Gas Works Remediation for Residential Development

Synopsis

The remediation of Tunbridge Wells Gas Works to a standard suitable for residential development was always going to be a challenging exercise. To have achieved this in the context of a very commercially driven timeframe, within a strict regulatory regime, whilst keeping to budget required a highly innovative design and an unprecedented degree of partnering between all stakeholders. This complex project resulted in successful treatment and re-use onsite of over 99% of the approximately 40,000 tonnes of contaminated soil processed. From initial investigation to first residential occupations was a period of less than 16 months. The projects undoubted success is the product of intensive activity by all involved and perhaps unusually leaves in its wake a real sense of pride, satisfaction, and closer relations for those who collaborated.

Introduction

The site which extends to approximately 4 hectares had previously been used for gas production from the early 1890's until mid 1970 (Figure 1), and then subsequently as a Transco Depot. SecondSite undertook ground investigations in early 2000 to assess the extent of contamination and associated environmental liabilities. Remediation as part of a risk reduction exercise was undertaken in 2002 with identified areas of highly contaminated soil excavated as part of a "dig and dump" strategy and removed from site to landfill. The brief only met a specified sit end use of "securely fenced vacant land" and residual elevated levels of hydrocarbon contamination where reported to still be present.

Regeneration

The site was purchased by Barratt Homes (Kent) for residential redevelopment in 2004 with a scheme comprised of 176 units of mixed "market" and "affordable" dwellings with private and open landscaped areas (Figure 6 - top left). Proposals included; adoptable access roads, cycle and pedestrian access linking with the nearby parkland, retained woodland to be enhanced as part of the wider parkland, and the "opening up" of a culverted stream through the entire length of the former gasworks to create a landscape feature designed and managed to enhance its ecological diversity and to increase wildlife populations.

Community and Stakeholder Acceptance

Southern Testing where employed by the Developer to investigate the extent of residual contamination and determine the scope of remedial works required to meet planning conditions attached to the development proposals. The site presented a number of immediate issues; previous remediation works had not been signed off by the Regulators, nor did the level of cleanup meet the requirements for the proposed residential end use. Southern Testing recognised the concerns raised both within the local community and by the regulators, and so arranged extensive consultations with the Developer, Environment Agency (EA), Environmental Health Officer (EHO), Planning Authority (PA) and residents at a very early stage. An Investigation strategy was discussed upfront and submitted for approval prior to commencement of any site works. The regulators were kept informed of site progress throughout the investigation, monitoring, conceptual design, pilot and laboratory trials, and undertook several site visits. This unprecedented degree of early involvement was critical to obtaining the backing of the EA and EHO for the proposed remedial strategy during the later stages of the design process and has helped to streamline the validation process.

Site Characterisation

The site is underlain by Wadhurst Clay at the base of a valley with fairly steeply sloping ground. A culverted stream marked the eastern boundary, while to the west the site is bound by a railway and the remaining Gas Holder Station to the north. Ground conditions encountered comprised a significant depth of made ground over a silty laminated and fissured clay and mudstone (Wadhurst Clay). The substructure to several of the historic gas works

buildings, including a gasholder, remained intact below ground. The soils were generally found to be contaminated with PAH's, TPH, and BTEX compounds associated with town gas production. Significant hydrocarbon contamination was identified along the boundary with the remaining Gas Holder Station. A shallow compacted clay wall had been constructed as part of the earlier risk reduction exercise along part of this boundary. However, investigation indicated this to be ineffective and saturated with contaminants migrating from the adjoining site.

Although located on a non-aquifer, groundwater modelling was complicated due to the nature of the underlying soils. Seepages were encountered as perched water within the made ground and laterally limited bodies throughout the underlying clay and mudstone. Locally ground water, particularly at the northern end of the site around the historic process buildings and structures, was found to be contaminated with PAH's TPH, BTEX compounds, phenols, cyanide and ammonia.

Assessment of Remedial Options

Southern Testing's illustrative remediation strategy identified contaminated zones of soils and a risk of contaminant migration both onto the site from beneath the existing neighbouring Gas Holder Station, and offsite. A dig and dump solution was considered to be an unsustainable and excessively expensive approach, and the design brief was to assume a totally balanced site with no net loss of material. Both in-situ and ex-situ techniques were considered, however it was felt that an ex-situ treatment technique offered benefits on a site of this nature, given the generally clayey nature of the underlying soils and the impersistent nature of the contamination. An exsitu solution gave the added benefit of dealing with physical obstructions and improving the overall validation process. A number of ex-situ techniques were identified the most suitable were considered to be stabilisation and bioremediation. After extensive consultation with the regulators and various specialist remediation specialists, an innovative and sustainable treatment system was designed incorporating elements of bioremediation and stabilisation.

Technical Innovation (Best Practice)

The Developer wished to incorporate a variety of sustainable and innovative techniques that were designed to meet the planning, environmental and geotechnical requirements of the site while managing the longer term environmental liabilities. Southern Testing proposed that the best remediation strategy for the site would be one that utilised a combined treatment system. Following successful treatability studies, Specialist Remediation Contractor "Biogenie" carried out soil treatment using "ex-situ bio-piles". During the 14-week treatment process pipes were installed within the soil stockpile as shown in the attached schematic (Figure 5 & 6) with amendments (nutrients) added to allow optimum conditions to be created for natural degradation of contaminants. Biogenie also provided a system for collection and treatment of waters encountered in excavation, prior to discharge under consent to foul sewer.

To mitigate against risks of both onsite and offsite contaminant migration, Specialist Remediation Contractor "May Gurney" was appointed to design and implement "in ground barriers". To prevent recontamination of remediated soils and reduce the risks of future onsite migration of contaminants from beneath the adjoining gas holder station, a non-reactive / impermeable "in ground barrier" was constructed to a depth of between 9.5 m and 12.5m along the length of the northern site boundary (approximately 100m) keying into the clean underlying Wadhurst Clay.

Figure 1 - Former Gas Works Layout

Figure 2 – Excavation of Tar Tank Structure

Figure 3 – Zonal Excavation and Remediation

Figure 4 – Contamination around Culvert

Figure 5 – Remediated Zone

BARRATT Biogénie MAY GURNEY Southern Testing Environmental & Geotechnical

Due to the highly variable permeability of the clay materials underlying the site, groundwater flow modelling is extremely complex. A general trend in a north-easterly direction has been observed. Risk analysis suggested there was a possibility that potentially contaminated residual ground waters may form spring lines with a flow direction towards the lower site areas adjacent to the stream. For this reason, allowance was made for installation of a semi-permeable reactive clay barrier along the eastern boundary (approximately 80m to a depth of 9.5m) to intercept any such migrating water. The technique utilised modified clay, which is organiphillic so contaminants are removed by adsorbing to it (Figure 7). The effectiveness of the modified clay was trialled in laboratory treatability studies using samples taken from site. Construction precautions within the properties include; hydrocarbon vapour membranes within the floor slab construction, with well-ventilated sub floor voids; selection of suitably resistant pipes with respect to utility services and drainage.

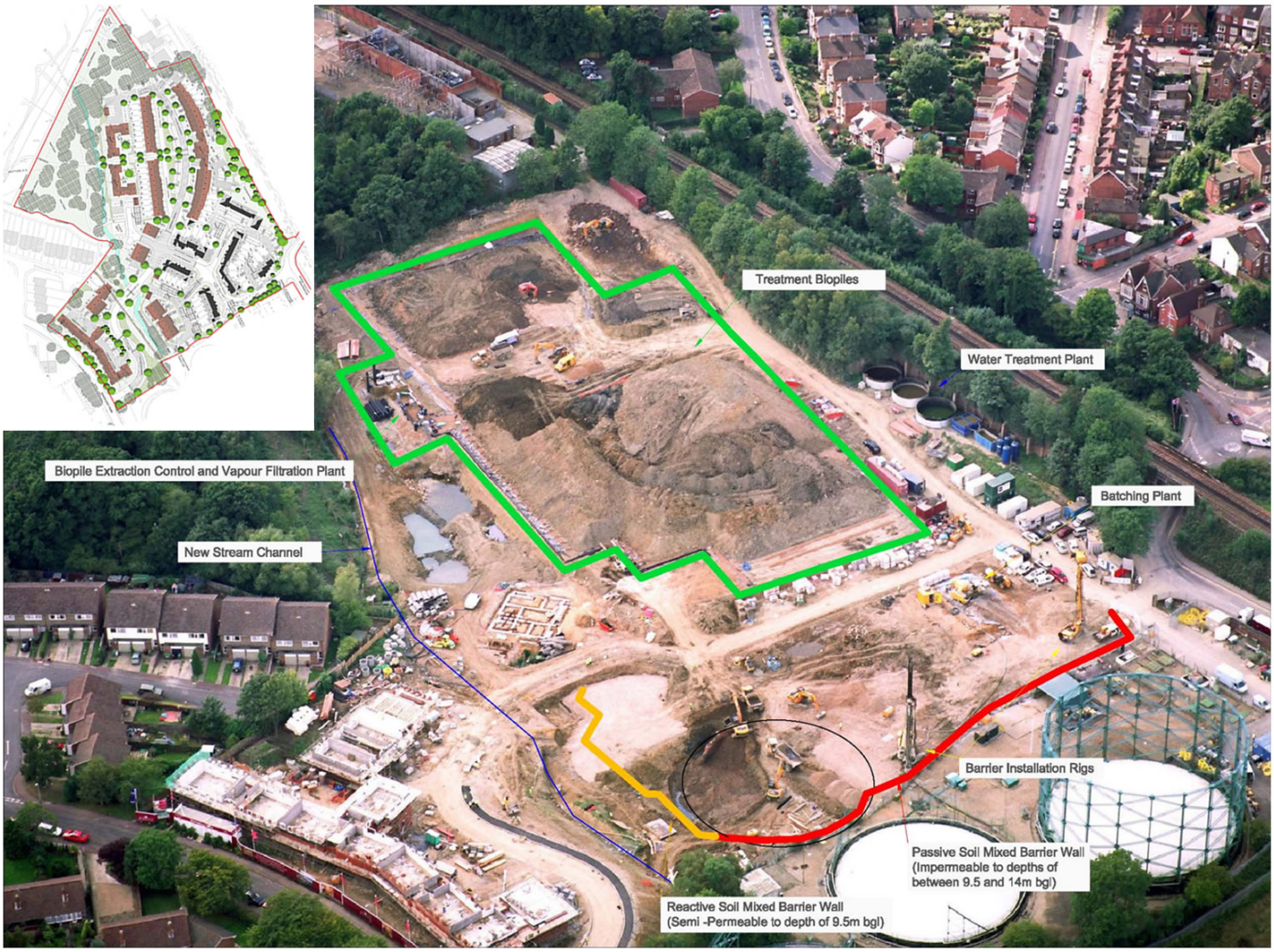

Figure 6 - Remediation in Summer 2005. Redevelopment to east within Phase 1 (Proposed Development Layout top left)

In addition, the new stream channel has been designed to incorporate a hydrocarbon resistant liner, puddle clay surround and erosion mat. An engineered site surfacing will be provided within all garden and open landscaped areas to provide positive drainage for infiltration in a fully clean environment.

Cost Effectiveness and Durability

Specialist remediation had the benefit that it was around one third of the cost of a dig and dump remediation scheme, in addition to significant environmental benefits previously mentioned. The fact that the contract was let on a re-measurement basis meant that a tight control was retained over the finical budget. The accuracy of the site characterisation was confirmed by the fact that the finished scheme fell within the £1.5 million budget. The flexibility of the Specialist Remediation Contractors involved allowed the groundwork element of their Contracts to be undertaken by the Developers own ground works Contractor (Landmark) which provided significant savings due to economies of scale as well as simplifying management and health and safety issues by reducing the number of Contractors simultaneously operating onsite.

BARRATT
Biogénie
MAY GURNEY
Southern Testing
Environmental & Geotechnical

Substantial water treatment infrastructure was established by Biogenie to deal with groundwater in excavations and with run off from their bio-piles. This treatment plant was also able to be used by the Developer during construction work in dewatering some of the lower water logged parts of the site and deeper excavations for weir box construction along the stream.

Sustainability

Biogenie successfully treated approximately 30,000m^3 of soil to meet strict validation criteria agreed with the EA and EHO for reuse onsite. The alternative to this scheme would have resulted in significant and unjustified additional loading on landfill and some 4,000 unnecessary lorry movements through the local area and beyond to remove and reinstate soils. Less than 300 tonnes of identified contaminated soils, which were mainly cyanide-impacted and not treatable, were segregated and disposed of at landfill.

Reduction of Pollution

An exceptionally contaminated site, which was unusable and a blight to the surrounding area, was successfully remediated using sustainable methods to provide an aesthetically pleasing addition to the local community. These work were carried out within a very commercially driven timeframe, with the treatment times being on average of 16 weeks. The treatment achieved significant pollution reduction with for example PAH contamination reduced by 90% and TPH by 82%.

Health and Safety

There were significant Health and Safety benefits to the scheme (such as reduced lorry movements, controlled excavations multidisciplinary contractors, highly trained site staff etc) There were also however significant complications presented by the build programme (not least in the number of simultaneous operations on site). These were very competently addresses at the design stage and any issues solved by the very close working relationship of those involved.

Further complications were represented by the presence of several live gas and electric mains along the site boundary with the holder station to the north and excavations in close proximity to the railway line to the east. These issues were overcome in close consultation with Transco and Network Rail. In some areas these negotiations have enabled the works to be within 1.5m of live high-pressure gas mains for example. The added advantage of the way the scheme was that the Developer was present onsite throughout and was thus able to be Principle Contractor during the remediation and construction.

Validation and Monitoring

Biogenie were responsible for monitoring of the bio piles during treatment to ensure that optimum conditions were maintained and for validation sampling of all treat materials to meet agreed criteria for reuse on site. Southern Testing undertook and extensive sampling and validation exercise to demonstrate identified zones of contaminants were appropriately excavated for treatment. All target criteria were successfully achieved.

The in ground barriers have now been in operation for nearly 10 months. Ground water monitoring wells located on either side, along the length of the barriers, are indicating the system to be operating within the design criteria.

Figure 5 – Schematic Ex-situ Biopile

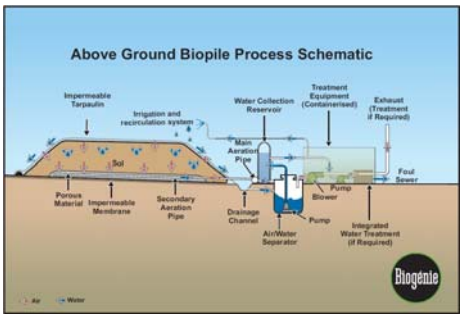

Figure 6 - Bio-Pile Collector Pipework

Figure 7 - Reactive Barrier Wall Installation

Figure 8 – Phase 2a Complete. Barrier wall beneath footpath and new stream channel

BARRATT

Biogénie

MAY GURNEY

Southern Testing
Environmental & Geotechnical