

APPLICATION PROTOCOL ENRETECH-1 SOIL REMEDIATION PROJECT

Parameters:

Project:	Crude Oil Spill
Manager:	
Site:	2 hectare field contaminated by spilled crude oil. Do not own the land.
Contents:	Crude oil - mainly diesel range with only about 1% >C28 and not much <C10. .
TPH Detected	Highest level about 35,000 ppm TPH. Average about 15,000 ppm. Low aromatics, metals and PAHs.
Other Cmpds Detected	None reported.
Trial Volume:	Trial will involve 2 x 16 m ³ plots, with one plot applied ex-situ and the other in-situ.
Target:	QLD EPA require to below 5,000 ppm TPH.
Method:	In-situ and ex-situ application with Enretech-1 and tilling, as described below.

In-Situ Treatment:

1. The Enretech-1 process is most effective when the dry absorbent is thoroughly tilled and blended with contaminated soil. This simple fact is quite critical to the success of the bioremediation as bioavailability requires physical contact between the Enretech-1 fibres and the hydrocarbons to be remediated. For the in-situ plot, the soil contamination is reported to be less than 50cm in depth and thus is shallow enough to be treated by tilling in Enretech-1. This can be done manually, with a small roto-tiller, or with larger earth moving equipment. The more thorough the mixing, the better.

Based on the TPH levels measured, the optimum application rate for Enretech-1 is 18 kg per cubic metre of soil. With 16 cubic metres of soil to remediate per plot, this equates to 288 kg per plot or 29 x 10kg bags of ERT-1. With 2 plots, this totals 58 x 10 kg of ERT-1.

For clayey soil clean-up operations such as this, there are always sections of soil that are more heavily contaminated than others. Thus, when applying the Enretech-1 powder (manually), workers must use their judgment and apply more ERT-1 on visible "hot spots" and less on areas of lower contamination.

2. As the ERT-1 is thoroughly blended into the soil, spray water lightly over the process to minimise dusting. The water need not be potable, but should be fresh (not brackish). Then, it is important that, after the Enretech-1 powder has been thoroughly blended into the contaminated soil, copious amounts of water should be applied to the site. After the soil has dried out enough, the soil should be tilled again. Addition of water activates the bacteria in ERT-1 and also mobilises the hydrocarbons in the soil, ensuring maximum opportunity for contact with ERT-1 fibres. ERT-1 contains around 3% available nitrogen imbedded in its fibres, so N should not need to be added. Mark this point as the starting date. Collect soil samples and have them analysed for TPH, moisture, pH.

Check the soil pH. Most bacteria grow best in a relatively narrow range around neutrality (pH 6-8). Die off typically occurs below pH of 4 and above a pH of 9.5. If the soil pH is outside this range it can be brought back to the desired range.

After initial application, do not overwater as this may result in oil-contaminated water leaving the remediation site, as not all of the crude oil in the soil will necessarily have been absorbed by ERT-1 fibres.

3. Simple regular tilling will provide sufficient oxygen. For the first 2 weeks, tilling should be undertaken every 3 days to ensure even distribution of the soil, contaminants and Enretech-1. Due to site access limitations, and cost constraints, tilling will then be conducted every 2 weeks for the duration of the project.
4. Fluctuations in soil water content have been known to accelerate biodegradation, so allow the soil to go through wet/dry cycles. However, as a rule, soil moisture should remain around 30% (typically reported by the lab conducting the TPH analysis).

As soil moisture content is not readily measurable in the field without expensive equipment, soil tension can be used as a guide. The easiest way to qualitatively assess if the soil contains sufficient moisture is to press a handful of soil into a clod. If the soil does not stick to your fingers and the clod is not significantly darker on the inside than on the outside, irrigation is required. **Soil moisture should be assessed every third day for deciding when to irrigate.**

5. Collect soil samples after the first 4 weeks and analyse for TPH, moisture and pH. These test results will give us an indication of the initial remediation rate. If the rate after 30 days appears to be low, check with the list of 'trouble-shooting' actions (below). After that (assuming good rate), collect and test soil samples monthly. Depending on a number of variables, soil contamination levels should have dropped significantly by 3-4 months.

Trouble-Shooting

If the biodegradation rates stalls, then one of the following has become rate-limiting:

- Nutrients (usually N)
- Electron Acceptor (ie: oxygen - insufficient mixing)
- Poor bioavailability
- Recalcitrance

If the rate appears to have slowed or stalled, add nitrogen in the form of an NPK fertiliser (13:13:13) or urea (watch the pH) and thoroughly mix the pile. If no change, then try adding more N (NPK 34:0:0). If still no change, try adding a surfactant. However, if a suitable microbial mass is not present, the addition of a surfactant will not increase the degradation rate.

If still no change, try adding more ERT-1. Mix thoroughly, keep moist and take soil samples after 7 days and conduct a TPH, total available nitrogen, and a microbial count. If the biomass is present, and there is sufficient nutrients and oxygen, but still no change in TPH, then we may be left with inherent recalcitrance. These are compounds that will not biodegrade under normal conditions because of the compounds' molecular structures and size. However, as the crude oil spilled in this case is relatively fresh, the overall percentage of recalcitrant compounds is expected to be low.

ENRETECH-1 APPLICATION PROTOCOL EXECUTIVE SUMMARY

1. Apply Enretech-1 to the soil surface at a rate of 18 kg per cubic metre or 29 x 10kg bags per plot at the trial site. Till the ERT-1 into the soil as thoroughly as possible. Vary the quantity of ERT-1 dispensed during initial application, depending on the degree of visible contamination. No free liquid should remain.
2. During ERT-1 application, spray a light mist of water over the soil to minimise dustiness. Once the ERT-1 is thoroughly mixed into the soil, apply copious amounts of water to activate the process. Avoid flooding.
3. When the soil is dry enough, till thoroughly again. Mark this point as the start date and collect soil samples. Analyse soil for TPH, pH and moisture.
4. Till the soil every 3 days for the first two weeks. Then till thoroughly every 2 weeks for the remainder of the project.
5. Maintain soil moisture around 30%, but allow the soil to go through wet-dry cycles. Assess soil moisture every 3 days for deciding when to irrigate.
6. Collect soil samples after 30, 60 and 90 days. Analyse for TPH, pH and moisture. Adjust treatment accordingly.