAME	APPLICATION DATE	SOLID Ma	LIQUID Ma	EASTING	NORTHING	AREA Ha
RED 1	SBM	MANAIA	31.3.2011		40	1702844.1007	5652775.0369	2.50
18	SBM/WBM	KA 20	07.4.2014	220	12	1702394.695	5651910.036	3.10
21	SBM/WBM	KA 20	31.7.2014	220	110	1701740.805	5651675.564	2.74
30	SBM/WBM	KA 20	08.4.2014	154	150	1701312.872	5651961.576	2.70
31	SBM/WBM	KA 20	10.4.2014	209		1701338.229	5651874.283	3.40
32	SBM/WBM LIQUID	K1A	17.1.2011		40	1701571.4466	5651757.8574	3.40
34	LIQUID	K1A	18.2.2011	110		1701432.5314	5651561.4748	3.10
34	SBM/WBM	KA 20	01.8.2014	175		1701432.5314	5651561.4748	3.10
35	LIQUID	K1A	10.3.2011		190	1701453.8797	5651475.0048	3.00
40	SBM/WBM	K3E	11.3.2010	190		1701492.1158	5651271.2579	3.20
41	SBM/WBM	K3E	11.3.2010	130		1701512.756	5651196.784	3.20
42	SBM/WBM	K1A	7.4.2010		290	1701581.6811	5651094.6354	3.80
43	SBM/WBM	K3E	11.3.2010	120		1701540.8645	5650998.9507	3.35
44	SBM/WBM	K3E	22.2.2010	120		1701557.7892	5650999.449	3.50
47	SBM/WBM	K3E	12.3.2010	140		1701861.7859	5651973.4661	4.70
48	SBM/WBM LIQUID	K1A	12.4.2010	170	340	1701949.2284	5651839.249	5.90
49	SBM/WBM	K3E	22.2.2010	100		1701978.1658	565114.14	3.20
50	SBM/WBM	K3E	10.3.2010	160		1702004.6589	5651066.7448	5.00
78	SBM	MANAIA	2.3.2011	130		1701040.4093	5652946.4928	3.15
79	SBM	MANAIA	23.3.2011	50	90	1701281.9305	5653061.987	3.30
81	SBM	008M2A	1.4.2011	80	90	1701449.789	5652706.9883	3.00
83	SBM	MANAIA	28.3.2011	120		1701420.805	5652856.1698	3.05
84	SBM	MANAIA	28.3.2011	110		1701401.8436	5652943.1511	3.45
86	LIQUID	BELUGA 1	21.05.2012		130	1701384.9590	5653140.5600	3.50
86	SBM	BELUGA 1	22.05.2012	50		1701384.9590	5653140.5600	3.50
86	SBM	BELUGA 1	23.05.2012	80		1701384.9590	5653140.5600	3.50
88	SBM	BELUGA 1	02.04.2012	70		1701880.8617	5652751.1995	4.50
88	SBM	BELUGA 1	03.04.2012	60		1701880.8617	5652751.1995	4.50
89	SBM/LIQUID	BELUGA 1	20.03.2012	80	130	1701730.1480	5652883.4308	1.70
89	SBM	BELUGA 1	26.03.2012	80		1701730.1480	5652883.4308	1.70
89	SBM	BELUGA 1	28.03.2012	120		1701730.1480	5652883.4308	1.70
102	LIQUID	BELUGA 1	02.04.2012		120	1701801.7281	5653389.7186	1.30
103	LIQUID	BELUGA 1	26.03.2012		190	1701886.5995	5653415.9915	1.30
104	LIQUID	BELUGA 1	21.03.2012		130	1701801.7281	5653436.6198	1.80
104	LIQUID	BELUGA 1	22.03.2012		30	1701801.7281	5653436.6198	1.80
104	LIQUID	BELUGA 1	26.03.2012		140	1701801.7281	5653436.6198	1.80
92	SBM	MANAIA	16.3.2011	50		1701980.9803	5653141.5336	2.70
95	SBM	MANAIA	16.3.2011	70		1701650.4624	5653108.5938	2.20
96	SBM	MANAIA	16.3.2011	80		1701689.1445	5653095.2419	2.30
97	SBM	MANAIA	15.3.2011		170	1701838.4469	5653251.7844	1.90
101	SBM/WBM	BELUGA 1	24.5.2014	99		1701546.1736	5652638.3639	1.68
105	SBM	MRPP1	30.3.2010	120		1702086.9883	5653451.5115	1.90
106	SBM	MRPP1	30.3.2010	100		1702165.2265	5653468.9424	1.60
109	LIQUID	MANAIA	9.9.2010		80	1702181.9172	5653079.0581	3.10
110	SBM/WBM	MANAIA	2.6.2010		360	1702151.6393	5653186.6304	3.50
111	SBM	MANAIA	28.3.2011	120		1702189.2935	5653308.9184	2.90
112	SBM/WBM	BELUGA 1	17.6.2010		430	1702400.5903	5653409.0924	3.95
113	SBM/WBM	MANAIA/EVA A/ MRPP2/MRPP3/M RPP1	23.4.2009	600		1702366.1241	5653356.1796	3.20
115	SBM/WBM	BELUGA 1	1.12.2010		190	1702713.8302	5653586.2554	2.30
133	SBM/WBM	BELUGA 1				1702947.5999	5653881.2916	0.70
134	SBM	MRPP1 / MRPP2	16.3.2010	120	40	1702679.6948	5653306.816	1.30
135	SBM	MRPP1 / MRPP2	16.3.2010	120	40	1702589.4113	5653198.2809	1.55
136	SBM	MRPP1 / MRPP2	8.9.2010	90	180	1702442.6169	5653242.1715	3.80
138	LIQUID	BELUGA 1	16.5.2010		370	1702646.6486	5653461.9877	3.50
139	SBM/WBM	KA 20	26.2.2014	22		1702586.493	5652707.447	3.00
140	SBM/WBM	KA 20	26.2.2014	33		1702612.522	5652609.139	2.10
141	SBM/WBM	KA 19	03.3.2014	296	265	1702692.770	5652472.380	2.65
142	SBM	MANAIA	28.3.2011	150	150	1702742.882	5652416.2866	3.10
142	SBM/WBM	KA 19	20.3.2014	160	159	1702742.882	5652416.2866	3.10

NOTES

1. CO ORDINATE SYSTEM : NZTM2000
2. HEIGHTS ABOVE SEA LEVEL

DERBY AND SURREY ROAD LANDSPREAD DISPOSAL SITE PLAN SHOWING AREAS OF DISPOSAL

NO.	DATE	BY	CHD	DESCRIPTION
1	25-8-11	BP	CW	ADD PADDOCKS & LANDSPREAD INFO
2	01-11-12	BP	CW	ADD NEW LANDSPREAD INFO
3	18-08-14	BP	CW	ADD 2014 LANDSPREAD INFO
4		BP	CW	ADD 2015 LANDSPREAD INFO

DRAWN BY	BP	06-01-2016
PROJECT No.	104	
LOCATION	SURREY ROAD	
SCALE	1 : 1500	

0 50 100 200 300 400 500

DRAWING No. MI SWACO 101

REV 4

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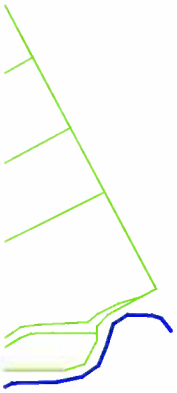
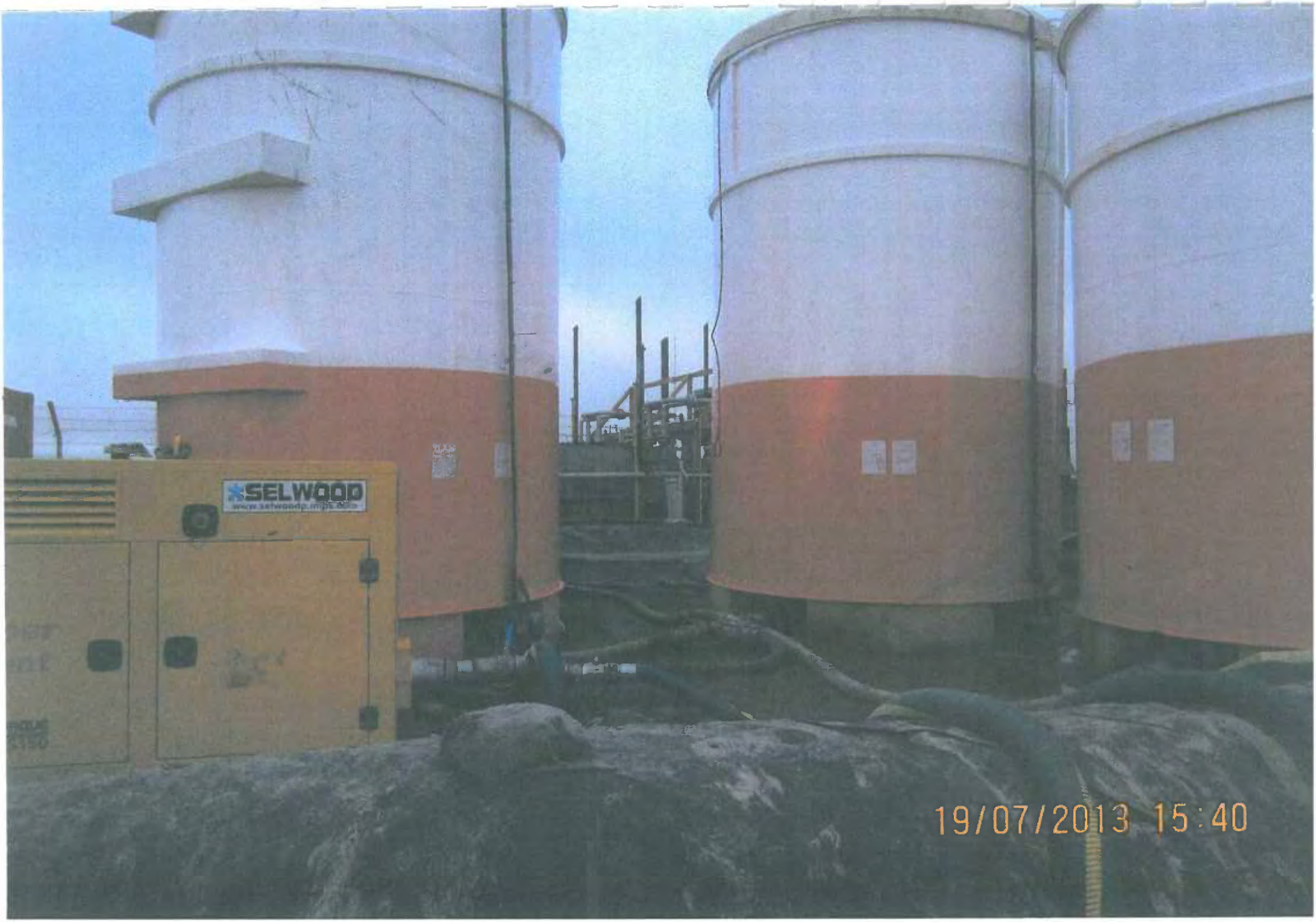
CELLPHONE 027 477 6271



NO.	MUD TYPE	WELL NAME	APPLICATION DATE	SOLID M3	LIQUID M3.	EASTING	NORTHING	AREA /Ha.
RED 1	SBM	MANAIA	31.3.2011		40	1702844.1007	5652779.0369	2.50
18	SBM/WBM	KA 20	07.4.2014	220	12	1702094.095	5651910.036	5.10
21	SBM/WBM	KA 20	31.7.2014	220	110	1701740.825	5651675.584	2,74
30	SBM/WBM	KA 20	08.4.2014	154	160	1701312.872	5651961.576	2.70
31	SBM/WBM	KA 20	10.4.2014	209		1701338.229	5651874.283	3.40
32	SBM/WBM LIQUID	K1A	17.1.2011		40	1701371.6466	5651757.2574	3.40
34	LIQUID	K1A	18.2.2011	110		1701432.5514	5651561.4748	3.10
34	SBM/WBM	KA 20	01.8.2014	175		1701432.5514	5651561.4748	3.10
35	LIQUID	K1A	10.3.2011		190	1701455.8797	5651475.0048	3,00
40	SBM/WBM	K3E	11.3.2010	130		1701492.1158	5651271.3579	3.20
41	SBM/WBM	K3E	11.3.2010	130		1701512.756	5651190.724	3.20
42	SBM/WBM	K1A	7.4.2010		290	1701521.6211	5651094.6354	3.80
43	SBM/WBM	K3E	11.3.2010	120		1701545.8045	5650992.3507	3,35
44	SBM/WBM	K3E	22.2.2010	120		1701557.7892	5650909.443	3.50
47	SBM/WBM	K3E	12.3.2010	140		1701861.7859	5651373.4661	4.70
48	SBM/WBM LIQUID	K1A	12.4.2010	170	340	1701949.0284	5651239.249	5.90
49	SBM/WBM	K3E	22.2.2010	100		1701978.1652	5651143.14	3.20
50	SBM/WBM	K3E	15.3.2010	160		1702004.6929	5651066.7448	5,00
78	SBM	MANAIA	2.3.2011	130		1701040.4093	5652946.4928	3,15
79	SBM	MANAIA	23.3.2011	50	90	1701021.5305	5653061.987	3.30
81	SBM	008M2A	1.4.2011	80	90	1701449.729	5652706.3823	3,00
83	SBM	MANAIA	28.3.2011	120		1701420.905	5652856.1608	3.05
84	SBM	MANAIA	28.3.2011	110		1701401.5436	5652943.1511	3,45
86	LIQUID	BELUGA 1	21.05.2012		130	1701324.9500	5653140.5600	3.50
86	SBM	BELUGA 1	22.05.2012	50		1701324.9500	5653140.5600	3.50
86	SBM	BELUGA 1	23.05.2012	80		1701324.9500	5653140.5600	3.50
88	SBM	BELUGA 1	02.04.2012	70		1701880.2617	56527511995	4.50
88	SBM	BELUGA 1	05.04.2012	60		1701880.2617	56527511995	4.50
89	SBM/LIQUID	BELUGA 1	20.03.2012	80	130	1701730.1480	5652823.4308	1.70
89	SBM	BELUGA 1	26.03.2012	80		1701730.1480	5652823.4308	1,70
89	SBM	BELUGA 1	28.03.2012	120		1701730.1480	5652823.4308	1,70
102	LIQUID	BELUGA 1	02.04.2012		120	1701801.7281	5653389.7186	1,30
103	LIQUID	BELUGA 1	26.03.2012		190	1701886.5895	5653415.3915	1,30
104	LIQUID	BELUGA 1	21.03.2012		130	1701801.7281	5653431.6192	1,80
104	LIQUID	BELUGA 1	22.03.2012		30	1701801.7281	5653431.6192	1,80
104	LIQUID	BELUGA 1	26.03.2012		140	1701801.7281	5653431.6192	1,80
92	SBM	MANAIA	16.3.2011	50		1701880.9803	5653141.5536	2.70
95	SBM	MANAIA	16.3.2011	70		1701650.4624	5653102.5932	2.20
96	SBM	MANAIA	16.3.2011	20		1701629.1445	5653205.2419	2.30
97	SBM	MANAIA	15.3.2011		170	1701838.4469	5653251.7244	1,90
101	SBM/WBM	BELUGA 1	24.5.2014	99		1701546.1736	5652638.3639	1,68
105	SBM	MR2P1	30.3.2010	120		1702086.3883	5653451.5115	1,90
106	SBM	MR2P1	30.3.2010	100		1702185.2255	5653468.9424	1,80
109	LIQUID	MANAIA	9.9.2010		20	1702181.9172	5653079.0521	3.10
110	SBM/WBM	MANAIA	2.6.2010		380	1702151.6533	5653186.6314	3.50
111	SBM	MANAIA	28.3.2011	120		1702129.2835	5653302.9184	2.90
112	SBM/WBM	BELUGA 1	17.6.2010		430	1702400.5903	5653403.0924	3,95
113	SBM/WBM	MANGAHEWA A/ MR3P8/MR4P9/M R5P12	23.4.2009	600		1702366.1241	5653556.1796	3.20
115	SBM/WBM	BELUGA 1	1.12.2010		190	1702713.8302	5653586.2504	2.30
133	SBM/WBM	BELUGA 1				1702947.5999	5653281.2916	070
134	SBM	MR1P7 / MR2P1	18.3.2010	120	40	1702679.6848	5653306.816	1,30
135	SBM	MR1P7 / MR2P1	18.3.2010	120	40	1702585.4113	5653198.2808	1,55
136	SBM	MR1P7 / MR2P1	8.9.2010	90	120	1702442.6169	5653242.1715	3.80
138	LIQUID	BELUGA 1	18.6.2010		370	1702646.6426	5653461.9277	3.50
139	SBM/WBM	KA 20	26.2.2014	22		1702588.493	5652707.447	3,00
140	SBM/WBM	KA 20	26.2.2014	33		1702612.522	5652609.159	2.10
141	SBM/WBM	KA 19	03.3.2014	296	265	1702692.770	5652472.580	2,65
142	SBM	MANAIA	28.3.2011	150	150	1702742.882	5652416.2866	3.10
142	SBM/WBM	KA 19	20.3.2014	180	159	1702742.882	5652416.2866	3,10

DRAWN BY	BP	06-01-2016
PROJECT No.	104	
LOCATION	SURREY ROAD	
SCALE	1 : 1500	


SELWOOD
19/07/2013 15:40

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ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477 shpv1
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

Sample Name: 140 B **Lab Number:** 1266477.1
Sample Type: Mixed Pasture, Dairy (P1)

Analysis		Level Found	Medium Range	Low / Medium / High
Nitrogen*	%	4.2	4.0 - 5.0	
Phosphorus	%	0.35	0.38 - 0.45	
Potassium	%	2.6	2.5 - 3.0	
Sulphur	%	0.25	0.30 - 0.40	
Calcium	%	0.88	0.60 - 1.00	
Magnesium	%	0.30	0.20 - 0.30	
Sodium	%	0.180	0.150 - 0.300	
Iron	mg/kg	98	100 - 250	
Manganese	mg/kg	230	60 - 150	
Zinc	mg/kg	32	30 - 50	
Copper	mg/kg	10	10 - 12	
Boron	mg/kg	13		
Molybdenum	mg/kg	0.41	0.50 - 1.2	
Cobalt	mg/kg	0.35	0.10 - 0.20	
Selenium	mg/kg	0.12	0.08 - 0.15	
Iodine	mg/kg	0.24	0.40 - 0.80	
Chloride*	%	0.97	0.30 - 2.4	
Nitrate-N	mg/kg	< 100		
Dry Matter*	%	14.1	12.0 - 30.0	
Crude Protein*	%DM	28.0	20.0 - 30.0	
Acid Detergent Fibre*	%DM	24.9	20.0 - 30.0	
Neutral Detergent Fibre*	%DM	32.6	30.0 - 45.0	
Ash*	%DM	10.1	7.0 - 14.0	
Organic Matter*	%DM	89.9		
Soluble Sugars*	%DM	9.5		
Starch*	%DM	0.8		
Crude Fat*	%DM	3.9		
Digestibility of Organic Matter in Dry Matter (DOMD)*	%	71.5	65.0 - 80.0	
Metabolisable Energy*	MJ/kgDM	11.4	9.0 - 12.0	

Non Structural Carbohydrate*	%DM	25.4	
OMD in-vivo*	%DM	79.6	
Grass Staggers Index*	me	1.0	(<1.8 recommended, >2.2 increased risk)
K/Na Ratio*		15	(<10 recommended, >20 increased risk)
Ca/P Ratio*		2.5	(>1.5 recommended, <1.2 increased risk)
DCAD*	me	324	(<200 recommended, >200 increased risk)

The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477 shpv1
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

Sample Name: 140 T **Lab Number:** 1266477.2
Sample Type: Mixed Pasture. Dairy (P1)

Analyte		Level Found	Medium Range	Low	Medium	High
Nitrogen*	%	3.9	4.0 - 5.0			
Phosphorus	%	0.35	0.38 - 0.45			
Potassium	%	3.3	2.5 - 3.0			
Sulphur	%	0.34	0.30 - 0.40			
Calcium	%	0.34	0.60 - 1.00			
Magnesium	%	0.22	0.20 - 0.30			
Sodium	%	0.367	0.150 - 0.300			
Iron	mg/kg	113	100 - 250			
Manganese	mg/kg	300	60 - 150			
Zinc	mg/kg	34	30 - 50			
Copper	mg/kg	12	10 - 12			
Boron	mg/kg	4				
Molybdenum	mg/kg	0.38	0.50 - 1.2			
Cobalt	mg/kg	0.20	0.10 - 0.20			
Selenium	mg/kg	0.06	0.08 - 0.15			
Iodine	mg/kg	0.25	0.40 - 0.80			
Chloride*	%	1.59	0.30 - 2.4			
Nitrate-N	mg/kg	831				
Dry Matter*	%	16.2	12.0 - 30.0			
Crude Protein*	%DM	25.8	20.0 - 30.0			
Acid Detergent Fibre*	%DM	25.8	20.0 - 30.0			
Neutral Detergent Fibre*	%DM	43.3	30.0 - 45.0			
Ash*	%DM	11.3	7.0 - 14.0			
Organic Matter*	%DM	88.7				
Soluble Sugars*	%DM	8.5				
Starch*	%DM	< 0.5				
Crude Fat*	%DM	3.6				
Digestibility of Organic Matter in Dry Matter (DOMD)*	%	69.4	65.0 - 80.0			
Metabolisable Energy*	MJ/kgDM	11.1	9.0 - 12.0			

Non Structural Carbohydrate*	%DM	16.0	
OMD in-vivo*	%DM	78.3	
Grass Staggers Index*	me	2.4	(<1.8 recommended, >2.2 increased risk)
K/Na Ratio*		9	(<10 recommended, >20 increased risk)
Ca/P Ratio*		1.0	(>1.5 recommended, <1.2 increased risk)
DCAD*	me	350	(<200 recommended, >200 increased risk)

The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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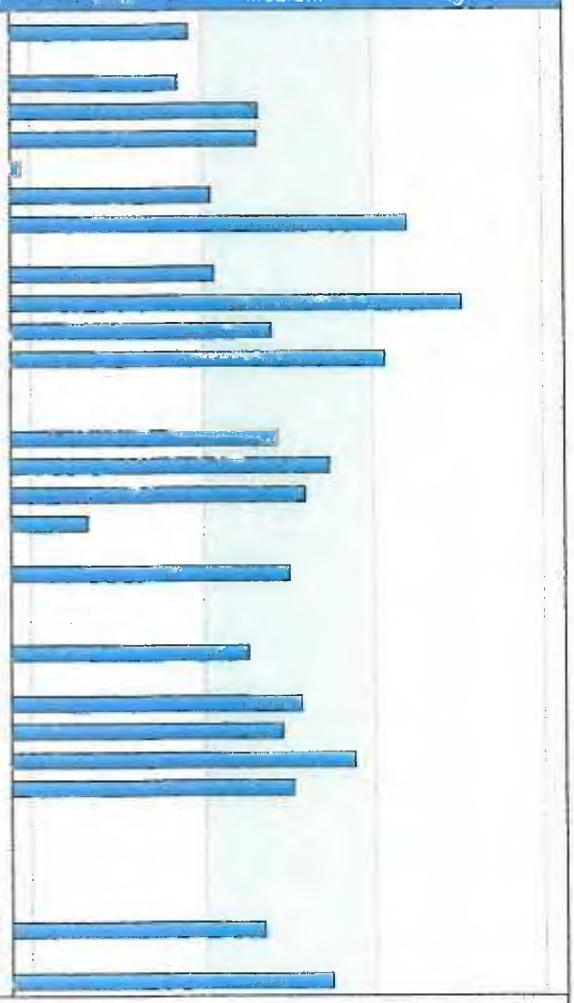
ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477 shpvt
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

Sample Name: 139 T **Lab Number:** 1266477.3
Sample Type: Mixed Pasture, Dairy (P1)

Analyte		Level Found	Medium Range
Nitrogen*	%	3.9	4.0 - 5.0
Phosphorus	%	0.36	0.38 - 0.45
Potassium	%	2.7	2.5 - 3.0
Sulphur	%	0.33	0.30 - 0.40
Calcium	%	0.28	0.60 - 1.00
Magnesium	%	0.20	0.20 - 0.30
Sodium	%	0.404	0.150 - 0.300
Iron	mg/kg	110	100 - 250
Manganese	mg/kg	280	60 - 150
Zinc	mg/kg	38	30 - 50
Copper	mg/kg	13	10 - 12
Boron	mg/kg	3	
Molybdenum	mg/kg	0.80	0.50 - 1.2
Cobalt	mg/kg	0.17	0.10 - 0.20
Selenium	mg/kg	0.12	0.08 - 0.15
Iodine	mg/kg	0.16	0.40 - 0.80
Chloride*	%	1.36	0.30 - 2.4
Nitrate-N	mg/kg	242	
Dry Matter*	%	16.7	12.0 - 30.0
Crude Protein*	%DM	25.7	20.0 - 30.0
Acid Detergent Fibre*	%DM	24.6	20.0 - 30.0
Neutral Detergent Fibre*	%DM	43.2	30.0 - 45.0
Ash*	%DM	10.6	7.0 - 14.0
Organic Matter*	%DM	89.4	
Soluble Sugars*	%DM	9.9	
Starch*	%DM	0.6	
Crude Fat*	%DM	3.6	
Digestibility of Organic Matter in Dry Matter (DOMD)*	%	70.2	65.0 - 80.0
Metabolisable Energy*	MJ/kgDM	11.2	9.0 - 12.0
Non Structural Carbohydrate*	%DM	16.8	
OMD in-vivo*	%DM	78.5	
Grass Staggers Index*	me	2.2	(<1.8 recommended, >2.2 increased risk)
K/Na Ratio*		7	(<10 recommended, >20 increased risk)
Ca/P Ratio*		0.8	(>1.5 recommended, <1.2 increased risk)
DCAD*	me	270	(<200 recommended, >200 increased risk)



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: it is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. *ANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477 snpv1
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

Sample Name: 139 B **Lab Number:** 1266477.4
Sample Type: Mixed Pasture, Dairy (P1)

Analysis		Level Found	Median Range	Low / Medium / High
Nitrogen*	%	2.9	4.0 - 5.0	
Phosphorus	%	0.29	0.38 - 0.45	
Potassium	%	3.1	2.5 - 3.0	
Sulphur	%	0.26	0.30 - 0.40	
Calcium	%	0.30	0.60 - 1.00	
Magnesium	%	0.12	0.20 - 0.30	
Sodium	%	0.095	0.150 - 0.300	
Iron	mg/kg	152	100 - 250	
Manganese	mg/kg	300	60 - 150	
Zinc	mg/kg	28	30 - 50	
Copper	mg/kg	9	10 - 12	
Boron	mg/kg	2		
Molybdenum	mg/kg	1.10	0.50 - 1.2	
Cobalt	mg/kg	0.26	0.10 - 0.20	
Selenium	mg/kg	0.43	0.08 - 0.15	
Iodine	mg/kg	0.24	0.40 - 0.80	
Chloride*	%	1.48	0.30 - 2.4	
Nitrate-N	mg/kg	< 100		
Dry Matter*	%	21.0	12.0 - 30.0	
Crude Protein*	%DM	18.9	20.0 - 30.0	
Acid Detergent Fibre*	%DM	26.3	20.0 - 30.0	
Neutral Detergent Fibre*	%DM	46.6	30.0 - 45.0	
Ash*	%DM	10.2	7.0 - 14.0	
Organic Matter*	%DM	89.8		
Soluble Sugars*	%DM	9.5		
Starch*	%DM	0.9		
Crude Fat*	%DM	3.5		
Digestibility of Organic Matter in Dry Matter (DOMD)*	%	65.3	65.0 - 80.0	
Metabolisable Energy*	MJ/kgDM	10.4	9.0 - 12.0	
Non Structural Carbohydrate*	%DM	20.8		
OMD in-vivo*	%DM	72.7		
Grass Staggers Index*	me	3.2	(<1.8 recommended, >2.2 increased risk)	
K/Na Ratio*		33	(<10 recommended, >20 increased risk)	
Ca/P Ratio*		1.0	(>1.5 recommended, <1.2 increased risk)	
DCAD*	me	257	(<200 recommended, >200 increased risk)	

The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

Analyst's Comments

Samples 1-4 Comment:
The nutrient ratio indices have been calculated to assist in evaluating the suitability of this sample as a dairy feed. Although based on published calculations, they should be used with caution, as metabolic disorders can be induced by a multitude of factors, and not just these nutrient ratios alone. For further details of the calculations, please contact this laboratory. Note that the nutrient balances and indices are calculated on the basis that the pasture/forage tested is the total animal diet. These may not be appropriate where additional supplements are included in the animal diet.

Samples 1-4 Comment:
The medium range for Dry Matter% shown above is for fresh samples. If the sample has been cut and wilted prior to sampling, then higher DM% levels will result. Typical DM% values range from:
12-15% (spring); 15-20% (summer); 20-30% (summer dry); 13-18% (aut/winter); above 30% (wilted herbage for silage/balage).

Samples 1-4 Comment:
Pastures and Feeds with Nitrate-N levels below 1000mg/kg are generally safe to feed.
If results are wanted as Nitrate (rather than Nitrate-N) then use the following equation to convert:
Nitrate-N (mg/kg) x 4.427 x 0.0001 = Nitrate (%). Please refer to Hill Laboratories Technical Note - Nitrate-Nitrogen in Pasture and Stock Feeds for further information.

Samples 1-4 Comment:
The medium ranges shown are the higher of either the minimum requirement for lush grass growth or animal nutritional requirements fed on an 'ad-lib' basis.

Samples 1-4 Comment:
The boron level in mixed herbage is especially difficult to interpret. This is because grasses typically have 5 - 10 mg/kg and clover 18 - 25 mg/kg, making the mixed herbage B level very dependent upon the relative proportions of grass and clover in the sample. It is further complicated by the natural seasonal trend of low levels of boron during winter/spring c.f. higher levels in summer/autumn. As a consequence, we no longer provide a graphical interpretation for B in mixed herbage. A clover-only sample is recommended for monitoring boron status in pasture.

Samples 1-4 Comment:
The starch analysis is not a precise test at low levels (0 - 10%). Low levels of starch reported are therefore not reliable and must be interpreted with caution.

Samples 1-4 Comment:
Low Iodine has been linked to reduced survival rates of new-born lambs and calves, as well as reduced conception rates and milk production in cows and ewes. This may happen where clinical 'goitre' symptoms are not observed.

Samples 1-4 Comment:
The medium range guidelines shown in the histogram report relate to sampling protocols as per Hill Laboratories' crop guides and are based on reference values where these are published. Results for samples collected at different growth stages or from different plant parts than those described in the crop guide should be interpreted with caution.

Samples 1-4 Comment:
Iron levels greater than 350 mg/kg indicate some soil contamination is present on the herbage sample. This may result in an elevated cobalt level due to soil containing significantly higher levels of cobalt than herbage.

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ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477 shpv1
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014
	PO Box 44	**Date Reported:**	30-Apr-2014
	INGLEWOOD 4347	**Quote No:**	
		Order No:	
		Client Reference:	Mile Square Farm
Phone:	06 756 8071	**Submitted By:**	G Bishop

SUMMARY OF METHODS

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

Sample Type: Plant

Test	Method Description	Default Detection Limit	Sample No
Crude Fat*	Estimated by NIR, calibration based on Petroleum Spirit extraction by Ankom auto analyser, AOCS Official Procedure AM-5-04. Reported on a Dry Matter basis.	0.5 %	1-4
Sample Registration*	Samples were registered according to instructions received.	-	1-4
Plant Prep (Dry & Grind)*	Oven dried at 62°C overnight and ground to pass through a 1.0mm screen. Analytical results are reported from this sample fraction and are not corrected for residual moisture (typically 5%), unless units denoted as %DM.	-	1-4
Nitrogen*	Estimated by NIR, calibration based on N by Dumas combustion. Result not corrected for residual moisture (typically 5%).	0.1 %	1-4
Phosphorus	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	0.02 %	1-4
Potassium	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	0.1 %	1-4
Sulphur	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	0.02 %	1-4
Calcium	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	0.02 %	1-4
Magnesium	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	0.02 %	1-4
Sodium	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	0.002 %	1-4
Iron	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	5 mg/kg	1-4
Manganese	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	3 mg/kg	1-4
Zinc	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	2 mg/kg	1-4
Copper	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	1 mg/kg	1-4
Boron	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-OES.	1 mg/kg	1-4
Molybdenum	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-MS.	0.02 mg/kg	1-4
Cobalt	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-MS.	0.01 mg/kg	1-4
Selenium	Nitric Acid/Hydrogen Peroxide digestion followed by ICP-MS.	0.01 mg/kg	1-4
Iodine	TMAH extraction followed by ICP-MS.	0.05 mg/kg	1-4
Chloride*	Estimated by NIR, calibration based on 2% acetic acid extraction, potentiometric titration.	0.05 %	1-4
Nitrate-N	2% acetic acid extraction followed by Salicylate colorimetry or Cd reduction followed by NED colorimetry.	100 mg/kg	1-4
Dry Matter*	Weight Loss on drying at 105°C for 24 hours. (Silage corrected for loss of volatiles).	0.5 %	1-4
Crude Protein*	Nitrogen multiplied by 6.25. Reported on DM basis.	0.5 %DM	1-4
Acid Detergent Fibre*	Estimated by NIR (calibration based on ADF by a modified NFTA method). Reported on DM basis.	0.5 %	1-4
Neutral Detergent Fibre*	Estimated by NIR, calibration based on NDF by NFTA method. Reported on DM basis.	0.5 %	1-4
Ash*	Estimated by NIR, calibration based on weight loss after ashing at 600°C for two hours. Reported on DM basis.	0.5 %	1-4
Organic Matter*	Organic Matter is 100 - Ash. Reported on DM basis.	0.5 %DM	1-4

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ANALYSIS REPORT

Client:	Mile Square Farms	**Lab No:**	1266477	shpv1
Address:	C/- C Boyd	**Date Registered:**	24-Apr-2014	
	PO Box 44	**Date Reported:**	30-Apr-2014	
	INGLEWOOD 4347	**Quote No:**		
		Order No:		
		Client Reference:	Mile Square Farm	
Phone:	06 756 8071	**Submitted By:**	G Bishop	

Sample Type: Plant

Test	Method Description	Default Detection Limit	Sample No
Organic Matter Digestibility (in-vitro)*	Organic Matter Digestibility (OMD) estimated by NIR, calibration based on AFIA (Australian Fodder Industry Association) Pepsin-Cellulase procedure.	1.0 %	1-4
Digestibility of Organic Matter in Dry Matter (DOMD)*	Calculated from Organic Matter Digestibility (OMD) using AFIA (Australian Fodder Industry Association) Standard Equation.	0.5 %	1-4
Metabolisable Energy*	Calculated from Dry Organic Matter Digestibility (DOMD) using AFRC and Lincoln University standard formulae.	0.5 MJ/kgDM	1-4
Soluble Sugars*	Estimated by NIR, calibration based on an 80:20 ethanol:water extraction and colorimetric determination. Reported on DM basis.	0.5 %	1-4
Starch*	Estimated by NIR, calibration based on Enzymic Hydrolysis of Starch. Reported on DM basis.	0.5 %	1-4
OMD in-vivo*	Organic Matter Digestibility in-vivo (OMD in-vivo) determined using AFIA (Australian Fodder Industry Association) in vitro Pepsin-Cellulase procedure and derived as in-vivo using a linear regression based on calibration samples from Lincoln University. Reported on DM basis.	1.0 %DM	1-4
Non Structural Carbohydrate*	NSC = 100 - (CP + Ash + CFat + NDF). Reported on DM basis.	0.5 %DM	1-4

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

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

Shelley Edhouse
Quality Assurance Officer - Agriculture Division

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ANALYSIS REPORT

Client:	Schlumberger Seaco Inc	**Lab No:**	1333066 SPv1
Contact:	Ross Henry	**Date Registered:**	01-Oct-2014
	C/- Schlumberger Seaco Inc	**Date Reported:**	15-Oct-2014
	PO Box 7100	**Quote No:**	
	Fitzroy	**Order No:**	1543
	NEW PLYMOUTH 4341	**Client Reference:**	
		Submitted By:	Ross Henry

Sample Type: Aqueous

Sample Name:		Surrey Rd SW3 Outlet 19-Sep-2014	Surrey Rd SW3 Upstream 19-Sep-2014	Surrey Rd SW3 Downstream 19-Sep-2014		
Lab Number:		1333066.1	1333066.2	1333066.3		
Total Kjeldahl Nitrogen (TKN)	g/m³	0.61	-	-	-	-
Carbonaceous Biochemical Oxygen Demand (cBOD5)	g O_2/m³	-	< 2	< 2	-	-
Chemical Oxygen Demand (COD)	g O_2/m³	14	-	-	-	-
Oil and Grease	g/m³	< 5 #1	-	-	-	-

Analyst's Comments

#1 There was insufficient sample to perform the oil and grease analysis on this sample . Therefore a smaller aliquot was taken prior to analysis, resulting in a detection limit higher than that normally achieved.

SUMMARY OF METHODS

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Total Kjeldahl Digestion	Sulphuric acid digestion with copper sulphate catalyst.	-	1
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D. (modified) 4500 NH_3 F (modified) 22nd ed. 2012.	0.10 g/m³	1
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, dilutions, seeded. Analysed at Hill Laboratories - Microbiology; 1 Clow Place, Hamilton. APHA 5210 B (modified) 22nd ed. 2012.	2 g O_2/m³	2-3
Chemical Oxygen Demand (COD), trace level	Dichromate/sulphuric acid digestion in Hach tubes, colorimetry. Trace Level method. APHA 5220 D 22nd ed. 2012.	6 g O_2/m³	1
Oil and Grease	Sample filtration through filter aid, Soxhlet extraction, gravimetric determination of extracted Oil & Grease. APHA 5520 D (modified) 22nd ed. 2012.	4 g/m³	1

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

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

Martin Cowell - BSc
Client Services Manager - Environmental Division

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ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1389195 SPv1
Contact:	Ross Henry	**Date Registered:**	25-Feb-2015
	C/- Schlumberger New Zealand Limited	**Date Reported:**	10-Mar-2015
	PO Box 7100	**Quote No:**	31151
	Fitzroy	**Order No:**	
	NEW PLYMOUTH 4341	**Client Reference:**	Stormwater Analysis
		Submitted By:	Ross Henry

Sample Type: Aqueous

Sample Name:	Surrey Road Stormwater 3 19-Feb-2015 1:00 pm	Surry Road SW3 Upstream 19-Feb-2015 1:00 pm	Surry Road SW3 Downstream 19-Feb-2015 1:00 pm		
Lab Number:	1389195.1	1389195.2	1389195.3		
Individual Tests					
Free Ammonia* g/m³ at Client Temperature	< 0.010	-	-	-	-
pH pH Units	6.9	-	-	-	-
Total Suspended Solids g/m³	7	-	-	-	-
Sample Temperature* °C	20	-	-	-	-
Total Ammoniacal-N g/m³	< 0.010	-	-	-	-
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$) g O_2/m³	< 2	< 2	< 2	-	-
Oil and Grease g/m³	< 4	-	-	-	-
Chlorine, Free & Combined					
Free Chlorine g/m³	0.15	-	-	-	-
Combined Chlorine g/m³	< 0.08	-	-	-	-

SUMMARY OF METHODS

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Free Ammonia*	Calculation from NH4N, pH, Temperature (Calculations based on data for distilled water). APHA Table 8010:VI 22nd ed. 2012.	0.010 g/m³ at Client Temperature	1
Chlorine, Free & Combined	DPD Colorimetric	0.05 g/m³	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
pH	pH meter. APHA 4500-H^+ B 22nd ed. 2012.	0.1 pH Units	1
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 22nd ed. 2012.	3 g/m³	1
Sample Temperature*	Supplied by customer, otherwise 20°C.	0.10 °C	1
Total Ammoniacal-N	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 F (modified from manual analysis) 22nd ed. 2012.	0.010 g/m³	1
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, dilutions, seeded. Analysed at Hill Laboratories - Microbiology, 1 Clow Place, Hamilton. APHA 5210 B (modified) 22nd ed. 2012.	2 g O_2/m³	1-3
Oil and Grease	Sample filtration through filter aid, Soxhlet extraction, gravimetric determination of extracted Oil & Grease. APHA 5520 D (modified) 22nd ed. 2012.	4 g/m³	1

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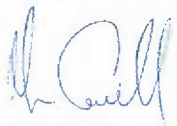

Martin Cowell - BSc
Client Services Manager - Environmental Division

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ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1448850 SPv1
Contact:	Ruka Te Moana	**Date Registered:**	10-Jul-2015
	C/- Schlumberger New Zealand Limited	**Date Reported:**	22-Jul-2015
	PO Box 7100	**Quote No:**	31151
	Fitzroy	**Order No:**	M16600073A
	NEW PLYMOUTH 4341	**Client Reference:**	Surrey Road SW3 Outlet & Upstream
		Submitted By:	Ruka Te Moana

Sample Type: Aqueous

	Sample Name:	Surrey Road SW3 Outlet 08-Jul-2015 12:30 pm	Surrey Road SW3 Upstream 08-Jul-2015 12:30 pm			
	Lab Number:	1448850.1	1448850.2			
Individual Tests						
Free Ammonia*	g/m³ at Client Temperature	< 0.010	-	-	-	-
pH	pH Units	7.3	-	-	-	-
Total Suspended Solids	g/m³	4	-	-	-	-
Sample Temperature*	°C	20	-	-	-	-
Total Ammoniacal-N	g/m³	0.39	-	-	-	-
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m³	< 2	< 2	-	-	-
Oil and Grease	g/m³	< 5 #1	-	-	-	-
Chlorine, Free & Combined						
Free Chlorine	g/m³	< 0.05	-	-	-	-
Combined Chlorine	g/m³	< 0.08	-	-	-	-

Analyst's Comments

#1 There was insufficient sample to perform the oil and grease analysis on this sample. Therefore a smaller aliquot was taken prior to analysis, resulting in a detection limit higher than that normally achieved.

SUMMARY OF METHODS

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Free Ammonia*	Calculation from NH4N, pH, Temperature (Calculations based on data for distilled water). APHA Table 8010:VI 22nd ed. 2012.	0.010 g/m³ at Client Temperature	1
Chlorine, Free & Combined	DPD Colorimetric	0.05 g/m³	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
pH	pH meter. APHA 4500-H^+ B 22nd ed. 2012. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field.	0.1 pH Units	1
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 22nd ed. 2012.	3 g/m³	1
Sample Temperature*	Supplied by customer, otherwise 20°C.	0.10 °C	1
Total Ammoniacal-N	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH_4-N = NH_4+-N + NH_3-N). APHA 4500-NH_3 F (modified from manual analysis) 22nd ed. 2012.	0.010 g/m³	1
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, dilutions, seeded. Analysed at Hill Laboratories - Microbiology; 1 Clow Place, Hamilton. APHA 5210 B (modified) 22nd ed. 2012.	2 g O_2/m³	1-2

Sample Type: Aqueous			
Test	Method Description	Default Detection Limit	Sample No
Oil and Grease	Sample filtration through filter aid, Soxhlet extraction, gravimetric determination of extracted Oil & Grease. APHA 5520 D (modified) 22nd ed. 2012.	4 g/m^3	1

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

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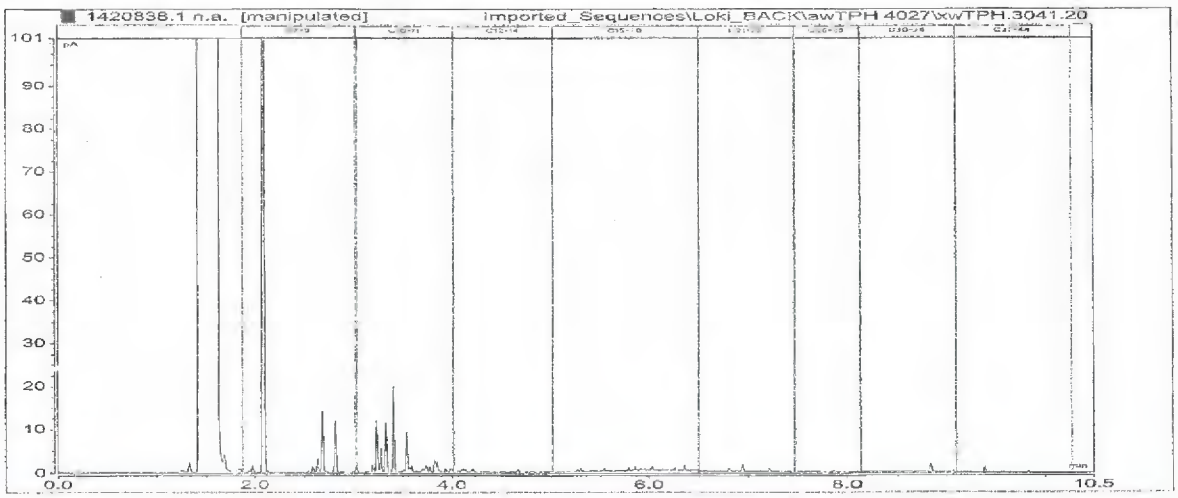
ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1420838	SPv1
Contact:	R Henry	**Date Registered:**	02-May-2015	
	C/- Schlumberger New Zealand Limited	**Date Reported:**	21-May-2015	
	PO Box 7100	**Quote No:**	34979	
	Fitzroy	**Order No:**	M16600016A	
	NEW PLYMOUTH 4341	**Client Reference:**	Pre-Landspread Samples	
		Submitted By:	R Henry	

Sample Type: Aqueous

Sample Name:		Cell 3 Surrey Road				
Lab Number:		1420838.1				
Individual Tests						
Chloride	g/m³	79	-	-	-	-
Total Nitrogen	g/m³	0.87	-	-	-	-
Nitrate-N + Nitrite-N	g/m³	0.06	-	-	-	-
Total Kjeldahl Nitrogen (TKN)	g/m³	0.81	-	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	3.4	-	-	-	-
C10 - C14	g/m³	0.9	-	-	-	-
C15 - C36	g/m³	0.5	-	-	-	-
Total hydrocarbons (C7 - C36)	g/m³	4.8	-	-	-	-

1420838.1
Cell 3 Surrey Road
Client Chromatogram for TPH by FID



SUMMARY OF METHODS

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Total Petroleum Hydrocarbons in Water*	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines [KBIs:2803,10734]	0.10 - 0.7 g/m³	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Kjeldahl Digestion	Sulphuric acid digestion with copper sulphate catalyst.	-	1
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl- E (modified from continuous flow analysis) 22nd ed. 2012.	0.5 g/m³	1
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m³ is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m³, the Default Detection Limit for Total Nitrogen will be 0.11 g/m³.	0.05 g/m³	1
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3- I 22nd ed. 2012.	0.002 g/m³	1
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D. (modified) 4500 NH_3 F (modified) 22nd ed. 2012.	0.10 g/m³	1

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

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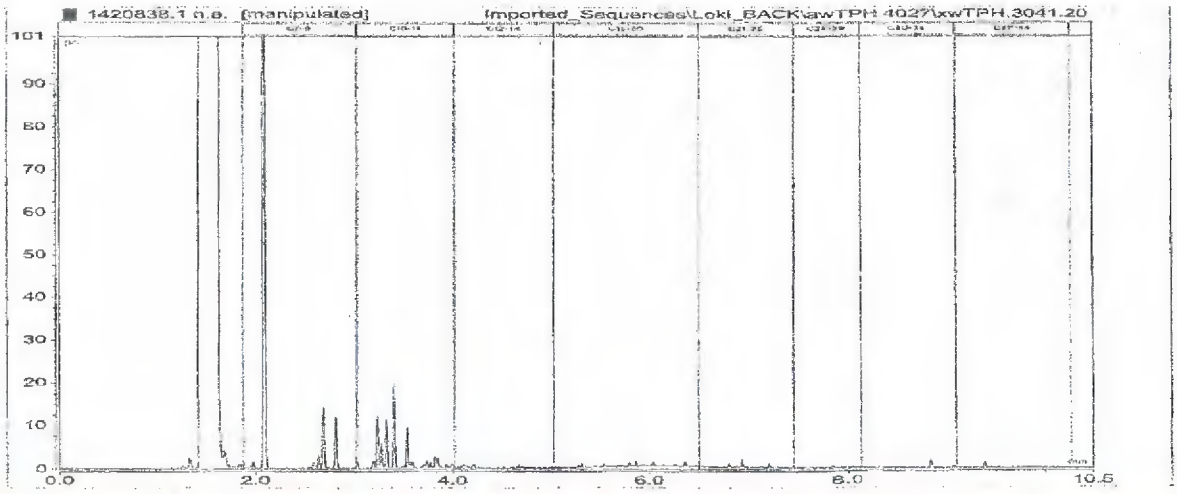
ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	Lab No:	1420838 SPv1
Contact:	R Henry	Date Registered:	02-May-2015
	C/- Schlumberger New Zealand Limited	Date Reported:	21-May-2015
	PO Box 7100	Quote No:	34979
	Fitzroy	Order No:	M16600016A
	NEW PLYMOUTH 4341	Client Reference:	Pre-Landspread Samples
		Submitted By:	R Henry

Sample Type: Aqueous

Sample Name:	Cell 3 Surrey Road				
Lab Number:	1420838.1				
Individual Tests					
Chloride	g/m³	79	-	-	-
Total Nitrogen	g/m³	0.87	-	-	-
Nitrate-N + Nitrite-N	g/m³	0.06	-	-	-
Total Kjeldahl Nitrogen (TKN)	g/m³	0.81	-	-	-
Total Petroleum Hydrocarbons in Water					
C7 - C9	g/m³	3.4	-	-	-
C10 - C14	g/m³	0.9	-	-	-
C15 - C36	g/m³	0.5	-	-	-
Total hydrocarbons (C7 - C36)	g/m³	4.8	-	-	-

1420838.1
Cell 3 Surrey Road
Client Chromatogram for TPH by FID



SUMMARY OF METHODS

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Total Petroleum Hydrocarbons in Water*	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines [KBIs:2803,10734]	0.10 - 0.7 g/m³	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1

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ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1449036 svgpv1
Address:	PO Box 7100	**Date Registered:**	10-Jul-2015
	Fitzroy	**Date Reported:**	21-Jul-2015
	NEW PLYMOUTH 4341	**Quote No:**	34979
		Order No:	M16600073A
		Client Reference:	Ross Henry
		Add. Client Ref:	Ross Henry
Phone:	06 755 0037	**Submitted By:**	R Henry

Soil Analysis Results

Sample Name:	Paddock 18 02-Jul-2015	Paddock 30 02-Jul-2015	Paddock 31 02-Jul-2015	Paddock 34 02-Jul-2015	Paddock 142 (Prior 141) 02-Jul-2014	Paddock 143 (Prior 142) 02-Jul-2014
Lab Number:	1449036.1	1449036.2	1449036.3	1449036.4	1449036.5	1449036.6
Sample Type:	SOIL General, Outdoor	SOIL General, Outdoor	SOIL General, Outdoor	SOIL General, Outdoor	SOIL General, Outdoor	SOIL General, Outdoor
Sample Type Code:	S10	S10	S10	S10	S10	S10
pH pH Units	6.6	6.3	6.3	6.2	7.5	6.6
Volume Weight g/mL	0.78	0.77	0.65	0.67	0.90	0.81
Soluble Salts (Field) %	< 0.05	< 0.05	< 0.05	< 0.05	0.06	< 0.05
Chloride mg/kg	20	16	10	11	11	11
Total Nitrogen %	0.85	0.61	0.63	0.62	0.47	0.62
Total Soluble Salts* mg/L	251	178.2	105.6	132.0	310	85.8
Electrical Conductivity (Sat Paste)* mS/cm	0.4	0.3	0.2	0.2	0.5	0.1
Nitrate-N (Sat Paste)* mg/L	15	8	4	8	2	4
Ammonium-N (Sat Paste)* mg/L	6	4	2	3	2	2
Phosphorus (Sat Paste)* mg/L	3	4	2	2	1	< 1
Potassium (Sat Paste)* mg/L	23	21	10	11	27	5
Calcium (Sat Paste)* mg/L	38	28	19	19	83	15
Magnesium (Sat Paste)* mg/L	4	2	2	2	3	1
Sodium (Sat Paste)* mg/L	13	11	7	10	10	7
Sodium Absorption Ratio*	0.6	0.5	0.4	0.6	0.3	0.5

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ANALYSIS REPORT

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Address:	PO Box 7100	**Date Registered:**	10-Jul-2015
	Fitzroy	**Date Reported:**	21-Jul-2015
	NEW PLYMOUTH 4341	**Quote No:**	34979
		Order No:	M16600073A
		Client Reference:	Ross Henry
		Add. Client Ref:	Ross Henry
Phone:	06 755 0037	**Submitted By:**	R Henry

SUMMARY OF METHODS

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

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Sample Registration*	Samples were registered according to instructions received.	-	1-6
Soil Prep (Dry & Grind)*	Air dried at 35 - 40°C overnight (residual moisture typically 4%) and crushed to pass through a 2mm screen.	-	1-6
pH	1:2 (v/v) soil:water slurry followed by potentiometric determination of pH.	0.1 pH Units	1-6
Total Nitrogen	Dumas combustion.	0.04 %	1-6
Soluble Salts (Field)	1:5 soil:water extraction followed by potentiometric determination of conductivity. Calculated by EC (mS/cm) x 0.35.	0.05 %	1-6
Chloride	Saturated Calcium Sulphate extraction followed by Potentiometric Titration.	10 mg/kg	1-6
Total Soluble Salts*	Saturated Paste extraction followed by potentiometric conductivity determination (25°C).	1.0 mg/L	1-6
Electrical Conductivity (Sat Paste)*	Saturated Paste extraction followed by potentiometric conductivity determination (25°C).	0.1 mS/cm	1-6
Nitrate-N (Sat Paste)*	Saturated Paste extraction followed by Salicylate colorimetry.	1 mg/L	1-6
Ammonium-N (Sat Paste)*	Saturated Paste extraction followed by Berthelot colorimetry.	1 mg/L	1-6
Phosphorus (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-6
Potassium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-6
Calcium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-6
Magnesium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-6
Sodium (Sat Paste)*	Saturated Paste extraction followed by ICP-OES.	1 mg/L	1-6
Sodium Absorption Ratio (SAR)*	Calculation from the sodium, calcium and magnesium determined on a Saturated Paste extract.	0.2	1-6
Volume Weight	The weight/volume ratio of dried, ground soil.	0.01 g/mL	1-6

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W.M.Homewood.

Wendy Homewood
Operations Support - Agriculture Division

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ANALYSIS REPORT

Client:	Schlumberger New Zealand Limited	**Lab No:**	1448849	SPv1
Contact:	R Henry	**Date Registered:**	10-Jul-2015	
	C/- Schlumberger New Zealand Limited	**Date Reported:**	23-Jul-2015	
	PO Box 7100	**Quote No:**	34979	
	Fitzroy	**Order No:**	M16600073A	
	NEW PLYMOUTH 4341	**Client Reference:**		
		Submitted By:	R Henry	

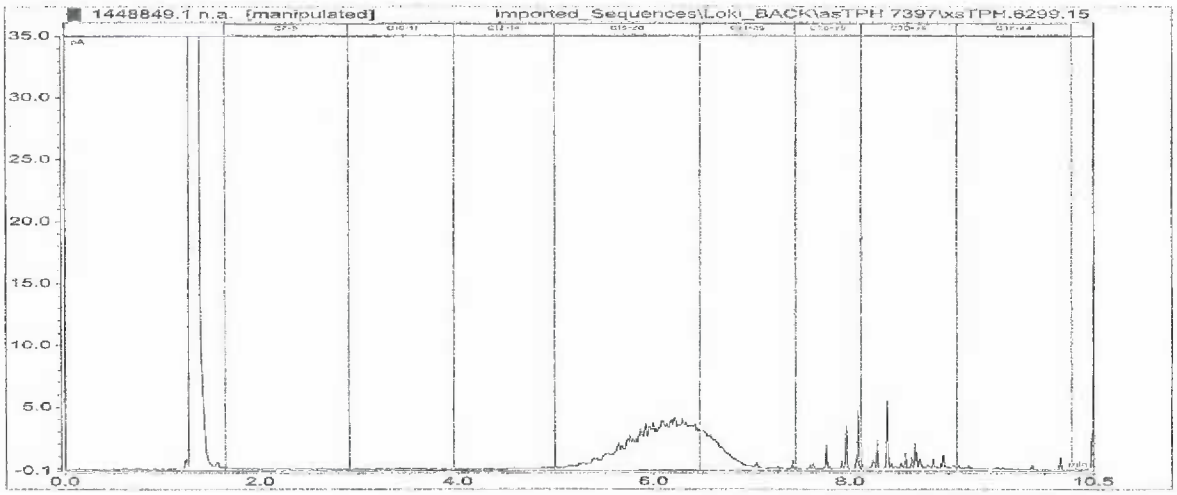
Sample Type: Soil

Sample Name:		Paddock 18 02-Jul-2015	Paddock 30 02-Jul-2015	Paddock 31 02-Jul-2015	Paddock 34 02-Jul-2015	Paddock 142 (Prior 141) 02-Jul-2014
Lab Number:		1448849.1	1448849.2	1448849.3	1448849.4	1448849.5
Individual Tests						
Dry Matter	g/100g as rcvd	50	57	57	52	68
Density*	g/mL at 20°C	0.75	0.66	0.78	0.77	1.08
Total Recoverable Barium	mg/kg dry wt	2,600	930	3,200	4,600	4,700
Total Recoverable Sodium	mg/kg dry wt	530	670	490	590	580
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	2	2	3	< 2	2
Total Recoverable Cadmium	mg/kg dry wt	0.29	0.49	0.31	0.32	0.12
Total Recoverable Chromium	mg/kg dry wt	8	9	9	9	7
Total Recoverable Copper	mg/kg dry wt	40	32	37	38	37
Total Recoverable Lead	mg/kg dry wt	5.4	9.7	5.8	9.0	8.9
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Nickel	mg/kg dry wt	3	4	5	3	4
Total Recoverable Zinc	mg/kg dry wt	35	37	34	40	39
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.11	< 0.09	< 0.09	< 0.10	< 0.07
Toluene	mg/kg dry wt	< 0.11	< 0.09	< 0.09	< 0.10	< 0.07
Ethylbenzene	mg/kg dry wt	< 0.11	< 0.09	< 0.09	< 0.10	< 0.07
m&p-Xylene	mg/kg dry wt	< 0.3	< 0.17	< 0.17	< 0.2	< 0.13
o-Xylene	mg/kg dry wt	< 0.11	< 0.09	< 0.09	< 0.10	< 0.07
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.05	< 0.04	< 0.04	< 0.05	< 0.04
Acenaphthylene	mg/kg dry wt	0.06	< 0.04	< 0.04	< 0.05	< 0.04
Anthracene	mg/kg dry wt	< 0.05	< 0.04	< 0.04	< 0.05	< 0.04
Benzo[a]anthracene	mg/kg dry wt	0.07	< 0.04	< 0.04	< 0.05	0.03
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.08	< 0.04	< 0.04	< 0.05	0.04
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.18	0.04	< 0.04	0.05	0.08
Benzo[g,h,i]perylene	mg/kg dry wt	0.24	< 0.04	< 0.04	< 0.05	0.13
Benzo[k]fluoranthene	mg/kg dry wt	0.07	< 0.04	< 0.04	< 0.05	0.04
Chrysene	mg/kg dry wt	0.11	< 0.04	< 0.04	< 0.05	0.07
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.05	< 0.04	< 0.04	< 0.05	< 0.04
Fluoranthene	mg/kg dry wt	0.11	< 0.04	< 0.04	< 0.05	0.06
Fluorene	mg/kg dry wt	< 0.05	< 0.04	< 0.04	< 0.05	< 0.04
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.10	< 0.04	< 0.04	< 0.05	0.03
Naphthalene	mg/kg dry wt	< 0.3	< 0.19	< 0.19	< 0.3	< 0.16
Phenanthrene	mg/kg dry wt	0.07	< 0.04	< 0.04	< 0.05	< 0.04
Pyrene	mg/kg dry wt	0.11	< 0.04	< 0.04	< 0.05	0.06

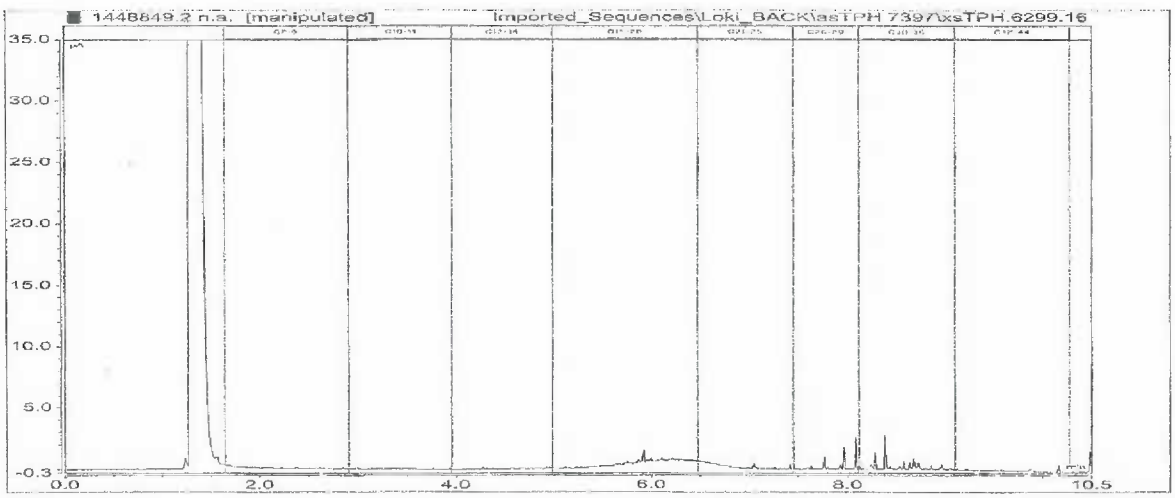
Sample Type: Soil						
Sample Name:		Paddock 18 02-Jul-2015	Paddock 30 02-Jul-2015	Paddock 31 02-Jul-2015	Paddock 34 02-Jul-2015	Paddock 142 (Prior 141) 02-Jul-2014
Lab Number:		1448849.1	1448849.2	1448849.3	1448849.4	1448849.5
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 13	< 12	< 12	< 13	< 10
C10 - C14	mg/kg dry wt	< 30	< 30	< 30	< 30	32
C15 - C36	mg/kg dry wt	500	134	133	122	1,770
Total hydrocarbons (C7 - C36)	mg/kg dry wt	500	134	133	122	1,800

Sample Name:		Paddock 143 (Prior 142) 02-Jul-2014				
Lab Number:		1448849.6				
Individual Tests						
Dry Matter	g/100g as rcvd	61	-	-	-	-
Density*	g/mL at 20°C	0.87	-	-	-	-
Total Recoverable Barium	mg/kg dry wt	2,100	-	-	-	-
Total Recoverable Sodium	mg/kg dry wt	500	-	-	-	-
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	3	-	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.37	-	-	-	-
Total Recoverable Chromium	mg/kg dry wt	8	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	40	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	6.6	-	-	-	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Nickel	mg/kg dry wt	3	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	29	-	-	-	-
BTEX in Soil by Headspace GC-MS						
Benzene	mg/kg dry wt	< 0.08	-	-	-	-
Toluene	mg/kg dry wt	< 0.08	-	-	-	-
Ethylbenzene	mg/kg dry wt	< 0.08	-	-	-	-
m&p-Xylene	mg/kg dry wt	< 0.16	-	-	-	-
o-Xylene	mg/kg dry wt	< 0.08	-	-	-	-
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.04	-	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.04	-	-	-	-
Anthracene	mg/kg dry wt	< 0.04	-	-	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.04	-	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.04	-	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.06	-	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	0.08	-	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.04	-	-	-	-
Chrysene	mg/kg dry wt	0.05	-	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.04	-	-	-	-
Fluoranthene	mg/kg dry wt	0.04	-	-	-	-
Fluorene	mg/kg dry wt	< 0.04	-	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.04	-	-	-	-
Naphthalene	mg/kg dry wt	< 0.18	-	-	-	-
Phenanthrene	mg/kg dry wt	< 0.04	-	-	-	-
Pyrene	mg/kg dry wt	0.07	-	-	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 11	-	-	-	-
C10 - C14	mg/kg dry wt	< 30	-	-	-	-
C15 - C36	mg/kg dry wt	380	-	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	380	-	-	-	-

1448849.1
Paddock 18 02-Jul-2015
Client Chromatogram for TPH by FID



1448849.2
Paddock 30 02-Jul-2015
Client Chromatogram for TPH by FID



1448849.3
Paddock 31 02-Jul-2015
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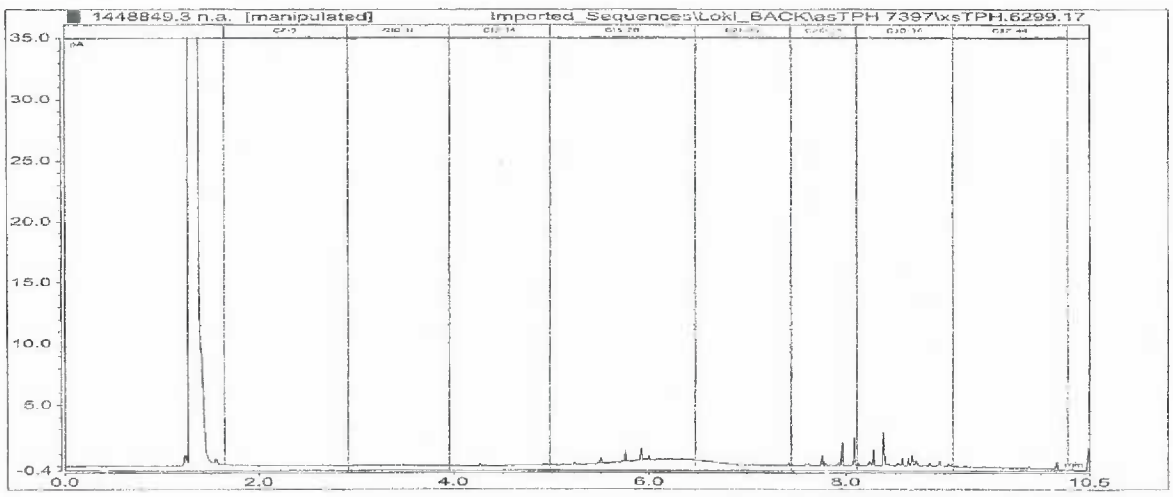
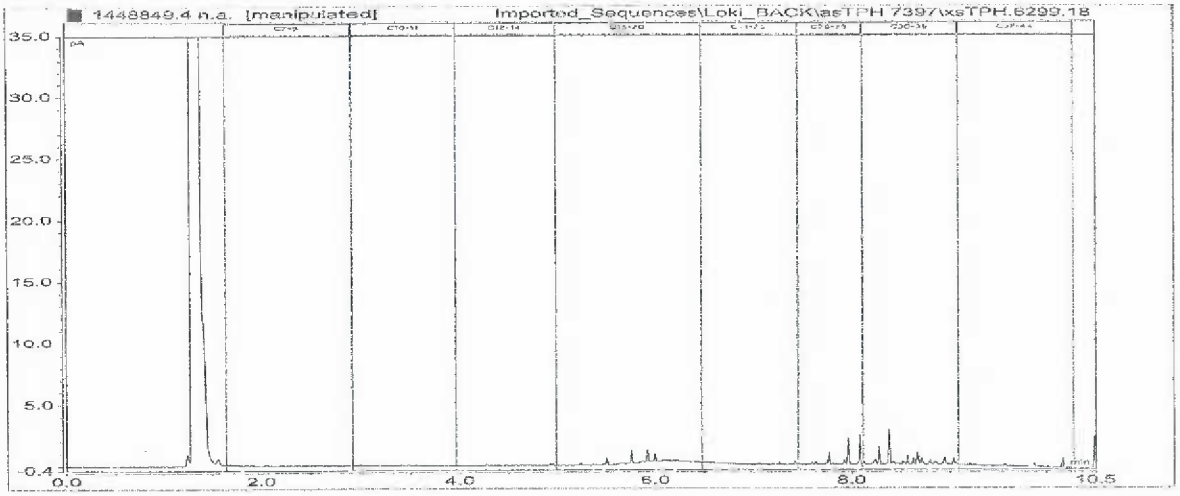
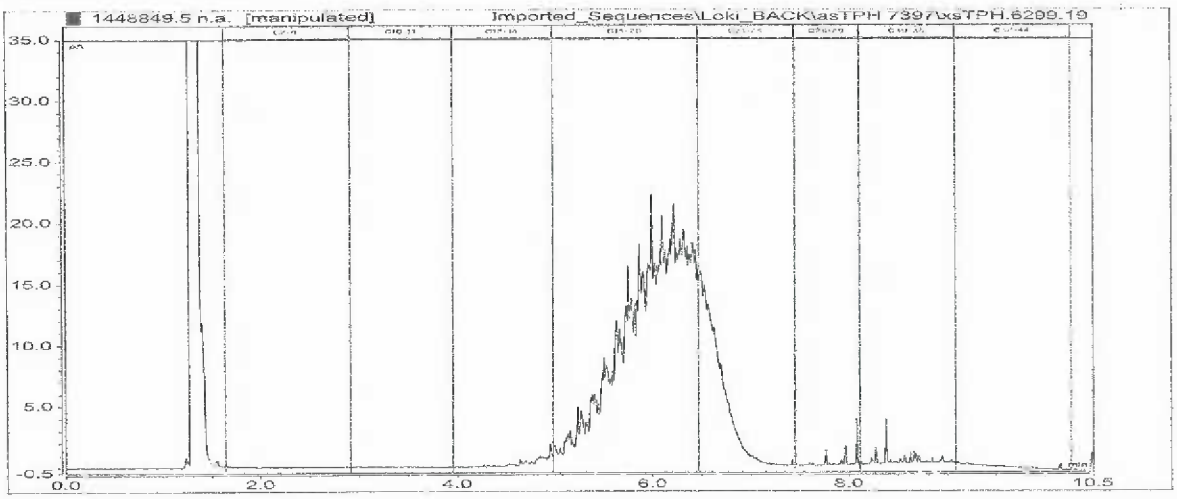


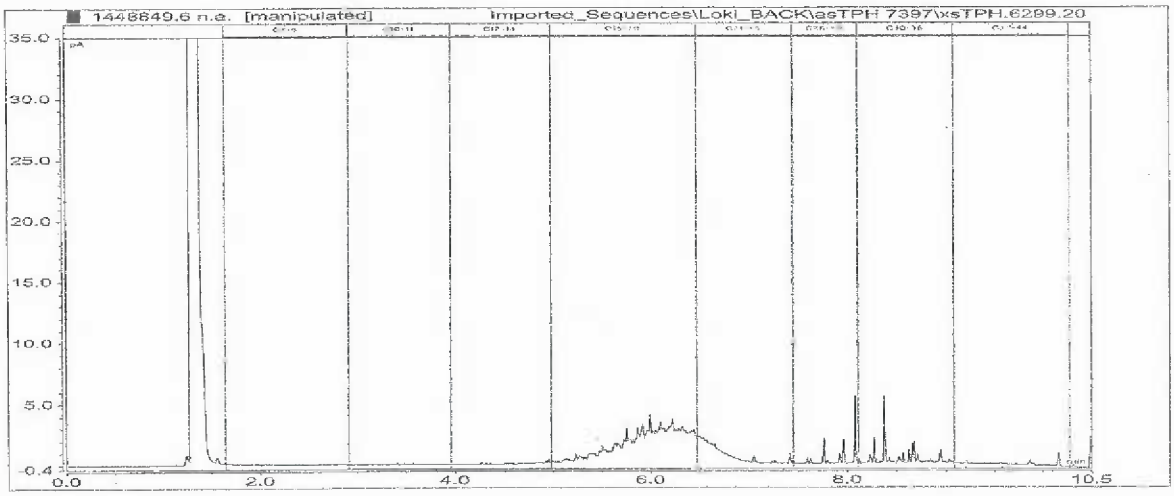
1448849.4
Paddock 34 02-Jul-2015
Client Chromatogram for TPH by FID



1448849.5
Paddock 142 (Prior 141) 02-Jul-2014
Client Chromatogram for TPH by FID



1448849.6
Paddock 143 (Prior 142) 02-Jul-2014
Client Chromatogram for TPH by FID



Analyst's Comments

Please treat the TPH and BTEX results with caution as samples were not received in sealed glass jars so volatile loss would have occurred.

It is noted that Chrysene was higher than expected when compared to Benzo[a]anthracene in sample 1448849.5 & .6. It is possible that Benzo(l)phenanthrene is present which co-elutes with Chrysene.

SUMMARY OF METHODS

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

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-6
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	1-6
BTEX in Soil by Headspace GC-MS	Solvent extraction, Headspace GC-MS analysis US EPA 8260B. Tested on as received sample [KBIs:5782,26687,3629]	0.05 - 0.10 mg/kg dry wt	1-6
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample. [KBIs:5786,2805,2695]	0.010 - 0.05 mg/kg dry wt	1-6
Total Petroleum Hydrocarbons in Soil*	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample [KBIs:5786,2805,10734]	8 - 60 mg/kg dry wt	1-6
TPH + PAH + BTEX profile	Sonication extraction, SPE cleanup, GC & GC-MS analysis	0.010 - 60 mg/kg dry wt	1-6
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1-6
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-6
Density*	Calculation: weight of sample / volume of sample at 20°C. Gravimetric determination.	0.02 g/mL at 20°C	1-6
Total Recoverable Barium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-6
Total Recoverable Sodium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	1-6

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

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

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

Variation of Consents 7559-1 and 7591-1.

Applications were required to vary the consents 7559-1 and 7591-1 to accommodate the new spreading methods utilised at the Surrey Rd land farm, and also for the receiving of drilling waste from offshore.

1. The direct injection trial 2014 system.
2. The use of a pump/irrigator to spread storm water from cell 3.

We have enclosed the details of the Taranaki Regional Council's requirements as below.

To discharge drilling waste cuttings [consisting of drilling cuttings ad drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into the land via landfarming

Review and change of consent conditions to bring them inline with best practice so that the purpose now reads:

To discharge drilling waste cuttings [consisting of drilling cuttings and drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into the land via landfarming, landspreading, injection spreading and irrigation.

Applicant	Colin David Boyd
Postal address	PO Box 44 INGLEWOOD 4347
Site location	Surrey Road, Inglewood
Grid reference(s)	1701847E-5651476N
Legal description	SEC 17 & 18 Blk XIV Egmont SD
Catchment	Waitara
Tributary	Mangamawhete, Mangatenghu
Review date(s)	June 2016 and/or June 2017, June 2018, June 2019 and June 2024,
Expiry date	1 June 2027

1. Introduction

This Officer's report relates to two matters: firstly a review of conditions which was proposed to the applicant in June 2013 (#1206414), second a change of the consent conditions application (#1570503 & #1571467).

Colin David Boyd ('the applicant') holds consent 7559-1. This consent contains a review condition, special condition 26. The Council served a notice of review as per the consent conditions in June 2013 in accordance with sections 128 and 129 of the Resource Management Act (RMA).

The reasons for the review and the information taken into account when deciding to review the consent are that:

1) Special conditions of the consent provide for the council to review, amend, delete or add consent conditions 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 consent; and
2) The existing special conditions are not adequate to deal with potential adverse effects on the environment.

The notice of review stated that all of the conditions of the consent are subject to the review but the Council only proposed to review the following:

- Limits for Sodium Absorption Ratio (SAR);
- Limits for Total Petroleum Hydrocarbons (TPH);
- Conditions requiring lining of drilling waste storage pits; and
- The adequacy of the provisions to review the conditions

The applicant also requested a change to consent conditions, the changes proposed are detailed below:

- Variation to include an irrigator, to allow the consent holder to spread the liquid fraction of the drilling waste;
- Variation to include the use of an injection spreader, as previously utilised during field trials;
- Variation to include deliveries from outside the 12 nautical mile limit of the Taranaki Region, within the Taranaki Region.
- The inclusion of metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn) and Salts (Barite – Barium, Calcium, Magnesium, Sodium and Potassium) to the initial screen of pre-land farmable material.
- Amendment to the current surrender criteria with respect to metal and hydrocarbon concentrations inline with international best practice and expert opinion.

This report includes my assessment of the review of the application under the RMA and my recommendation that the changes proposed by the review and the application are made to the consent.

2. Proposed Changes

The consent holder operates a drilling mud storage facility at Surrey Road, whereby drilling muds consisting of both water and synthetic based materials are brought to the facility from well sites, both onshore and offshore and discharged into set storage cells. Material is these cells is analytically tested and then either landfarmed or landspread across the consent holder's paddocks at a consented application rate. The consent holder has been operating this facility since November 2009 when the Council granted the original consent.

I have discussed each of the proposed changes in more detail below:

2.1 Sodium Absorption Ratio (SAR)

The original review notice detailed that a limit to the Sodium Absorption Ratio (SAR) would be applied.

The current condition 18 of the consent states the following;

'The sodium absorption ratio (SAR) of the soil layer containing the discharge shall be less than 18, or alternatively if the background of the soil exceeds 18, the application of the waste shall not increase the SAR by more than 1.'

While the consent holder has complied with the original consented limit in relation to SAR, this condition should be more directed in the protection of the soil from the excesses of a high SAR which can have a detrimental effect in causing a de-flocculation of soil particles, a loss of soil structure and a reduction of water infiltration.

Through a review of the reported SAR collected by the Council during the 2010-2015 period **Figure 1**, the vast majority of samples analysed were under or equal to a maximum of 8, with the odd outlier >8. I also compared the current practice with that of the *Alberta Energy Regulator, Directive 050: Drilling Waste Management (May 2015)*, and slightly adjusted the value to suit Taranaki Conditions. Therefore I recommend the following alteration to Condition 18:

'After incorporation of the waste with the soil, the waste soil mix shall not be more than 3 units higher than background soil SAR, or exceed a SAR of 8. Alternatively if the soil SAR exceeds 8, the application of the waste shall not increase the SAR by more than 1.'

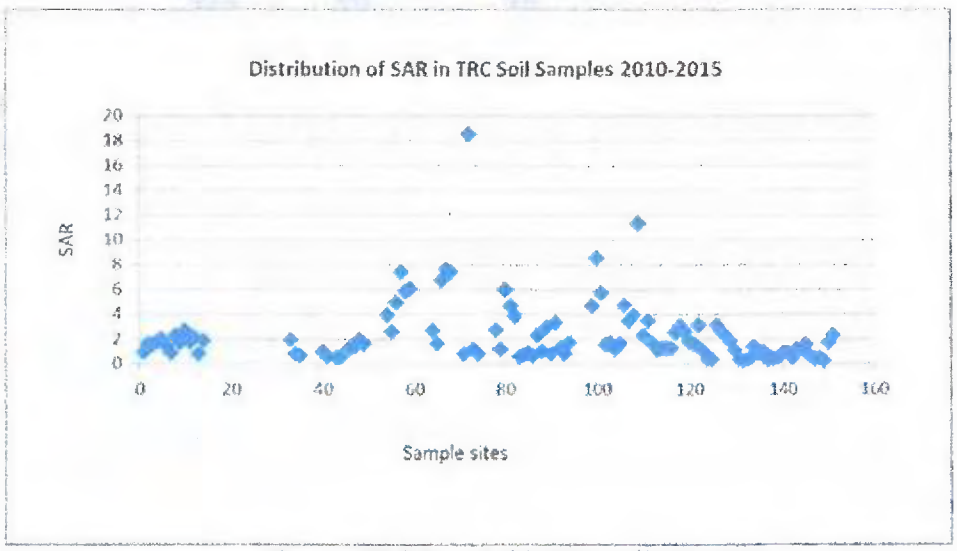


Figure 1 TRC Reported SAR in Soil 2010-2015

2.2 Limits to Total Petroleum Hydrocarbons

The status quo with regard to hydrocarbon concentration in the soil, post load out and incorporation into the soil via landfarming is determined by Condition 11 of the Consent;

'As soon as practicable following the application of drilling wastes to land, the consent holder shall incorporate the material into the soil to a depth of at least 250mm, so that the hydrocarbon concentration at any point in the soil/waste mix is less than 50,000mg/kg'

Following expert advice from *Pattle Delamore Partners (PDP) (Review of Petroleum Waste land farming May 2013)* and in line with *Alberta Energy Regulator, Directive 050: Drilling Waste Management (May 2015)*, I recommend Condition 11 be changed to the following;

Note that during landfarming, the application depth of material can be up to 300mm, post incorporation. As the applicant is also proposing the use of an injection spreader, where the depth of application is 100mm, this condition reflects the depth of application.

Amended Condition 11

'As soon as practicable following the application of drilling wastes to land, the consent holder shall incorporate the material into the soil to a depth of at least 250mm for landfarming and 100mm for the injection spreader, so that the hydrocarbon concentration at any point in the soil/ waste mix is equal to or less than 20,000mg/kg (2%) dry weight at any point'.

2.3 Conditions requiring the lining of drilling waste storage pits

The site is comprised of three drilling mud storage cells, 1, 2 and 3 respectively. In 2013 the site operator, Mi Swaco, lined two of three storage cells with fit for purpose, impermeable synthetic liners. In line with the best practicable option and expert opinion (*PDP 2013*) the recommendation is that the consent holder will line the third storage cell with a similar impermeable synthetic liner. This will be stipulated by new Condition 4.

New Condition 4

'Any pits used for stockpiling solid or liquid waste shall be lined with 'fit for purpose' high-grade synthetic liners or equivalent and the consent holder shall demonstrate, that the lined pits are suitable for storing liquid without leakage through the base or side walls. The Consent holder shall monitor the integrity of the pit liners and repair or replace liners as required.'

2.4 The adequacy of the provisions to review the conditions of the Consent

To ensure that the conditions remain relevant and appropriate my recommendation is that the consent provide for annual review until 2019.

Amended Condition 26

'In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2016 and/or June 2017 and/or June 2018 and/or June 2019 and/ or June 2025 for the purpose of ensuring that the conditions area 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, or to take into account any Act of Parliament, regulations, national policy statement , and national environmental standard which is relevant to this consent.'

2.5 Expansion of initial screen of pre-landfarmable materials

The inclusion of Metals (Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni) and Zinc (Zn)) and Salts (Barium (Ba), Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K)) and Nitrogen (N) to the initial screen of pre-land farmable material

Current Condition 6 of the Consent states;

The Consent holder shall notify the Chief Executive, Taranaki Regional Council, [by emailing worknotification@trc.govt.nz] at least 48 hours prior to landfarming stockpiled material. Notification shall include the following information:

a) The Consent number;
b) The name of the well[s] from which the waste was generated;
c) The type of waste to be landfarmed;
d) The volume and weight of the wastes to be landfarmed;
e) The concentration of chlorides, nitrogen and hydrocarbons in the waste; and
f) The specific location and area over which the waste will be landfarmed.

in order to demonstrate compliance with conditions 12, 13 and 14 of this consent.

I recommend that in accordance with the change application, Condition 6 (e) is changed to read as follows:
Amended Condition 6, e):

e) The specific concentrations of Metals (Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni) and Zinc (Zn)) and Salts (Barium (Ba), Calcium (Ca), Chloride (Cl), Magnesium (Mg), Sodium (Na), Potassium (K)), Hydrocarbons (Total Petroleum Hydrocarbons, Mono Cyclic Aromatic Hydrocarbons and Poly Cyclic Aromatic Hydrocarbons) and Nitrogen (N) in the waste prior to application.

The amendment and expansion of the pre screening analysis is to allow the operator to further quantify the material which they are farming out. It will also aid with monitoring other conditions of this consent such as:

- Amended Condition 12, which deals with application and concentration rate in terms of hydrocarbon concentration of the landfarmable material once incorporated into the soil; 2% hydrocarbon.

- Condition 13, the chloride loading rate;

- Condition 14, the nitrogen loading rate;
- Amended Condition 18, heavy metal concentration limits for the soil;
- New Condition 19, post soil incorporation, the waste soil mix is limited to a maximum increase of 3 units beyond existing soil SAR, but not to exceed a SAR of 8.

These criteria will be analysed and quantified pre-load out, as currently they are only partially analysed.

2.6 Adjustment to the method utilised by the Consent holder to apply landspreadble fluid component of the storage cells

On site observations and analysis during intense rainfall episodes, found that the nature of the stormwater system dictated that fluid components of the storage cells had the potential to move through the stormwater system and as a result had the potential to discharge into the Mangatenghu stream.

Stormwater from Cell 1 would drain (via a goose-kneck system) through Cell 2 and into Cell 3, whereby it would then flow into the stormwater ponds and eventually discharge into Mangatenghu Stream

The consent holder intends to fit a pump and irrigator to existing Cell 3. This will allow for the spreading of the same liquid fraction as would be spread through the use of the landspreader, however, this fraction will now be irrigated to a specific area and the area will be treated as a spread area, and will be subject to the same conditions of this consent.

As such, I recommend, Special Condition 1) will have amendment c), added to it which will detail the following:

Amended Special Condition 1 c):

'Landspreading of liquid fraction of drilling wastes and or stormwater component of the storage cells will be undertaken through the use of a landspreader/and or irrigator. Throughout the application of the liquid fraction the Consent holder shall maintain pasture cover at all times.'

2.7 Re-application of material to specific areas which had previously received material

The current condition 11 details the following;

'Any area of land used for landfarming of drilling waste in accordance with condition 9 of this consent shall not be used for any subsequent discharges of drilling waste.'

The consent holder will be required to demonstrate through laboratory analysis, that in areas where they intend to re-spread material, that the location does not exceed the condition stipulated values of the consent.

New Condition 10

'the areas which are irrigated, injection spread, landspread or landfarmed may receive future applications of material if they are below the consented criteria outlined by Conditions 18,19 and 20 of this consent.'

2.8 The inclusion of an injection spreader to the method of application to ground

The consent holder requested to include the use of an injection spreader to the mode of application. The consent holder undertook a trial application of this machine during 2013-2014 monitoring year and would like it to be included to the method of application.

The injection spreader utilises steel discs that slice into the ground and then the material is applied/pumped into the slice. It enables the portion of land to remain vegetated while the material is applied and the consent holder found that it limits the potential for overland flow in periods of heavier precipitation. The spreader injects the material to a depth of 100mm, which is different in application technique in comparison to landfarming; where the top soil is removed and stockpiled before being mixed and re seeded.

2.9 I recommend that this provision is allowed to include deliveries from outside the 12 nautical mile limit of the Taranaki Region

Current condition 7 is:

'The exercise of this consent is limited to wastes generated in the Taranaki Region'

The Consent holder would like to farm material which has been generated in the offshore environment from outside the 12 nautical mile limit. Currently the site contains material generated in the Maari Oil Field which would place it outside of the Taranaki Region, thus my recommendation is that condition 7 is amended as follows.

Amended Condition 7

'The exercise of this consent is limited to waste generated in the Taranaki Region, and from outside the 12 nautical mile maritime limit, within the Taranaki Basin.'

2.10 The concentration of specific heavy metals in the soil layer containing the discharge will be lowered

The original Condition 17 of the Consent Stipulates:

"The concentration of metals in the soil layer containing the discharge shall comply with the guidelines for heavy metals in soil set out in Table 7.1, Section 7 of the "Guidelines for the safe application of biosolids to land in New Zealand"

Inline with expert advice, (*Cavanagh, Landcare Research, Land application of waste from oil and gas wells, May 2015*) I recommend that this condition will be amended to the following:

Amended Condition 17:

The concentration of the metals in the soil layer containing the discharge shall comply with the following criteria:

Metal / Salt	*Maximum value (mg/kg)*
Arsenic [1]	*17*
Barium – Barite [2]	*10,000*
Extractable Barium [2]	*250*
Cadmium [1]	*0.8*
Chromium [3]	*600*
Copper [3]	*100*
Lead [1]	*160*
Nickel [3]	*60*
Mercury	*1*
Zinc [3]	*300*
[1]SCS – Rural Residential MfE 2011b; [2] Alberta Environment 2009; [3] NZWWA 2003, lowest of protection of human health and ecological receptors. (Biosolids to land). Amended from Cavanagh, Landcare Research, Land application of waste from oil and gas wells, May 2015	

2.11 The surrender criteria with respect to hydrocarbon concentration and specifically, Total Petroleum Hydrocarbon speciation analysis will be amended

The original consent condition 19 states:

At the time of expiry, cancellation, or surrender of this consent the concentrations of hydrocarbons in the soil shall comply with the guideline values for sandy silt set out in Tables 4.12 and 4.15 of the "Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand" [MfE, 1999].

While these limits set by the Ministry have been adequate, expert advice has amended the assessment criteria with respect to the final Total Petroleum Hydrocarbon end points in the soil, relating to surrender criteria. These limits have been developed by *the Canadian Council of Ministers of the Environment (CCME), in the document Canada Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale, 2008.* Stipulated by Table 5.2 and 5.3 in the document.

This analysis focuses on a slightly different fractionation of the hydrocarbon chain breakdown than is currently assessed under the MfE guidelines in New Zealand.

Poly Aromatic Hydrocarbons and Mono Aromatic Hydrocarbons remain governed by Table 4.12 , *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand Module 4, Tier 1 Soil Screening Criteria, Surface <1m.*

Amended Condition 19:

'After 1 March 2027 (three months before the consent expiry date), constituents in the soil at any depth less than 500 mm shall meet the standards shown in the following table:'

Constituent	Standard
Conductivity	Not greater that 290 mS/m
Chloride	Not greater than 700 mg/kg
Sodium	Not greater than 460 mg/kg
Total Soluble Salts	Not greater than 2500 mg/kg
TPH Fraction	Guideline Value Agricultural Ecological Direct Soil Contact (Fine Sand) From table 5.2
F1 (C6-C10)	210
F2 (>C10-C16)	150
F3 (>C16-C34)	1300
F4 (>C34)	5600
Canadian Council of Ministers of the Environment (CCME), in the document Canada Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale, 2008. Table 5.2	
Soil Type/ Contaminant	Depth of contamination
	Surface (<1m) (mg/kg)
SANDY Silt	
MAHs	
Benzene	1.1
Toluene	82
Ethylbenzene	59
Xylene	59
PAHs	
Naphthalene	7.2
Non-carc (Pyrene)	160
Benzo(a)pyrene	0.027
Table 4.12 SANDY SILT Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (MfE 1999)	

'The requirement to meet these standards shall not apply if, before 1 March 2027, the consent holder applies for a new consent to replace this consent when it expires, and that the application is not subsequently withdrawn.'

2.12 Surrender Conditions

New condition 21:

> *'This consent cannot be surrendered unless the standards specified in condition 20 have been met.'*

2.13 Stockpiling Limit

Amended Condition 9:

> 'The stockpiling of material authorised by this consent shall be limited to a maximum volume of 4,000 cubic metres at any one time on the site. All stockpiled material must be landfarmed within nine months of being brought onto the site.'

3. Processing of an application for change of consent conditions

A change or review of conditions is processed in accordance with sections 88 to 121 of the RMA, with all necessary modifications, as if:

1. the application were an application for a resource consent for a discretionary activity; and
2. the references to a resource consent and to the activity were references only to the change of a condition and the effects of the change respectively.

Therefore, they are discretionary activities, with the assessment focusing only on the proposed changes and effects of the changes.

4. Non-notification

The Council's Consent Manager determined that the review and the application are to be processed on a non-notified basis because the adverse effects will not be more than minor and nobody is adversely affected. These decisions are documented separately.

5. Assessment of environmental effects

The effects of the proposed changes must be assessed against the existing environment. The existing environment includes permitted activities and activities already consented. Therefore the assessment is of the changes to the environment that will result from the conditions being changed.

The changes associated with this application and review are focussed on mitigating any potential effects to the existing environment, the majority of these changes are administrative, and if there are any consequences for the environment they are less than minor.

6. Statutory assessment

When determining the application the Council must promote the sustainable management of natural and physical resources. Sustainable management means managing the use, development and protection of these resources in a manner which

enables people and communities to provide for their social, cultural and economic wellbeing while:

a) sustaining the potential of natural resources to meet the reasonably foreseeable need of future generations;
b) safeguarding the life supporting capacity of water and ecosystems; and
c) avoiding, remedying and mitigation adverse effects of the application on the environment.

In promoting the sustainable management the Council must;

- recognise and provide for 'matters of national importance' (listed in section 6 of the RMA);
- have particular regard for 'other matters' (listed in section 7 of the RMA); and
- take account of the principles of the Treaty of Waitangi (section 8 of the RMA).

In my assessment the changes proposed enables people and communities to provide for their social, cultural and economic wellbeing. It also meets the other requirements of sustainable management.

Subject to promoting sustainable management the Council must have regard to:

a) any actual and potential effects on the environment of allowing the proposed change to conditions;
b) any relevant provisions of statutory policy documents; and
c) any other matter the consent authority considers relevant and reasonably necessary to determine the application.

In section 5 of this report I have assessed the actual and potential effects of the proposed changes the types of conditions necessary to avoid any adverse effects. My recommendation reflects appropriate regard for the environmental effects.

In making my recommendation I have also had regard to the provisions of the appropriate statutory documents.

7. Consent duration and review dates

The application is for a change of consent conditions so the expiry date can not be changed, this 1 June 2027.

The existing consent provides for the consent conditions to be reviewed in June 2021, this has been amended so that the Council will be able to monitor the progress of the newly amended conditions, so that future review dates will be June 2016 and/or June 2017, June 2018, June 2019, June 2024 and June 2027.

8. Monitoring

The recommended change to consent conditions will not require any change to the monitoring programme for the site. The only monitoring related change is in the form of analysis of the pre land farmable drilling waste which will be undertaken by the Consent holder.

9. Consent conditions

My recommendation is to allow the changes to conditions directly associated with the application. The changes are amendments to the existing conditions of the Consent.

The changes to conditions recommended are summarised in the table below.

Previous Condition No(s)	New Condition No(s)	Comment
1 (C)	1 (C)	See section 2.6
2-3	2-3	Unchanged
4	4	See section 2.3
4-5	5-6	Unchanged
6	7	See section 2.5
7	8	See section 2.9
8-9	9-10	See section 2.13
10	11	See section 2.7
11	12	See section 2.2
12-16	13-17	Unchanged
17	18	See section 2.10
18	19	See section 2.1
19	20	See section 2.11
20	21	See section 2.12
26	27	See section 2.4

10. Reasons for decision

The reasons for the recommended decision are detailed in this report, but in summary they are:

a) The changes to conditions proposed are consistent with statutory policies and promote the sustainable management of natural and physical resources; and
b) Undertaking the activity in accordance with the changed conditions recommended is will not cause any significant change to the environmental effects of the activity.

11. Recommendation

My recommendation is that the conditions of consent 7559-1

to discharge drilling waste cuttings [consisting of drilling cuttings ad drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into the land via landfarming.

Are changed by replacing the existing conditions as shown below

to … *to discharge drilling waste cuttings [consisting of drilling cuttings ad drilling fluids] from hydrocarbon exploration activities with water based muds and synthetic based muds onto and into the land via landfarming, landspreading, injection spreading and irrigation.*

be approved subject to the following conditions.

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. For the purposes of this consent the following definitions shall apply:

   a. stockpiling means a discharge of drilling wastes from vehicles, tanks, or other containers onto land, but without subsequently spreading, or incorporating into the soil within 24 hours of such discharge; and
   b. landfarming means the discharge of drilling waste onto land, subsequent spreading, incorporation into the soil and re-sowing into pasture or crop.
   c. landspreading means the discharge to land of the liquid fraction of drilling wastes. This includes the stormwater component of the storage cells through the use of a landspreader/and or irrigator. Throughout the application of the liquid fraction the Consent holder shall maintain pasture cover at all times.

2. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects on the environment from the exercise of this consent. For the purpose of this consent, the best practicable option will include undertaking the landfarming of drilling waste during extended periods of dry weather.

Requirements prior to exercise of consent

3. Prior to the exercise of this consent, the consent holder shall install a minimum of three groundwater monitoring wells. The wells shall be at locations and to depths, that enable the collection of groundwater samples [to assess any changes in groundwater quality] to the satisfaction of the Chief Executive, Taranaki Regional Council. The wells shall be installed in accordance with NZS 4411:2001 and all associated costs shall be met by the consent holder.

4. Any pits used for stockpiling solid or liquid waste shall be lined with 'fit for purpose' high-grade synthetic liner or equivalent and the consent holder shall demonstrate, that the lined pits are suitable for storing liquid without leakage through the base or side walls. The Consent holder shall monitor the integrity of the pit liners and repair or replace liners as required.

5. Prior to the exercise of this consent, the consent holder shall provide, to the written satisfaction of the Chief Executive, Taranaki Regional Council, a landfarming and stockpiling management plan to demonstrate the activity will be conducted to comply with all of the conditions of this consent. The management plan shall be reviewed annually and shall include as a minimum:

   a. control of site access;
   b. procedures for notification to Council of disposal activities;
   c. procedures for the receipt and stockpiling of drilling wastes onto the site;
   d. procedures for the management of stormwater recovered from, or discharging from, the drilling waste stockpiling area;
   e. methods used for the mixing and testing of different waste types;
   f. procedures for landfarming drilling wastes [including means of transfer from stockpiling area, means of spreading, and incorporation into the soil];
   g. contingency procedures;
   h. sampling regime and methodology; and
   i. post-landfarming management, monitoring and site reinstatement.

Notification and sampling requirements prior to discharge

6. The consent holder shall notify the Chief Executive, Taranaki Regional Council, [by emailing worknotification@trc.govt.nz.] at least 48 hours prior to permitting drilling wastes onto the site for stockpiling, from each well drilled. Notification shall include the following information:

   a. the consent number;
   b. the name of the well[s] from which the waste was generated;
   c. the type of waste to be stockpiled; and
   d. the volume of waste to be stockpiled.

7. The consent holder shall notify the Chief Executive, Taranaki Regional Council, [by emailing worknotification@trc.govt.nz.] at least 48 hours prior to the application of stockpiled material. Notification shall include the following information:

   a. the consent number;
   b. the name of the well[s] from which the waste was generated;
   c. the type of waste to be applied to land;
   d. the volume and weight of the waste to be applied to land;
   e. the specific concentrations of Metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), Salts (Barium, Calcium, Chloride, Magnesium, Sodium, Potassium). Hydrocarbons (Total Petroleum Hydrocarbons, Mono Cyclic Aromatic Hydrocarbons and Poly Cyclic Aromatic Hydrocarbons) and Nitrogen in the waste prior application to land; and
   f. the specific location and area over which the waste will be applied.

   in order to demonstrate compliance with conditions 10, 12, 13 and 14 of this consent.

Discharge limits

8. The exercise of this consent is limited to waste generated in the Taranaki region, including from outside the 12 nautical mile maritime limit within the Taranaki Basin.

9. The stockpiling of material authorised by this consent shall be limited to a maximum volume of 4,000 cubic metres at any one time on the site. All stockpiled material must be landfarmed within nine months of being brought onto the site.

10. For the purposes of landfarming, drilling wastes shall be applied to land in a layer not exceeding:

    a. 100 mm thick for wastes with a hydrocarbon concentration less than 50,000 mg/kg dry weight; or
    b. 50 mm thick for wastes with a hydrocarbon concentration equal to or greater than 50,000 mg/kg dry weight; and
    c. in a rate and manner such that no ponded liquids remain after one hour, for all wastes;

    prior to incorporation into the soil.

11. The areas which are irrigated, injection spread, landspread or landfarmed may receive future applications of material if they are below the consented criteria outlined by Conditions 18, 19 and 20 of this consent.

12. As soon as practicable following the application of drilling wastes to land, the consent holder shall incorporate the material into the soil to a depth of at least 250mm for landfarming and 100mm for the injection spreader, so that the hydrocarbon concentration at any point in the soil/ waste mix is equal to or less than 20,000mg/kg (2%) dry weight at any point'.

13. The exercise of this consent shall not result in a chloride loading exceeding 800 kg/ha.

14. The nitrogen loading [including that from any application of nitrogen fertiliser] over any area where drilling wastes are applied, shall not exceed 1000 kilograms per hectare over any 5 year period.

15. As soon as practicable following the landfarming of drilling wastes the discharge area shall be re-sown into pasture [or into crop]. If revegetation cannot be established within two months of the discharge, the consent holder shall undertake appropriate land stabilisation measures to minimise wind and/or stormwater erosion.

16. No discharge shall take place within 25 metres of a water body [including farm drains], or property boundary.

Receiving environment limits for soil

17. The conductivity of the soil layer containing the discharge shall be less than

400 mS/m, or alternatively, if the background soil conductivity exceeds 400 mS/m, the application of waste shall not increase the soil conductivity by more than 100 mS/m.

18. The concentration of metals and salts in the soil layer containing the discharge shall comply with the following criteria:

Metal/ Salt	Maximum value (mg/kg)
Arsenic [1]	17
Barium – Barite [2]	10,000
Extractable Barium [2]	250
Cadmium [1]	0.8
Chromium [3]	600
Copper [3]	100
Lead [1]	160
Nickel [3]	60
Mercury	1
Zinc [3]	300
[1]SCS – Rural Residential MfE 2011b; [2] Alberta Environment 2009; [3] NZWWA 2003, lowest of protection of human health and ecological receptors. (Biosolids to land)	

19. After incorporation of the waste within the soil, the sodium absorption ratio (SAR) of the waste soil mix shall not be more than 3 units higher than background soil SAR, or exceed a SAR of 8. Alternatively if the soil SAR exceeds 8, the application of the waste shall not increase the SAR by more than 1.

20. After 1 March 2027 (three months before the consent expiry date), constituents in the soil at any depth less than 500 mm shall meet the standards shown in the following table:

Constituent	Standard
Conductivity	Not greater that 290 mS/m
Chloride	Not greater than 700 mg/kg
Sodium	Not greater than 460 mg/kg
Total Soluble Salts	Not greater than 2500 mg/kg
TPH Fraction	Guideline Value Agricultural Ecological Direct Soil Contact (Fine Sand) From table 5.2
F1 (C6-C10)	210
F2 (>C10-C16)	150
F3 (>C16-C34)	1300
F4 (>C34)	5600
Canadian Council of Ministers of the Environment (CCME), in the document Canada Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale, 2008. Table 5.2	

Soil Type/ Contaminant	Depth of contamination
	Surface (<1m) (mg/kg)
SANDY Silt	
MAHs	
Benzene	1.1
Toluene	82
Ethylbenzene	59
Xylene	59
PAHs	
Naphthalene	7.2
Non-carc (Pyrene)	160
Benzo(a)pyrene	0.027
Table 4.12 SANDY SILT Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (MfE 1999)	

The requirement to meet these standards shall not apply if, before 1 March 2027, the consent holder applies for a new consent to replace this consent when it expires, and that the application is not subsequently withdrawn.

21. This consent may not be surrendered unless the standards specified in condition 20 have been met.

Receiving environment limits for water

22. The exercise of this consent shall not result in a level of total dissolved salts within any surface water or groundwater of more than 2500 g/m^3.

23. The exercise of this consent shall not result in any contaminant concentration, within surface water or groundwater, which exceeds the background concentration for that particular contaminant, as determined by the Chief Executive, Taranaki Regional Council.

Monitoring and reporting

24. The consent holder shall keep records of the following:

    a) wastes from each individual well [including records of all additives used at the wellsite during the drilling process]
    b) composition of wastes, including concentrations of chloride, nitrogen and total hydrocarbons
    c) stockpiling area[s]
    d) volumes of material stockpiled
    e) landfarming area[s], including a map showing each individual disposal area and GPS co-ordinates
    f) volumes and weights of wastes landfarmed
    g) dates of commencement and completion of stockpiling and landfarming events
    h) treatments applied
    i) details of monitoring, including sampling locations, sampling methods and the results of analysis

and shall make the records available to the Chief Executive, Taranaki Regional Council.

25. The consent holder shall provide to the Chief Executive, Taranaki Regional Council, by 31 August of each year, a report on all records required to be kept in accordance with condition 23, for the period of the previous 1 July to 30 June.

Lapse and review

26. This consent shall lapse on the 31 December 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.

27. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2016 and/or June 2017 and/or June 2018 and/or June 2019 and/ or June 2025 for the purpose of ensuring that the conditions area 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, or to take into account any Act of Parliament, regulations, national policy statement , and national environmental standard which is relevant to this consent.

Recommending Officer

Nathan Crook
Scientific Officer

Recommendation Confirmed

AD McLay
Director-Resource Management