

# In Situ Reduction of Hexavalent Chromium

Timely remediation of a former component factory in Northern Switzerland





Cover page and above: Indoor remediation activities in the existing historical building (to be retained). Below: the same existing building as seen from the outside.

### Introduction

At a small town in Northern Switzerland, hexavalent chromium (CrVI) was found under the former site of a precision component factory specialised in non-ferrous machining and hot stamping. The contamination was due to historical leakages from chrome-plating tanks and the onsite water treatment plant.

The site was composed of sandy/silty gravels on top of a marl bedrock; with a shallow, fast flowing aquifer (hydraulic gradient of 1%) typical of mountain areas. Strongly aerobic conditions (dissolved oxygen was at saturation point (10mg/L)) resulted in stable concentrations of Cr(VI) in the groundwater.

CSD Ingénieurs identified a total mass of 10 kg of Cr(VI), with the contaminant plume beginning at the water treatment plant building and approaching the site boundaries. Cr(VI) concentrations were in the range of 100-200  $\mu$ g/L. A stringent target level of 10  $\mu$ g/L was set, due to Swiss laws (OSites) and the sensitivity of the aquifer, proximity to a river and the regular flood events in the area that can bring contamination to the surface.

The area, now the property of a real estate company, still has all its historical buildings, and is partly rented out to several small business activities. A complete redevelopment of the area is expected to happen in the future, however full-scale remediation was required in the shorter term, to avoid the further migration of the contaminant plume and potential impact of the downgradient river.



## The Challenge

It was key to identify a remediation solution that would be effective, minimize disturbance to the ongoing business activities, maintain the historic buildings in place and at the same time minimize the treatment cost (as there was no direct return on investment after remediation).

CSD's remediation plan comprised demolition of the wastewater treatment building and excavation of contaminated soil in the vadose zone over an area of approx. 500 m<sup>2</sup>. Groundwater remediation was needed under the entire footprint of the excavation, in the courtyard immediately downgradient and also under part of a historical building on the site.

#### **Remedial Technology**

CSD performed a remediation options appraisal considering and comparing different solutions, including pump & treat, excavation of aquifer soil and several in situ approaches. In order to ensure effective groundwater remediation with minimal site disturbance, in situ reduction of hexavalent chromium was selected, using a combination of REGENESIS technologies.

This comprised two treatment mechanisms: the high-volume organic substrate 3-D Microemulsion (3DME) created biogeochemical Cr(VI) reduction, co-applied with another REGENESIS reducing agent able to provide direct chemical reduction of Cr(VI) into non-toxic trivalent chromium compounds. Both reagents are extremely long lasting, and their combined use ensures a longevity of 3 to 5 years upon a single injection.

3DME has an extraordinary distribution capability, thanks to the formation of micelles that self-distribute through the aquifer following low pressure injection. This allowed a widely spaced injection grid of 5-7 m between points, minimizing disturbance and injection costs.







#### Application

Direct Push Technology (DPT) was used to apply the products under low pressure, into the target area. A total of 16 points, forming an irregular grid of 5 x 7 m, was applied. The target aquifer was found at variable depths throughout the treatment area and so an precise vertical injection thickness was used for each point, ranging from 3.5 to 5.0 mBGL. A specialized retractable tip was used to provide even- distribution of the products covering the capillary fringe to the top of the underlying bedrock.

Each injection point used approx. 180 kg 3DME and 30 kg of chemical reducing agent, diluted to form a solution of 900-1300 L per point. The injection points located inside the historical building, needed to be drilled through a pavement several meters above the natural ground level, passing through an inaccessible cavity. These points were predrilled prior to using the DPT injection rig and the holes repaired following application.

Injection activities were performed by REGENESIS Remediation Services and lasted for 6 days, after which backfilling of the excavation was immediately possible.





Top left: Indoor direct push injection through the floor slab. Above Left: Direct push injections into the bottom of the excavation. Above right: Site injection plan showing injection points (IP)



#### Results

Post application monitoring was performed by CSD and showed the immediate establishment of reducing conditions, with a decrease of dissolved oxygen and the achievement of negative Redox potential.

Three months post injection, Cr(VI) had already been completely reduced in the entire monitoring network, located within and downgradient of the treatment area. This included in the 5 compliancy monitoring wells external to the treatment area.

The stringent target of 10  $\mu$ g/L was reached in all wells, with 3  $\mu$ g/L being the maximum level detected and several wells being below detection limit of <1  $\mu$ g/L. These reductions continue to be maintained in the ongoing monitoring. Long term monitoring is continuing for 5 years after achievement of the targets with campaigns every 9 months to observe the stability of the reductions achieved.



### Conclusion

The combined remedial approach succesfully met the requirements of the site; low cost, low disturbance, avoiding demolition of historical building and achieving low remediation targets.

Safe and easy application was coupled with the rapid and stable reductions provided complete client satisfaction.

#### **Project Reference**

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Above: Outdoor mixing area of the remediation reagents Below: Indoor injections made possible with the small footprint of the Direct Push rig.



#### **More information**

Scan the QR code to explore treatment options for your hexavalent chromium or chlorinated solvent site.

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