Chemical Oxidation | Enhanced Aerobic Biodegradation

REGENESIS

Treating 1,2 Dichloroethane in a Mixed Plume – Kent, UK

A Remediation Case Study on the Power of ISCO and ENA

with Royal HaskoningDHV

Geology	Gravel
Contaminant Of Concern	1,2 Dichloroethane (DCA)
COC Range	Up to 8,000 µg/L
Target Level	1,250 µg/L
Treatment Area & Thickness	2,400 m^2 Area A = 7 m BGL to 9 m BGL Area B = 5.5 m BGL to 7.5 m BGL
Former Site Use	Former Engineering Works
Project Driver	Voluntary Remediation to Reduce Potential Environmental Impact
Product Design details	In Situ Treatment (ISCO & ENA)

Introduction

The groundwater under a former engineering works in the south east of England had become impacted with a mixture of contaminants due to processing and storage activities at the site. Contamination was shown to be advecting from the site boundary and so a voluntary remediation programme was deemed necessary by the leaseholder.

Royal HaskoningDHV were engaged to investigate the extent of the contamination, develop a remediation strategy and validate the remedial works onsite. The main groundwater contaminant of concern was 1,2 Dichloroethane (DCA), which was present in concentrations up to 8,000 µg/L. Petroleum hydrocarbons and vinyl chloride were also identified in the made ground and shallow river terrace gravels (RTGs) at problematic concentrations. Remediation works were further complicated by low-level radioactive waste (flints) left over from manufacturing works onsite.

Groundwater contamination was observed at low concentrations across the site, however two main areas of contamination were identified as requiring treatment, area A in the north and area B to the south (see fig 3 on page 2).

Fig. 1 - The former engineering works

Fig. 2 - Radiological monitoring was completed throughout the project.

Remediation Strategy

A remedial options appraisal was completed and enhanced aerobic natural attenuation was identified as being most beneficial due to the:

- uncertainty, disruption and open-ended costs of pump and treat
- low concentrations would make chemical oxidation inefficient
- enhanced reductive dechlorination of the DCA and VC would not address the petroleum hydrocarbons.

Regenesis then provided a remediation design using ORC Advanced to provide a controlled release of dissolved oxygen into the groundwater for a period of 9 to 12 months from a single injection in order to stimulate and maintain accelerated natural attenuation of the contaminants of concern (COCs).

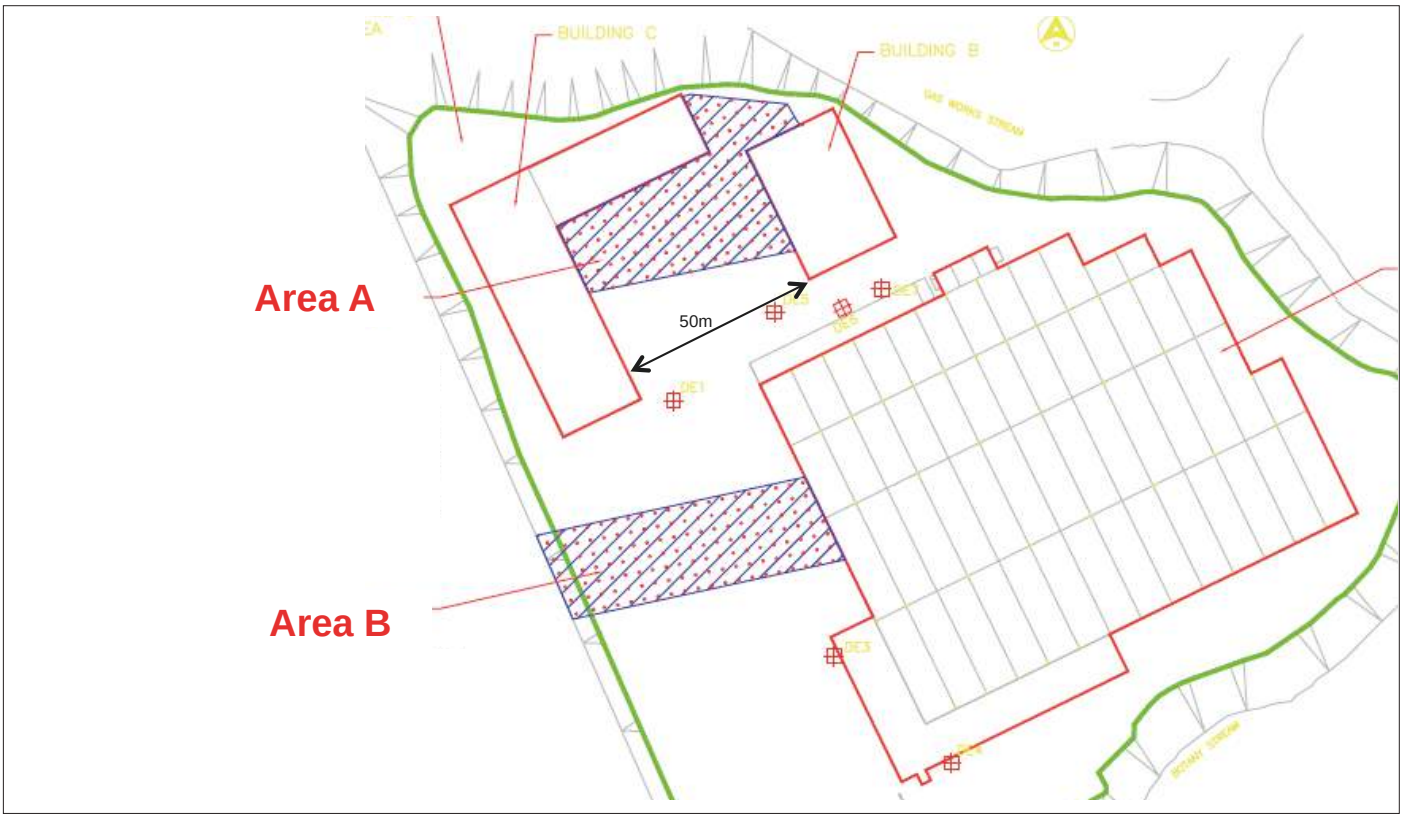

Fig 3. - Site Map showing the two application areas

Pilot Study

It was determined that a pilot study should be completed, comprising a pump test, tracer test and small-scale injection of ORC Advanced.
Regenesis completed a pump test in the Tunbridge Wells Sands (TWS) underlying the RTGs and despite significant drawdown there was no response in the RTGs or nearby TWS boreholes. This confirmed that there was limited potential for the contamination to migrate into or within the underlying TWS.

Regenesis completed a tracer test (see fig. 4), using 20% rhodamine, in the RTGs which confirmed a low hydraulic gradient across the site but also showed a much lower permeability than was previously thought.

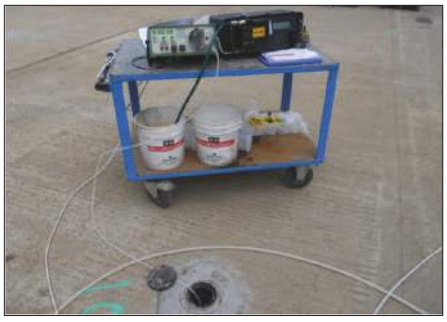

Fig. 4 - Pumping and dye test

Regenesis then injected a low dose of ORC Advanced on 4 m by 4 m grid across a 10 m by 10 m area in Area A (See fig. 5). The low dose and spacing were based on the relatively low concentrations of the COCs and the presumed permeability of the RTGs. The application resulted in some degradation of the COCs, but did not provide the significant reduction in concentrations that was hoped for. It was determined that aerobic biological degradation was possible, but the dose and spacing required redesigning based on the information garnered in the pilot study activities.

Fig. 5 - ORC-A pilot test application in Area A

The information from the pilot study improved the accuracy of the Conceptual Site Model (CSM) and the confirmation of Site Specific Target Values (SSTVs) for the remediation based on revised Detailed Quantitative Risk Assessment (DQRA) for each COC.

The SSTVs were defined as;

- Vinyl chloride – 42.2 mg/l
- 1,2 Dichloroethane – 1,250 mg/l
- Aliphatic TPH >C5-C6 – 853 mg/l
- Aliphatic TPH >C6-C8 – 853 mg/l

Prior to the works beginning, Regenesis installed a number of validation wells across the target areas, which allowed the target areas to be more accurately delineated at 2,400 m. Based on the revised CSM and results from the pilot study, a 3 m by 3 m injection grid of 242 injection points was proposed across the site, targeting contamination in Areas A and B (N.B. there was no injection possible within the buildings). The design targeted the contamination within the RTGs between 6-9 m BGL. As the RTG had been found to be more silty than expected, the ORC Advanced dosage was increased from that used in the pilot study to allow for the lower permeability and higher fraction of organic carbon (FOC), which would affect the radius of influence of the ORC Advanced and provide an extra oxygen sink. A low dose of RegenOx was also included in order to provide an initial period of in situ chemical oxidation (ISCO) and rapidly increase the redox conditions to speed up the onset of aerobic biological degradation.

The extra validation wells were cored using a mini-sonic drill rig, which allowed the top and base of the impacted gravel band to be mapped across the site (See fig. 6 and 7). This allowed the injection depths to be made very accurate within the targeted treatment zone; in Area A the injection depths were generally from 7 m BGL to 9 m BGL and in Area B they were from 5.5 m BGL to 7.5 m BGL.

The groundwater analysis from the new validation wells also improved the resolution of the COC distribution within the target areas. This allowed RRS to alter and refine the dosages for each injection point across the target areas. Area A was re-mapped with 3 different doses and Area B with 2 different doses. By combining the information from the cores and the groundwater analysis, the treatment was made extremely accurate both laterally and vertically across the site. See fig 8.
Regenesis completed a single application into the injection grid using two direct push injection rigs. This involved breaking out the concrete, then driving a direct-push injection rod into the ground and injecting the correct dose at intervals across the target vertical thickness. Each point was then sealed with

Fig 6 and 7 - Confirming the CSM

Fig 8 - Map showing the refined dosage designs for Area A and B

bentonite and the concrete reinstalled. All 242 injection points were completed in 16 days. See fig 9-11.

Results

The application resulted in the significant, rapid and sustained reduction in all of the COC's and achieved remedial targets for;

- Aliphatic C5-C6 (20 out of 20 wells in treatment area)
- Aliphatic C6-C8 (20 out of 20 wells in treatment area)
- VC (20 out of 20 wells in treatment area)
- 1,2-DCA (18 out of 20 wells in treatment area)

In Area A all of the validation wells met SSTV's for all COC's and in Area B two wells had marginal failures close to the upgradient edge of the treatment zone next to the building where no injection could be completed. See fig 12 for graphs of COC reductions across the site.

The remediation resulted in the reduction of contaminant mass across the site for all contaminants of concern (see fig. 13) and the residual concentrations may be expected to decline further over time.

Fig 9-11 - Application on site

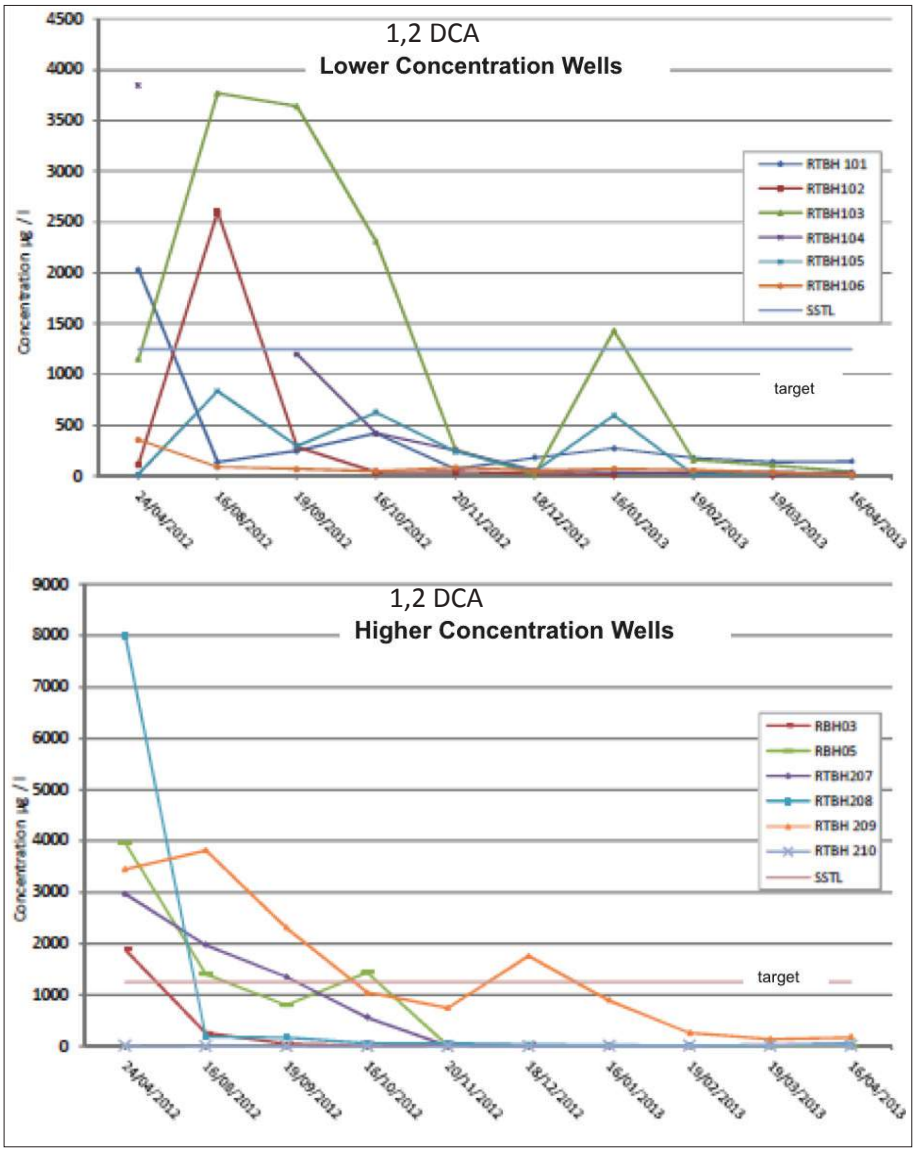

Fig 12 - 1,2 DCA Reductions Across the Site, split by lower & higher concetrations wells

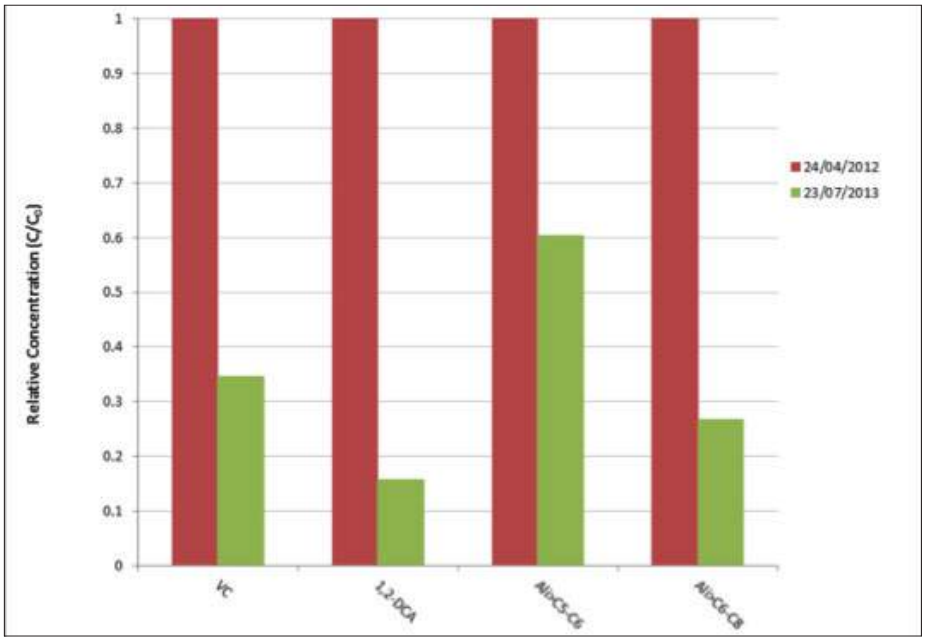

Fig. 13 - Relative concentration reduction

The results were presented by Royal HaskoningDHV to the Environment Agency, who granted regulatory closure of the site.

Conclusion

An intelligent and staged approach was used in completing the site investigation, development and implementation of a remedial strategy for the site. This comprised;

- Initial Site Investigation and DQRA
- Involvement of regulators at early stage
- Testing CSM (pump and tracer test) and potential remedial strategy (ORC Advanced pilot)
- Further delineation laterally and vertically, through coring and groundwater sampling
- Tailored dosage to match localized geological and geochemical conditions across site

This resulted in a highly accurate in situ remedial design, which quickly brought COC concentrations below the SSTVs and continued to reduce the contaminant levels throughout the validation period. The site is an excellent example of how good site investigation and design can provide cost effective and assured remediation of problematic contaminants.

As the works were completed in only 16 days onsite, in a single injection, with no active remedial equipment being operated onsite, disturbance to the site was minimised. The remediation allowed confident regulatory sign off after 12 months of validation sampling, with the EA going on to comment that '*we appreciate the way the contamination has been responsively and effectively managed at the site and look forward to working with you at some point in the future*'.

For more information or to discuss your project, please contact:

Gareth Leonard
Regenesis
Managing Director, Europe

gleonard@regenesis.com
+44 (0) 1833 630 411

Contact Reference:
David Allen
Royal HaskoningDHV
Team Leader, Energy and Infrastructure Consenting

david.allen@rhdhv.com
+44 (0) 151 243 9288