Sustainable Low Temperature Thermal Remediation of Pesticides

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Background/Objectives. Site investigation activities at a former pesticide manufacturing plant in the UK identified impacts from kerosene (TPH) and high boiling temperature dieldrin, within saturated gravels that overlie chalk bedrock. A total contaminant mass of several thousand kilograms was estimated to be present in the target source zone. The TPH was present mainly as light non-aqueous phase liquid (LNAPL). Dieldrin was shown to present a potential risk to a nearby river and the chalk groundwater below. In order to mitigate these risks a source zone remediation strategy was developed and implemented.

Approach/Activities. A sustainability based remedial options appraisal was undertaken. The results showed thermal remediation could address both the TPH and pesticide impacts, although high temperatures of circa 350ºC would be required to volatilize the dieldrin and achieve a predicted 95 - 99% mass removal. Initially this high temperature strategy using in situ thermal desorption (ISTD) as the heating methodology was modelled and evaluated using Petrasim PC based software, but attaining the target temperature was identified to be wholly unsustainable in terms of energy consumption and cost.

Therefore a more innovative strategy of using steam enhanced extraction (SEE) to mobilize, rather than volatilize, the TPH at lower temperatures was developed and bench tested. The bench-scale treatability study was conducted to determine the effectiveness of thermal remediation activities to reduce combined concentrations of TPH and dieldrin. The results of the bench testing demonstrated that dieldrin was likely solubilized in the TPH LNAPL and could be removed at lower temperatures of between 70 and 100ºC, although total mass removal was expected to reduce to circa 90%.

ERM further engaged with the UK regulatory authority (Environment Agency) to agree a change in the heating methodology from ISTD to SEE; this reduced predicted energy requirements by 80%. Whilst the anticipated mass recovery was also expected to decrease by 5 - 10%, it was recognized by the regulator, via the modelling and bench testing, that the risk could still be reduced to an acceptable level in a manner that factored in cost benefit for the client, substantial indirect reduction in environmental impact (avoidance of large energy requirement) and achieved sustainable land management. The regulators also recognized the recalcitrant nature of pesticides and difficulty of remediation and an endpoint objective was therefore agreed on an asymptotic recovery basis, rather than concentration or mass derived target.

Results/Lessons Learned. Steam injection, together with simultaneous vapour and liquid recovery commenced on 4 April 2017. Mobilization of LNAPL was observed as temperatures approached 70ºC and dieldrin concentrations were detected at concentrations greater than had been observed in the laboratory. The majority of the mass was removed as NAPL at average soil temperatures between 70 and 80ºC, confirming success suggested at bench scale. TPH mass removed by mobilization is circa 4,100 kg. This innovative approach is likely to have applicability to other chemical and pharmaceutical sector sites.