TDP 2 - Remediation of Basford Gasworks using Soil Washing

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Soil washing plant

Executive Summary

The former Basford Gas Works owned by SecondSite Property Holdings Ltd (now National Grid Property Holdings Ltd) is located to the northwest of Nottingham City Centre. It operated from 1854 until 1972. The site was decommissioned and was remediated in 1997 using soil washing technology as one element of a larger integrated remediation programme of soil recovery and re-use.

The main contaminant at the site was coal tar, which occurred at depths ranging from 1.5 m to 9.5 m below ground surface within the made ground and the underlying natural ground beneath the site.

A risk based process was used to develop the remediation strategy for the site, utilising a source - pathway - receptor analysis. The site specific risk assessment process identified polynuclear aromatic hydrocarbons (PAHs), phenolics, ammonia and complex cyanides as the main drivers for remediation. Risk based remediation standards for a range of contaminants were agreed with the local authority and Environment Agency and these formed the target concentrations to be achieved by the soil washing plant. Other values were selected from published guidance and experience at similar sites.

The first stage of the waste minimisation process was to identify clean material on site; ensure that any significant contamination hotspots had not been missed; and provide detailed particle size information for the soil washing process. To achieve this, a further investigation of the site, primarily trial pitting, was conducted on a 10 m x 10 m sampling grid.

From the trial pit data, and the geotechnical and chemical test results, a model was created detailing the spatial distribution of the different ground material types. This was used to create a "distribution of materials drawing" upon which the subsequent excavation was based.

Based on the model and drawing, material was selectively excavated and treated by appropriate methods using the following techniques:

- Selective digging
- Conventional dry screening
- Crushing
- Ash recovery
- Tarmac recovery
- Manual picking
- Soil washing
- Offsite removal

Based on the results of the field characterisation, the site was classified *in situ* into 10 categories of material types and a ground model was created detailing distribution of the different material types. Material was then selectively excavated and treated by the

appropriate method.
A laboratory-scale treatability study was initially commissioned to assess whether soil washing was a viable treatment technology for the site. This included a pilot trial to select and scale the most appropriate unit processes for a full scale integrated plant and to allow the soil washing contractor to assess the technical and financial risks and thus arrive at unit costs for the process.

During remediation 277,748 tonnes of contaminated soil were excavated. Of that, approximately 161,650 tonnes of material were supplied to the soil washing plant. 152,042 tonnes passed the oversize screen and entered the plant and the remaining 9,608 tonnes were rejected. Approximately 36,698 tonnes were screened and crushed, 78,908 tonnes were consigned to offsite landfill, and 4,740 tonnes of tarmac and 6,744 tonnes of ash breeze were removed for offsite recycling. Approximately 81,402 tonnes of clean fill was imported to site and the site was restored to the original ground levels.

The material that entered the soil washing plant produced 125,761 tonnes of clean material (sand and gravel fractions) and 32,240 tonnes of contaminated filter cake. The average daily production was 370 tonnes of clean output. Of the material processed as clean, 99 % was successfully cleaned in the first pass to a level below the site limits. The plant operated under all weather conditions. During the winter period pipes were drained on cold nights to prevent freezing. The soil washing plant was relatively quiet particularly compared to other site operations such as concrete breaking.

The degree of contamination of the filter cake was typically three times the input contaminant concentration. The consistency of the cake varied from a soft clay to a slurry and required the blending in of more than 15,000 tonnes of excavated contaminated soil to stabilise it to a degree where it could be landfilled off-site.

The cost of soil washing 152,042 tonnes of material to produce 125,761 tonnes of clean and 32,240 tonnes of contaminated material was £21.11/tonne excluding screening of the feed and £20.43/tonne including screening the feed. The screening process was not included as part of the soil washing process and was costed as a separate item.

The on-site processing scheme saved over 14,500 lorry movements compared to the traditional dig and dump approach, a significant benefit to the local community over the lifetime of the project. The net environmental benefit consisted of the avoidance of 700,000 miles of transportation, a resultant saving of approximately 86,000 gallons of diesel fuel and the corresponding reduction in associated exhaust gas emissions.

The process used to remediate the site resulted in the recovery for re-use of approximately 76 % of the excavated material compared with only 11 % using traditional site characterisation and remedial methods, and represents a substantial saving in landfill space and primary aggregate production.

The application of soil washing resulted in a reduction in energy usage over traditional dig and dump. In this case, the difference is mostly due to the relative energy consumptions of the on-site processing plant compared to road haulage.

The results demonstrated that soil washing technology is capable of treating a wide range of granular made ground and natural soil types contaminated with gasworks processing wastes.

One of the main factors governing the economic viability of soil washing is the amount and moisture content of the contaminated fines fraction and their associated disposal cost. A method for treatment of the fines which would either render them suitable for re-use on the site or acceptable to the landfill operator would significantly improve the economic viability of soil washing.

Early involvement of the regulator is beneficial in identifying and addressing issues at an early stage. Reaching agreement on ground clean up specifications and the methodology to be employed is crucial. The team managing and progressing the remediation project should communicate information to the regulator at every stage. Delays due to poor communication can be expensive.

Significant contaminant losses can occur even before treatment through volatilisation during material

Clean coarse output from soil washing plant containing natural and made ground.

handling activities such as excavation, sorting, stockpiling and moving. This should be taken into account during the planning of the trial or full scale cleanup, and every attempt should be made to minimise the handling and disturbance of contaminated material.

Occupational hygiene considerations for the full scale remedial operation are not trivial and should be considered carefully. Work involving hand digging at the site should be avoided if at all possible and should only be allowed if alternative means cannot be used.

This project only proved to be economic due to the relatively large quantities of material requiring treatment. Due to the high mobilisation costs associated with most *ex situ* treatment processes, it is unlikely that many projects will be cost effective where there are relatively small volumes of material requiring treatment. One possible solution is to establish 'semi-mobile' processing plant which can sit on a central hub site and process materials from other sites within an economic radius for transport before moving on to another location. Another is to erect a fixed treatment plant at the edge of an operating landfill. However, there are clearly regulatory issues which need to be addressed before this can happen.

The need for pilot studies remains one of the major barriers to the introduction of many remediation technologies to the UK market. Site owners are faced with the prospect of either adopting, with a high degree of confidence, the conventional disposal to landfill approach or having to invest in further site investigation and pilot studies to prove the viability of a proposed technology. Obviously, if this additional work subsequently shows that the technology is not suitable, the investment has been wasted. The scale of the pilot study is also important as larger scale tests provide more confidence.

These problems are exacerbated when more than one process technology is proposed, as integration becomes a key issue and the need for multiple licenses approved by the regulator impacts the economics.

The use of simple lab tests such as size/contaminant distribution can give a very useful first indication as to whether or not soil washing is potentially applicable. If these look promising then further lab tests to remove specific mineral/material types - e.g. sink/float tests can be conducted. Though as has been found in this study, it is not just the ability to separate the contaminants to specific fractions that determines applicability, the optimisation of dewatering and filtration of the fines is also a key cost driver.

There was no contractual agreement for properly controlling the physical quality of the filter cake. In some instances this led to difficulties in storage and transport of the cake and, in extreme cases, problems with the designated landfill site's ability to accept it. In future projects, it is therefore recommended that the physical properties of the cake be defined at the outset from laboratory and pilot scale trials.

Fines dewatering and subsequent filter cake disposal remain a concern and were perhaps the subject of more discussion during the project than any other single issue. It is predicted that disposal of filter cake will become more problematic as the European Landfill Directive is introduced as such materials are likely to fail the waste acceptance criteria (WAC). It is recommended that further research is conducted into stabilisation and/or treatment of filter cake.

Quality of product was generally very high, with 99 % of all batches achieving the specified remediation target. Experience on this project has shown that where soluble contamination (such as phenolics) is present in significant quantities, it may be prudent to include an additional 'rinse' step to remove entrained, contaminated water.

Conclusions

1. The results have demonstrated that soil washing technology is capable of treating a wide range of granular made ground and natural soil types contaminated with gasworks processing wastes.

2. This project has shown that one of the main factors governing the economic viability of soil washing is the amount and moisture content of the contaminated fines fraction and the associated disposal cost. In the extreme it is possible that a landfill operator would refuse to take such fines on the grounds of geotechnical properties alone (or at least charge a premium to take them). A method for treatment of the fines which would either render them suitable for re-use on the site or more acceptable to the landfill operator would significantly improve the economic viability of soil washing. Processes currently under consideration include solvent washing and chemical stabilisation. Pilot tests of the solvent washing process were encouraging and demonstrated that treatment targets could be attained, however, the overall economic viability is uncertain at this time.

3. Due to the high mobilisation costs associated with most *ex situ* treatment processes, it is unlikely that many will be cost effective on projects where there are relatively small volumes of material requiring treatment. One possible solution would be to establish 'semi-mobile' processing plant, which can set up at a central hub site to process materials from other sites within an economic transport radius before moving on to another location. Another would be to erect a fixed treatment plant at the edge of an operating landfill. However, there are clearly regulatory issues which need to be addressed before this can happen, perhaps the most significant of which is the interpretation of when the treated material ceases to be classified as a waste.

4. The need for pilot studies remains one of the major barriers to the introduction of many remediation technologies to the UK market. Site owners are faced with the prospect of either adopting, with a high degree of confidence, the conventional disposal to landfill approach or having to invest in further site investigation and pilot studies to prove the viability of a proposed technology. Obviously, if this additional work subsequently shows that the technology is not suitable, the investment has been wasted. Since, at present, there is little perceived difference between off-site disposal costs and on-site treatment costs in many cases, it is difficult to justify the financial risk in embarking on a project which might have to be aborted. The scale of the pilot study is also important, as larger scale tests provide more confidence. However, this also increases the financial risk and, in the case of Basford, one of the originally short listed technology vendors was rejected due to the excessively high cost and scale of the proposed pilot study. To a certain extent these are issues which have to be addressed by the technology vendors in structuring payment terms for pilot studies which, if successful would lead to full scale implementation.

5. The use of a novel remediation method on this site has been very well received by a wide range of interested parties from the local residents, who have seen a key site regenerated in a manner which has minimised traffic movements, to the Environment Agency and Environmental Health Department both of whom have been supportive of the approach adopted.

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