Case Study - iterative modelling to predict the location and size of an off site Chlorinated Solvent Source Zone

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Summary

PCE contamination of groundwater was identified during the remediation of this former petrol station. There was no known use of chlorinated solvents on the site however it was located adjacent to a laundry. An investigation was carried out which suggested the source to be off site and thus beyond the area available for investigation. A probabilistic groundwater risk assessment was then carried out using Consim and the model was calibrated with the measured groundwater concentrations on site. The contaminant source was subsequently confirmed to be within a few metres of its predicted location by the Environment Agency.

Introduction

Within England and Wales the majority of soil and groundwater contamination tends to be addressed through 'voluntary' action under the planning regime as opposed to being dealt with through primary legislation such as Part IIA of the 1990:EPA. The planning permission for any given development is restricted to the boundaries of the application site and so commonly only part of a contaminant plume may be present within the area available for investigation. As access beyond the site boundary is often unavailable or 'politically' sensitive it is often necessary to attempt to characterise a contaminant source zone or down-gradient plume from the limited data that can be obtained from within a site's boundaries.

Iterative modeling was adopted at this former petrol station in an attempt to match the predicted contaminant plume concentrations to those measured on site, and thus estimate the source characteristics.

Tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE) and vinyl chloride (VC) were measured in the groundwater during the remediation of the fuel contaminated soils. Desk study research confirmed that there had been no known usage of chlorinated solvents on site but that PCE had been used on the adjacent laundry. A Planning Condition however, required that the source be characterised and a risk assessment be carried out to assess the down-gradient effect of the contamination.

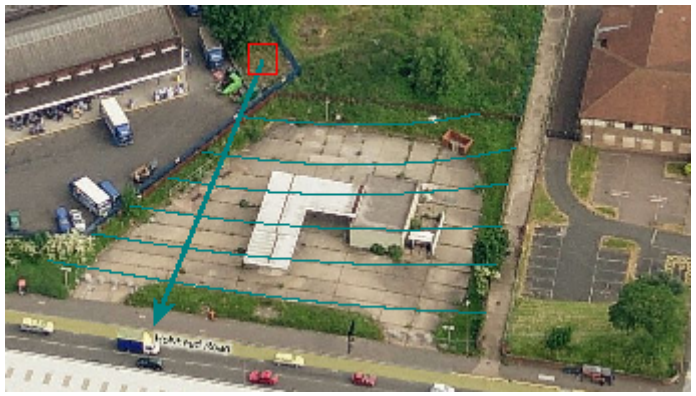

Figure 1. Groundwater flow across the site

Methodology

Groundwater monitoring boreholes were advanced through the Glacial Deposits in the limited area of proposed soft and hard landscaping whilst the new structures were erected over the main area of the site. Groundwater level measurements were taken and permeability testing was carried out to establish the aquifer characteristics and samples of the groundwater were recovered for laboratory analysis. This data was used to update the conceptual site model and a detailed groundwater risk assessment was carried out using the probabilistic Consim model. This model predicts the down-gradient concentration allowing for the effects of dilution, dispersion and degradation from an known contaminant source. However, at this site the size and location of the source could not be determined. An assumed source area was therefore modelled and the predicted down-gradient concentrations were compared with the measured concentrations. An iterative process was then carried out to calibrate the model, and thus estimate the source zone characteristics.

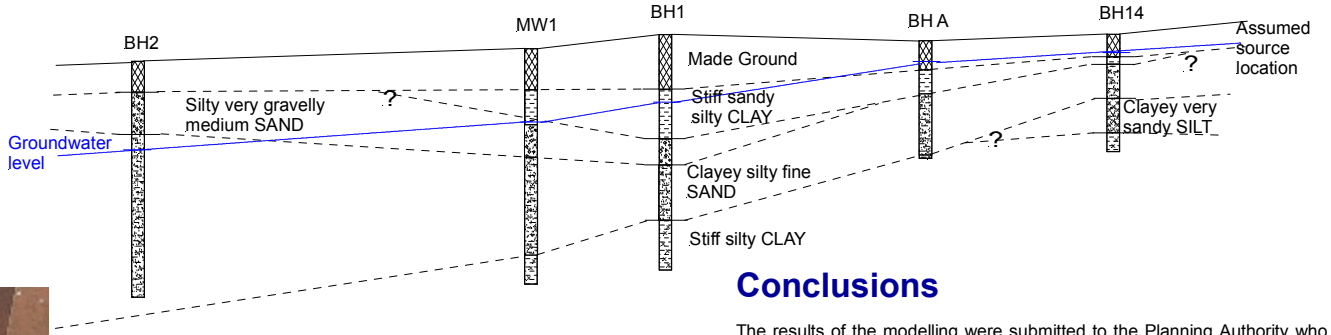

Figure 2. Cross section through the site in the direction of groundwater flow indicating the geological sequence encountered in the boreholes.

Results

The iterative modelling provided a strong correlation to the measured groundwater concentrations for a relatively small source located some 5 m from the site boundary on an adjacent laundry site. The monitoring indicated the presence of TCE, DCE and VC which suggested that the source was relatively old and that natural attenuation of the PCE to TCE and then through DCE to VC was occurring. The modelling indicated that this natural attenuation would reduce the down-gradient concentrations to an acceptable degree such that intrusive remediation would not be required.

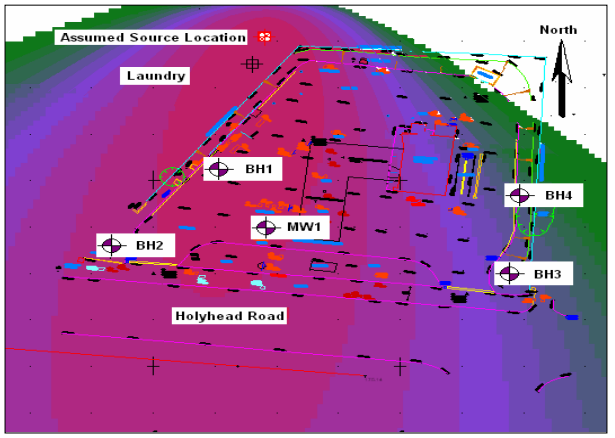

Figure 3. Predicted PCE plume across the site from the assumed off site source zone.

Conclusions

The results of the modelling were submitted to the Planning Authority who, following consultations with the Environment Agency agreed to discharge the planning Condition relating to contaminated land thus allowing the development to proceed. The Environment Agency subsequently visited the up-gradient site and located a zone of rust residue within a metre or so of the location suggested by the Consim model. These residues were confirmed to be from drums of waste dry cleaning solvent. It is understood that some years prior to the remedial works on the petrol station, these drums had been emptied onto the ground in error by contractors during resurfacing works at the laundry. The solvent in the cleaning waste had then migrated through the Glacial Deposits and entered the groundwater. The actual size and location of the source zone is considered to be within one to two meters of that predicted by the iterative modeling process.

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