



Figure 1 - Site prior to remediation

Site Overview

The site comprises of a rectangularly shaped area of land around 1.4 ha in size. The site is bordered on the west side by a stream. Prior to development the east side comprised of a steep slope with gradients varying from 1 in 2.5 to 1 in 3. The southern boundary of the site is defined by a small road and the northern site boundary is bordered by open space areas.

Historically the site consisted of a tannery believed to be present in the central area of the site. Production is thought to have begun around the 1830's believed to have ceased in the 1960's. The tannery and surrounding buildings were demolished in the 1990's in readiness for future development.

Redevelopment proposals include residential housing and gardens.

Generally, the southern and the eastern part of the site had moderate / low concentrations of contaminants. High levels of arsenic, cadmium and chromium were generally present in the north western portion of the site. It was considered that the contamination identified within these areas was a result of the former on-

site processes, in particular the drip-drying of tanned hides in the open areas of the site.

Chemical testing indicated that the arsenic was highly leachable and dissolved phase arsenic had been identified within the groundwater. Arsenic levels in the north-west of the site were typically in the order 4,000 to 8,300mg/kg, with one identified hotspot as high as 46,100mg/kg.

Groundwater levels recorded generally ranged between 1m and 2.8m in the southern areas and between 2.2 and 3.7m in the central and northern areas of the site. The data indicated that the groundwater was flowing in an easterly direction (away from the stream) underneath the site. This was consistent with the regional topography falling to the east.



Figure 2 -Typical site contamination.

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Objectives

The environmental consultants considered three remediation strategies namely:

Cover systems to be used to mitigate the human health risk. If an impermeable layer was included within this cover then the reduction in infiltration may also reduce the risks to surface water and groundwater. This solution was considered inappropriate for such high concentrations of arsenic identified.

Dig and Dump to remove the very high concentrations but, on the basis that the material would be classed as hazardous, off-site disposal was considered to be too expensive.

Soil Fixing [Chemical Immobilisation] was considered to be the most cost effective approach for treatment of the highly contaminated soil.

Working closely with the consultants a remediation strategy was formulated based on a P20 model using an Environmental Quality Standard of 50ug/l for arsenic (drinking water standard) at the external compliance point for the site. The Environment Agency was satisfied with the Tier 3 Soil P20 Risk Assessment model and the proposed leachate target for the treated material.

Prior to site works being undertaken, Envirotreat conducted a series of treatability trials with modified E-Clays coupled with a range of specialist additives which demonstrated effective remediation of all the contaminants of concern.

The treatability work demonstrated that careful control of pH was crucial during the treatment stage. A correlation between increasing pH (addition of cementitious additives) and arsenic leachability was demonstrated. This confirmed that it was not possible to chemically stabilise

arsenic compounds by use of cementitious additives alone. In fact it was shown that addition of cementitious additives could exacerbate the arsenic groundwater problem.

Envirotreat were able to address these identified concerns by precise pH control prior to chemical stabilisation / encapsulation, coupled with optimal addition of iron based compounds to maximise E-Clay reactivity towards the targeted pollutants of concern.

On- Site Works

The treatment works were carried out under the auspices of Envirotreat's Mobile Treatment Licence (MTL).

The proposed strategy involved the *ex-situ* remediation of 6,500 m³ of contaminated material.

The contaminated material was excavated using conventional plant and equipment and delivered to the treatment zone by the main contractor. Excavations were validated by the consultant.

A specialist processing (*allu*) bucket mounted on an excavator was used to mix the contaminated soil and treatment reagents in 10m³ batches within the bespoke mixing bin.

Following treatment, soils were stockpiled and allowed to fully cure. Validation samples were submitted for total and leachable contaminant analysis.

Following satisfactory validation testing the soils were utilised as fill within the final redevelopment by the main contractor.

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Validation and Results

The objective was to achieve treated soil leachate target values which had been derived by the P20 Risk Assessment model. For the key pollutant of concern [arsenic] the treated soil leachate value was assessed through P20 modelling on the basis that the external compliance value for the site was 50ug/l.

The P20 risk assessment derived maximum leachate levels for treated soils were as follows:

- Arsenic 1,130ug/l
- Cadmium 33ug/l
- Total Chromium 565ug/l
- Total Petroleum Hydrocarbon 600ug/l

The results for arsenic and chromium are shown graphically below:

Chart1: Validation Results for Arsenic

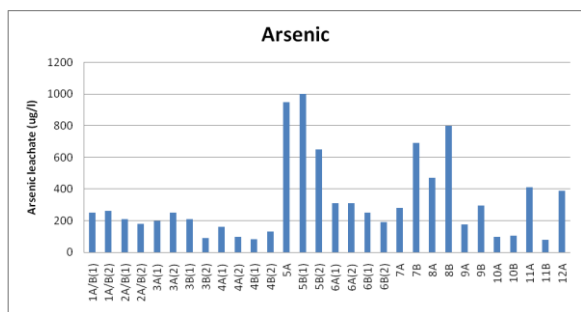
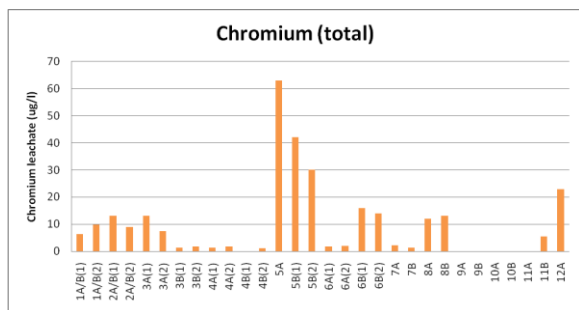


Chart2: Validation Results for Chromium



In respect to Cadmium and TPH, all validation results were less than the limit of detection.



Figure 3 Proposed final development.