

Southwark Integrated Waste Management Facility

Old Kent Road, Bermondsey, London

Veolia ES Southwark

Environmental Statement

**Chapter 11
Hydrogeology & Ground Conditions**

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Figure 11.1: Geology of Site Location

Chapter 11 Appendices (See Volume 2)

Appendix 11.1: Crossfield Consulting Limited, Southwark Waste Project, Old Kent Road, London SE15, Site Investigation Reports, Volumes 1 – 4, for Fitzpatrick Contractors Limited

11 Hydrogeology & Ground Conditions

11.1 Introduction

- 11.1.1 This chapter assesses the hydrogeology and land contamination effects associated with the proposed development of an Integrated Waste Management Facility (IWMF) on land off Old Kent Road, Bermondsey, London, within the administrative boundary of Southwark Council.
- 11.1.2 Full details of the development proposed are presented in Chapter 4, which sets the basis against which the assessment has been conducted.
- 11.1.3 The assessment aims to determine whether the site is contaminated, and if so whether it may have an adverse impact on proposed development, human health or controlled waters. Geotechnical considerations relating to ground conditions are also assessed to determine the suitability of the site for proposed development.
- 11.1.4 As mentioned in Chapter 3, a planning application (ref. 08/CO/0044) has recently been submitted by Southwark Council for the site levelling and remediation works in preparation for the future IWMF.

11.2 Legislation and Planning Context

- 11.2.1 A detailed review of the development plan documents and planning context in relation to the development proposals is provided in Chapter 3.
- 11.2.2 This section summarises those policies that are directly relevant to hydrogeology and land contamination issues.

National Policy & Legislation

- 11.2.3 Contaminated land is addressed by the following National Policy and Legislation:-
- Environmental Protection Act 1990 Part IIA. A regime for the identification and remediation of contaminated land, implemented by the Local Authorities and the Environment Agency and is subject to statutory guidance.
 - Water Resources Act 1991. Section 85. Control of pollution of groundwater by land contamination through direct or indirect discharges. The Environment Agency will encourage the effective remedial measures to prevent pollution.
 - The Environment Act (1995) provides clarification of the roles for assessment, enforcement and remediation of contaminated land using the regulations summarised above.
 - Section 106 (S106) of the Town and Country Planning Act 1990 allows a local planning authority (LPA) to enter into a legally-binding agreement or planning obligation, with a land developer over a related issue.
 - The Environment Agency will seek to ensure that Planning Permission contains conditions designed to protect water resources.
 - Planning Policy Statement 23 (PPS23) 2004 – Planning and Pollution Control sets out the relationship between controls of development under planning law and pollution control legislation. It is relevant to industrial development and the redevelopment of contaminated land.
 - CLR 11 - The Model Procedures for the Management of Land Contamination, CLR 11, have been developed to provide the technical framework for applying a risk management process when dealing with land affected by contamination. The process involves identifying, making decisions on,

and taking appropriate action to deal with land contamination in a way that is consistent with government policies and legislation within the UK.

Regional Policy

The London Plan, Spatial Development Strategy for Greater London (Consolidated with Alterations since 2004), February 2008

- 11.2.4 The proposed development site falls within the administrative areas of the London Borough of Southwark. This plan sets out the regulatory framework for London and is reviewed in detail in Chapter 3.
- 11.2.5 Relevant policies from the London Plan with regard to contaminated land comprise:
- Policy 4.A.33: Bringing Contaminated Land into Beneficial Use.
 - Policy 4.A.3: Sustainable Design and Construction.
- 11.2.6 Waste management and disposal issues which have some relevance to contaminated land comprise:
- Policy 4.A.21: Waste Strategic Policy and Targets.
 - Policy 4.A.22: Spatial Policies for Waste Management.
 - Policy 4.A.23: Criteria for Selection of Sites for Waste Management and Disposal.

Local Policy

- 11.2.7 The Southwark Plan was adopted in July 2007. It provides a framework for all land use and development in Southwark. Please see Chapter 3 for a detailed review.
- 11.2.8 Relevant policies from the Southwark Plan with regard to contaminated land include:
- SP11: Amenity and Environmental Quality.
 - SP12: Pollution.
 - Policy 3.1: Environmental Effects.
 - Policy 3.9: Water.
 - Policy 3.10: Hazardous Substances.

11.3 Assessment Methodology

Relevant Guidance

- 11.3.1 Contaminated land occurs where historical land-management practices have led to the deliberate or accidental release or disposal of substances onto the land. These substances can pose a risk to humans, controlled waters, ecological systems, produce, livestock and buildings. "Contaminated land" is defined by section 78A(2) of Part IIA of the Environmental Protection Act 1990 as: "any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that:
- **Significant Harm** is being caused or there is a significant possibility of such harm being caused; or
 - **Pollution of Controlled Waters** is being, or is likely to be caused.
- 11.3.2 Within the current regulatory framework the determination of contaminated land uses a risk-based approach. Under the risk assessment procedure, for harm to the non-aquatic environment, or pollution of controlled waters to occur, there must be a 'pollutant linkage'. The linkage is based on the characterisation of the following:

- **Source** of contamination (Hazard)
- **Pathway** for the contaminant to move from source to receptor
- **Receptor** (target) which is affected by the contaminant. This includes human beings, ecology, controlled waters, physical systems and built structures, which could be affected by the hazard.

Consultations

11.3.3 As detailed in Chapter 1, a formal scoping exercise has been undertaken to inform the scope of the Environmental Assessment. The formal Scoping response is included at Appendix 1.2. The exercise highlighted the following issues relevant to hydrogeology and ground conditions:

- The Land Contamination assessment should include the use of a suitable ground risk assessment.

Methodology

Desk Study

11.3.4 The site conditions have been compiled from a number of sources relating to site setting, historical land use and geology. To establish the environmental setting an 'Envirocheck' report, which contains environmental information obtained from a number of consultees, was obtained and included as part of a site investigation report. The information collected was presented within a Site Investigation report by Crossfield Consulting Limited (CCL) issued in 2007, which is included in Appendix 11.1.

Fieldwork

11.3.5 Three previous ground investigations were undertaken at the site:

- Celtic Technologies Limited (CELTIC) in 2001 and 2005;
- CCL between 24th September and 16th October 2007.

11.3.6 The CCL investigation comprised the drilling of 13 no. cable percussion boreholes by J.B. Site Investigations Limited to depths of between 2.5 m and 22 mBGL (metres below ground level) between 24th September and 4th October 2007; the drilling of 35 no. dynamic sampling boreholes by Dynamic Sampling UK Limited to between 1.8 m and 4.5 mBGL between 24th September and 5th October 2007, and 10 no. static cone penetration tests by Fugro Engineering Services Limited to a maximum depth of 15.6 mBGL between 30th September and 1st October 2007.

11.3.7 As part of the CCL investigation, soil samples from boreholes were taken from representative near surface Made Ground and stained odorous natural materials, and where changes in strata were identified. These samples were collected in appropriate containers, and sent in cool boxes to Alcontrol Geochem, a UKAS accredited laboratory. Groundwater samples and depths to groundwater were taken on 15th to 16th October 2007 from boreholes standpipes BH1A, BH2 – BH8, BH10 – BH13 and from previous investigation borehole standpipes BH25, CBH04, CBH06, CBH08, CBH14.

Analysis

11.3.8 Chemical analysis was undertaken for a large number of soil samples and a number of groundwater samples obtained from boreholes during the CELTIC site investigations in 2001 and 2005, and during the CCL investigation in 2007. This comprised analysis of inorganic determinands, phenols, total petroleum hydrocarbons (aromatic / aliphatic split with carbon number banding), volatile organic compounds, and polyaromatic hydrocarbons.

11.3.9 Geotechnical testing was undertaken for a large number of soil samples obtained from the CCL investigation. Testing was undertaken for moisture content, atterberg limits, pH value, water soluble sulphate and organic content.

Cumulative Impacts

- 11.3.10 No proposed new developments have been identified that have the potential to impact cumulatively with the proposal.

11.4 Baseline Conditions

- 11.4.1 The existing site conditions were confirmed through the desk based study and site investigation report attached at Appendix 11.1, and previous site investigations undertaken at the site described in Section 11.3.4.
- 11.4.2 The information sources used to determine environmental conditions, site sensitivity and site use (current and historical) are detailed below:
- Landmark Envirocheck Report. 31st August 2007. Reference number: 22642931_1_1;
 - Environmental Agency (EA) Groundwater Vulnerability Map Sheet 40 'Thames Estuary';
 - Ordnance Survey (OS) Landranger Sheet 177 'East London', 1:50,000;
 - BGS Geological Map, Sheet 270 'South London', 1:50,000;
 - British Standards Institutions (BSI). 1999. BS5930:1999 – Code for practice for site investigations;
 - BSI. 2001. BS10175:2001 – Investigation of potentially contaminated sites – Code of Practice;
 - EA website for Flood Map and Source Protection Zones (SPZs) – <http://www.environment-agency.gov.uk/maps>;
 - London Borough of Southwark, Parc de Bercy Geo-environmental Site Investigation Interpretative Report, Ove Arup and Partners Ltd, July 2007.
- 11.4.3 It should be noted however that the remediation and leveling works associated with the construction of the proposed IWMF is subject to a separate planning application recently submitted by Southwark Council (ref. 08/CO/0044). Therefore, it is anticipated that the baseline conditions that will prevail at the time the proposed development commences is that of a remediated site suitable for the construction and operation of the IWMF.

Site Description

- 11.4.4 The site of the proposed development comprises the eastern part of the former gasworks site at the southern end of Old Kent Road, Bermondsey, London, within the administrative area of the London Borough at Southwark.
- 11.4.5 The site covers an area of 5.6 hectares forming part of a larger site of 11 hectares which was an operational gasworks from the 1890s to the 1960s. The site's immediate surrounding environment is mainly industrial with an electrical substation on its northern boundary.
- 11.4.6 The site lies within the River Thames defended flood plain.

Potential Sensitive Receptors

- 11.4.7 The closest sensitive receptors with regard to human health are blocks of apartments alongside Varcoe Road, Eagle Close and Gerrards Close, located at about 30 m to the north of the site. Another residential area is located 50 m to the southeast of the site, which includes a playground and primary school.
- 11.4.8 Potential sensitive receptors with regard to human health on site comprise site end users.
- 11.4.9 The closest receptors with regard to groundwater at the site are the underlying minor aquifer within superficial deposits and the more sensitive major aquifer within the Upper Chalk.

- 11.4.10 Off-site groundwater receptors comprise groundwater at the down hydraulic gradient site boundary where a potential pollutant linkage may occur from contamination at the site. There is potential for a pollutant linkage to the nearest groundwater abstraction located 401 m southeast of the site.
- 11.4.11 There are no surface water features in the vicinity of the site.

Historical Land Use

- 11.4.12 The site has historically been used as part of a gas works that, prior to this, was largely open land. Historical maps indicate gas storage tanks were located to the west of the site from 1896. The 1896 map indicates that the site was used for conveyors and tramways with an engine room in the north of the site, with warehouses in the south of the site being first identified on the 1931 map. The 1967 map shows that training and distribution buildings replaced the process buildings in the north of the site. The current site layout comprises the same basic layout with some additional small buildings and extensions.
- 11.4.13 The 1940 gas works plan from the CCL report indicates that the site was bombed during the war with several hits occurring on this land and surrounding gas works.
- 11.4.14 There are no current landfills within a 500 m radius of the site. There are two former landfills within a 500 m radius of the site. These are located at 63 m north of the site (Old Canal Filling, inert waste), and 223 m southeast of the site (Idleron Road).
- 11.4.15 There are no integrated pollution control authorisations recorded within 500 m from the site. There are three active local authority pollution prevention and control entries recorded within a 500 m radius of the site, the nearest being 112 m south of the site (petrol filling station).

Geology

- 11.4.16 The ground conditions described are based on the findings of the recent site investigations, most notably the CCL investigation in 2007, and the published geology of the area, which is illustrated in Figure 11.1.
- 11.4.17 Made Ground comprises soft to stiff, sandy, gravelly clays and loose to dense, locally clayey, gravelly sands and sandy gravels. Fragments of ash, brick and clinker were encountered within the sands and gravels, with brick, concrete, ash, clinker, coal and slag encountered within the clays. Made Ground encountered was generally less than 2 m in thickness with a maximum thickness of 4.1 m. It had a thickness of 2.9 m to 3.8 m in the raised southern section of the site.
- 11.4.18 Alluvium / Langley Silt deposits, underlying the Made Ground across the whole site, comprise soft to firm, orange brown, green brown, grey organic sands and clays with evidence of vegetation at shallow depth. At depth, these become soft to firm, locally firm to stiff, orange brown, sandy to very sandy clays and loose to medium dense, clayey to very clayey sands. These deposits were generally between 2 m and 4 m in thickness, with a maximum thickness of 7 m.
- 11.4.19 Kempton Park Gravels, underlying the Alluvium / Langley Silt deposits across the whole site, comprise medium to dense to dense gravelly sands and sandy gravels with occasional thin clay bands. These extended to a maximum depth of 11.7 m.
- 11.4.20 Thanet Sand, underlying the Kempton Park Gravel deposits across the whole site, comprise medium to very dense, grey silty sands and sandy clays / silts. The Thanet Sand was encountered at thicknesses of 4 m to 8 m, to depths of up to 20 mBGL.
- 11.4.21 Upper Chalk, underlying the Thanet Sand across the whole site, comprises white, gravelly clays / silts and clayey, silty gravels and cobbles including flint. These were present to depths of greater than 22 m, the maximum depth of the investigation.

Hydrogeology

- 11.4.22 The EA Groundwater Vulnerability map indicates two geological classifications at the site. The majority of the site is described as shown as a minor aquifer (variable permeable), which is described as fractured or

potentially fractured rocks, which do not have a high primary permeability or other formations of variable permeability including unconsolidated deposits. The minor aquifer comprises the Kempton Park Gravels and Thanet Sand formations. These aquifers are described as being important for local supplies and in supplying baseflow to rivers but do not produce large quantities of water.

- 11.4.23 The other EA groundwater vulnerability classification underlying the site is a major aquifer (highly permeable), the Upper Chalk, which is described as highly permeable formations usually with a known or probable presence of significant fracturing. These may be highly productive and able to support large abstractions for public water supply or other purposes. It is presumed that this major aquifer underlies the minor aquifer across the whole of the site due to the presence of the Chalk.
- 11.4.24 The Alluvium / Langley Silt is a low permeability formation, which is possibly an aquitard.
- 11.4.25 It is assumed that the Kempton Gravels, underlying Thanet Sands and Upper Chalk are in hydraulic continuity.
- 11.4.26 The EA Groundwater Vulnerability Map classifies the soils underlying the site as soils of high leaching potential. A worst case scenario is assumed due to classification as an urban area.
- 11.4.27 The EA indicates that the site does not lie within a Groundwater Protection Zone.
- 11.4.28 There are six recorded groundwater abstractions within 2 km from the site, the nearest being 401 m southeast of the site where groundwater is extracted for non-evaporative cooling process.
- 11.4.29 Groundwater has been encountered within Kempton Park Gravels during drilling operations as is described in the CCL site investigation report issued in 2007. Groundwater was monitored at depths of –1.85 m O.D in the northern part of the site to –2.15 m O.D in the southern site area. This indicated a groundwater flow direction to the southwest, with an approximate hydraulic gradient of 0.002 across the site. In situ rising head permeability tests undertaken in borehole standpipes installed with slotted section within Kempton Gravels measured a hydraulic conductivity of between 3.6×10^{-6} m/s and above 1×10^{-4} m/s. An interpolated groundwater contour plan can be found within the site investigation report in Appendix 11.1.
- 11.4.30 Groundwater was also encountered within the Upper Chalk during drilling operations as is described in the CCL site investigation report. Groundwater was monitored at depths of –1.80 m O.D in the northern part of the site to –2.6 m O.D in the southern section of the site. This indicated a groundwater flow direction to the southwest, with an approximate hydraulic gradient of 0.0032 across the site. In situ rising head permeability tests undertaken in borehole standpipes installed with slotted section within Upper Chalk strata measured a hydraulic conductivity of between 1.1×10^{-4} m/s and above 1×10^{-4} m/s. An interpolated groundwater contour plan can be found within the site investigation report in Appendix 11.1.
- 11.4.31 There are no pollution incidents register entries at the site. There are two entries recorded within 500 m of the site that are unrelated to the site.

Soil and Groundwater Contamination

- 11.4.32 Contamination has been encountered in soils within Made Ground as elevated concentrations of metals, petroleum hydrocarbons and polycyclic aromatic hydrocarbons were identified. No elevated concentrations of contaminants were identified in soils within underlying natural strata.
- 11.4.33 Contamination has been encountered within shallow and deep groundwater as elevated concentrations of metals and hydrocarbons were identified.

Ground Gases

- 11.4.34 Ground gas monitoring, undertaken at the site by Celtic Technologies Limited from boreholes between 2001 and 2005, detected no methane and no carbon dioxide across the majority of the site, although a maximum concentration of 5.1% was recorded on one occasion in one location.

Groundwater Risk Assessment

- 11.4.35 A groundwater risk assessment was undertaken as part of the CCL site investigation report issued in 2007.
- 11.4.36 Groundwater analytical data was screened against relevant environmental quality standards (EQS) in order to assess whether the concentration of a contaminant or chemical is present at an acceptable concentration in groundwater.
- 11.4.37 Soil analytical data obtained from the 2001 and 2005 CELTIC investigations and from the 2007 CCL investigation were used for comparison with Generic Assessment Criteria (GACs) derived from site specific risk assessments undertaken using Environment Agency R&D Publication 20 (EA P20) software, as is described further in Section 11.4.41.
- 11.4.38 The shallow groundwater analytical data obtained from CELTIC investigations undertaken from 2001 to 2005 was assessed separately to that obtained from the 2007 CCL investigation. The deep groundwater analytical data obtained from the 2005 CELTIC investigation and 2007 CCL investigation from boreholes installed within the Chalk was also independently assessed.
- 11.4.39 The shallow groundwater screening exercise undertaken for the 2001 and 2005 data showed general compliance with EQS although elevated concentrations of ammonia, zinc, mercury, tetrachloroethene, and polycyclic aromatic hydrocarbons were identified locally. The shallow groundwater screening exercise undertaken for the 2007 data also showed general compliance with EQS with elevated concentrations of ammonia, tetrachloroethene and polycyclic aromatic hydrocarbons identified locally.
- 11.4.40 The deep aquifer screening exercise undertaken for the 2005 data showed general compliance with EQS although there were elevated concentrations of ammonia, arsenic, zinc, benzene, tetrachloroethene and polycyclic aromatic hydrocarbons identified locally. The deep aquifer screening exercise for the 2007 data also showed general compliance with EQS with elevated concentrations of ammonia, arsenic, selenium, cyanide, benzene and polycyclic aromatic hydrocarbons identified locally.
- 11.4.41 Given that contaminant concentrations in groundwater measured across the site exceed the screening criteria and elevated contaminant concentrations in soil were identified, site-specific Level 1, 2 and 3 soil risk assessments and a Level 3 groundwater risk assessment were undertaken using EA P20 software to assess risk to groundwater at the southern site boundary (as is included in Appendix 11.1).
- 11.4.42 The Level 1, 2 and 3 soil risk assessments were undertaken for higher carbon range aromatic petroleum hydrocarbons, and polycyclic aromatic hydrocarbons (including naphthalene and benzo(a)pyrene). The Level 3 risk assessment for groundwater within the Kempton Gravels was undertaken for ammonia, mercury, zinc, tetrachloroethene and polycyclic aromatic hydrocarbons (including benzo(a)pyrene) while the Level 3 risk assessment for groundwater within the Chalk was undertaken for ammonia, arsenic, cyanide, selenium, zinc, benzene, tetrachloroethene, and polycyclic aromatic hydrocarbons (including benzo(a)pyrene).
- 11.4.43 The results of the soil risk assessments suggested that polycyclic aromatic hydrocarbons and aromatic petroleum hydrocarbons encountered in shallow soils underlying the site do not pose a risk to controlled waters.
- 11.4.44 The results of the groundwater risk assessments suggested that the majority of chemical contamination within groundwater is unlikely to migrate off site. Potential for migration off-site has been indicated for a number of metals and fluoranthene.
- 11.4.45 It was considered in the CCL report that there was no significant contaminant source within soils on the site that could impact underlying groundwater, and that the contaminated groundwater underlying the site is the result of an off-site source.
- 11.4.46 In the CCL report, remediation was not recommended at the site in order to reduce contaminant concentrations in groundwater as the contaminant source was considered likely to be off-site.

Human Health Risk Assessment

- 11.4.47 A detailed human health risk assessment was undertaken by CCL with the aim of identifying any potential risk to future users of the site in accordance with the current UK legislation. This can be found within the site investigation report presented in Appendix 11.1.
- 11.4.48 Soil data was screened against GACs for commercial / industrial use. This criteria comprised Soil Guideline Values (EA, 2002) and GACs produced by LQM (2006) as is stated in the CCL report. 1% soil organic matter was assumed for the GACs used for the 2001 and 2005 CELTIC investigation soil data with 5% soil organic matter assumed for the 2007 CCL investigation data.
- 11.4.49 A screening exercise of the CELTIC investigation soil data against the Generic Assessment Criteria showed general compliance with screening criteria although there were elevated concentrations of benzo(a)pyrene locally, and isolated elevated concentrations of lead and dibenzo(ah)anthracene. Screening of the 2007 CCL investigation soil data also showed general compliance with screening criteria although there were locally elevated concentrations of lead, aromatic petroleum hydrocarbon bands C21 – C35, naphthalene, benzo(a)pyrene and dibenzo(a)anthracene.
- 11.4.50 Due to the presence of elevated concentrations of petroleum and polyaromatic hydrocarbons within shallow soils, mitigation measures were recommended in the CCL report as a requirement to protect site end users. The overall risk post development to site end users was considered negligible. The report recommends that this comprises a barrier of clean topsoil (450 mm layer) in any soft landscaped areas above existing soils.

Limitations

- 11.4.51 The desk study is limited to an interpretation of the available information, which is subject to uncertainty in terms of the dates of acquisition and the suitability of the intrusive investigation. Nevertheless, it has been considered fit for purpose in delineating the environmental setting and sensitivity of the site.
- 11.4.52 The fieldwork undertaken, including the site walkover, was limited by the ground conditions on site.

Proposed Development

- 11.4.53 The proposed development of the site currently involves demolition of existing buildings on site followed by leveling the ground across the site through a bulk earthworks cut to fill operation. This should result in the north side of the site being raised by about 1.5m. Following this, buildings and roadways of the Southwark Integrated Waste Management facility are planned for construction.
- 11.4.54 The material within the southern and southwestern site area that is raised up to 3 m above the rest of the site is proposed for removal to level ground across the site. Potentially inert, non-hazardous and hazardous wastes may be present. Potential mitigation measures are detailed in Section 11.5.8.

11.5 Incorporated Enhancement and Mitigation

Construction Phase

Construction Areas and Storage of Materials

- 11.5.1 Areas of hardstanding, such as car parks and roads, which will be incorporated into the development, should reduce the migration of any hydrocarbon contaminants into the ground below the site and surface water collection drains can be used in conjunction with interceptors to collect runoff. This will help reduce potential contamination of land and groundwater.
- 11.5.2 Chemicals, oil and fuel used on the operational site should be stored in bunded structures. The bunds should be designed and constructed in accordance with the latest regulatory guidance. The bunds should have impermeable bases, which will mitigate impacts to soil and groundwater resulting from leakage.

- 11.5.3 Materials transported to site for processing should be subsequently contained within appropriately constructed structures with impermeable bases, which should mitigate impacts to soil and groundwater resulting from leakage.
- 11.5.4 Foundations and services should be designed and constructed to minimise the creation of pathways for the migration of contaminants. The method of design and construction should be determined following an assessment of the results of further site investigation to be undertaken at the detailed design stage. This will help to reduce the potential contamination of groundwater.

Waste Management

- 11.5.5 Contamination has been identified in shallow soils so therefore mitigation measures have been recommended to protect site end users. The CCL report recommended that a barrier of clean topsoil (450 mm layer) is laid in any soft landscaped areas above existing soils.
- 11.5.6 Due to the identified presence of contamination in hot spots across the site, site preparation works shall be undertaken comprising selective excavation across the site in these areas, with segregation being undertaken between clean and contaminated material.
- 11.5.7 Uncontaminated material or contaminated materials with concentrations below the relevant GACs derived in the CCL report should be re-used on site for site filling operations.
- 11.5.8 Site construction and preparation works should be undertaken in such a way as to prevent, contain or limit, as far as reasonably practical, any adverse impacts arising from the presence of any contamination material encountered, generated or stored during the construction activities. A series of measures, consistent with current industry best practice for construction on brownfield sites, will be implemented and include the following:
- If contaminated ground is encountered during the excavation and construction of the new works, then the contaminated material will be excavated and stored in designated areas. These will be covered, with provision made for capture and disposal of any generated leachate. Soil sampling of identified contamination should be undertaken and sent to a UKAS / MCERTS accredited laboratory for WAC testing. The material would then be taken to a suitably licensed facility, via a licensed haulier (or where practical and economically viable, treated prior to reuse).
 - Waste storage shall depend on type and classification of waste. Any waste storage containers (skips, bins) should be marked up clearly with covers / lids used to prevent escape. The waste should be minimised and segregated to allow for recycling.
 - Waste disposal should be undertaken by registered contractors with waste transfer notes being collected for all waste that leaves site. These transfer notes should be kept for a minimum of two years for inert / non hazardous waste. Duty of Care should be applied to all waste. Waste should be transferred to an authorised body of which appropriate licenses should be obtained and validated for disposal of specific waste. These licenses comprise Waste Carrier License, Waste Management License of Disposal Points, Pollution Prevention Control (PPC) permit, and waste management exemption where applicable.
 - If hazardous waste is identified the EA must be informed and it must be stored, controlled and disposed of by EA approved procedures. There must be no mixing with inert or non-hazardous waste. Consignment notes detailing properties of disposed hazardous waste should be obtained and kept for a minimum of three years.
 - If significant volumes of contaminated material are discovered then remediation may be considered on site so that the material can be reused.

Management of Groundwater

- 11.5.9 Groundwater may be encountered during the excavation works. Wherever possible any groundwater encountered should be sprayed over the existing ground to be allowed to soak away. However, if necessary, an application will be submitted for a temporary discharge consent from the EA to deal with any contaminated groundwater encountered during the construction of the works. Groundwater should be discharged off site in accordance with current best practice.

- 11.5.10 If a consent is obtained from the EA, the following procedures should be implemented:
- A UKAS / MCERTS accredited laboratory should be used to test any suspect groundwater to determine the level of contamination.
 - If no contamination is found then groundwater should be run through a series of settlement tanks to remove solids before disposal off site.

Operational Phase

Drainage Design

- 11.5.11 An overview of the proposed surface water drainage strategy can be found in Chapter 10. The requirement to restrict potential contamination migration through sub-soils and groundwater will be addressed as part of the detailed design following the grant of the planning permission.

Storage of Chemicals

- 11.5.12 The use of appropriate containment measures for all potentially hazardous chemicals used and stored on-site is included in the plant design. Such measures include:
- The use of suitably sized vessels constructed of suitable materials to withstand corrosion and leakage;
 - Containment bunds designed to retain the stored volumes within a controlled area prior to clean-up;
 - The careful and controlled movement of all hazardous chemicals from the point of origin or storage to the point of use within suitable vessels and with manually controlled cut off valves at the point of distribution.
 - Spill kits should accompany all hazardous chemicals in storage and transit.

11.6 Identification and Evaluation of Key Impacts

- 11.6.1 Specific impacts identified from the proposed development, taking into account the incorporated mitigation measures, occurring either during the construction or the operational phase of the development are discussed in the following sections.

Land Contamination

- 11.6.2 This section details the potential land contamination impacts of the development during the construction and operational phases. Mitigation measures to address these impacts are considered in later sections.

Construction Phase

- 11.6.3 During the construction phase, designated areas will be used for construction vehicles and for the storage of materials. Potential impacts anticipated include:
- Sediment generation and movement;
 - Surface water and groundwater pollution arising from the movement of contaminated soils, material stores and vehicle movements;
 - Accumulation of surface water or groundwater in excavations;
 - Loss of existing boreholes.
- 11.6.4 Additional runoff might be generated in small volume. It is considered that runoff may easily be accepted as infiltration by soils at the site.
- 11.6.5 Soil and dust particulate material, mobilised in surface water runoff, are typical contaminants released from earthworks activities. There is therefore the potential for movement down-gradient of contaminated sediment

generated from loose topsoil during the construction phase. The surface water runoff during the construction phase should be managed through a temporary drainage network strategy.

- 11.6.6 Disturbance of residual soil contamination during site construction may result in mobilisation of contaminants, adding to contamination already present in shallow groundwater beneath the site. Localised soil contamination and groundwater contamination sources were identified by the site investigation. The groundwater risk assessment considered that there was no significant contaminant soil source on site that could impact underlying groundwater. The potential for contamination migration as a result of a disturbance during construction is considered to be low given the nature of the site subsurface. However, migration of existing contamination identified by the investigation will persist.
- 11.6.7 Disturbance of the unsaturated zone is likely to have a limited impact on deep groundwater quality. However, deep excavations or pilings may open a preferential pathway for contamination. The magnitude of impact of foundation constructions, creating contamination pathways, is considered to be low to moderate due to reasonably high permeabilities associated with Kempton Gravels and underlying Chalk. It is considered that the impact could be of minor to moderate significance. Methods of piling to mitigate adverse impacts are discussed in Section 11.7.
- 11.6.8 There is a possibility of accidental spillage or leakage while chemicals and fuels are stored on the site. These materials may be carried by subsequent surface runoff and pollute surface water or infiltrate and pollute groundwater. The mitigation measures including in Section 11.7 are included to address this issue.
- 11.6.9 Mobilisation of contamination may also result from the removal of the any existing site drainage infrastructure, which may contain contaminated water and sediment. It is considered that the impact is of minor significance.
- 11.6.10 Water may accumulate in excavations due to presence of shallow sand, gravel and clay. The recent CCL investigation suggests that groundwater level were largely encountered below 4 mBGL. Therefore groundwater may be encountered in excavations within shallow sands, gravel and clay. A slight adverse impact will be generated for the removal and disposal of contaminated groundwater.
- 11.6.11 Existing boreholes on site may be damaged by vehicle movement or vandalism resulting in potential contamination of underlying aquifer. It is recommended that these are decommissioned in line with current EA guidance unless specific boreholes are required for monitoring post construction phase.

Operational Phase

- 11.6.12 The primary concerns resulting from the operation of the facility, are:
- A significant part of the site will be converted to an impermeable state, and so potentially reduce infiltration and generate surface runoff.
 - The structures required for the development may have a permanent impact on groundwater flow. However, these are anticipated to be low with the significance minor.
 - The management of the facility involves the storage of waste, chemicals and fuel. Contaminated water, liquids leaching from waste chemicals, oil or fuel stored on site have the potential to leak and enter the subsurface and controlled waters if poorly managed. Contaminated surface water runoff including areas of hardstanding is likely to have a low impact on the groundwater beneath the site.
 - Groundwater levels beneath the site may potentially change as a result of site development. Increased and improved hardstanding is likely to reduce infiltration and recharge of shallow groundwater. The impacts of changing groundwater are considered to be low and the significance minor.

Geotechnical / Engineering Conditions

Construction and Operation

- 11.6.13 This section details the potential geotechnical and engineering impacts of the development during the construction and operational phases. Mitigation measures need to address these impacts are considered in

later sections. It must be noted that the design plans for the project are in their early stages and require further detailed design and confirmation.

- 11.6.14 There is potential for underground obstructions at the site such as brick and concrete rubble within Made Ground. In addition, voids may be present, such as additional services or drainage runs, which may cause delays in works. The impact is considered to be low.
- 11.6.15 Site investigation works were undertaken in order to assess ground conditions, engineering properties, and suitability for the proposed development on site.
- 11.6.16 Site investigation works were undertaken in order to assess the ground conditions, engineering properties and suitability for the proposed development site. The geology of the site may impact the geotechnical aspects of the proposed development due to the thickness and nature of the alluvial soils and underlying gravels. Potential impacts are:
- Poor bearing capacity of the soft soils.
 - Potential heave on the basement from groundwater.
 - Low subgrade performance of hardstanding.
- 11.6.17 The magnitude of the geotechnical and engineering impact on the development is considered to be low to moderate and the significance minor to moderate.
- 11.6.18 Soil gas monitoring has indicated low carbon dioxide concentrations and no detected methane across the site. The gas flux was not recorded but due to the low gas concentrations the magnitude and risk are considered to be low.

11.7 Mitigation

Land Contamination

Construction

- 11.7.1 The construction phase could potentially uncover soil contamination not previously identified during site investigation works. Contaminants should be dealt with in accordance with a works method statement to be formulated and agreed with the regulatory authorities.
- 11.7.2 Mitigation measures can be implemented during construction of the proposed development to alleviate or limit the potential impacts. These include:
- Protective measures to prevent contaminated soil or groundwater from entering any of the watercourses in accordance with EA guidelines.
 - Localised soil contamination source zones and groundwater contamination sources were identified by the site investigation. A formalised remedial methodology should be developed in order to ensure the control and re use of materials across the site, detailing mitigation measures described in Section 11.5.8. This would be covered as part of the separate planning application for the remediation and site preparation works prior to the construction of the facility.
 - Monitoring of ground and surface water quality throughout the development program should be undertaken to ensure that site operations are not detrimentally impacting upon ground or surface waters resources.
 - Any fuels or chemicals used during construction should be stored in bunded areas with impermeable bases in accordance with EA guidelines, thereby limiting the potential for migration of contaminants into groundwater following any leakages / spillages.
 - A discharge consent would be applied for in order to remove excavation waters to a surface water / foul sewer depending on the water quality. Where required pre-treatment with silt traps and interceptor should be undertaken.

- The site investigation has identified that the presence and extent of contaminated soil does not currently pose unacceptable risks to future site users. Use of appropriate levels of Personal Protective Equipment is required throughout the construction program to mitigate potential risks associated with dermal contact. Works should be documented in full with a works remedial methodology.
- The risk of piling causing a preferential flow path for shallow contamination could be mitigated by using continuous flight auger piles. The methodology for piling would need further assessment and subsequent agreement with the regulators.

Geotechnical / Engineering Conditions

Construction

- 11.7.3 It is considered that the following foundations options should be considered, subject to the structural details being confirmed. It must be noted that the design plans for the project are in their early stages and require further detailed design and confirmation. Any foundations for the structures should be agreed with the regulators. Details of the proposed options should be provided by the Specialist Contractor and may include:
- Flat slab raft foundations / ground bearing floor slabs on improved ground as recommended within the CCL report.
 - Driven pre-cast concrete or displacement auger piles, with potential requirement of boring at individual pile locations to facilitate installation as recommended within the CCL report. Continuous flight auger piles may also be considered.
- 11.7.4 The Made Ground may need to be improved by dynamic compaction, using appropriate plant however this will be further determined as part of the detailed design.
- 11.7.5 Soakaway drainage may be suitable within Made Ground and Kempton Gravels below the site but not within low permeability Alluvial / Langley Silt deposits. It would be necessary for any soakaways constructed within the Kempton Gravel to be located above groundwater. There should be at least 5 m between buildings and soakaways.
- 11.7.6 A suitable thickness of sub base and capping below the proposed pavements and hardstanding areas would mitigate potential differential settlement.
- 11.7.7 The CCL report states that no significant concentrations of carbon dioxide and methane have been detected within boreholes across the site. In addition, radon gas has not been encountered. The CCL report states that the proposed development should not be constrained by issues relating to soil gases. However further clarification is required in order to determine whether the monitoring was undertaken in accordance with C665 'Assessing Risks Posed by Hazardous Ground Gases'. It may be deemed necessary to undertake further monitoring before construction. Without adequate information, there may be a requirement for control measures such as a gas protective membrane installed below the buildings.
- 11.7.8 Table 11.1 summarises the additional mitigation measures (additional to those incorporated within the development proposals) recommended as a result of the impact assessment.

Table 11.1: Summary of Recommended Additional Mitigation Measures

Phase	Recommended Mitigation
Construction	<ul style="list-style-type: none"> - A temporary surface water management strategy should be employed. - Any fuels or chemicals used during construction should be stored in bunded areas with impermeable bases, thereby limiting the potential for migration of contaminants into groundwater following and leakages/spillages. - Protective measures should be put in place to prevent contaminated soil from entering any of the watercourses. - A discharge consent is required in order to remove excavation waters to a surface water / foul sewer depending on the water quality. - Foundation options include flat slab raft foundations / ground bearing floor slabs on improved ground, or driven pre-cast concrete or displacement auger piles, with potential requirement of boring at individual pile locations to facilitate installation. Continuous flight auger piles may also be considered to restrict flow paths for shallow contamination. - The Made Ground may need to be improved by dynamic compaction, using appropriate plant however this will be further determined as part of the detailed design. - Differential settlement should be overcome by utilising a suitable thickness of sub base and capping below the proposed pavements. - More monitoring may be required before construction to assess risk of ground gases in accordance with C665. Without sufficient information, mitigation measures such as a gas protective membrane may be deemed necessary.
Operation	Storage of all fuels and chemicals within appropriately bunded areas on the site.
Operation	Adequate site drainage and interceptors to reduce the risk associated with impact to the site subsoil's and controlled waters. Surface and controlled waters should be managed through a surface water management strategy, as detailed in Chapter 10.

11.8 Residual Impact

11.8.1 The potential and residual impacts should be ascertained in accordance with terminology appropriate to the topic specific guidance/regulations. Where these are not available, the following levels of significance should be used

Neutral

Minor not noteworthy or material

Moderate noteworthy, material

Major extremely noteworthy / material

Substantial

Construction Phase

11.8.2 It is possible to reduce the potential construction impacts to an overall low level by implementing the mitigation measures outlined above. The method used should comprise a two tier approach:

- Each specific construction method used should be accompanied by a specific risk assessment prepared by the specialist contractor and agreed with the regulatory bodies.

- Based on the risk assessments for each activity a construction management plan should be assembled by the contractor outlining work methods and suitable temporary control measures.

11.8.3 The potential risks to controlled waters resulting from any groundwater contamination identified at the site by the site investigation and risk assessment can be mitigated by the implementation of an appropriate remediation strategy. This remedial strategy is subject to a separate planning application by Southwark Council for the remediation and site preparation works prior to the construction of the IWMF. The remedial method(s) employed will be agreed with the EA prior to construction and will reduce the residual impacts to "low".

11.8.4 Soil contamination identified may present unacceptable risks to controlled waters. Remediation may be required to address these risks, which through necessity will reduce soil contamination in the principal source areas.

Operational Phase

11.8.5 Where the mitigation procedures described are implemented in an appropriate manner, the impacts discussed in this chapter can be mitigated. It is, therefore, considered that development can proceed with no unacceptable risks to future users, based on soil contamination and geotechnical issues.

11.8.6 Residual impacts, their magnitude and significance are summarised in the table below.

Table 11.2: Summary of Residual Impacts

Phase	Impact	Impact Type	Magnitude	Significance	Geographical Level of Importance of Issue				
					I	N	R	B	L
Construction	Disturbance of residual soil / groundwater contamination.	Adverse	Low	Minor					*
Construction	Impact from accidental spillage of contaminants.	Adverse	Low	Minor					*
Construction	Impact from building foundations, pavements and hard standing.	Adverse	Low to moderate	Minor to moderate					*
Operation	Impacts of potential vehicle spillage	Adverse	Low	Minor					*
Operation	Impacts of chemical storage	Adverse	Low	Minor					*
Operation	Impacts from buildings foundations, pavements and hardstanding	Adverse	Low to moderate	Minor to moderate					*
Operation	Impacts of contamination on groundwater.	Adverse	Low	Minor					*
Operation	Impacts on groundwater flow	Adverse	Low	Minor					*
Operation	Impacts of accidental hydrocarbon or chemical spillage	Adverse	Low	Minor					*

Key: I: International N: National R: Regional B: Borough L: Local

11.9 Conclusions

11.9.1 The Environmental Impact Assessment has identified a number of constraints of the site all of which can be mitigated to produce a negligible adverse impact or beneficial impact.

11.9.2 Where the mitigation procedures described in Section 11.7 are implemented in an appropriate manner, the impacts discussed in this chapter can be mitigated.

11.9.3 With the incorporation of the recommended mitigation measures, adverse impacts from the development relating to land contamination and geotechnical conditions are not expected. It is considered that the development can take place.