Submission to the Parliamentary Commissioner for the Environment: Investigation into Hydraulic Fracturing in New Zealand, with special attention to Drilling Waste Management in Taranaki – Landfarming

Prepared by Climate Justice Taranaki, 3 November 2013

Overview

This review compares several international and national guidelines with Taranaki Regional Council (TRC)'s consent formulation and monitoring procedures concerning oil and gas drilling waste management, with special attention to landfarming. Numerous deviations from the official guidelines can be found in council and industry practices in Taranaki. The key issues discussed in the submission are:

1) Hydrocarbon loading limits far exceeds guidelines
2) Decadal consent duration
3) Lack of stock withdrawal period
4) Handling and treatment of waste
5) Sampling method and sample size
6) Fracking chemicals and other hazardous substances
7) Environmental effects off-site – Discharge distance from water bodies
8) Source of waste – Taranaki becoming New Zealand's petrochemical waste dump

The submitter, Climate Justice Taranaki, urges the Commissioner for the Environment to call for an immediate, nationwide ban on fracking, and more specifically the disposal of drilling and fracking wastes on farms. The risks of landfarming on food safety, animal health and the environment are too great to justify continuation of such practices.

Background

In the media, TRC has claimed that *"good science"* underlies the process and monitoring of landfarm operations, with particular reference to *"excellent research from Alberta"* (Rural News, 8 Aug 2013). Indeed, several recent TRC compliance monitoring reports on landfarm operations stated:

> *"Taranaki Regional Council has granted consents for land spreading of drilling wastes at several locations around the region, with conditions stipulating maximum loading limits and application depths for various contaminants based on Canadian standards, which have been modified for conditions in Taranaki"* (TRC 829868, 2011, TRC 1141122, 2013).

Yet review of many monitoring reports has identified many discrepancies from Canadian guidelines. These involve definitions (Appendix 1) and consent conditions relating to the discharge of drilling wastes onto and into land (including landfarming, landspreading, land treatment and mix-bury-cover) such as loading limits, toxicity testing, sampling, consent duration and closure requirements.

This submission highlights some of the specific guidelines in the Alberta Energy Resources Conservation Board (ERCB, now AER) Directive 050: Drilling Waste Management (revised 2012) and Alberta Energy Regulator (AER, formerly ERCB) Directive 058: Oilfield Waste Management Requirements for the Upstream Petroleum Industry (2006) and compares them with the current TRC consent formulation and monitoring of drilling waste discharge operations (excluding deep well injection). The Ministry for Environment (MFE)

Guidelines for the Safe Application of Biosolids to Land in NZ (2003) and Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in NZ Modules 1 to 7 (revised 2011), and the TRC Guidelines for the Control of Disposal of Drilling Wastes Onto and Into Land are also examined.

TRC Consents to Discharge Drilling Wastes onto and into Land via Landfarming

1. Hydrocarbon loading limits far exceed guidelines

Commissioned by TRC, Pattle Delamore Partners (PDP) "Review of Petroleum Waste Land Farming" (June 2013) points out that both old and new consents for landfarms fail to limit hydrocarbon loading to 20,000 mg/kg TPH (or 2 % by mass) as required in Alberta Directive 050. The PDP review states:

> *"The intent is to achieve no more than 20,000 mg/kg TPH after mixing into the soil, but the wording of the consents suggests that a maximum of up to 50,000 mg/kg would be permissible. A hydrocarbon concentration up to 50,000 mg/kg could inhibit the bioremediation process, being possibly toxic to soil microorganisms. …*
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> *While … hydrocarbon concentrations are generally well below 50,000 mg/kg in the reports viewed, one of the monitoring reports supplied by TRC in fact has reported hydrocarbon concentrations in one drilling waste of 300,000 mg/kg and in another approaching 200,000 mg/kg. This means that, in practice, an average concentration after mixing of 50,000 mg/kg could result…"*

The Alberta Directive 050 also sets limits for metal and salinity content within the treatment zone, specifies soil conditions required in treatment zone and subsoil below to protect groundwater, and requires the predicted time to reduce the hydrocarbon content to closure criteria to not exceed five years.

It is critical that TRC reviews and revises all current consents on landfarms to ensure that conditions are in place for a maximum limit of hydrocarbon loading of 20,000 mg/kg (after mixing into the soil) and other requirements that reflect those in Alberta guidelines.

2. Decadal consent duration

Based on several resource consents on landfarms, TRC commonly uses both MFE Biosolids Guidelines 2003 and MFE Petroleum Guidelines 2011 (Module 4) when setting consent conditions.

E.g. In the new BTW Kakaramea landfarm consent 7942 [granted 21 Oct 2011, expire 1 June 2028] and the older BTW Brown Road landfarm consent 6867-1 [granted 27 April 2006; change to conditions 4 Feb 2010; expire 1 June 2020] (Appendix I in TRC 1141122, 2013):

> *"15. At any time the levels of metals in the soil shall comply with the guidelines for heavy metals in soil set out in Table 7.1, Section 7 of the Guidelines for safe application of biosolids to land in New Zealand" [MfE and NZWWA 2003].*
>
> *22. At the time of expiry, cancellation, or surrender of this consent the levels of hydrocarbons in the soil shall comply with the guideline values for sandy soil in the surface layer [less than 1 metre depth] set out*

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

The very long duration of consents for landfarms was explained in TRC Guidelines for the Control of Disposal of Drilling Wastes Onto and Into Land (undated):

*"Experience has shown that the limits in Table 1 cannot be met by land spreading of OBM [oil based mud] without additional measures. This is particularly true of the hydrocarbon limits. Experience to date in Taranaki is that the concentrations of polyaromatic and monoaromatic ('BTEX') compounds may also have to be restricted. The Council's approach is to look at allowing a higher initial concentration along with a longer consent duration and a requirement that such limits are satisfied before the consent is relinquished. In some circumstances a **bond** could be considered as security for site reinstatement to acceptable limits."*

The extra long (commonly 14 years) consent duration for landfarms is a concern. **It contradicts the Alberta Directive 050** section 15.3 re biodegradation of drilling waste by land treatment, which states:

"21) Licensees must ensure that the predicted time to reduce the petroleum hydrocarbon content in the treatment zone to meet closure criteria (i.e., the endpoints set out in Table 3.2) does not exceed five years."

2.1 Bond and insurance

Indeed a "bond" would be very useful and prudent as *"security for site reinstatement to acceptable limits".* **But do existing consents have such a condition of requiring a bond?**

Following an East Coast landowner's enquiry to FMG re insurance cover on damage relating to fracking activities (including fracking waste disposal, deepwell injection), Climate Justice Taranaki (TRC) wrote to the major insurance companies in NZ (e.g. FMG, Vero, Tower, State, Lumley, AA), asking the same question. Replies from all companies indicated exclusion of insurance cover for any fracking or drilling relating damage/lose. One company advised that landowners should insist on seeing **companies' liability insurance** before letting them onto their properties, and check with neighbours who have oil/gas activities on their land as they may be deemed partially liable.

3. Lack of stock withdrawal period

What is even more worrying is the fact that animals were allowed to graze on operating landfarms when hydrocarbon residues were at levels above consent conditions (limits) or MFE Petroleum Guidelines.

Climate Justice Taranaki (CJT)'s second submission (12 Aug 2013) to the PCE office gave several examples of landfarms (Geary, C Boyd, Brown Road) in Taranaki where stock were allowed to graze on areas with *"recent spreading"* of drilling wastes (TRC report 169501, 2006; TRC 830821, 2011; TRC 1141122, 2013). CJT's media release *"New landfarm report fails to address critical issues"* (6 Oct 2013) lists several poignant quotes from TRC inspectors.

Because conditions on the levels of hydrocarbons do not have to be met until the expiry (cancellation or surrendering) of the consents which are several years to over a decade after disposal, the operators had not breached any consent conditions technically.

But do MFE guidelines actually allow animal grazing on such contaminated lands?

The MFE Biosolids Guidelines 2003 states, *"Imposing public exclusion or **stock withdrawal periods** following the application of biosolids to land is a potentially important – and sometimes essential – risk management technique for restricted use biosolids … Consent applications should contain details of public exclusion or stock withdrawal proposals… The optimal exclusion period can depend on factors such as the sludge treatment system, climate, soil type, and land use, but usually ranges from 6 to 12 months*."

TRC Guidelines reveal this recommendation from Landcare Research's study on the disposal of oil-based drilling mud onto land:

> *"It was considered that neither the residual hydrocarbons nor the elevated barium levels were having an adverse effect upon livestock. However, it was considered that as a precautionary measure it might be appropriate to **withhold stock for a year** after pasture was first established."*

Why is there no guideline or consent condition for stock withdrawal periods on landfarms? Why is Landcare's recommendation not followed? How can TRC or landfarm operators be sure that the level of risks on animal health and food safety is acceptable when stock are returned to graze?

In Alberta, drilling waste can only be land treated (by biodegradation) on the well site that generated the drilling waste or on a remote site. In the latter case, upon completion of the activity, the land treatment area must meet specified soil endpoints and the licensee (operator) must reclaim the site and obtain documentation from the government before it can be returned to the original landuse. **Effectively, land treatment or landfarming (industrial land use) and cattle grazing or cropping (agriculture) cannot occur at the same time on the same site.**

Why is a similar land use management not implemented in Taranaki?

Surely a great deal is at stake here where the risks of contamination by drilling wastes can be detrimental to dairy production which is critical to the province's and NZ's economy. Already contamination has occurred when a contracted tanker containing petroleum industry waste ended up in a Fonterra plant on 1 November 2013, contaminating another 14 tankers during an automated washing system. **Is it possible that the same industrial waste carrying tanker(s) have been used to transport raw milk on occasion?**

3.1 Are landfarms "vindicated"?

In late September 2013, TRC announced, *"An independent report on landfarming in Taranaki has vindicated the science behind the process"* (TDN, 3 Oct 2013). In a Radio NZ interview (4 Oct 2013), the author Doug Edmeades claimed that *"even if the [consent] limits are exceeded, these petrochemicals are broken down by the bugs in the soil"* and there is *"no toxicity at all".* But it is well known that long-chain hydrocarbons (C>9) do not biodegrade easily, hence often exceed the limits. Alberta Directive 058 explains:

> *"Biodegradation success is typically greatest when the hydrocarbon contaminant consists of low molecular weight aromatics and aliphatics. Hydrocarbon contaminants containing a large fraction of asphaltenes or nitrogen and sulphur rich heterocyclic compounds may take a long time to degrade and may even produce toxic intermediates."*

Moreover, drilling wastes contain many toxic chemicals, although most are not tested for during landfarm monitoring. The author also claimed that the level of petrochemical residues when animals were put back on pasture was *"absolutely zero".* But TRC monitoring reports have clearly revealed presence of such residues,

in some cases above consent limits (TRC report 169501, 2006; TRC 830821, 2011; TRC 1141122, 2013). See also C. Cheung's letter to the editor "Who do we trust?" (TDN, 7 Oct 2013).

3.2 Landfarms are running out of space

In June 2013, Fonterra announced that it would not accept milk from any new landfarms. In September 2013, TRC announced that Taranaki's landfarms will be filling up *"in a matter of months"* or *"in a year or two"*. In the latter announcement, TRC suggested "*the option of dedicated landfarms, where waste could be spread more than once*", and "*landfarms could potentially operate on dry-stock farms…"* and even *"some cropping land".*

How would these operations be regulated and monitored? What kind of guidelines and consent conditions would be required to ensure animal health, food safety and minimal environmental effects?

According to Alberta Directive 058:

> *"Sites receiving multiple applications of oilfield wastes are considered* ***dedicated land treatment facilities****, which in the past the EUB [Energy and Utilities Board] approved as a component or type of oilfield waste management facility. In late 1995 a task group was established to review and update the AEP document Guidelines for Land Treatment of Industrial Waste. … during the interim … the EUB will not accept, review, or approve any applications for new dedicated land treatment facilities. ... As well, during this interim period the EUB will not accept, review, or approve applications for the expansion of existing approved land treatment facilities."*

Indeed, due to operational and contaminant loading issues, AER has stopped approving dedicated land treatment facilities under Directive 058 since 1996. The AER has also required AER (ERCB)-regulated land treatment facilities to stop receiving oilfield waste in order to undergo closure (remediate and reclaim the site).

4. Handling and Treatment of Waste

The Alberta Directive 058 has detailed criteria for the characterisation/identification of certain wastes as "dangerous oilfield waste" which require specific control. Notably "*Dangerous oilfield waste must not be mixed with any solid or liquid for the primary purpose of dilution to avoid any Alberta regulatory requirement*".

The MFE Biosolids Guidelines 2003 limits the blending to that of *"sewage sludge with other substances (e.g. pumice, sand, sub-soils, bark, sawdust, green waste)"* while "*The use of blending to get rid of other contaminated materials is not an acceptable practice…"*

The TRC Guidelines for the Control of Disposal of Drilling Wastes Onto and Into Land (undated, Appendix 4) include this as a typical consent condition:

> *"17. The consent holder shall ensure that areas used for the stockpiling and discharge of water based drilling wastes are kept separate and distinct from areas utilised for the stockpiling and discharge of cuttings from wells drilled with synthetic based muds. Further, stockpile and discharge areas for individual wells shall be kept separate and distinct."*

Consent 7884-1 (one of at least 3 consents) for BTW Brown Rd landfarm, consent 6236-1 for Greymouth Hawera landfarm (part of Fonterra's experimental farm) and consent 5325 for AR Geary have incorporated such a condition re separation of different waste types (Consents 7884-1; TRC 548593, 2009; TRC 1137286w2, 2013). But it seems not all landfarm consents have such a condition (e.g. Consents 6867-1 and 7670-1 for BTW Brown Rd landfarm, Consent 7942-1 for BTW Kakaramea landfarm and Consent 7613-1 for BTW South Road Oeo landfarm).

Detailed operations on individual landfarms are rarely described in TRC monitoring reports. TRC 1141122, 2013 however, included BTW's company annual reports (2011) for consents 6867-1 and 7670-1 at Brown Road landfarm. These company reports disclosed their stockpiling and landfarming records (Table 1), the latter listed *"treatments applied*" including:

> *"The sump at Mangahewa-D was emptied and the remaining 14m^3 of WBM was blended with the Waitui-1 SBM stockpiled onsite", "Contaminated stormwater fluids from the Mangahewa C site were discharged into the same pits as the Waitui-1 SBM, MPS, OBM, Cheal B WBM & The PTCS", "The **fracture water** was landfarmed after being stockpiled for a minimum of two months. Over this time the water was diluted by stormwater and subject to UV treatment by sunlight…"* etc.

Notably, the **Alberta Directive 058 prohibits land treatment (e.g. landfarming) of flowback fluids from fracking operations**.

Based on the site maps provided in the BTW company report on consent 6867-1, it appears that wastes were segregated and disposed of in different plots designated for specific wastes (WBM, SBM, fracture water) from Oct 2006 till Dec 2010 when wastes became mixed and were disposed on plots designated for "mix" waste. The landfarm area under consent 7670-1 is also divided into plots of individual and mixed waste types. The stockpiling and landfarming records (Aug 2010-2011) showed that wastes were mixed:

> *"Cheal B WBM, fluids and SBM was blended with Sidewinder-2 WBM, MPS OBM and Copper-moki WBM…"; "The Sidewinder 3 & 4 WBM was blended with the Cheal C WBM".*

5. Sampling method and sample size

Alberta Directive 050 states, for drilling waste and site characterization requirements for biodegradation (section 15.2):

*"5) Licensees must determine background soil conditions **before beginning biodegradation** operations. Sampling must, as a minimum, consist of the following:*

*a) Divide each hectare of land comprising a biodegradation area into four equal plots. For biodegradation sites that are less than 1 ha in size, divide the sites into **equal plots that are no more than ¼ ha** (2500 m2) in size. Depending on the treatment method, take the following samples from each plot:*

i) land treatment method

- *combine a minimum of **five soil samples from a 0- to 15-cm depth**, or from the treatment zone (depth of incorporation), to form one composite sample; and*
- *combine a minimum of **five soil samples from a 15- to 45-cm depth**, or from the soil profile for 30 cm directly below the treatment or incorporation zone, to form one composite sample. …*

b) Analyze each sample for

i) pH,

ii) salinity (EC, SAR) and total mineral nitrogen,

iii) major ions (Ca2+, Mg2+, Na+, K+, Cl-, NH4+, NO2-, NO3-, SO42-, PO43-),

iv) median grain size, per cent clay, per cent sand, per cent fines, plasticity index (PI), and liquid limit (LL), and

v) metals as listed in Table 3.4.

c) *Analyze a **discrete soil sample** for each depth profile set out in 5(a)(i) or (ii) above for BTEX and hydrocarbon fractions F1 through F4, unless there is sufficient site information to substantiate the absence of hydrocarbons in the soil (e.g., the area was previously undisturbed and is unlikely to be subject to contaminant migration from other areas of the site or from off-site sources).*

6) ***Upon closure, licensees must re-evaluate soil conditions** of the biodegradation site as follows:*

a) *Sample and analyze each plot as set out in **requirements 5(a), (b), and (c)** above, and depending on treatment method, also do the following sampling and analysis for each plot:*

i) land treatment method
*- take a minimum of **one soil sample (not composited) for each depth** (0 to 15 cm or treatment zone, and 15 to 45 cm or soil profile for 30 cm below the treatment zone), and analyze for BTEX and hydrocarbon fractions F1 to F4. …*

b) *If there is evidence of contamination in the deeper soil sample (15 to 45 cm for land treatment and 30 to 60 cm for biodegradation in a contained system), sample at 30-cm intervals, and analyze the samples following the protocol set out in requirements 5(a), 5(b), and 6(a) above, until the extent of contamination has been delineated. The contaminants must be remediated; then the site must be resampled."*

MFE Petroleum Guidelines 2011 Module 3 recommends at least **1 soil sample per 25 m^2** of waste disposal area (Table 3.2) and states:

*"Samples collected for the analysis of volatile organic components (BTEX, lighter fuels) **should not be composited** since compositing can cause the loss of the more volatile components. Transferring samples between containers or during compositing compromises the integrity of the samples because residue can be left on the container. Compositing is also not recommended when hot spots of petroleum hydrocarbons need to be delineated."*

The Pattle Delamore Partners (PDP) Review of Petroleum Waste Land Farming (June 2013) points out one of the many issues with the current landfarm monitoring in Taranaki:

"A reservation with the sampling of landfarmed areas is the practice of analysing composite soil samples of up to 10 sub-samples. While this method is good for determining an average concentration, if the composite is properly homogenised, it is poor practice to homogenise samples intended for hydrocarbon analysis as the homogenising process may result in a loss of volatile hydrocarbon components. If not homogenised, it is doubtful whether the 1 to 3 g actually analysed by the laboratory will be properly representative of the samples taken, let alone the sampled area. …Consideration should be given to analysing a larger number of individual samples, rather than composite samples."

5.1 Small sample size and lack of statistical analysis

In Edmeades' landfarming study (Sept 2013), only three completed landfarms were examined, and only two sets of soil (0-75mm depth) and pasture samples were collected from each for hydrocarbon analyses. Considering the size of the farms (e.g. Geary landfarm is 30ha) and the variety of wastes they have received (water- and synthetic-based muds, oily wastes and fracking fluids, etc.), a substantial number of samples (composite and discrete) would be required for thorough testing, statistical analysis and waste type comparisons.

As quoted above, Directive 050 requires a minimum of five samples (from each of two soil depths) for each 2,500 m^2 plot to form composite samples for pH, salinity, ions, grain size and metals analyses, plus a minimum of one discrete sample (from each of two depths) for BTEX and hydrocarbon fractions analyses.

The Edmeades report presents no clear information on sample size, locations (types of wastes) or statistical analyses. Its conclusions re contamination or soil health are thus questionable at best.

The report also contrasts poorly with BTW's company annual reports (2011) for consents 6867-1 and 7670-1 on Brown Road landfarm during diposal (In TRC 1141122, 2013). The company reports provide information on the sources (which wellsites) and types of wastes and where (e.g. plots B2-B16 and shown on site maps) they were spread within the landfarm. The reports explain their monitoring procedure clearly:

> *"Specific landfarmed areas are located through the use of a GPS navigational system. … A central point is located within each area. … Sampling involves collecting a composite of 8-10 sub-samples from a transect line running from the central point of a landfarmed area. Typically, samples are retrieved from approximately 250mm but this can vary depending on the location of the drilling mud layer."*

The company reports also contain lab analyses reports for individual plots which are useful in comparing the degradation progress of different types of wastes in different plots.

5.2 Impacts of landfarming on soil biota

The Edmeades landfarming report (Sept 2013) emphasized that "*there were abundant earthworm casts on all sites indicating considerable soil biological activity."* This view was quickly hailed by Federated Farmers (TDN, 10 Oct 2013). But Edmeades' study was not about earthworms. In fact, previous TRC investigations suggested that earthworm poluations had been impacted upon by drilling waste application but that they were making a slow recovery (TRC 894052w2, 2011).

Since 2010, there has been a dedicated study focussing on the impacts of land farming of drilling wastes on soil biota within sandy soils in Taranaki. This study was set out partly to examine the potential implications of recent changes to consent conditions relating to chloride loading limits at some landfarms. It uses nematodes and microbes as indicators as they are considered more sensitive to contaminants than earthworms (TRC 894052w2, 2011). This study shared two of three sites, BTW Brown Road and Origin Schrider landfarms, with Edmeades'. The soil biota study is far more robust in terms of the extent and complexity of the sampling regime:

"Four 5x5m plots were set up at 5 metre intervals along transects within each of the treatment [by water-based or synthetic-based mud] and control areas [with tillage but no drilling wastes]. 25 soil cores (75mm in length and 28 mm in diameter) were collected within each of these plots on August 9 and 10, 2010, and composited to form one sample per plot. …

The effect of landfarming on microbe and nematode communities/populations over time was investigated by comparing areas where drilling muds had only recently been applied with results from the same areas one and two years later (sampled in 2010), and with results from areas where land spreading had been used 3 and 4 years previously (sampled in 2006 and 2007)."

Year 1 (2010/2011) of the study concluded:

> *"Overall, there were very few statistical differences in the parameters investigated for assessing the health of soil biota communities and soil chemical composition among control and treatment areas. However, this may be due to the relatively small samples' sizes and replicate numbers, and differences in site management after drilling waste application (e.g. differences in tilling regimes, fertiliser application rates etc). Therefore, it is difficult to reach definitive conclusions from the results of this study, and further research in years 2 and 3 of this project is required to elucidate some of the patterns emerging from this study."*

Its recommendations include:

> *"…pending the results of years 2 and 3 of this study, the council may need to review the consent conditions imposed thus far on **synthetic based mud** application at landfarms, which would most likely involve reducing the current spreading levels, and/or measures to ensure that drilling waste application is equally spread across treated areas. Thus, it is recommended that the sampling at these sites scheduled for 2011/2012 and 2012/2013 continue (years 2 and 3 of the study), in order to monitor and assess the long-term patterns and effects on soil post-landfarming operations. …*
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> *It is also recommended that research be carried out on the application of **fracking wastes** at landfarming sites, as the chemical composition of these wastes compared to synthetic and water based muds needs to be clarified, as does their effect on soil nutrient levels, biodiversity and health. A project brief has been completed for this work (FRODO # 930194), and sampling of these sites will begin in due course…."*

So are these recommendations being followed through?

Why did TRC commission Edmeades to conduct such a snap shot study when there is already a much more thorough and long-term study in progress? Is it simply a "greenwashing" exercise set out to "vindicate" landfarms (TDN, 3 Oct 2013) **before the more detailed study gets the chance to reveal its findings?**

6. Fracking Chemicals and other Hazardous Substances

Previous submissions from Climate Justice Taranaki (CJT submissions to PCE Nov 2012 and Aug 2013) have documented in detail TRC's failure to issue resource consents specific to fracking and fracking associated waste disposal prior to August 2011.

Take the case of BTW Brown Road landfarm, TRC 1141122, 2013 (Table 6) reveals that approximately 900 m^3 of "*Fraccing wastes*" from Waitui-1 well was received on 14 April 2011 and *"held in storage for assessment of consent application".* But BTW annual report for consent 6867-1 (2011) Table 1 also states that 1590 m^3 of "Fracture water" was received from Mangahewa-C well, of which 384 m^3 had been landfarmed by 9 July 2010.

In Alberta, storage of flowback fluids from fracking operations is subject to AER Directive 055: Storage Requirements for the Upstream Petroleum Industry (2001). Contrary to TRC allowing landfarming of fracking (or fraccing) wastes, the **Alberta Directive 058 prohibits land treatment (e.g. landfarming) of flowback fluids from fracking operations** but approves deep well disposal for water-based flowback fracking fluids and specific waste management facilities to process hydrocarbon-based flowback fluids for reuse.

6.1 Consent ambiguity re fracking waste disposal

It's not clear how the "fraccing wastes" from Waitui-1, the remaining "fracture water" from Mangahewa-C and/or other fracking associated wastes have been disposed of at the Brown Road site or elsewhere, and what kind of consents were issued for that purpose.

Further research revealed that fraccing wastes from Waitui-1 might have been disposed of at Brown Road under the later consent 7884 -1 (issued on 8 July 2011; expire on 1 June 2027). The consent purpose is:

> *"To discharge wastes from hydrocarbon exploration, well work-over, production and storage activities, onto and into land via landfarming at …"*

And *"Only those wastes specified in application 6815 shall be discharged."*

No fracking, fraccing or fracturing is mentioned in the consent. The only hint is in the monitoring report TRC 1141122, 2013 which says:

> *"The Company lodged application 6815 on 14 June 2011 for a new landfarming consent which would include drilling waste, oily waste, condensate storage tank wastewater, and **well work-over fluids [which includes frac fluids]**. The consent (7884-1) was subsequently granted after the end of the period [2010-2011] under review."*

Such ambiguity makes it really difficult to gain a clear understanding when conducting research or compilation of consents that concern the disposal of fracking associated wastes.

Is TRC attempting to conceal or understate the extent of fracking and associated activities across the region?

Which other landfarms have or are taking fracking wastes? Are mix-bury-cover sites also taking fracking wastes?

Some of the more recent TRC consents are equally ambiguous. E.g. Consent 9535-1 (granted 2 April 2013) for Cheal Petroleum has this purpose:

> *"To discharge treated stormwater, treated surplus drilling water and treated produced water from hydrocarbon exploration and production operations at the Cheal-D wellsite, onto land and into an unnamed tributary of the Kahikatea Stream".*

Consent 7532-1 (granted 7 August 2013) for Greymouth Petroleum has a similar purpose**:**

> *"To discharge treated stormwater, treated surplus drilling water and treated produced water from hydrocarbon exploration and production operations at the Urenui-1 wellsite, onto land where it may enter an unnamed tributary of the Onaero River".*

Would "surplus drilling water" contain returned frack fluids?

What kind of treatment and disposal methods do these consents imply?

What exactly is discharge "onto land"? Does it involve landfarming or mix-bury-cover or simply letting the contaminated water run onto land and into streams?

What are the environmental impacts and health risks of such disposal onto land and into waterways?

A new study *"Impacts of shale gas wastewater disposal on water quality in Pennsylvania"* (Warner et al. 2013) examined the quality of shale gas wastewater from fracking and the stream water above and below the disposal site.

> *"While water contamination can be mitigated by treatment to a certain degree, our findings indicate that disposal of wastewater from both conventional and unconventional oil and gas operations has degraded the surface water and sediments … This could be a long-term legacy of radioactivity,"* said Nathaniel R. Warner (lead author).
>
> *"Radium levels were about 200 times greater in sediment samples collected where the Josephine Brine Treatment Facility discharges its treated wastewater into Blacklick Creek than in sediment samples collected just upstream of the plant. …The treatment removes a substantial portion of the radioactivity, but it does not remove many of the other salts, including bromide… When the high-bromide effluents are discharged to the stream, it increases the concentrations of bromide above the original background levels. This is significant because bromide increases the risks for formation of highly toxic disinfection byproducts in drinking water treatment facilities that are located downstream,"* explained co-author Avner Vengosh (Duke Univeristy news, 2 Oct 2013).

6.2 Lack of Toxicity Testing

BTW's company annual reports (2011) for consents 6867-1 and 7670-1 on Brown Road landfarm during diposal (In TRC 1141122, 2013) include tables of "Chemical products and constituents", showing the many chemical products that have been disposed of on site. Report on consent 6867-1 alone lists 44 such hazardous products (e.g. Glute 25, G-Seal, Novatec F, Safe-Surf NS…), presumably products used in drilling and/or fracking, all have been spread on Brown Road landfarm. The HSNO classifications (e.g. 3.1D – flammable, 6.1D – acute toxicity, 9.1D – aquatic toxicity…) of each product were also listed.

As explained in CJT's November 2012 submission to the PCE, the Hazardous Substances and New Organisms Act (HSNO) is far from adequate in controlling the import, use and disposal of hazardous chemicals involved in fracking in NZ (CJT submission to PCE, 12Nov2012). This problem is further complicated by the fact that many of the fracking chemicals have undisclosed constituents, hence unknown toxicity.

Alberta Directive 050 states:

> *"An evaluation of potential toxicity is required for the fluids, solids, or total waste components of all drilling wastes… Directive 050 retains the luminescent bacterial toxicity test but also introduces the concept of using terrestrial toxicity testing as an alternative…"*

Note the above is recommended specifically for the disposal of water-based drilling wastes or biodegraded hydrocarbon-based drilling wastes by landspreading:

> *"Waste must pass a toxicity assessment if a hydrocarbon flag was encountered, or if mud additives/products were used in concentrations exceeding the luminescent bacteria toxicity test threshold, or if toxicity data are unknown."*

The Pattle Delamore Partners (PDP) Review of Petroleum Waste Land Farming (June 2013) highlights:

"The possibility exists that mud-additives within drilling wastes, such as surfactants and biocides, are eco-toxic and therefore inhibit biodegradation" and confirms that the *"Alberta Directive requires toxicity testing"*.

What kind of tests, if any, are being conducted in NZ/Taranaki to determine the toxicity levels of fracking wastes, with numerous hazardous components, and the cumulative effects they may have prior to and after disposal, especially on landfarms?

At least in one landfarm, the Greymouth Hawera landfarm (Fonterra experimental farm), *"the establishment of permanent pasture over part of the site remains [for several years] an issue"* (TRC 1137286w2, 2013).

Have specific toxicity tests been conducted to help explain the problem of pasture establishment and identify potential solutions?

6.3 Register of Selected Land Use

The Pattle Delamore Partners (PDP) Review of Petroleum Waste Land Farming (June 2013) questions whether landfarms should be listed on TRC's Register of Selected Land Use and whether the National Environment Standard (NES) for Assessing and Managing Contaminants in Soil to Protect Human Health applies to landfarms. Currently, *"Taranaki has no sites that are classified as contaminated, all sites either have no contamination, have been remediated, or are actively managed to ensure they do not pose an unacceptable public or environmental risk"* (TRC website re Contaminated land). Such listing is important for ensuring that landowners (current and subsequent) have all the information about the concerned piece of land when planning and making management decisions. And CJT recommends Taranaki's district councils to thoroughly consider the application of the NES on landfarms.

7. Environmental effects off-site – Discharge distance from water bodies

Alberta Directive 050 states:

"The biodegradation [land treatment] site must be located so that… it is at least 100 m away from a water body and 50 m away from a water well…"

Yet TRC consents for landfarms allow disposal much closer, typically 25 m, to water bodies. E.g. consent 6867-1 for BTW Brown Road landfarm states:

"No discharge shall take place within 25 metres of a surface water body, property boundary, or 50 metres of the Tasman Sea."

Notably, consent conditions for 6867-1 was changed on 4 Feb 2010 to:

- allow mixing of different waste types,
- remove the chloride and nitrogen loading limits and consequently reduce the maximum application thickness from 150 mm to 100 mm,
- reduce the buffer distance to the Tasman Sea from 100 m to 50 m,
- increase the maximum stockpiled volume from 2,000 m^3 to 6,000 m^3, and
- allow for the disposal of oily wastes

Consent 6236-1 for Greymouth Hawera landfarm also prohibits discharge within just 25 metres of surface water which includes Nowell's Lakes, but also the Tasman Sea. Note Nowell's Lake is a Key Native Ecosystem, home to the "Acutely Threatened" Australasian bittern and an "Acutely Threatened" LENZ environment.

Consents 7670-1 for BTW Brown Road landfarm, 7613-1 for BTW South Road Oeo landfarm and 7942-1 for BTW Kakaramea landfarm all prohibit discharge within 25 metres of surface water or property boundaries, and specifically the Mangaroa Stream in the case of the Kakaramea. Consents 6900-1, 6900-2, 7559-1 and 7591-1 for C Boyd landfarm prohibits discharge within 25 metres of a water body (which includes farm drains), or property boundaries.

This common condition appears to be in line with the TRC Fresh Water Plan rule 29 on the *"discharge of contaminants from industrial and trade premises onto or into land"* which states *"the discharge shall not be within 25m of a surface water body"*. But the above landfarm consents do NOT seem to have explicit conditions that reflect the following condition under Fresh Water Plan rule 29:

> *"The discharge shall not be within 50m of any existing bore well or spring used for water supply"*.

So how is this restriction on discharge at 25 metres from surface water bodies determined? Is it adequate, comparing that with the 100 metres under the Alberta Directive 050?

Is the current TRC monitoring regime on environmental effects adequate, especially considering the huge range of hazardous chemicals involved in fracking, and a largely agricultural landscape?

Noticeably, the Edmeades landfarming report (Sept 2013) excludes any consideration of effects off-site (e.g. runoff or leaching of contaminants). This severely limits the argument that landfarming is environmentally sound. TRC monitoring of the BTW Brown Road landfarm (2010-2011), one of the three completed landfarms included in Edmeades' report, did not appear to have any sampling or assessment of environmental effects off-site (TRC 1141122, 2013).

7.1 Greymouth Hawera landfarm

TRC monitoring at the Greymouth Hawera landfarm in 2006-2007 included 5 inspections and 2 soil samples, but no water samples (TRC 322550, 2008). The inspector on 27 June 2007 recommended that *"boundary markers be installed to identify the [25 m] buffer zone for Nowell Lakes"*. Note again that Nowell's Lake is a Key Native Ecosystem. During that year, Greymouth was found to have breached condition 8 by constructing a new holding pit in a historical disposal area. Compliance with nitrogen loading could not be assessed because analysis of nitrogen content was not conducted for 3 of the disposals. And:

> *"Compliance with receiving environment conditions could not be assessed, as no post application sampling was conducted by the Company for disposals during the current or previous years. This sampling is a requirement of both the Compliance Monitoring Programme and Site Management Plan. …*
>
> *There were discussions concerning the status of the area on the seaward side of the access track. The area was previously used to dispose of wastes and condition 8 of the consent prohibits any further discharges in this area. …*
>
> *The Council has raised its concern with Greymouth over the area of land available at the site for future disposals. Greymouth will need to demonstrate that it has the capacity to dispose of further wastes prior to accepting them on site."*

TRC monitoring in 2007-2008 included 8 inspections and 4 soil samples but no water samples (TRC 555713, 2009). Issues of historic disposal and shortage of space were documented again. The report concluded:

> *"A complete and thorough assessment of environmental effects from the landfarm operation is difficult, due to the incomplete provision of information that is required by the consent."*

Monitoring in 2009-2010 involved four inspections, eight soil samples and one water sample from a tributary exiting Nowell Lake, despite elevated levels of hydrocarbon and sodium in several of the soil samples (TRC 782391, 2010). It is not clear from this report if/how the issues of condition 8 re disposing on previously used areas and shortage of land availability were resolved. Although results from a few samples were provided by Greymouth, the TRC 2010-2011 monitoring involved only three inspections, one soil sample and one water sample (TRC 931224, 2011).

Importantly, condition 27 of consent 6236-1 for the Greymouth Hawera landfarm states:

> *"The exercise of this consent shall not result in any adverse impacts on groundwater as a result of leaching, or on surface water including aquatic ecosystems, and/or result in a change to the suitability of use of the receiving water as determined by the Chief Executive, Taranaki Regional Council."*

How can TRC be sure that this condition has been met when there has been no groundwater sample collected in the annual monitoring programs?

The PDP Review of Petroleum Waste Land Farming (June 2013) points out:

> *"leaching to groundwater is more likely in well-drained soils. … However, **some earlier consents did not require monitoring of groundwater, contrary to what is generally considered to be good practice**. …*
>
> *In some later consents, for single applications of mud on sandy soil, restrictions on nitrogen and chloride were dispensed with in favour of not permitting any increase of contaminant concentrations in surface or groundwater except total dissolved salts, on the basis that high rainfall at these sites would result in flushing through of these contaminants.*
>
> *For such a performance-based requirement to be effective requires (a) the consent holder to have sufficient knowledge about likely effects of particular waste loadings to ensure that groundwater or surface water is not contaminated and (b) sufficient, and sufficiently accurate, monitoring to demonstrate compliance. **It is doubtful whether monitoring is frequent enough in all cases to demonstrate such compliance, particularly in sandy soils where effects could be rapid and have reduced by the time monitoring occurred; meanwhile an aquatic environment could have been affected**. If Council compliance monitoring is stringent, the consent holder is forced to be cautious; otherwise the consent condition has less effect."*

7.2 C Boyd landfarm

TRC monitoring of the C Boyd landfarm (2010-2011) adjacent to Egmont National Park included testing of receiving water quality and biomonitoring of the *unnamed tributaries of the Mangamawhete and Mangatengehu Streams (TRC 934866, 2012):*

> *"As a result of an inspection observing hydrocarbons being discharged to the stream, changes were made to the on-site drainage prior to the current survey, meaning that site 2 was no longer impacted by the skimmer pit discharge, and that site 3 became the primary impact site. This resulted in a significant*

reduction in iron oxide sedimentation observed at site 2, but a notable increase in this sedimentation observed at site 3. In addition to this, site 3, the most downstream site, also suffered from significant periphyton proliferation."

During the one year monitoring period, two incidents had occurred relating to the discharge of stormwater from a drilling mud pit into the tributary and an oil sheen in one of the farm drains.

Clearly, landfarms do (or have the potential to) adversely impact on the environment off-site.

8. Source of wastes – Taranaki becoming NZ's petrochemical waste dump?

The TRC Guidelines for the Control of Disposal of Drilling Wastes Onto and Into Land (undated, Appendix 4) has this as a typical consent conditions:

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

But given that the same TRC Guidelines stated upfront:

"It is not a rulebook rigidly applied. Applicants are encouraged to contact the Council to discuss their particular operations including the applicability of the conditions set out here. They present a general framework within which specific applications will be considered, and provide certainty as to outcome for applications that fall within agreed boundaries, while retaining flexibility and structure for the consideration of applications that may not conform to the conventional exploration practices."

It may be of little surprise that TRC has since taken this condition off most landfarm consents, and has already accepted drilling wastes from elsewhere in the country. E.g. BTW's Kakaramea has received drilling waste from Dannevirke. Two abatement notices were issued to this and BTW's Oeo landfarm in May 2013 for breaching consent conditions (TDN 15 May 2013).

But has TRC forgotten that Taranaki is running out of landfarm space and Fonterra is not taking milk from new landfarms?
Do we have the capacity to deal with other region's petrochemical waste?
Are we prepared to sacrifice Taranaki's dairy-based economy for a waste-based industry?
And why aren't other regions dealing with their own wastes?

Jean Kahui had made several enquires to TRC about the drilling waste being brought over from TAG Oil's Tararua well (Ngapaeruru 1) to be dumped in Taranaki landfarms. In her letter to the PCE (23 Sept 2013):

"Simply put, the well was spudded, and within four days a "predisposal sample" was registered [23 April 2013] at Hill Laboratories in Hamilton. The analysis reported little more than elevated levels of potassium chloride and to a lesser extent sodium chloride.

Of the entire drilling programme, which ran 24 hours a day until May 14 and reached a depth of 1417m this was the only sample collected by btw, analysed and reported to TRC regarding the disposal of the total contents of the drill cuttings and well waste. This one analysis report is now the official record of the dangerous contents of the entire drilling waste that came from the Ngapaeruru 1. Another sample would only be taken if wbm [water-based mud] were changed to sbm [synthetic-based mud] during the job or when the next stage of developing the well begins."

This kind of sampling and analyses can hardly be considered representative.

Importantly, the geological characteristics in other regions are substantially different from that in Taranaki. The drilling and fracking chemicals (with undisclosed constituents) used in other regions are possibly different from those used in Taranaki. **The range of contaminants, including radioactive tracers, NORMS (naturally occurring radioactive materials) and heavy metals, are likely to be quite different from those generated in Taranaki, and will require different tests and treatment, prior to and during disposal**.

TRC and companies have not demonstrated the ability to ensure adequate data, robust analyses, objective reporting, monitoring and assessment, just dealing with Taranaki's own waste.

Can we expect TRC and the industry to effectively manage wastes from beyond the region as well, without major health, safety and environmental issues?

Conclusion

The disposal of drilling and fracking wastes on farms is a risky practice, with the potential to cause serious impacts on animal health, food safety and the environment, both on-site and off-site. A tainted image or repeated contamination scares in the agriculture sector can be devastating to NZ's economy.

In our view, TRC's current consenting and monitoring regime on the discharge of drilling wastes onto and into land via landfarming is inadequate and fails to follow international and national guidelines or best practices.

The primary purpose of landfarming is to perpetuate the fossil fuel industry at a time when real opportunities lie in the swift transition to a low carbon economy – one that will sustain rather than destroy our life-supporting climate.

We urge the Commissioner for the Environment to call for an immediate, nation-wide ban on fracking, and more specifically a ban on the disposal of drilling and fracking wastes on farms.

Appendix 1. Definitions

There are variations and discrepancies in the definition of "landfarming" or "land farming" among users.

NZ Ministry for Environment's definition is this:

> *"Land farming is a biological treatment process that reduces the toxicity of organic constituents in soil by enhancing the natural microbial degradation process"* (MFE Petroleum Guidelines 2011, Module 7).

Ball et al. (2011), a detailed review on treatment and disposal of drill cuttings, defines landfarming as:

> *"the controlled and repeated application of wastes to the surface of the soil, using the naturally occurring soil micro-organisms to mineralize the contaminating hydrocarbons."*

It differs from "land spreading", also known as "land treatment", which typically receives one single application of drilling waste.

Alberta ERCB Directive 050 (Canadian guidelines that TRC often refers to) which covers a wide range of disposal methods (pump-off, disposal onto forested public lands, landspray, landspread, land treatment, mix-bury-cover) has no mention at all of "landfarm" or "land farm". According to the directive:

> "***Landspreading*** *involves spreading water-based drilling waste on the shallow subsoil [maximum 1 m] of a well site, pipeline-right-of-way ... or remote drilling waste storage site ... and incorporating it into the shallow subsoil."*

It does not permit landspreading of *"drilling wastes resulting from hydrocarbon-based mud systems, unless the drilling waste has undergone biodegradation".* Landspreading can only occur on sites (or an area of a site) not previously used for drilling waste disposal, and within a duration of five years (ERCB Directive 050, section 14.3).

The Directive defines **landspraying** as a method that:

> *"involves spraying fluid or total waste onto topsoil and may or may not involve incorporating the waste into the soil. Incorporation is typically done when the drilling waste has been landsprayed on cultivated land. ... Drilling waste that has been landsprayed on vegetated land is typically not incorporated. ... Vegetated lands include grasslands, native prairie and forage lands [tame forage including pasture], but not forested Public Lands."*

Landspraying does not allow disposal of hydrocarbon-based drilling wastes either.

To manage drilling wastes contaminated with formation hydrocarbons or hydrocarbon-based drilling wastes, two **biodegradation** techniques: land treatment and treatment within a contained system, are often used. Directive 050 (section 15) explains:

> *"**Land treatment** involves applying the drilling waste from one well or one waste set (i.e., contents of a remote sump that only received drilling waste from one licensee's drilling program over one drilling season) to a dedicated parcel of land and cultivating it into the receiving subsoil, where the inherent soil processes biodegrade, transform, and assimilate the waste constituents."* The emphasis:

"The organic constituents [to be reduced by microbial process] must be biodegradable and not toxic to the microorganisms. …
Licensees must close sites used to biodegrade drilling waste within five years of the date that the biodegradation commenced. Upon completion of the biodegradation activity, the site must not exceed the soil quality endpoints set out in Section 3…"

Importantly, land treatment sites can only be located within oil/gas well sites.

For hydrocarbon contaminated soils and pit sludges, the Alberta Directive 058: Oilfield Waste Management Requirements for the Upstream Petroleum Industry (2006) may also be relevant. This Directive describes the process of *"on-site **land treatment** of a single application of hydrocarbon contaminated soil or pit/pond sludge"* as one of two biodegradation techniques.

Notably in Alberta, the closure of a well site, remote drilling waste storage site, or oilfield waste management facility all involves an environmental site assessment to determine if there is any contamination, implementation of a remedial program to deal with the contamination, confirmatory environmental assessment to verify success of remediation and that the site meets criteria applicable for the next land use, and surface land reclamation.

Taranaki Regional Council (TRC) Guidelines for the Control of Disposal of Drilling Wastes Onto and Into Land (undated) has no mention or definition of landfarming either. It says:

*"There are two conventional methods for disposal of such wastes onto land, namely land spreading and mix-bury-cover [MBC]. **Land spreading** involves spreading the drilling solids on the land surface and mixing them into the surface soil. **MBC** involves mixing the drilling solids with clean soil and burying the mixed material in an unlined pit. …*
It is considered that the land spreading disposal method described in the G-50 Guidelines [precursor of Directive 050] is more suitable to the Taranaki situation than MBC and the Council would therefore encourage land spreading disposal of drilling wastes as the preferred method of disposal. …
The Council will assess any proposal for the disposal of waste drilling material by land spreading or MBC on a case-by-case basis based on the extent of compliance with the guidelines produced in Canada [the G-50 Guidelines] and modified to Taranaki conditions [Turner 2002, Taranaki Regional Council 2001, 2002, 2003, and these guidelines]."

But in many TRC monitoring reports, land farming is given this definition:

*"**Landfarming** is a technology that uses natural and assisted bioremediation to reduce the concentration of petroleum compounds through degradation, while simultaneously utilising the drilling muds to stabilise poor quality sandy soils for subsequent land use"* (TRC 1141122, 2013).

TRC consents have been granted for the disposal of water-based mud (WBM), synthetic-based mud (SBM) and oily wastes on Taranaki landfarms. Definition in consents granted is this:

"Landfarming means the discharge of drilling waste onto land, subsequent spreading and incorporation into the soil, and includes any stripping and relaying of topsoil".

TRC explains the basic steps in the landfarming process (TRC 1141122, 2013):

1. *Drilling waste is transported from wellsites by truck (cuttings) or tanker (liquids). It may be discharged directly to land or placed in a dedicated storage pit.*
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.*

To date, Taranaki landfarms have been consented for "one-off applications" of drilling mud rather than multiple applications, as seen from the condition *"an area of land used for the landfarming... shall not be used for any subsequent discharges of drilling waste"* (See consent 6867-1 in TRC 1141122, 2013).

It seems that TRC, when referring to Canadian research and guidelines on landfarming, was actually talking about landspreading, landspraying, land treatment or some kind of a hybrid system, involving modifications of definitions and much simplified and flexible guidelines.