



Photo 1 - Housing development at the Former Gas Works site.

Completion Date:	September 2004
Development:	Residential Housing & Hotel Development
Developer:	Barratt Eastern Counties & Robert Leonard Group
Remediation Contractor:	Knight Environmental Limited
End Value:	£40m

### Site Overview

The former Southend Gas Works Site, Essex was historically utilised for coal / coke storage and gas purification. In recent years its usage transferred to a gas distribution depot and contractors yard, until becoming a boat maintenance and storage yard.

It is located on the Eastern Esplanade, bound by the Thames Estuary 50m to the south, with residential properties to the north, east and west. The site is a 25,000 m<sup>2</sup> development of over 200 residential properties and a luxury hotel with a fitness and health centre.

Historical use has resulted in considerable soil contamination across the site typically found on Gas Works sites. The contaminants identified on-site included BTEX, PAH's, TPH's and heavy metals. 'Blue Billy' waste and associated cyanides produced during gas purification was also problematic.

### Objective

The remediation strategy for the Southend Gas Works site was designed to address the source contamination on-site and indirectly the pathway contamination issues, with the intention of protecting the groundwater receptor, the Thames Estuary.

### Methodology

The remediation strategy employed on-site by Envirotreat for the treatment of over 15,800m<sup>3</sup> contaminated soils was *ex-situ* soil mixing. This included 1,500m<sup>3</sup> of high levels of cyanide containing 'Blue Billy' waste.

The works were conducted under the auspices of Envirotreat's Mobile Process Licence (MPL). Specialist technology, materials and supervision were supplied by Envirotreat, whilst Knight Environmental Ltd supplied all the required plant, and labour for the Envirotreat® Process.

The identified contamination was excavated, stockpiled and treated on-site using the Envirotreat E-clay® technology. The treatment operation utilised 2 No. slurry production units and mixing zones, which were relocated around the site as the job progressed, allowing the build to begin, prior to the completion of the remediation works (Photo 2).

Each set up comprised of a 1000L paddle mixer where the E-clay® reagents were combined together before being pumped across to the mixing zone. An excavator mounted with a specialist processing bucket attachment then mixed the E-clay® slurry and contaminated soils.



Photo 2 - Treatment of contaminated soils running parallel with Phase 1 of the building program.

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The processing bucket is a specialist attachment with rotating blade at the base of the bucket, which facilitate a high degree of mixing. This approach was utilised due to the clayey nature of material requiring treatment.



Photo 3 - Mixing of clayey soils with E-clay® slurry using the processing bucket attachment on a conventional 30T excavator.

The soils were mixed in 10m<sup>3</sup> batches to allow known quantities of contaminated soils to be combined with the E-clay® slurry until a homogenous mix was produced. The treated soils were then reused on-site as a substitute for imported clean fill, thus preventing the need for off site disposal.

### Validation

Validation of the treated material was carried out on 32 No. batch samples of material treated, equating to 1 No. batch sample every 500m<sup>3</sup> treated soils. Samples were leached and analysed under supervision of Knight Environmental by a UKAS accredited laboratory.

### Results

Table 1 summarises the Maximum Contaminant Level (MCL) of contamination present in the soil prior to remediation, the Site Specific Target Levels (SSTL's) as derived from a Tier 3 Groundwater Risk Assessment and the Mean Average of the leachate of 32 No. batch samples taken to validate the treated

material for each of the identified contaminants of concern. 4 No. batch samples represented the treatment of 'Blue Billy' and are reported separately.

Contaminant of Concern	MCL in Soil Prior to Clean-up (mgkg <sup>-1</sup> )	SSTL (mg <sup>-1</sup> )	Leachate of Treated Tot. Soils (mg <sup>-1</sup> )	Leachate of Treated 'Blue Billy' (mg <sup>-1</sup> )
Arsenic	170	0.44	0.019	0.027
Cadmium	26	0.05	0.001	0.001
Chromium	1,100	2.22	0.01	0.02
Lead	44,000	0.22	0.01	0.01
Mercury	24	0.009	0.00008	0.00005
Selenium	1	0.09	0.011	0.013
Copper	600	0.25	0.066	0.096
Nickel	170	1.78	0.030	0.043
Zinc	9,130	4.44	0.0071	0.0053
Phenol	1,300	17.8	0.07	0.05
Total Cyanide	23,000	13.6	5.16	20.2
Total PAH's (16)	6,900	**	0.2315	0.7087

\* Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo (a) anthracene, Chrysene, Benzo (b) fluoranthene, Benzo (k) fluoranthene, Benzo (a) pyrene, Indeno (1,2,3-cd) pyrene, Dibenzo (a,h) anthracene, Benzo (g,h,i) perylene.

\*\* SSTL derived individually for each PAH.

Table 1 - Summary of treated soils leachate results compared to SSTL derived from Tier 3 GW Risk Assessment conducted by Envirotreat and agreed with the Environment Agency.

The remediation project was successfully completed under the auspices of the MPL, with the results illustrating that the objective of protecting the groundwater receptor, the Thames Estuary, has been achieved. The contaminants of concern have been fully addressed with levels below the agreed Site Specific Target Levels for each contaminant, thus allowing the material to be reused on-site for a beneficial purpose (Photo 4).



Photo 4 - Treated soils redeposited ready for the construction phase to begin.