Snapshot

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TDP24 - Thermally enhanced soil vapour extraction to remediate the unsaturated zone at the Western Storage Area, Harwell

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Summary

A mix of chlorinated hydrocarbons and non-halogenated aromatic compounds are being remediated using conductive heating thermally enhanced soil vapour extraction (TESVE) technology at the Harwell Science and Innovation Campus in Oxfordshire. This is the first application of TESVE technology in the UK using in situ thermal desorption (ISTD) technology.

Soil vapour extraction (SVE) is a well-established remedial technology that reduces concentrations of volatile contaminants from the unsaturated zone. SVE can be enhanced by the use of heat, in this case thermal conductive heating, to facilitate an increase in contaminant mass removal rate and total contaminant mass removed from a source area.

Chlorinated hydrocarbons, including tetrachloroethene (PCE), trichloroethene (TCE), trichloroethane (TCA) and chloroform were disposed in a series of 25 shallow unlined pits within Chalk bedrock on the site during the 1970s and 1980s.

Following the discovery of groundwater contamination in late 1989, a programme of work was implemented to delineate, contain and then remediate the groundwater contamination and its sources. A groundwater containment plant was installed on the site which became operational in early 1994. This came to the end of its design life in 2007 and was replaced by a more efficient plant.

The primary source material, which comprised laboratory waste and vessels which contained the solvents, was excavated and removed from the pits in 2004. Residual chlorinated hydrocarbons are present within the unsaturated and saturated zone beneath the pits.

Pilot trial heater wells, extraction well and temperature monitoring wells

In 2006 Provectus Group completed a series of remediation pilot trials evaluating various remediation technologies at the site. Both conventional SVE in long screened wells and focused SVE targeting discrete elevations in the Chalk were evaluated together with air/ozone sparging and thermal conductive heating enhancement options. The trials concluded that TESVE would be highly effective at reducing contaminant mass in the unsaturated zone and consequently the ongoing impact on groundwater quality.

In terms of the overall site remediation, phased works are currently in progress, sequentially working on each disposal pit area across the site. The primary aim is to reduce the mass of volatile organic compounds in the source area unsaturated zone to the extent that it is economically feasible, resulting in a diminishing flux of mass to groundwater over time. Progressive broad-scale SVE is being undertaken from a network of extraction wells targeted at depths from 3 m bgl to 20 m bgl in areas within and around former pit locations. The SVE process is then thermally enhanced by replacing selected SVE wells with in situ heaters which extend beneath the unsaturated zone under each disposal pit. Remediation work in this demonstration project focused on Pit Nos. 1, 2

and 3 and this vicinity of the Western Storage Area (WSA) of the site. The works were undertaken in a yearly cycle matching both water table fluctuations and available funding.

The following lines of evidence were apparent indicating that significant and effective contaminant source removal had been achieved through the utilisation of TESVE beneath Pit No.3:

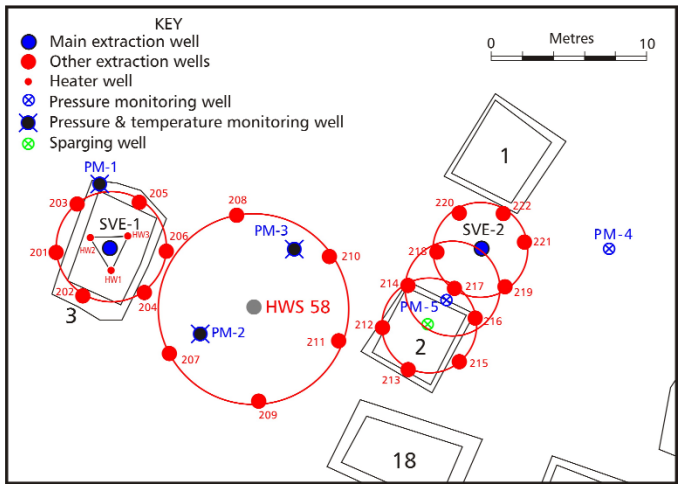
- *Contaminant mass removal rates increased from 2 kg/day under conventional SVE extraction to in excess of 17 kg/day during initial thermal enhancement works. Verification extraction monitoring seven months post-treatment recorded a rate of 0.1 kg/day confirming the occurrence of additional attenuation following treatment and that a high degree of clean up had been achieved.*

- *Free product identified in monitoring wells in the vicinity of Pit No.3 prior to thermal treatment attenuated during the course of the TESVE works and no evidence of its reoccurrence was apparent following completion of treatment.*

- *Increases in temperatures enhanced mobilisation and dissolution of hydrocarbons, making them available for extraction and/or biodegradation at elevated temperatures.*

- *Post-treatment analysis of groundwater samples has revealed significantly lower concentrations of dissolved phase hydrocarbons in the vicinity of the treatment area compared to untreated areas of the WSA.*

- *Analysis of condensate recovered in the latter stages of treatment revealed total contaminant concentrations to be one to two orders of magnitude lower than those recorded during the initial stages of the remediation works, indicating a significant reduction in pore water contaminant concentrations.*



SVE well layout

- *Off-gas flow rate monitoring and analysis has revealed that approximately 1 tonne of contaminants have been removed during the course of the works undertaken at, and in the vicinity of, Pit No.3. It is estimated that in the region of 70% of the contaminant mass removed was extracted from the single TESVE well in the centre of Pit No.3.*

High levels of power were shown to only be required for relatively short periods of time in order to raise the temperature of the treatment zone to the target level. Consequently due to the relatively rapid rate of remediation, TESVE is proven to be an economic and sustainable technology in many circumstances when the whole life cycle costs of the project are considered.

The project has demonstrated that the quantity of contaminant successfully removed from the unsaturated zone beneath the former pit areas increases significantly with the utilisation of thermal conductive heating enhancement of the SVE process. There is also evidence of groundwater quality improvement occurring in the saturated zone including the thermal desorption and removal of non-aqueous phase liquids identified within the most significantly contaminated pit areas.

To obtain a copy of the full TDP24 report (90 pages), please visit the Membership section of the CL:AIRE website at www.claire.co.uk/Membership