Sustainable Remediation Project Recognition: Diesel Fuel Loss Remediation, Wallis Lake, NSW

The Fuel Loss Incident

The Wallis Lake Fishermen's Co-operative located at Tuncurry in the Mid North Coast region of New South Wales is an organisation owned by the local fishermen and acts as the central receiving depot to handle the distribution of the daily catch as well as the group purchasing agent, where the supplies of equipment, fuel etc required by the fishermen are purchased in bulk and sold to its members. Diesel fuel for the fishing vessels is stored in an above ground tank close to the Co-op's building on the Wallis Lake foreshore. The tank supplies fuel via an underground pipeline to a dispenser adjacent to the Co-op's main jetty. In November 2018 a loss of approximately 9,000L of diesel fuel occurred from an unsealed sump surrounding the pipeline. Diesel was observed seeping through the rock revetment and into Wallis Lake. The source of the loss was quickly isolated and the spill contained with booms on the lake although seepage continued to occur.

Remediation Project Objectives

Soon after the diesel loss event MidCoast Council issued a regulatory *Direction to Take Clean-Up Action* notice in relation to the diesel loss. The notice required a number of specific actions which included determination of the nature and extent of contamination and provision of a Remediation Action Plan (RAP). The objective of the RAP was to determine the most appropriate remediation approach to mitigate potential risks to human health and the environment and define an assessment scope to facilitate detailed design of remedial works. This RAP was compiled in general accordance with *International Standard ISO 18504:2017 Soil Quality – Sustainable Remediation*.

Stakeholder Engagement and Identification of Options for Breaking Source – Pathway – Receptor Linkages

Following initial stakeholder engagement and with full consideration of site constraints it was considered that excavation and off-site disposal (or ex-situ treatment) of impacted soil was unlikely to be feasible for the site. Excavations would require stabilisation through measures such as sheet piling and could result in adverse structural effects to the nearby building and jetty. Furthermore, excavations would also result in significant loss of amenity, as the area is utilised by the general public and disruption to fishing operations including the dispensing of fuel for fishing vessels. Saturated zone source treatment technologies to remove, modify or immobilise the contaminant source, or interrupt the exposure route were therefore considered to be potentially applicable for remediation of residual source material at the site. Eight potential site treatment options were short listed.

A semi-quantitative options assessment process was followed considering economic, social, environmental and economic dimensions. The approach applied numerical ratings and weightings to the following range of indicators but without fully quantifying or monetising every aspect in detail. The indicator categories adopted for the assessment were based on those set out in *SuRF-UK Indicator Set for Sustainable Remediation Assessment* published in November 2011.

Social	**Neighbourhood and locality** – Consideration of how implementation would affect the local community in terms of noise, odour, vibrations etc, as well as project duration and the area of the waterfront required for implementation which would result in loss of amenity for the public and fishermen. **Human health and safety** – Consideration of potential health and safety risks to remediation site workers, the co-operative members and workers and the general public during implementation and complexities in risk management. **Uncertainty and evidence** – Consideration of certainty of remediation option implementation in meeting project objectives, regulatory standards and stakeholder/community perceptions of remediation effectiveness in terms of contamination mobility and/or volume reduction.
Environ-mental	**Ecology** – Consideration of potential effects on the ecology of local area, notably marine ecosystems associated with Wallis Lake in terms of disturbance or direct impacts from contaminant mobilisation or discharges of amendments etc. **Air** – Consideration of emissions that may affect climate change and/or air quality. **Natural resources and waste** – Consideration of how implementation would impact natural resources for example in terms of materials requirements, water use and use of energy and fuels both in terms of on-site implementation and off-site aspects such as manufacture of chemical amendments as well as waste generation and disposal.
Economic	**Direct economic costs and benefits** – Consideration of the direct financial costs and benefits of each option. **Indirect economic costs and benefits** – Consideration of financial consequences to the fishing community through loss of use of the wharf area and reduction in financial resources as well as implications for future insurance costs. **Project lifespan and flexibility** – Consideration of duration of the risk management (remediation) benefit as well as the requirements for ongoing institutional controls and the ability of the strategy to changing circumstances, including discovery of additional contamination and additional site constraints.

On the basis of the findings of the remediation options assessment it emerged that the preferred remediation strategy comprised the formation of a passive groundwater containment slurry wall through injection of a slurry containing oxygen releasing amendment in close proximity and parallel to the foreshore, hydraulically down gradient of the source zone.

There were significant data gaps with respect to the location of free and dissolved phase and it was also a regulatory requirement to determine nature and extent of petroleum hydrocarbon contamination at the site. In order to minimise the economic, social and environmental impacts of the delineation/characterisation works it was decided to utilise a suite of equipment and technologies that could undertake works and potentially complete the remediation works in a single mobilisation. It was established that this strategy could be achieved through the utilisation of drilling equipment capable of:

- Undertaking high resolution vertical profiling to determine water table elevation, hydraulic conductivity and the lateral and vertical extent of light non-aqueous phase liquid (LNAPL) impacts using an optical image profiler (OIP) probe combined with an electrical conductivity and hydraulic profiling probe (HPT);
- Drilling of soil bores to collect delineation/validation soil samples for laboratory analysis to validate the OIP data; and
- Drilling and construction of permanent groundwater monitoring wells and temporary remediation wells for placement of a slurry containing oxygen releasing amendment.

Implementation of Delineation and Characterisation Works and CSM Update

Delineation and characterisation were carried out with the area of investigation using a Geoprobe® drilling rig to undertake High Resolution Vertical Profiling, soil sampling and construction of eight additional groundwater monitoring wells. Two zones of LNAPL impact were identified, one resulting the November 2018 diesel loss, approximately 300 m^2 and an earlier motor spirit loss which covered approximately an additional 100 m^2 to the south. The impacts were found to be generally present within natural sand deposits with a hydraulic conductivity (permeability) in the range 5 to 25 m/day at between 0.9 and 1.2 m below the surface.

Implementation of Remedial Measures

Two oxygen-releasing agent slurry walls were successfully constructed in the sub-surface using Regenesis® ORC Advanced® placed into a series of boreholes drilled with a hollow stem auger using the same Geoprobe® drilling rig utilised for the delineation and characterisation works. The main wall is approximately 20m in length, spanning the vertical contaminated saturated thickness, (including the capillary fringe and tidal "smear zone") parallel to Wallis Lake waterfront. A supplementary wall approximately 5.5 m in length was constructed hydraulically down gradient of the point of diesel loss where field observation had noted that the majority of LNAPL transport was occurring through the ballast rock directly to the north of the main wharf area, possibly due to the existence of preferential pathways in this area.

Following completion of the slurry wall installations, it is now anticipated that:

- A reduction in the hydraulic conductivity in the effected aquifer will reduce the number of preferential pathways for flow of LNAPL and dissolved phase hydrocarbon impacted groundwater into Wallis Lake; and
- The oxygen-releasing agent is slowly releasing oxygen into the groundwater regime which is significantly increasing rates of natural attenuation of petroleum hydrocarbons in groundwater, a process that could continue for up to a year, thereby resulting in continued "polishing" of groundwater quality.

Summary of Sustainable Remediation Approach and Sustainable Outcomes

The methodologies adopted in the design and implementation of the remediation of the diesel loss at the Wallis Lake Fisherman's Co-operative were consistent with procedures and tiered assessment frameworks set out International Standard ISO:18504. SuRF-UK have identified six key principles which should be considered by practitioners in the design, implementation and reporting of sustainable remediation schemes. The key principles are listed in the table below together with commentary on how these principles were complied with during the design and implementation of the remediation works at the site.

Principle	Commentary
Protection of human health and the wider environment	The remediation works were successful in limiting the lateral migration of diesel LNAPL into Wallis Lake and thereby broke this complete pathway which could result in harm to human health and the environment and in development of the remedial approach gave due consideration to the costs, benefits, effectiveness, durability and technical feasibility of available options.
Safe working practices	The delineation/characterisation and remediation works were completed in a safe manner for all site workers, fishermen and co-operative workers using the site and for local community and minimised impacts on the environment.
Consistent, clear and reproducible evidence-based decision making	Risk-based remediation decisions were made having regard to regulatory requirements and environmental, social and economic factors, and considered both current and likely future implications. The use of the Geoprobe® OIP and HPT equipment, validated by laboratory soil sampling gave clear and unequivocal indication of the lateral and vertical extent of the area of impact in real time.
Record keeping and transparent reporting	Remediation decisions and the evidence used to reach them, were documented in a clear and easily understood format in order to demonstrate to interested parties that a sustainable solution had been adopted.
Good governance and stakeholder involvement	Remediation decisions were made having regard to the views of stakeholders and followed a clear process in which they participated.
Sound science	Decisions were made on the basis of sound science, relevant and accurate data, and clearly explained assumptions, uncertainties and professional judgment. This ensured that decisions were based upon the best available information and are justifiable and reproducible.

This innovative project was the first Australian use of a Geoprobe® combined Optical Image Profiler (OIP) and Hydraulic Profiling Tool (HPT), which was utilised alongside information obtained from limited scope soil boring and monitoring well installations. The investigations allowed delineation and characterisation of the diesel contamination and site ground conditions, notably hydraulic conductivity, in a time-frame that facilitated real-time decision making to develop a robust conceptual site model from which to finalise the design of the remediation works for immediate implementation. This time saving resulted in significant economic benefits, eliminating costs associated with multiple mobilisations, environmental benefits as the migration of diesel contaminant mass into Wallis Lake was mitigated without delay and social benefits as a minimal closure period for the wharf area was required to complete the works resulting in very little inconvenience for the co-operative members and loss of amenity for the general public.

Similarly, economic, social and environmental benefits were apparent from being able to utilise a single medium-size truck to transport and deploy all the plant and equipment required to complete the remediation design and implementation of the remediation works in a single ten day visit. The delineation/characterisation and remediation implementation works were completed safely, with low levels of emissions, odours, noise and vibrations, minimal waste generation and insignificant impact on the local ecology.

Furthermore, based on the observed reduction of low tide hydrocarbon sheen formation on Wallis Lake, there is a high degree of certainty that the works have met the project objectives, regulatory standards and stakeholder/community perceptions of remediation effectiveness in terms of limiting contamination mobility and mitigating potential risk to sensitive marine ecosystems and fisheries within Wallis Lake. Post remediation groundwater monitoring is currently in progress as part of the validation process.

The project relates to remediation of a diesel spill on the shoreline at Wallis Lake, NSW which posed a significant risk to marine ecosystems and fisheries.

The submission is made jointly by the following organisations who all worked together to bring about the success of this project:

- Contaminated Land Solutions Pty Ltd
- Geochem Technologies Pty Ltd
- Kerr Environmental Pty Ltd
- Regional Geotechnical Solutions Pty Ltd
- Wallis Lake Fisherman's Co-operative

Dr David Tully
Director
Contaminated Land Solutions Pty Ltd
0410 012 292
david.tully@contaminatedlandsolutions.com.au