CASE STUDY

Permeable Reactive Barrier Installation

Former Gas Works, Eshiels, Scotland

Plate 1 – Post Remediation

Development:
Remediation of former Gas Works, Eshiels

Client:
Scottish Borders Council

Installation Partner:
carillion

The site is located at Eshiels near Peebles in the Scottish Borders Region. The site was previously a gas works and is currently operating as a depot and licenced Waste Transfer Station for the Scottish Borders Council.

Ground investigations showed the site to be overlain by Made Ground with a variable thickness of between 0.2 - 6.5m bgl. The Made Ground is typically underlain by Alluvium Deposits extending to depths of over 11m bgl. The Alluvium Deposits comprise of medium dense to dense silty sandy gravel with some cobbles. In addition to the above, geological maps indicate the above to be underlain by Llandovery Formations (Gala), comprising medium to thick bedded and coarse-grained sandstones with thin siltstones.

At the time of the investigation, groundwater was encountered between 0.6 - 8.0m bgl. The direction of groundwater flow was in an easterly direction and most likely impacting the River Tweed to the south east.

The Site Investigation identified potential receptors as the River Tweed, localised groundwater, site users and neighbouring residents.

The Waste Transfer Site was part of a former Gas Works and was contaminated with pollutants typical of such industrial activity. The contaminants of concern (COC) identified for treatment by the reactive barrier are listed in Table 1.

Table 1 - Contaminants of Concern

Contaminant	Maximum Concentration (µg/l)	EQS (µg/l)	DWS (µg/l)
Ammonia	7,700	15	NV
Ammonium	9,200	NV	500
Free Cyanide	100	1	50
Chromium	23	10	50
Copper	14	6	2000
Lead	4	10	25
Nickel	201	100	20
Zinc	359	50	5000
Pentachlorophenol	9.1	2	NV
Total Phenols	32,700	NV	NV
Benzene	1,637	30	1
Toluene	3,314	50	NV
Ethylbenzene	327	20	NV
Xylene	1,874	30	NV
Total Polyaromatic Hydrocarbons (USEPA 16)	2,360	NV	0.1
Benzo(a)pyrene	0.1	NV	0.01

NV = no value.

The prime concerns were the protection of offsite groundwater receptors and particularly the River Tweed. **An Envirotreat Soil Mixed Reactive Permeable Barrier was considered the best technology solution for this application, as it would address all contaminants of concern within the groundwater to the proposed clean up criteria, within the budgets available.**

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Objective

The objective of the proposed Envirotreat Soil Mixed Barrier System was to protect the surrounding environment from potential offsite migration of contaminated groundwater originating from historical use of the site as a gas works.

Methodology

The Soil Mixed Barrier System was designed to incorporate a combination of two relatively low permeability sections and a permeable reactive section using proprietary E-Clay® Technology. The low permeability sections were designed to channel groundwater through the reactive section.

Prior to installation the efficacy of the barrier design was demonstrated to the client and SEPA by means of treatability trialling and hydrogeological modelling (groundwater contours are shown in Plate 2). The purpose of this treatability study was to demonstrate the suitability of the designated site-specific E-clay formulation for the sorption and immobilisation of the identified contaminants of concern. The study used both batch test and column test procedures as recommended in Environment Agency guidance documents "*Guidance on the use of Permeable Reactive Barriers for Remediating Contaminated Groundwater*"[1] and "*Guidance on treatability studies for permeable reactive barriers (PRBs)*".

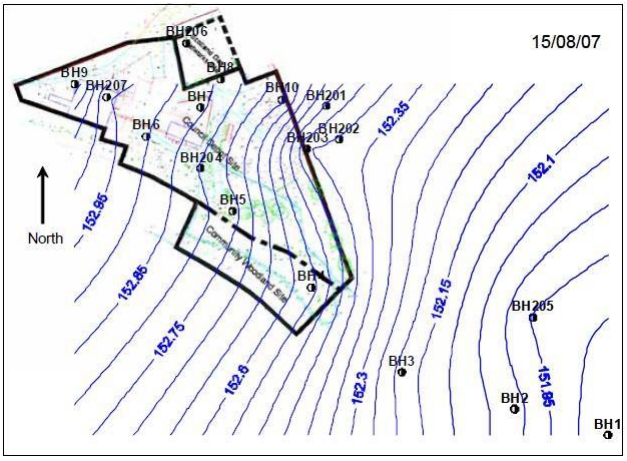

Plate 2 – Groundwater Contours for the Eshiels Site

Installation

Carillion installed the barrier sections using a Continuous Flight Auger (CFA) drilling rig. The permeable section of the barrier incorporated a purpose designed E-clay formation whilst the relatively low permeability sections contained a site specific blend of OPC and Bentonite. The respective materials were injected in slurry form through ejection ports located in the CFA mixing head. Unlike displacement piling, complete mixing is ensured with minimal spoil generation.

The two low permeability barrier walls were constructed using a total of 240 overlapping soil mixed columns, installed in a single row to a depth of 10 metres below ground level. The permeable reactive section was constructed using a total of 160 overlapping soil mixed columns, installed in a double row to the same depth (the double row columns interlocked in both directions). The inner row of columns contained proprietary E-Clay slurry designed specifically for treating the known presence of ammonia(ium). The outer row of columns contained proprietary E-Clay slurry designed specifically for treating the other contaminants of concern. The slurry batching facility and CFA barrier installation are shown in Plates 3 and 4 respectively

Plate 3 – Fully Automated Batching Plant

The cement and bentonite materials were stored in two screw-fed horizontal silos and automatically weigh batched in the feeder system prior to use.

Plate 4 - Barrier Installation utilising a Carillion Piling CFA Rig and Expertise

Results & Validation

The efficacy of the barrier system is to be assessed through periodic groundwater sampling from monitoring wells upstream and downstream of the barrier installation. Additionally, the River Tweed will be sampled upstream and downstream of the barrier installation. It is proposed that sampling is to be carried out on a monthly basis for year one and bimonthly for year two.

Due to ongoing redevelopment at the facility the monitoring boreholes have not been installed at the time of writing.

Groundwater samples will be analysed for Arsenic, Zinc, Benzene, Chromium, Ammonical Nitrogen, Toluene, Copper, Free Cyanide, Ethylbenzene, Lead, Pentachlorophenol, Xylene, Nickel, Phenol and speciated PAH.

It is predicted that following completion of the barrier system, the clean up criteria specified in Tables 2 and 3 will be achieved.

Table 2 - Proposed / Agreed Clean Up Criteria

Contaminants of concern (µg/l)	Max. in groundwater (Average High)	Predicted concentrations at the end of 2 years monitoring	Source / Based on
Ammoniacal Nitrogen	9,200 (4,700)	750	90 - 95% Reduction
Free Cyanide	100	50	EU DWS
Chromium	23	10	EQS
Copper	14	10	Detection limit
Lead	4	10	EQS
Nickel	201	100	EQS
Zinc	359	50	EQS
Pentachlorophenol	9	2	EQS
Total Phenols	32700 (6,900)	690	90% Reduction of AH

Table 3 - Proposed / Agreed Clean Up Criteria

Contaminants of concern (µg/l)	Max. in groundwater (Average High)	Predicted concentrations at the end of 2 years monitoring	Source / Based on
Benzene	1637 (391)	40	90% Reduction of AH
Toluene	3314 (880)	88	90% Reduction of AH
Ethylbenzene	327 (125)	300	EQS
Xylene	1874 (646)	65	90% Reduction of AH
Total PAH	2360 (864)	92	Tier 3 remedial target

The installed barrier system is shown in Plate 5 below.

Plate 5 – The Installed Soil Mixed Barrier System for the Eshiels Project