

includes the proposed site for GH8, indicates that this area was classified as having a low to moderate/low risk of encountering UXO.

3 Earthworks

3.1 Extent of earthworks

The proposed earthworks are summarised below and shown in drawings provided in Appendix C:

- Reduce site levels to 24.5mAOD on the western side and to 25mAOD in the east. A 500mm piling mat will be installed on the western side to accommodate the piling rig.
- Sheet piles will be installed around the outer face of the ring beam perimeter, which will be a maximum of 400mm off the outer face of the ring beam to accommodate shuttering.
- Excavation of the ring beam footprint; a 1.5m working space within the inner face of the ring beam and the extended working area and 1:1 batter up to 25mAOD follow.
- Cut internal levels of the plot N2 to 24.7mAOD to accommodate hard landscaping.
- Cut external levels around plot N2 down to 25mAOD in the north and tapered down to 23.5mAOD at the canal side.

3.2 Cut and fill quantities and types

As outlined above, the enabling works for the relocation of GH8 include: site strip; sheet pile installation; ring beam construction; excavation of a working area and battering. The soil material that will arise as a result of the proposed works will comprise Made Ground and some London Clay.

Made Ground was encountered in all investigation locations positioned within the site application border.

An estimation of the earthworks cut volumes is provided in Table 3 below. The volumes have been estimated based on the potential excavation to accommodate future landscaping.

Table 3 Estimation of earthworks cut volumes ('in ground' volumes)

Earthworks Phases	Approximate volume (m³)	Material type
Site strip (including an area of triplet strip in N1)	5,110	Made Ground
Gasholder No 8 Re-erection - Proposed earthworks: Sheet piled	3,647	Made Ground and London Clay
Gasholder No 8 Re-erection – Trim down to accommodate future landscaping based on proposed handover finished levels (total volume 1140m³)	416	Un-remediated soil
	724	Piling platform
Notes: • Volumes were calculated by BAM Nuttall Limited • Estimated volumes do not include for material bulking. It should be noted that bulking of earthworks can vary significantly, often between 5% – 30% of the excavated volume.		

A piling mat will be installed on the western side of the site. The fill volume for this is provided below in Table 4.

Table 4 Estimation of earthworks fill volumes ('in ground' volumes)

Description	Approximate volume (m³)	Material type
Install 500mm piling mat in western side of the site	1,160	Piling mat, crushed fill
Notes: Volumes were calculated by BAM Nuttall Limited		

The result of the works is an estimated maximum unbulked surplus volume of 9897m³.

The number of lorry movements required to move this material off-site is estimated to be approximately 1164. This figure is based on 8.5m³ loads of material (as per Appendix 16A of the ES).

3.3 Suitable material

3.3.1 Definition

Suitable material is defined as excavated material that, by its chemical and physical properties, is suitable for use in the development.

Engineering fill material is defined as material that is suitable for fill to structures or for application within carriageways, pedestrian pavements and hard landscape areas. However moisture content (which varies given the weather) will govern whether the material can be reused. The following Specification for Highway Works classifications will be used for suitable engineering fill.

- general fill: Class 1 or Class 2 (none required for development on this site);
- capping: Class 6F or 7F; and
- sub-base: Type 1.

3.3.2 Re-use of existing material

During excavation, some materials may be suitable for re-use in other areas of the KXC site, subject to validation testing to confirm chemical and geotechnical suitability. If suitable and required, materials will be reused.

3.4 Unsuitable material

3.4.1 Definition

Unsuitable excavated material is defined as material that is unsuitable for use in the development and must be removed from site to a suitably licensed landfill, or off-site treatment centre.

3.4.2 Classification

Unsuitable material will be categorised as Classes U1A, U1B or U2 in accordance with Specification for Highway Works. Unsuitable materials which may arise could include:

- soft cohesive material;
- contamination encountered during the works, which will be temporarily stockpiled on plastic sheeting (type to be determined by the contractor) and covered on site for testing prior to identifying the appropriate strategy for dealing with the material;
- Made Ground with unsuitable engineering properties (eg high fines content, high moisture content, significant quantities of organic matter); or
- other unsuitable materials designated as such due to non-compliance with particular engineering fill parameters for either pavements or landscape areas.

3.5 Materials handling

3.5.1 Stockpiling

The anticipated volume of excavation arisings to be removed from site (Table 4) reflects the likely maximum volumes of materials to be removed from site.

To the extent that later projects may require fill, spoil from the area designated for the relocation of GH8 may be stockpiled for re-use elsewhere on the KXC development area. Any stockpiling undertaken at an approved designated area within the wider KXC site will be based on material type. Temporary stockpiles will be placed on plastic sheeting or on hard standing areas, whilst classification testing is undertaken. Measures will be taken to restrict dust and surface water run-off from the temporary stockpiling in order to reduce the potential for contaminant migration and dust generation.

The classification of Made Ground soils for off-site disposal or treatment/recovery will be based on the ground investigation testing of samples from the recent ground investigation (see Section 2.2.2).

3.5.2 Treatment

If required, the pre-treatment of soils prior to transfer to a licensed landfill or soil recycling site, or re-use elsewhere, will be undertaken where practicable. Treatment may be undertaken within the wider KXC site where possible, or at an off-site treatment facility. It is a legal requirement to treat waste before disposal.

3.6 Drainage

Resting groundwater levels in the London Clay are below the maximum likely depth of excavation (about 3m). However, there is a potential for perched water to be present in Made Ground, particularly at 'low spots' in the surface of the underlying London Clay occurring either naturally or where previous structures or services have been present.

Excavations will be kept free of standing water in order to minimise the health and safety risk and minimise access difficulties. Where practicable, this will be achieved by use of a localised drainage sump and pump discharging to the existing combined sewer under the agreed discharge consent with Thames Water.

4 Remediation

4.1 Approach

This approach discussed in this ERP is in accordance with the remediation strategy set out in Volume 4, Part 16 of the ES.

A conceptual model (CM) has been established from field observations, investigation data and details of the works. The CM has been used to develop a source-pathway-receptor (SPR) model of the site, which in turn has been used to identify the plausible pollutant linkages (PPL) during construction and remaining following the re-erection of GH8. The outline requirements for remediation measures associated with the PPLs have then been considered.

4.2 Conceptual model

4.2.1 Introduction

The CM identifies the sources of potential contamination and the behaviour of the contamination in environmental media such as soils, groundwater, surface water and air. In accordance with the UK approach to contaminated land assessment and in line with the ES (paragraph 16.6.9), the potential human health and environmental risks after development have been considered in the context of a SPR model of the site. This characterises the potential sources of contamination and their potential pathways to the key receptors during the construction and operational phases of GH8. The SPR model is then used to identify PPLs which themselves inform the requirements for mitigation and remediation.

4.2.2 Potential Sources

Potential sources of historical contamination in the wider area and including the current site were reported in paragraphs 16.4.21 and 16.4.27 of the ES and are detailed below:

- **Railway lands:** Historical land raising of site levels, using material containing ash, clinker and slag has the potential to have increased levels of metals, sulphates and other inorganic in the soils. There is also a potential for asbestos containing materials to be found in these areas. Potential spills and leaks of hydrocarbons from rail use.
- **Diesel Depot:** Potential diesel contamination of the Made Ground down to the Made Ground/London Clay boundary, within the former diesel depot area. Significant diesel contamination was identified (off-site) in this area. Slight metal (arsenic, mercury, lead and selenium) contamination within ashy sand was also reported. Perched groundwater within Made Ground including diesel and moderate PAH contamination with free phase hydrocarbon contamination was identified (off-site) within an embankment. Slightly elevated concentrations of TPH, lead and benzo[a]pyrene (on-site) were recorded in five locations generally in the area of the former diesel depot as discussed in Section 2.2.2.

- **Outside former Diesel Depot:** Contamination limited to metals (copper, lead and zinc) and occasionally arsenic in black ashy sand layer of the Made Ground at slightly elevated concentrations. All materials tested were reported to have low leaching potential. Isolated, localised hydrocarbon spills were observed. Perched water included localised contamination by metals (chromium, lead, nickel and selenium) and significant localised diesel range organics contamination.
- **Former basin (Off-site):** Contamination arising from uncertified backfill (if any) to the remnant foundations of the former basin shown off-site to the east of the site boundary. It is possible that this may include various contaminants including asbestos containing material. Recent investigations did not include this area.

4.2.3 Potential Receptors

The potential receptors are as follows:

- Construction workers and neighbours during development;
- Future site users after development (which includes local residents and children who will eventually use the future park/open space);
- Maintenance workers after development;
- Trees and perennial plants, shrubs and hedges within soft landscaped areas (excluding tree pits);
- Landscaping building materials and services; and
- Controlled waters during and after development (ie groundwater and surface water in the Regent’s Canal).

4.2.4 Potential Pathways

Potential pathways comprise:

- Direct contact through human ingestion, inhalation and dermal contact.
- Migration of ground gas and hydrocarbon vapours into confined spaces.
- Lateral and vertical migration of perched groundwater.
- Surface overland flow.
- Uptake of phytotoxic contaminants by plants.

4.2.5 Plausible Pollutant Linkages

From the sources, pathways and receptors identified above, the possible SPR linkages for the future development are identified in Table 5 below.

Table 5 Plausible SPR linkages for completed public space development

Sources	Pathways	Receptors	PPL?
Potentially contaminated Made Ground and	Ingestion, dermal contact or inhalation of dust/ vapours.	On site Construction workers during	YES (prior to mitigation) There is a PPL between Made Ground and construction and maintenance who have the potential to come into direct contact with

Sources	Pathways	Receptors	PPL?
perched water		construction.	Made Ground materials.
	Inhalation of dust.	Off site Site neighbours during construction.	YES (prior to mitigation) There is a PPL between Made Ground and site neighbours who have the potential to inhale dusts during construction.
	Ingestion or dermal contact.	Users of the development during the operational stage (future site users, maintenance workers and gardeners).	YES Users of the development may come into contact with potentially contaminated Made Ground below the soil in some areas.
	Inhalation of vapour/ground gas	Users of the development during the operational stage.	NO There will be no above ground enclosed spaces where ground gases have the potential to accumulate.
	Vertical and lateral leaching, infiltration and dispersion.	Controlled waters.	NO The underlying London Clay is classified as a non-aquifer (unproductive strata) and acts as a hydraulic barrier to the underlying secondary and principal aquifers. The proposed works do not include penetration of the clay. Perched water has been identified in exploratory holes located on the site, however there is no pathway between potentially contaminated soils and the surface waters contained the canal. The water in the canal is contained by a combination of a canal wall and a liner which provides a physical barrier.
	Uptake of phytotoxic contaminants	Trees and perennial plants, shrubs and hedges	YES If trees and plants are be planted into existing in-situ Made Ground, instead of imported certified fill, there is a potential for uptake of contamination
	Direct contact with contamination	Building materials and services.	YES There is a potential for foundations and services to be impacted by contact with aggressive ground conditions, such as elevated sulphate and hydrocarbon concentrations which may remain in the existing in-situ Made Ground.

During the construction phase, appropriate mitigation measures to prevent risk of harm to human health and risk of pollution of controlled waters will be implemented as detailed in the ES (paragraph 16.6.10) and in the CoCP.

4.3 Remediation strategy

The site-wide remediation strategy for the KXC development is described within Volume 4 Part 16 of the ES (paragraphs 16.6.7 to 16.6.9). Paragraph 16.6.8 addresses the strategy for various sub-areas within the development site which for the area designation for the relocation of GH8 is:

- Use of capillary break layer in soft landscaping;
- Inert backfill for services trenches;
- Removal of hotspots of metals; and
- Excavate and treat on site material with high hydrocarbon/PAH content using bioremediation (including perched water).

This ERP has considered all the available ground investigation information from 22 exploration locations within the site application boundary. The results of the ground investigations have indicated that significant widespread contaminated ground is not expected to be present or encountered during the earthworks for the proposed re-erection of GH8. Hydrocarbon impacted Made Ground is locally present, generally in the western portion of the site, elevated concentrations of TPH and Benzo[a]pyrene found in three boreholes (TPE6, BH4 and TPC3). The south eastern portion of the site, to the east of the location where the gas holder will be erected, was not included in the recent investigation.

Asbestos has been identified in two samples at low concentrations (0.005%) of free fibres. There is a potential for further asbestos to be encountered during excavations. There are currently no national guidelines, survey standards or methods of assessing asbestos in soils and rubble. There are currently a number of initiatives taking place in the industry (CIRIA, EIC and CL:AIRE) to develop technical guidelines and client advice. The CIRIA project guidance is due to be published later this year. In addition the Health and Safety Executive (HSE) is reviewing the asbestos code of practices and will be revising HSG248 which we understand will incorporate more guidance on asbestos in soil. The HSE have recently confirmed that asbestos in soils are regulated by the Control of Asbestos Regulations 2012. Many of the protective principles, including the risk based management of hazards, are relevant to soils. There is therefore a legal duty for the identification and management of asbestos in soils and the use of competent (and in some cases licensed) organisations to undertake works of this nature.

The works shall be undertaken in a fashion to *prevent* the creation of dusts (the principal method of exposure). Sufficient wetting procedures shall be in place and dust prevention should be proactive. Boundary and representative personnel air/dust monitoring should be considered to demonstrate the effectiveness of the mitigation during work with Made Ground and to confirm the absence of fibre release and exposure during the works. Sufficient hygiene and protective measures shall be provided for works with Made Ground. Suitably competent personnel shall advise on and supervise the works and all staff should be briefed on the working methods. The works will require an assessment to consider whether it is necessary to notify the HSE and whether licensed sub-contractors are required. Stockpiles should be controlled in a similar fashion.

In view of the results, no further specific additional remediation measures (such as excavation beyond the limits proposed for construction, or specific on-site treatment) are considered as likely to be necessary. Historic results from the diesel

depot identified the potential to encounter free product associated with the diesel depot although none was reported during the recent site specific investigation. One historic on-site result was sufficiently high to suggest it might represent free hydrocarbon product. The limits of proposed excavation include the removal of the majority of the Made Ground within the GH8 re-erection area. Based on the excavation volumes marked on the sequence drawings presented in Appendix C a layer of Made Ground will be left in-situ surrounding the GH8 area. If free product is encountered, or obviously contaminated oily water, consideration shall be given to localised pumping and treatment.

In accordance with the requirements of the ES discussed above it will be necessary to provide a break layer or additional clean fill in areas of landscaping to protect future users and plants.

Notwithstanding the site investigation information, it is possible that other localised areas of contamination may exist at the site below and beyond the planned limits of excavation. Therefore a contamination watching brief will be maintained during the works for unsuitable or unexpected conditions and to ensure the various recommendations provided are implemented and recorded. If previously unidentified areas of potential contamination (such as hydrocarbon impacted soils) are encountered during the works, they will be dealt with in line with paragraph 16.6.9 of the ES. Soil will either be sampled in-situ in the ground (and left undisturbed while the samples are tested and the results interpreted) or be excavated and stockpiled separately in an appropriate manner. The Contaminated Land Officer at the Council will be informed if significant unexpected contamination is encountered.

Validation testing will be undertaken following remediation of any identified hotspots in line with Section 16.9 of the ES, the results of this validation testing to form the basis of a remediation plan report.

References

[1] AMEC Environment & Infrastructure UK Limited (2012), Gasholder 8 Reconstruction, Draft site investigation interpretive report.

[2] Ground Technology Services (2012), Kings Cross Gas Holder 8 Relocation SI, Factual Report.

[3] CL:AIRE (2011) The Definition of Waste: Development Industry Code of Practice