APPENDIX 11.2: PHASE 2 GEOENVIRONMENTAL AND GEOTECHNICAL SITE INVESTIGATION REPORT, RSK

Comer Homes Group

North London Business Park

Phase 2 Geo-environmental and Geotechnical Site Investigation

1921321-R01(00)

April 2021

RSK GENERAL NOTES

Project No.: 1921321-R01

Title: Phase 2 Geo-environmental and Geotechnical Site Investigation: North London Business Park, Oakleigh Road South, Barnet, N11 1NP

Client: Comer Homes Group

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EXECUTIVE SUMMARY

Commissioning and purpose of assessment	RSK Environment Limited (RSK) was commissioned by Comer Homes Group to carry out a Phase 2 Geo-environmental and Geotechnical Site Investigation of the land at North London Business Park, Oakleigh Road South, Barnet, N11 1NP, grid reference 528088, 193479. The overall aim of the project was to assess potential land contamination sources and geotechnical constraints to the proposed development.
DESK-BASED ASSESSMENT	
Site description and proposed development	The site currently comprises an operational business park with an accompanying school, occupying a total area of ~4.50 hectares. The site is being considered for development for residential use in addition to relocation of the existing school.
History of site and surrounding area	Historical information has been reviewed from a previous Preliminary Risk Assessment of the site. The site formerly comprised numerous gravel pits within the northern area of the site, later occupied from 1938 by New Southgate Works across the majority of the site. Minor alterations of the associated warehouse buildings are noted up to between 1990 and 2000. Based upon a previous assessment of the site, the present-day configuration of the site layout was identified from 2007.
Previous assessment (PRA) report	RSK have been provided with a Preliminary Risk Assessment report for the site completed by WSP Environmental Ltd (December 2007). The report details the entire site boundary, including an additional area towards the north and west of site, these additional areas are located within the remit of North London Business Park.
Geology and environment setting	According to published geological data for the surrounding area, the site is underlain by deposits of the London Clay Formation, which is underlain by deposits of the Lambeth Group at depth. Due to historical developments on site, Made Ground is likely to be present. Environmental receptors identified comprise of a central surface water feature located adjacent to the school buildings, identified as an artificial pond.
Site reconnaissance findings	Various areas of soft landscaping bunds are noted across the site, more notably within the northern-most part of site. Within these areas, extensive Made Ground soils are likely to be present. Variations in topography are noted across the site between the south-eastern and northern areas. No potentially contaminative current site activities were noted during the site walkover. No visual signs of contamination were noted at the central pond surface water feature.

Initial conceptual site model (CSM) and preliminary risk assessment (PRA)	Following a review of both the previous WSP Environmental Ltd report and other available information, it is considered that the preliminary Conceptual Site Model produced for the site by WSP Environmental Ltd is appropriate for the site. Hence the main on-site sources of contamination identified are as follows: ○ Potential infilled gravel pits within the north of site; ○ Historical developments on site, including bunds; and ○ Potential for UXO to be present on site. In addition, the following off-site sources of contamination have been identified: ○ Neighbouring sites with commercial/industrial history; and ○ Landfills and waste transfer stations within the vicinity.
INTRUSIVE INVESTIGATION & ASSESSMENT	
SI scope	The intrusive investigation works and subsequent monitoring of the site was completed between August and October 2020 and comprised the following investigation techniques. • 18No mechanically excavated trial pits, completed up to a maximum depth of 3.0m bgl; • 8No boreholes by cable percussive methods, completed up to a maximum depth of 40.0m bgl; • Installation of 8No combined gas and groundwater monitoring wells; and • A total of 3No return gas and groundwater monitoring visits.
SI factual findings	The reported ground conditions comprised a profile of Made Ground or natural Topsoil underlain by bedrock deposits of the London Clay Formation. Deposits considered to represent the Lambeth Group were encountered from between 26.3m and 32.0m below ground level. Groundwater strikes noted as 'seepages' were noted throughout the cable percussive boreholes. Groundwater was not encountered within any of the trial pit locations. Evidence of visual or olfactory evidence of contamination was limited to Made Ground soils, generally comprising asphalt and clinker fragments, with some localised asphalt odours.
Geo-environmental assessment	No site-wide contamination issues have been identified across the site however, some limited contamination issues have been identified within Made Ground and subsoil that potentially pose a risk to human health. Based upon return gas monitoring completed to date, it is considered appropriate to determine the site as Characteristic Situation 2, where gas protection measures will be required. A total of 2No shallow soil samples have been shown to contain hazardous properties with regards to waste disposal. As a result, some waste on site would require disposal at a suitably permitted hazardous waste landfill or treatment facility.

Geotechnical assessment	It is understood that the proposed development will adopt a piled foundation solution within the underlying London Clay Formation and Lambeth Group. No specific information relating to building loads has been provided. A foundation works risk assessment will not be required for the development. An assessment of the potential magnitude of both long-term and short-term heave associated with the formation of basements should be undertaken. The recommended sub-grade soil CBR value for the preliminary road pavement design is 5%. Due to the variability within the subgrade soils, the materials should be regarded as frost suspectable. It is recommended that buried concrete piled foundations are designed in accordance with Design Sulphate Class DS-3 and Aggressive Chemical Environment for Concrete Class AC-3 (ACEC-AC).
Recommendations including issues for further assessment	Some limited contamination issues have been identified which pose potential risks to human health, consequently remediation measures will be required to mitigate and/or accommodate these risks. Should unforeseen contamination be encountered during the development then specialist advice should be sought to determine the appropriate course of action. Imported material (e.g. topsoil, subsoil) should be validated before use on-site to confirm its suitability.
The information given in this summary is necessarily incomplete and is provided for initial briefing purposes only. The summary must not be used as a substitute for the full text of the report.	

1 INTRODUCTION

1.1 Commissioning

RSK Environment Limited (RSK) was commissioned by Comer Homes Group to carry out a Phase 2 Geo-environmental and Geotechnical Site Investigation of the land at North London Business Park, Oakleigh Road South, Barnet, N11 1NP. The project was carried out to an agreed brief as set out in RSK's proposal (Ref. T1921321, dated 16th July 2020).

The Site in question is being considered for development for residential and commercial use. The planned layout of the site is shown in **Appendix B**.

1.2 Objectives

The objective of the work is:

- To identify any land contamination and/or geotechnical constraints to the proposed development and to support discharge of relevant planning conditions and relevant building control requirements; and
- To identify the need for any additional investigation or remediation works to demonstrate that the site is suitable for its proposed use.

1.3 Scope of works

The scope of this assessment has been developed in accordance with relevant British Standards and authoritative technical guidance as referenced through the report. The assessment of the contamination status of the site is in line with the technical approach presented in Land Contamination Risk Management (LCRM) (Environment Agency, 2020) – which supersedes CLR11 Model Procedures for Land Contamination – and in general accordance with BS 10175: 2011 + A2 2017 (BSI, 2017). It is also compliant with relevant planning policy and guidance.

The scope of the intrusive investigation has been designed in line with the recommendations of BS5930:2015+A1:2020 Code of practice for ground investigations (BSI, 2020), which maintains compliance with BS EN 1997-1 and 1997-2 and their related standards. It has also been developed in general accordance with BS 10175: 2011 + A2 2017. Ground gas assessment has been undertaken in general accordance with BS8576: 2013 and BS 8485:2015+A1:2019. Note: Remove any references above that are not applicable.

A brief summary of relevant legislation and policy relating to land contamination is given in **Appendix C**.

The scope of works for the assessment, has included the following:

Desk Study:

- A summary of the preceding preliminary risk assessment;

- Assessment of local geology, hydrogeology and hydrology; and
- Completion of a site reconnaissance survey to assess the visual condition of the site.

Intrusive Investigation

- Design and implementation of an intrusive investigation, in situ testing, soil sampling, laboratory geo-environmental and geotechnical testing, groundwater and ground gas monitoring of installed boreholes;
- Interpretation of data to develop a refined conceptual site model (CSM);
- Generic quantitative risk assessment (GQRA) of relevant contaminant linkages;
- Interpretation of ground conditions and geotechnical data to provide preliminary recommendations with respect to foundations and infrastructure design;
- Preliminary assessment of the potential waste classification; and
- Preparation of this factual and/or interpretative report.

It is noted that the number and spread of the exploratory holes advanced on site were dictated by the client.

1.4 Existing reports

The following reports detailing previous works at the site were made available for review:

- Phase 1 Geo-Environmental Assessment, North London Business Park and Land at Oakleigh Road South, New Southgate, WSP Environmental Ltd, December 2007, report ref: 12220279.

Pertinent information from this report has been summarised in Section 3.

1.5 Limitations

This report is subject to the RSK service constraints given in Appendix A and limitations that may be described through this document.

2 SITE DETAILS

2.1 Site location

Site location details are presented below in **Table 1** and a site location plan is provided as **Figure 1**.

Table 1 Site location details

Site name	North London Business Park
Full site address and N11 1NP	Oakleigh Road South, Barnet N11 1NP
National Grid reference (centre of site)	528088, 193479

2.2 Site description

The Site boundary and current site layout are shown on **Figure 2**.

The Site covers an area of c. 4.5 hectares. It is currently occupied by a large commercial building (Comer Business and Innovation Centres) and St Andrew the Apostle Greek Orthodox School, with associated external car parking facilities.

The majority of the site comprises external space occupied by car parking, mounded soft landscaping areas with a large pond located within the eastern part of site. The building units on site are accessible by paved roads throughout the business park.

2.3 Surrounding land uses

The Site is located in Barnet within a predominantly residential setting. Immediate surrounding land uses are described in **Table 2**.

Table 2 Surrounding land uses

North	Residential
East	New Southgate Cemetery and Crematorium Mercedes Care Limited (Vehicle Repair Shop) Residential
South	Residential
West	Commercial buildings of North London Business Park Rail track

2.4 Development plans

The proposed layout of the site, at the time of preparing this report, is included in **Appendix B**.

The proposed development of the site comprises the relocation of the existing school and the development of residential units. The school is proposed to be relocated along the eastern boundary of site along Brunswick Park Road. In addition to the main school building, an additional hall and changing facilities with an accompanying sports field are also proposed along the southern boundary.

A total of 5No residential blocks are proposed along the western boundary of site, ranging between 3- and 8- storey with the inclusion of some basements, providing 360 units.

It is noted as part of the proposed development that the existing pond feature within the central part of site will not be retained.

Information regarding change of site levels has not been provided at the time of writing. From a visual assessment of the site, it is considered likely that some localised reprofiling of the site will be required.

No active planning applications pertaining to the site according to the London Borough of Barnet Council planning portal were identified.

2.5 Site services

Buried utility services and their backfill can provide preferential pathways for gas, vapour or groundwater to migrate along to another part of the site or to a receptor. They can also represent significant constraints to development.

Service plans obtained from utility companies either by RSK or the client are contained in **Appendix E**.

3 SUMMARY OF PREVIOUS REPORT (WSP)

RSK was provided with the following Preliminary Risk Assessment report prior to the intrusive works at the study site:

- Phase 1 Geo-Environmental Assessment, North London Business Park and Land at Oakleigh Road South, New Southgate, WSP Environmental Ltd, December 2007, report ref: 12220279.

A brief overview of the report is provided below, reference should be made to the full report provided in Appendix D for detailed information.

3.1 Introduction

The Preliminary Risk Assessment report was completed in December 2007 and details the entire site boundary, including an additional area towards the north and west of site. It is noted that the additional areas are still located within the remit of the North London Business Park area.

At the time of writing, full details of a proposed development were not identified. However, reference is made to the development of 'residential properties with gardens in the north and east of the site' as a receptor within the initial conceptual site model.

3.2 Site history

The previous Preliminary Risk Assessment included a review of historical Ordnance Survey maps to identify any potentially contaminative former land uses. It should be noted that the review of the historical maps included a larger site area than the site boundary targeted as part of RSK's intrusive works.

The previous historical map review by WSP Environmental Ltd (WSP) noted that, on the earliest available map record (1863), the site comprised land associated with the adjacent cemetery. A ground feature in the form of a cutting is noted towards the west of site from 1879. Gravel pits were noted within the northern part of the larger site boundary between 1879 and 1896.

From 1938 the site was noted to comprise a sports ground, with an accompanying miniature rifle range, pavilion and tank within the northern part of site. At this time, the southern part of site was noted to be occupied by New Southgate Works (Telephones and Cables), with a number of large warehouse style structures across the site. Two pond features separated by a weir were noted within the eastern part of site from 1981. Alternations for the warehouse buildings were noted between 1990 and 2000, with the map dated 2007 noted to show the 'current layout' (2007) of the site.

A review of historic publicly available satellite imagery (Google Earth, 2020) indicates that the commercial buildings, formerly identified by WSP as works up to early 2000s, underwent a phase of construction during late 2003. After this date, the satellite imagery appears to show the site in its present day (2020) configuration.

In addition to the details above, anecdotal information provided by a site representative during the initial assessment included the following:

- "a number of former aid raid shelters were present across the site; two shelters are still present, with access at ground level located in the centre of the site, adjacent to the multi-storey car park";
- "..additional shelters have since been infilled, and as such associated walls and foundations are likely to remain underground."

The following potentially contaminative former land uses within the site vicinity were noted following completion of the WSP historical map review:

- Great Northern Cemetery (adjacent southeast);
- Great Northway railway line (adjacent west);
- East Barnet Sewage Farm, Sewage Disposal Works, Unspecified Works (300m east)
- Photographic Works, Unspecified Works (200m south); and
- Unspecified Works, Depot (100m east).

3.3 Geology, Hydrogeology and Hydrology

Based upon a review of published geological records by the British Geological Survey, the site is detailed to be underlain by bedrock deposits of the London Clay Formation, anticipated up to a depth of around 30m below ground level, underlain by deposits of the Lambeth Group.

In addition, due to the apparent historical phases of development at the site, a profile of made ground is expected. An area of made ground is also noted by the British Geological Survey within the eastern part of site, this feature was noted likely to be associated with the former East Barnet Sewage Works.

As the site is underlain by unproductive strata of the London Clay Formation, it was noted that local groundwater resources are perceived not to be at risk from activities carried out on site. The nearest potable water supply was reported 700m south east of site. The study site is not located within an Environment Agency groundwater Source Protection Zone.

A surface water feature is located within the eastern part of site reported as an 'Un-named lake'. The nearest off-site surface water feature is located 400m towards the east. No surface water abstractions are located within 1km of the site.

3.4 WSP Environmental Conceptual Model

The following Sources, Pathways and sensitive Receptors was identified by WSP following initial review of the available data sources.

<u>Sources (on site)</u>

- Possibility of infilled former gravel pits in the north of site, may give rise to deep areas of Made Ground or ground gas generation;

- The site has had a long history of development, including railway sidings, telephones/cables works, electricity sub-stations and tanks, which could have resulted in contamination across the site;
- A number of bunds are present as a result of previous phases of redevelopment;
- The site is thought to have been bombed during World War II which could have resulted in unexploded ordnance (UXO) being present across the site; and
- Previous phases of redevelopment at the site have results in bunds/infilled air raid shelters which could have results in deep areas of Made Ground.

It is noted from the above that the former gravel pits and tank within the northern part of site are located within the northern part of the larger site boundary. As a result, it is considered that these features are located north of the current site boundary targeted as part of this RSK intrusive investigation.

Sources (off site)

- Neighbouring sites and land have had commercial/industrial history, including the sewage works and photo works; and
- Two landfill sites are located within 250m of the site. Two waste transfer stations are located within 500m of the site.

Pathways

- Direct contact with contaminated soils (ingestion, inhalation and dermal contact); and
- Ground gas migration form historic filing activities on site.

In addition, it was noted that the underlying solid geology is London Clay and is predominately cohesive and is likely to restrict the widespread transport of pollutants.

Receptors (Environmental)

- The un-named lake present within the eastern part of site.

Receptors (Human Health Risks)

- The proposed redevelopment plans include residential properties with gardens in the north and east of the site, there is unlikely to be a barrier between any subsurface contamination and the end users; and
- Third party neighbours are primarily residential in nature and, as such, a barrier between any subsurface contamination is unlikely to be present.

3.5 WSP Conclusions and Recommendations

Based upon the information obtained and reviewed within the previous report, WSP Environmental Ltd consider that the site represents a ‘medium risk’ with respect to environmental receptors.

The following recommendations, noted to be undertaken prior to redevelopment of the site, were provided:

- An intrusive phase II investigation should be undertaken to provide information relating to contamination issues, provide preliminary geotechnical advice and a ground gas assessment; and
- An unexploded ordnance desk study.

Following a review of both the previous WSP report and other available information, it is considered that the preliminary Conceptual Site Model produced for the site by WSP remains appropriate for the site.

4 SITE RECONNAISSANCE FINDINGS

In addition to the review of the previous risk assessment report detailed in Section 3, a site reconnaissance was completed by RSK prior to the intrusive works at the site. The characteristics of the site observed during the walkover are summarised in **Table 3**.

At the time of the survey, only external areas of the site were accessible.

A site plan is provided in **Figure 2** with photographic records included in **Appendix F** detailing the main features identified below.

Whilst the walkover summary includes consideration of current operations and housekeeping on the site as potential sources of contamination, it does not constitute a comprehensive environmental audit of the site, as covered under ISO 14001.

Table 3 Site reconnaissance findings

Feature	Description
Physical characteristics	
Access constraints	At the time of the survey, only external areas of the site were accessible. The external areas of site are readily accessible by foot or vehicle via roadways throughout the business park.
Site topography	There are significant changes in topographical level across the site. The northern part of site, within the vicinity of the commercial office buildings, is at a higher elevation than the south-eastern corner of site. Throughout the site several bunds are present, assumed to be associated with previous phases of redevelopment at the site.
Surface cover	Paved areas on site include roadways providing access throughout the business park and associated car parking facilities. Other paved areas include footpaths and an external playground located between the school building and lake within the central part of site. The remaining site cover comprises soft landscaping. It is noted that many of the soft landscaping areas are bunded with a higher elevation than the adjacent roadways throughout the business park.
Site drainage	Manhole covers and other formal drainage installations are located throughout the business park and within the vicinity of the central school development. No obvious outfalls to the central pond were observed.
Surface water	A large pond is located within the central-eastern part of site, surrounded by the school development to the north, access road to the east and bunded soft landscaping areas towards the south and west. The pond appears in good visual condition with no obvious signs of discolouring or other signs of contamination noted. There are no other surface water features on site or within its immediate vicinity.

Feature	Description
Trees and hedges	Vegetation present on-site comprises numerous species of mature trees with accompanying shrubs spread across the site. Main areas of tree cover are located adjacent to the southern, eastern and north-eastern boundaries of site, within areas of soft landscaping. It is noted some trees are located within bunded areas of soft landscaping, particularly along the southern part of site. No vegetation exhibiting signs of distress or die-back was observed.
Invasive species	Based upon the walkover survey, obvious evidence of Japanese Knotweed or other invasive species has not been identified on-site. However, it should be noted that a detailed survey of the possible presence or absence of invasive species is outside of the scope of investigation and consideration should be given to commissioning a specialist survey, as necessary.
Existing buildings on site	School buildings are present within the south western part of site. The buildings comprise up to 2-storey and include external paved areas and soft landscaping. A smaller outbuilding, utilised as a site security hut, is located along the Oakleigh Road access point within the eastern part of site.
Retaining walls and adjacent buildings on or close to site boundary	The business innovation centre is located directly adjacent to the western boundary of site, comprising up to a total of 3-storey. No retaining walls were observed.
Basements on-site	No evidence of existing or infilled basements was observed from the external observations of the site. Basements may be present beneath the school building or the adjacent business innovation centre adjacent west of site.
Made ground, earthworks and quarrying	Extensive Made Ground soils are expected to be present within the bunded soft landscaping areas, predominantly located within the northern and south-eastern parts of site.
Potentially unstable slopes on or close to site	No obvious signs of unstable slopes observed. The bunded areas noted across the site do not appear to pose a significant instability risk.
Environmental characteristics	
Underground/ above ground storage tanks and pipework	No evidence of underground or above-ground storage tanks were noted from the external observations of the site.
Potentially hazardous materials storage and use	No evidence of potentially hazardous materials storage and use were noted from the external observations of the site. It is considered unlikely for such materials to be present within the school building.
Asbestos-containing materials	No obvious asbestos construction materials were observed but a detailed survey of the buildings would be required to confirm the presence or otherwise of asbestos-containing materials.

Feature	Description
Waste storage	Waste from the school units are stored in wheelie bins within the south western corner of site. The business park area is maintained and cleaned with no obvious signs of fly-tipping observed.
Electricity sub-stations/ transformers	There is an existing sub-station located adjacent to the school building within the southern part of site. No evidence of oil leakage was observed.
Evidence of possible land contamination on-site	There is the potential for extensive Made Ground soils to be present within the bunded areas on site. No other significant sources of contamination were observed on site.
Potential off-site sources of ground contamination	The immediate site vicinity generally comprises a residential setting with the business innovation centre located directly adjacent to the western boundary. Potential sources of contamination noted within the immediate site vicinity include: • Vehicle repair shop located east of Brunswick Park Road from the eastern boundary of site, identified as Mercedes Care Limited; and • New Southgate Cemetery and Crematorium located east of Brunswick Park Road from the eastern boundary of site. As the business innovation centre is understood to comprise office units, it is not considered to pose as a significant source of contamination. It is however noted that contamination within this area may still be present as a result of historical land use as a works.

Potentially significant land contamination or geotechnical issues arising from the site reconnaissance survey are summarised below:

- Various areas of soft landscaping bunds noted across the site, likely to comprise Made Ground; and
- Variation in topography between the south-eastern and northern part of the site.

5 SITE INVESTIGATION STRATEGY & METHODOLOGY

5.1 Introduction

RSK carried out intrusive investigation works and subsequent monitoring of boreholes between August and October 2020.

5.2 Objectives

The specific objectives of the investigation were as follows:

- To establish the ground conditions underlying the site including the extent and thickness of any Made Ground;
- To investigate specific potential sources of contamination identified in initial WSP Environmental Ltd CSM;
- To determine groundwater depth and flow direction;
- To determine the ground gas regime underlying the site; and
- To assess geotechnical properties of soils.

5.3 Selection of investigation methods

The techniques adopted for the investigation were chosen with consideration of the objectives and site constraints, which are described below.

Cable percussion drilling was chosen based on the targeted drilling depth, requirement for in-situ geotechnical data, the opportunity to collect both disturbed and undisturbed samples and install monitoring wells. This was supplemented by mechanically excavated trial pitting to obtain a number of investigation locations and achieve greater visibility of the Made Ground.

Prior to conducting intrusive works, utility service plans were obtained and buried service clearance undertaken in line with RSK's health and safety procedures. Copies of statutory service records obtained by RSK as part of the agreed scope of works are contained in **Appendix E**.

5.4 Investigation strategy

The ground investigation was carried out using intrusive ground investigation techniques in general accordance with the recommendations of BS5930:2015+A1:2020, which maintains compliance with BS EN 1997-1 and 1997-2 and their related standards. Whilst every attempt was made to record full details of the strata encountered in the boreholes, techniques of hole formation and sampling will inevitably lead to disturbance, mixing or loss of material in some soils and rocks.

The investigation strategy involved targeted boreholes and trial pits. The investigation comprised an exploratory investigation, focussing on the developmental areas of the site.

Details of the investigation locations, installations and rationale are presented in **Table 4**. A total of 18 No. machine excavated trial pits were dug to a maximum depth of 3.0m bgl before being backfilled with arisings. In addition, 8 No. cable percussive boreholes were drilled to a maximum depth of 40.0m bgl, each installed with a combined gas and groundwater monitoring well.

Table 4 Exploratory hole and monitoring well location rationale

Investigation Type	Number	Designation	Monitoring well installation	Rationale Examples below
Mechanically excavated trial pits	18	TP1 – TP18	N/A	To accurately log the upper strata in targeted and non-targeted locations beneath the site. Collect samples from the shallow Made Ground and natural soils. To allow in-situ geotechnical testing via dynamic cone penetrometer methodologies.
Boreholes by cable percussive methods	8	BH1 – BH8	Gas and groundwater	To prove the geological succession beneath the site and obtain in-situ geotechnical data. To allow the installation of combined gas and groundwater monitoring wells.

5.4.1 Implementation of investigation works

The exploratory holes were logged by an engineer in general accordance with the recommendations of BS5930:2015+A1:2020 (which incorporates the requirements of BS EN ISO 14688-1, 14688-2 and 14689-1).

The monitoring well construction and associated response zones are detailed on the exploratory hole records in **Appendix H**.

The soil sampling and analysis strategy was designed to characterise each encountered soil strata, permit an assessment of the potential contaminant linkages identified and investigate the geotechnical characteristics. In addition, samples were taken to allow for geo-environmental and geotechnical testing to be undertaken.

Soils collected for laboratory analysis were placed in a variety of containers appropriate to the anticipated testing suite required. They were dispatched to the laboratory in cool boxes under chain of custody documentation. Samples were stored in accordance with the RSK quality procedures to maintain sample integrity and preservation and to minimise the chance of cross contamination.

Selected samples were placed in polythene bags for headspace screening with a photo-ionisation detector (PID) fitted with a 10.6 eV bulb. The PID screening results are presented on the exploratory hole records.

5.5 Monitoring programme

5.5.1 Ground gas monitoring

A total of 3 No. monitoring rounds have been undertaken to provide data to investigate the potential risk identified as part of the initial CSM.

The number of monitoring rounds undertaken is in general accordance with the decision matrix presented as Figure 6 of BS8576.

A calibrated infrared gas meter was used to measure gas flow, concentrations of carbon dioxide (CO_2), methane (CH_4) and oxygen (O_2) in percentage by volume, while hydrogen sulphide (H_2S) and carbon monoxide (CO) were recorded in parts per million.

Initial and steady state concentrations were recorded. In addition, during the first monitoring round, all wells were screened with a PID to establish if there are any interferences and cross-sensitivity of other hydrocarbons with the infrared gas meter.

The atmospheric pressure before and during monitoring, together with the weather conditions, were recorded. The monitoring included periods of falling atmospheric pressures and after/during rainfall.

All ground gas monitoring results together with the temporal conditions are contained within Appendix I. Equipment calibration certificates are available on request.

5.5.2 Groundwater monitoring

A total of three rounds of groundwater monitoring were undertaken concurrently with the ground gas monitoring. The monitoring records, including dates, are included in Appendix I.

5.5.3 Surface water sampling

Surface water samples were obtained from the pond located within the central-eastern part of site. A total of 2 No. samples were submitted for chemical analysis.

5.6 Laboratory testing

Laboratory testing was undertaken at a UKAS accredited laboratory with ISO17025 and MCERTS accredited test methods were specified where applicable for contamination testing and as shown in the laboratory test certificates appended.

5.6.1 Chemical analysis of soil samples

The soil sampling strategy was designed to characterise made ground and/or natural strata typically within the upper 1.0m of the ground profile whilst also characterising deeper strata and the potential for contaminant migration from relevant identified sources.

The programme of chemical tests undertaken on soil samples obtained from the intrusive investigation is presented in **Table 5** with the laboratory testing results contained in **Appendix J**.

Table 5 Summary of chemical testing of soil samples

Stratum	Tests undertaken	No. of tests
Made ground	SS2 - Speciated PAH-16MS, TPH CWG, pH, Metals, Total Sulphate, Water Soluble Sulphate, Asbestos Screen and ID	22
	TOC	6
	TPH CWG and VOCs	2
	Waste Acceptance Criteria	4
Topsoil	SS2 - Speciated PAH-16MS, TPH CWG, pH, Metals, Total Sulphate, Water Soluble Sulphate, Asbestos Screen and ID	4
London Clay Formation	SS2 - Speciated PAH-16MS, TPH CWG, pH, Metals, Total Sulphate, Water Soluble Sulphate, Asbestos Screen, and ID	1
	BRE Pyritic Geology (Soil – Greenfield)	24

5.6.2 Geotechnical analysis of soils

Where appropriate disturbed, bulk and undisturbed soil samples were taken for geotechnical classification testing with the depth and nature of samples detailed within the exploratory hole records.

Where appropriate, testing was undertaken in accordance with BS 1377:1990 Method of Tests for Soils for Civil Engineering Purposes or, where superseded, by the relevant part of BS EN ISO 17892:2014 Geotechnical investigation and testing - Laboratory Testing of Soil. Tests carried out in order to classify the concrete class required on-site have been undertaken following the procedures within BRE SD1:2005.

The programme of geotechnical tests undertaken on samples obtained from the intrusive investigation is presented in **Table 6**. The results and UKAS accreditation of tests methods are shown in **Appendix K**.

Table 6 Summary of geotechnical testing undertaken

Strata	Tests undertaken	No. of tests
London Clay Formation	Moisture content %	14
	Liquid/ plastic limits	14
	Qu Single Stage	23
	Consolidation and Measurement of Swelling	4
Lambeth Group	Qu Single Stage	2

5.6.3 Chemical analysis of surface water samples

Groundwater and surface water samples were collected in containers appropriate to the anticipated testing suite required. The containers were filled to capacity and placed in a cool box to minimise volatilisation.

Chemical testing undertaken on water samples obtained presented in **Table 7** with the laboratory testing results contained in **Appendix L**.

Table 7 Summary of chemical testing of water samples

Sample type	Tests undertaken	No. of tests
Surface water (pond)	Metals, Sulphates, Speciated PAHs, TPH CWG, pH	2

6 SITE INVESTIGATION FACTUAL FINDINGS

The results of the intrusive investigation and subsequent geo-environmental and geotechnical laboratory analysis undertaken are detailed below.

6.1 Ground conditions encountered

The descriptions of the strata encountered, notes regarding visual or olfactory evidence of contamination, list of samples taken, field observations of soil and groundwater, in-situ testing and details of monitoring well installations are included on the exploratory hole records presented in **Appendix H**.

The exploratory holes revealed that the site is underlain by a variable thickness of Made Ground or Topsoil over bedrock deposits of the London Clay Formation with strata considered to represent the Lambeth Group encountered at depth. This appears to confirm the anticipated stratigraphical succession detailed within the previous Preliminary Risk Assessment Report detailed in Section 3.0.

For the purposes of discussion, the ground conditions encountered during the fieldworks are summarised in **Table 8** with the strata discussed in subsequent subsections.

Table 8 General succession of strata encountered

Stratum	Exploratory holes encountered	Depth to top of stratum (m bgl)	Proven thickness
Topsoil	TP1, TP2, TP5 – TP7, TP11, TP13, TP14 BH5, BH6	GL	0.15m – 0.40m
Made Ground	TP1 – TP12, TP14 – TP18 BH1 – BH8	GL – 0.40m	0.45m – 2.50m
London Clay Formation	TP1, TP2, TP4 – TP9, TP13, TP14 BH1 – BH8	0.20 – 2.50	<39.24
Lambeth Group	BH1, BH3 – BH6	26.30 – 32.00	<10.86

6.1.1 Topsoil

The Topsoil encountered on site comprised a soft consistency cohesive soil with some flint gravels including roots and rootlets. Generally, Topsoil was encountered in the majority of the exploratory hole locations up to a maximum depth of 0.40m below ground level.

No evidence of anthropogenic materials was reported. However, as Topsoil was underlain by Made Ground soils it is considered that the Topsoil represents imported or potentially recycled site material.

6.1.2 Made ground

The Made Ground soils generally comprised a cohesive soil with a significant proportion of granular matrix of variable thickness, encountered at all of the exploratory holes apart from locations TP13 and BH8.

Locations that reported a profile of Made Ground greater than or equal to 1.50m in thickness are detailed in **Table 9**.

Table 9 Summary of extensive Made Ground soils encountered on site

Exploratory hole	Proven thickness (m)	Composition	Site location
TP5	1.70	Flint, concrete, brick, metal, glass, plastic	Bunded soft landscaping area within southern part of site, adjacent to school out building and central pond feature
TP10	2.00	Flint, concrete, brick, metal, timber, asphalt, clinker	Soft landscaping area adjacent to business centre entrance
TP12	1.50	Flint, concrete, brick, metal, glass, asphalt	
TP16	2.50	Flint, concrete, brick, metal, timber, asphalt, clinker Asphalt odour noted at 1.0m bgl	Large bunded soft landscaping area within the northern part of site
TP17	2.00	Flint, concrete, brick, metal, glass, plastic	
TP18	2.50	Flint, concrete, brick, metal, timber, asphalt, clinker	
BH1	2.50	Flint, concrete and frequent brick	Adjacent to central pond feature
BH4	1.70	Flint, concrete, brick, asphalt, clinker	South-western corner of site within sloped area
BH7	2.30	Flint, concrete and brick	Within car parking adjacent to business centre building

Based upon the summary provided in **Table 9**, it is noted that more extensive Made Ground soils were noted within either bunded soft landscaped areas, adjacent to key on-site and off-site developments or within proximity of the central pond feature.

6.1.3 London Clay Formation

This stratum was encountered at all of the cable percussive borehole locations and at the majority of the mechanically excavated trial pit locations. The London Clay Formation underlying the site comprises brown becoming grey stiff clay.

Some flint gravels were noted within the upper surface of the London Clay Formation, this is considered to represent a weathered surface layer as gravel content was noted to generally decrease with an increase in depth. Bands of claystone were also encountered at depth within this stratum.

Greater thicknesses of the London Clay Formation were encountered within the northern part of site, noted to be situated within an area of greater elevation than the southern part of the site.

A summary of the in-situ and laboratory test results recorded in the stratum are presented in **Table 10**.

Table 10 Summary of in-situ and laboratory test results for London Clay

Soil parameters	Min. Value	Max. Value	Reference
Moisture content (%)	28	36	**Appendix K**
Modified moisture content (%)	29	47	**Appendix K**
Liquid limit (%)	66	79	**Appendix K**
Plasticity limit (%)	22	26	**Appendix K**
Plasticity index (%)	44	55	**Appendix K**
Modified plasticity index (%)	30.8	50.49	**Appendix K**
Plasticity term	High	Very High	**Appendix K**
Volume change potential	Medium	High	**Appendix K**
SPT 'N' values	4	+50	**Appendix H**
SPT 'N_{60}' values	5.2	+50	**Appendix H**
Undrained shear strength inferred from SPT 'N_{60}' values (kN/m^2)*	29	372 (+500)^	**Appendix H**
Undrained shear strength measured by triaxial testing (kN/m^2)	34	511	**Appendix K**
Bulk density (Mg/m^3)	1.76	2.04	**Appendix K**
Consistency term from field description	Firm	Stiff	**Appendix H**
Notes: *derived using a Stroud Factor of 5.5, ^based on extrapolated N and () claystone			

6.1.4 Lambeth Group

This stratum was encountered beneath the London Clay Formation within the cable percussive boreholes from depths of between 26.30m and 30.00m below ground level, reported as stiff sandy clay.

Deposits considered to represent the Lambeth Group were reported at all of the cable percussive borehole locations, with the exception of boreholes BH7 and BH8. This is considered likely due to the higher elevation within the northern part of site where BH7 and BH8 were located.

Bands of siltstone were encountered at depth within the Lambeth Group at borehole locations BH1, BH4, BH5 and BH6 from depths of between 30.70m and 38.10m below ground level.

The Lambeth Group surface elevations are provided below in **Table 11** and reference should be made to the exploratory hole logs provided in **Appendix H** for detailed information.

Table 11 Elevations of Lambeth Group and Siltstone bands

Exploratory Hole	TOC elevation (m AOD)	Depth to Lambeth Group (m AOD - min)	Depth to Siltstone bands (m AOD - min)
BH1	48.83	19.13	12.23
BH3	50.85	18.85	N/A
BH4	52.47	26.17	20.87
BH5	49.91	19.71	11.81
BH6	51.43	21.43	20.73

Based upon the above, the surface of the Lambeth group appears to be discontinuous across the site, reported between elevations of 18.85m and 26.17m AOD. A review of the exploratory hole plan, presented as **Figure 2**, suggests that the presence of siltstone bands is likely to be discontinuous across the site.

A summary of the in-situ and laboratory test results recorded in the Lambeth Group are presented in **Table 12**.

Table 12 Summary of in-situ and laboratory test results for Lambeth Group

Soil parameters	Min. Value	Max. Value	Reference
Moisture content (%)	24	24	Appendix K
SPT 'N' values	38	+50	Appendix H
SPT 'N_{60}' values	49	+50	Appendix H
Undrained shear strength inferred from SPT 'N_{60}' values (kN/m^2)*	247	+500	Appendix H
Undrained shear strength measured by triaxial testing (kN/m^2)	181	448	Appendix K
Bulk density (Mg/m^3)	2.01	2.11	Appendix K
Notes: *derived using a Stroud Factor of 5, ^based on extrapolated N			

6.1.5 Visual/olfactory evidence of soil contamination

As detailed within Section 6.1.2 and Table 9, Made Ground was encountered at all of the exploratory holes apart from locations TP13 and BH8. Made Grounds was generally reported to comprise brick and concrete fragments, with some areas comprising asphalt, clinker and other anthropogenic materials.

6.2 Groundwater and surface water

6.2.1 Groundwater encountered during intrusive works

Groundwater was not encountered within any of the mechanically excavated trial pits during the intrusive works.

Some groundwater was encountered as seepages within the cable percussive boreholes during the intrusive investigation works, as detailed on the logs in **Appendix H**.

6.2.2 Groundwater encountered during monitoring

Rest groundwater levels recorded during the monitoring programme are summarised in **Table 13** based upon the data provided in **Appendix H**. Field data measurements are also shown in **Appendix H**.

Table 13 Summary of groundwater monitoring results

Monitoring well	Response zone stratum	TOC elevation (m AOD)	Depth to water (mb TOC)	Groundwater elevation (m AOD) – min.	Groundwater elevation (m AOD) – max.
BH1	Made Ground London Clay	48.83	Dry – 4.20	44.63	44.63
BH2	London Clay	50.08	4.80 – 4.83	45.28	45.25
BH3	Made Ground London Clay	50.85	0.80 – 3.93	46.92	50.05
BH4		52.47	Dry	N/A	N/A
BH5		49.91	1.81 – 2.80	47.11	48.1
BH6	London Clay	51.43	Dry	N/A	N/A
BH7	Made Ground London Clay	57.43	Dry	N/A	N/A
BH8		60.80	Dry – 3.05	57.75	57.75

Based upon the groundwater monitoring completed to date, it is considered that groundwater reported within the monitoring wells is considered likely to represent surface water ingress through Made Ground soils as opposed to a natural groundwater table.

6.3 Chemical laboratory results

The soil and surface water testing results are presented in **Appendix J** and **Appendix L**, respectively.

A total of 27 No. samples were screened for the presence of asbestos, none of the samples were identified to contain any asbestos fibres or bulk material. However, on a site where Made Ground is present, there remains the possibility of localised asbestos which has not yet been recorded.

6.4 Ground gas monitoring

The results of the ground gas monitoring and testing carried out are given in **Appendix I** and discussed in Section 7.

6.5 Geotechnical laboratory results

The results of the geotechnical testing are discussed in Section 9 and presented in **Appendix K**.

7 GEO-ENVIRONMENTAL ASSESSMENT

7.1 Refinement of initial CSM

The encountered ground conditions are the same as those anticipated within the initial Conceptual Site Model with no significant changes noted. Based upon the factual findings of the intrusive works, no changes are considered necessary to the initial Conceptual Site Model.

7.2 Linkages for assessment

As described in LCRM (Environment Agency, 2020), there are two stages of quantitative risk assessment (QRA), Tier 2 generic (GQRA) and Tier 3 detailed (DQRA). The GQRA comprises the comparison of soil, groundwater, soil gas and ground gas results with generic assessment criteria (GAC) that are appropriate to the linkage being assessed. This comparison can be undertaken directly against the laboratory results or following statistical analysis depending upon the sampling procedure that was adopted.

The potentially complete contaminant linkages that require further assessment and the methodology of assessment are presented in **Table 14**.

Table 14 Linkages for GQRA

Potentially relevant contaminant linkage	Assessment method
Soil data	
1. Oral, dermal and inhalation exposure with impacted soil, soil vapour and dust by future residents	Human health GAC in **Appendix M** for a proposed residential end-use with home-grown produce. As the proposed development layout has not been provided at the time of writing, the GAC for private gardens will provide the most conservative assessment for the site. Consideration given to the applicability of the use of Statistical Assessment. Methodology for statistical assessment.
2. Inhalation exposure of future residents to asbestos fibres	Qualitative assessment based on the asbestos minerals present, their form, concentration, location and the nature of the proposed development.
3. Uptake of contaminants by vegetation potentially impacting plant growth (phytotoxicity)	Comparison of soil data to GAC in **Appendix N** for phytotoxicity.
4. Contaminants permeating potable water supply pipes	Comparison of soil data to GAC in **Appendix O** for plastic water supply pipes using UK WIR (2010) guidance.
5. Leaching of soil contaminants and dissolved phase migration	Comparison of leachate data to the relevant GAC in Table 1 of **Appendix R**.
Water data	

Potentially relevant contaminant linkage	Assessment method
6. Direct assessment of surface water features	Comparison of surface water data to relevant GAC based on freshwater EQS in Table 1 of **Appendix R**.
Ground Gas	
7. Concentrations of methane and carbon dioxide in ground gas entering and accumulating in enclosed spaces or small rooms in new buildings, which could affect future site users. For methane this could create a potentially explosive atmosphere, while death by asphyxiation could result from carbon dioxide.	Borehole hazardous gas flow rates (Qhg) have been calculated using maximum (peak) methane and carbon dioxide concentrations and steady state flow rates in accordance with BS8485. This is subject to interpretation and use of professional judgement to designate the site or zones of the site characteristic situation by comparison to a Gas Screening Value (GSV) as appropriate and in line with the CSM.

7.3 Methodology and assessment of soil results

The analysis of laboratory results relating to soil samples submitted for testing, including leachate analysis, is included in the following sections.

7.3.1 Oral, dermal and inhalation exposure with impacted soil by future occupants/site users

In order to assess the soil results against the appropriate Generic Acceptance Criteria (GAC), the soil results have been split into appropriate data sets relevant to the oral, dermal and inhalation linkage.

The datasets being considered in the assessment are:

- Data set 1 Made Ground
- Data set 2 Natural Soils

As an initial assessment of each dataset, all soil results in each dataset have been directly compared against the GAC for residential with home-grown produce end use, to provide the most conservative assessment.

The ratio of soil contaminant concentrations of genotoxic PAHs (benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(ah)anthracene, indeno(123-cd)pyrene and benzo(ghi)perylene) against benzo(a)pyrene have been compared against lower and upper limits set out in C4SL project methodology (CL:AIRE, 2014). All genotoxic PAH ratios were within the upper and lower bounds of the underlying toxicological study. Therefore, and in accordance with HPA guidance (HPA, 2010), the assessment of genotoxic PAHs has been based on the use of benzo(a)pyrene as a surrogate marker. Therefore, a risk from genotoxic PAHs is only considered likely if the respective benzo(a)pyrene concentrations exceed the relevant GAC.

7.3.1.1 *Data set 1 – Made Ground*

All made ground results have been compared with the GAC for residential with home-grown produce. A soil organic matter (SOM) of 1% has been selected since laboratory results within the made ground range from 0.17% and 1.81%. The soil screening output spreadsheet is presented as Appendix P.

Assessment of the results indicates exceedances of the GAC for the contaminants shown in **Table 15**. These are highlighted in red on the screening output spreadsheet in **Appendix P**.

Table 15 Data summary table – Data set 1

Determinand	No. of samples tested	GAC (mg/kg)	No of exceedances	Maximum concentration (mg/kg)	
				Value	Location / depth (m bgl*)
Copper	21	2500	1	3550	TP4 (0.80m)
Lead	21	200	1	459	
Nickel	21	130	1	142	
Benzo(b)fluoranthene	21	2.6	1	2.65	
Dibenzo(ah)anthracene	21	0.27	1	0.27	

**Below surface level of bunded area within southern part of site*

7.3.1.2 *Data Set 1 Summary*

It is noted from the above assessment that the determinands reported in exceedance of their respective GAC in Table 15 are a single sample, obtained from exploratory hole location TP4 at 0.80m below ground level. At this location, the sample was reported to contain an 'asphalt odour' with a black to dark brown colour. The mechanically excavated trial pit was also terminated at a shallow (1.35m bgl) depth due to the presence of a potential service encountered at the base of the exploratory hole.

It is also noted that this sample was obtained from a bunded area within the southern part of the site, as a result it is considered that the sample was obtained from a level above the road/ground level directly adjacent to the north of the location.

Based upon the above, it is considered that localised remediation of the Made Ground material sampled within the area of TP4 would effectively remove the localised source of contamination noted on site. With regards to the proposed layout of the site, it is noted that the development proposal for this area of site comprises a changing unit for the school building and accompanying sports hall. As a result, this bunded area within the southern area of site will require removal as part of the proposed development, thus removing the source of contamination.

7.3.1.3 *Data set 2 – Natural Soils*

Natural soil results have been compared with the residential with home-grown produce GAC. A soil organic matter (SOM) of 1% has been selected to provide the most

conservative assessment. The soil screening output spreadsheet is presented as **Appendix P**.

Assessment of the results indicates exceedances of the GAC for the contaminants shown in **Table 16**. These are highlighted in red on the screening output spreadsheet in **Appendix P**.

Table 16 Data summary table – Data set 2

Determinand	No. of samples tested	GAC (mg/kg)	No of exceedances	Maximum concentration (mg/kg)	
				Value	Location / depth (m bgl)
Lead	5	200	2	219	TP2 (0.10m)
				563	TP6 (0.10m)

7.3.1.4 Data Set 2 Summary

Exceedances of the GAC for Lead are noted within two shallow (0.10m bgl) samples of topsoil from exploratory hole locations TP2 and TP6, located within the south-eastern and south-western parts of site respectively.

With reference to the exploratory hole logs provided in Appendix H, it is noted that both samples were underlain by similar Made Ground soils containing fragments of metal.

As detailed within the analysis of Data Set 1, no exceedances were reported within samples of Made Ground obtained from TP2 or TP6 at depths of 0.70m and 0.40m respectively.

On this basis, it is considered that the exceedances of Lead reported in the samples of topsoil may be a result of cross-contamination with respect to the interface of the underlying Made Ground, representing a localised hotspot of contamination.

Due to the shallow depth of the reported exceedances, it is considered local remediation in the form of a shallow strip would be appropriate to remove the localised sources of contamination noted within natural soils. It may also be prudent to remove any existing underlying Made Ground soils within these areas.

It is noted that such remediation measures would only be required within proposed areas of soft landscaping. If roads, buildings or hardstanding areas are proposed within the identified hotspot areas, no remediation is considered necessary as a potential contamination pathway would not be present in this post development scenario.

7.3.2 Inhalation exposure of future occupants/site users to asbestos fibres

The visual inspection at the laboratory identified no materials suspected of potentially containing asbestos and the scheduled laboratory screening for asbestos found no detectable asbestos fibres within the samples of Made Ground or natural soils. However, on a site where Made Ground is present, there remains the possibility of localised asbestos which has not yet been recorded.

7.3.3 Uptake of contaminants by vegetation potentially inhibiting plant growth (phytotoxicity)

The results have been compared with the GAC presented in **Appendix N** for this linkage.

The results indicate that a relevant contaminant linkage may exist associated with phytotoxic effects.

7.3.4 Impact of organic contaminants on potable water supply pipes

For initial assessment purposes, the results of the investigation have been compared with the GAC presented in Appendix O for this linkage, which are reproduced from *UK WIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (UK WIR, 2010).

The results indicate that a relevant linkage may exist associated with organic contaminants and therefore pollutant polyethylene (PE) and/or polyvinyl chloride (PVC) water supply pipes are expected to be unsuitable for use on the development unless remedial measures are implemented that mitigate the risk.

It should be noted that at the time of this investigation the future routes of water supply pipes had not been established, hence the investigation and sampling strategy may not be fully compliant with UK WIR recommendations. Consequently, a targeted investigation and specific sampling/analytical strategy may be required at a later date once the route(s) of the supply pipes are known. In addition, it is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements for assessment, which may not necessarily be the same as those recommended by UK WIR.

7.4 Methodology and assessment of water results

7.4.1 Direct assessment of surface water feature

Due to the presence of a large central pond feature located on site, samples of the surface water have been collected to provide a direct assessment of the water quality, this surface water feature was noted to be present on site from 1981.

The analytical results for surface waters are below the relevant GAC (EQS for freshwater) indicating that a complete pollutant linkage is unlikely to exist.

7.5 Ground gas risk assessment – bulk gases

7.5.1 Appropriate guidance

The risks to development from ground gases have been assessed in accordance with BS8485:2015+A1:2019 (BS8485), which provides guidance on ground gas (methane and carbon dioxide) characterisation and hazard assessment, as well as providing a framework for the prescription of protection measures within new buildings.

The process involves characterising the gas hazard from combining the qualitative assessment of risk (using the CSM) with ground investigation data so that a ‘characteristic

situation' (CS) can be derived for the site or zones within the site. Characteristic situations range from CS1 to CS6, the higher the CS, the higher the hazard potential. Gas protection measures within new buildings can be prescribed using a point scoring system, taking into consideration the CS and the proposed building type.

BS8485 indicates that the gas hazard can be characterised using the following methods:

- An empirical semi-quantitative approach using gas monitoring data to determine the 'characteristic situation' of the site (or zones of the site) and subsequent protective measures (Wilson and Card approach);
- An empirical semi-quantitative approach using TOC data to determine the 'characteristic situation' of the site (or zones of the site) and subsequent protective measures (CL:AIRE RB17 approach); or
- Detailed quantitative assessment methodologies.

For the purpose of this assessment, the empirical semi-quantitative approach above has been used to characterise the gas hazard and provide advice on the protective measures likely to be required within new buildings at the site.

7.5.2 Summary of the refined CSM for ground gas

In the assessment of risks and selection of appropriate mitigation measures, BS8485 highlights the importance of the conceptual model. In summary, potential sources of ground gas within influencing distance of the site identified in Section 3.4 comprise:

- Possibility of infilled former gravel pits in the north of site; and
- Ground gas generation from Made Ground associated with a number of earth bunds present across the site.

This assessment has been undertaken to assess risks to building structures and proposed end-users. The assessment has not taken into consideration the health and safety of construction workers. Risks may still be present to construction workers especially where works include the entry into excavations within the ground. Construction workers should undertake appropriate risk assessments and risks should be managed through health and safety procedures and safe systems of work.

7.5.3 Empirical semi-quantitative approach using borehole monitoring data (Wilson and Card approach, BS8485)

7.5.3.1 Background

The empirical semi-quantitative approach using gas monitoring data requires the designation of a gas screening value (GSV) for the entire site or zones within the site, which informs the hazard potential and associated prescribed ground gas protection measures within new buildings (where necessary). BS8485 defines the GSV as the *'flow rate (l/hr) of a specific hazardous gas* ***representative of a site or zone****, derived from assessment of borehole concentration and flow rate measurements and taking account of all other influencing factors, in accordance with a conceptual site model'.*

BS8485 Section 6.3.1 outlines the process for developing a GSV for the site or a zone as follows:

- Borehole hazardous gas flow rate (Q_{hg}) is calculated for each borehole standpipe for each monitoring event. The borehole hazardous gas flow rate is defined in BS8485 as the '*flow rate of a specific hazardous gas, either methane or carbon dioxide, from a borehole standpipe'*. The Q_{hg} is calculated from individual borehole measurements of total gas flow and the concentration of the specific hazardous gas. BS8485 states in Section 6.3.4 that the **maximum** gas concentration recorded during the monitoring event should be used, together with **steady-state** values of gas flows.
- The reliability of the measured gas flow rates and concentrations are assessed taking into account borehole construction;
- Decisions are made about how to deal with any temporal or spatial shortages in the data; and
- Judgements are made about what GSV to designate for use for design purposes taking all relevant information and the conceptual site model into account.

Once the Q_{hg} has been calculated for methane and carbon dioxide, individual borehole measurements are compared to the thresholds presented in Table 2 of BS8485 which inform the CS that directly relates to each individual measurement. Taking into account the site data (i.e. borehole gas concentration and flow rate to calculate the Q_{hg}) and all other influencing factors in accordance with the CSM, a decision can then be made regarding the GSV that is considered to be representative of the site or a zone within it.

Typical threshold concentrations of methane (1% v/v) and carbon dioxide (5% v/v), and flow rates (>70 l/h), are also considered when designating the GSV for the site or zone, which in turn dictates the hazard potential and CS. It is important to note that the site or zone characteristic GSV and maximum concentration or flow thresholds are guideline values and not absolute. The thresholds may be exceeded in certain circumstances, if the CSM indicates it is safe to do so.

7.5.3.2 Designation of a GSV for the site or zone

The results of the ground gas monitoring and testing undertaken, alongside site conditions at the time of monitoring, are given in **Appendix I**.

A summary of the maximum recorded concentrations per borehole (or minimum for oxygen) is presented in **Table 17** overleaf. This table also presents details of the response zone, maximum recorded initial and steady state flow rates and minimum recorded depth to water across all monitoring rounds.

The range of atmospheric pressure over the 3No monitoring rounds completed was 1008 - 1015 mbar and this was recorded to be falling at the time of one of the monitoring visits.

Table 17 Summary of ground gas monitoring results

Exploratory position ID	Response zone top (mbgl)	Response zone base (mbgl)	Response zone geological unit	No. of monitoring rounds	Peak CH_4 max. (%/vol)	Steady-state CH_4 max. (%/vol)	Peak CO_2 max. (%/vol)	Steady-state CO_2 max. (%/vol)	Oxygen min. (%/vol)	Peak gas flow max. (l/hr)	Steady-state gas flow max. (l/hr)	Depth to water min. (m)	Depth to water max. (m)	Atm. pressure min. (mb)	Atm pressure max. (mb)
BH1	1.00	4.93	London Clay Formation	3	<0.1	<0.1	3.5	3.5	17.1	<0.1	<0.1	Dry	4.20	1008	1015
BH2	1.00	4.98		3	<0.1	<0.1	6.3	6.3	12.6	<0.1	<0.1	4.80	4.83	1008	1015
BH3	1.00	4.93		3	<0.1	<0.1	1.6	1.6	18.2	<0.1	<0.1	0.80	3.93	1008	1015
BH4	1.00	4.83		3	<0.1	<0.1	7.6	7.6	10.1	<0.1	<0.1	Dry	Dry	1008	1015
BH5	1.00	4.95		3	<0.1	<0.1	5.3	5.3	10.5	<0.1	<0.1	1.81	2.80	1008	1015
BH6	1.00	5.00		3	<0.1	<0.1	1.9	1.9	17.0	<0.1	<0.1	Dry	Dry	1008	1015
BH7	1.00	4.97		3	<0.1	<0.1	1.0	1.0	8.4	<0.1	<0.1	Dry	Dry	1008	1015
BH8	1.00	4.91		3	<0.1	<0.1	9.4	9.4	10.0	<0.1	<0.1	Dry	3.05	1008	1015

7.5.3.3 *Designation of site gas screening value (GSV)*

BS8485 suggests that the GSV should be derived by multiplying the worse credible (worst case) recorded flow value in any standpipe in that strata or zone with the maximum gas concentration in any other standpipe in that strata or zone. Further guidance is given in BS8485 Section 6.3.

Considering the assessment of the gas monitoring results the following maximum GSV have been derived for the site.

- Methane GSV (0.0001 l/hr) = methane concentration (0.1% v/v)/100 x flow rate (0.1l/hr)
- Carbon Dioxide GSV (0.0094 l/hr) = carbon dioxide concentration (9.4% v/v)/100 x flow rate (0.1l/hr)

Based upon the GSV derived and the method for determining the CS presented within Table 2 of BS8485, the site can be characterised as CS1. BS8485 states that where elevated concentrations of methane (>1%) and carbon dioxide (>5%) are reported, consideration should be made to increase the Characteristic Situation from CS1 to CS2.

The main sources of ground gas comprise the following:

- Possibility of infilled former gravel pits in the north of site, giving rise to deep areas of Made Ground or ground gas generation; and
- Ground gas generation from Made Ground associated with a number of earth bunds present across the site.

The following exploratory hole locations in **Table 18** details locations with elevated concentrations of carbon dioxide during the programme of return monitoring. It is noted that no elevated concentrations of methane have been reported to date.

Table 18 Summary of elevated carbon dioxide concentrations

Exploratory Hole ID	Location	Peak CO2 Max (%/vol)		
		Monitoring Visit 1	Monitoring Visit 2	Monitoring Visit 3
BH2	South eastern area of site within bunded area, adjacent to pond feature	5.2	4.9	6.3
BH4	South western corner of site adjacent to school buildings	7.6	7.0	5.3
BH5	Central part of site located within playground area adjacent to school building	5.3	5.1	4.9
BH8	Northern part of site located adjacent to bunded area	7.5	9.4	8.7

In addition to the above, it is noted that monitoring location BH7 showed consistent depleted concentrations of oxygen (min: 8.4%), without the corresponding elevated carbon dioxide.

As shown above, consistent elevated concentrations of carbon dioxide were reported at the monitoring locations across the 3 No. return visits. It is noted that with reference to the exploratory hole location plan provided as **Figure 2**, these monitoring locations are spread across the entire site.

It has previously been acknowledged that the presence of the practically impermeable London Clay Formation underlying the entire site will reduce the migration of ground gases at the site. On this basis, it is considered that elevated concentrations of carbon dioxide may be a result of localised areas of Made Ground within the vicinity of the monitoring locations. This was as expected within the vicinity of the bunded soft landscaping areas and historical developments within the northern part of site.

On this basis, it is considered appropriate that the site is characterised as Characteristic Situation 2 (CS2) where basic gas protection measures are required.

7.5.3.4 Data Limitations

It should be noted that there are inherent limitations in ground gas monitoring including spatial adequacy of monitoring locations, changes in groundwater levels, variation in temporal or atmospheric conditions and whether these have been adequately characterised by the scope of monitoring undertaken.

The investigation undertaken to date has incorporated an appropriate number of ground gas monitoring visits, the data is considered reliable, and spatially representative of the site. It is also noted that 2 No. round(s) were completed during low and falling atmospheric pressure (<1000mb) indicating that possible worst-case conditions have been present during monitoring.

7.5.4 BS8485 recommended ground gas protection measures

Case 2: Characteristic Situation 2

Ground gas protective measures within buildings include a combination of:

- structural barriers;
- ventilation systems; and
- gas resistant membranes.

Section 7 of BS8485 provides a point scoring system for ground gas protective measures, whereby different barriers (i.e. structural barriers, ventilation systems, and gas resistant membranes) are assigned different point scores. A combination of protective measures (minimum of 2 types) can be used to achieve a total minimum gas protection point score, the total minimum point score required is determined based on the building type (see Table 3 in BS8485) and the risk classification.

Considering the CS determined for the site (CS2) and the proposed building type (Public building) a minimum point score (see Table 2 in BS8485) of 3 will be required to achieve an adequate level of protection.

As an example, a passive subfloor dispersal layer with a very good performance (score of 2.5) and a proprietary gas resistant membrane (score of 2) would provide a total point score of 4.5, which would be considered adequate for the proposed development.

It should be noted that for membranes to achieve a point score greater than zero they should be:

- Sufficiently impervious to methane and carbon dioxide;
- Capable after installation of providing a complete barrier to the entry of the relevant gas;
- Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;
- Sufficiently strong to withstand in service stresses (e.g. due to ground settlement if placed below a floor slab);
- Sufficiently strong to withstand the installation process and following construction activities until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, and dropping tools);
- Chemically resistant to degradation by other contaminants that might be present; and
- Verified in accordance with CIRIA C735.

A separate detailed gas protection design report should be prepared for the proposed mitigation measures and should be provided to and agreed with the local authority and relevant warranty providers prior to construction works commencing. The design report should include a combination of the following:

- Gas conceptualisation (severity of gas regime and sensitivity of land use);
- Building and construction related details such as floor slab, wall construction, ground conditions and any complex detailing
- Gas protection design sufficient to mitigate the gas risk and be practically installed given the building and construction related details. Likely to include venting calculations, product specifications, installation methodology and installer qualifications/experience
- Verification plan (prepared in accordance with CIRIA C735) to identify the verification tasks, frequency of such tasks and by whom they should be undertaken, regulatory requirement and contingency plans. The verification measures required will be dependent on a number of factors including the gas regime, the qualifications of the installers, the complexity of the design and the number of plots.

7.5.5 Implications of Foundation Design

As detailed in Section 11, piled foundation types are being considered for the development. Where such works may create preferential pathways for ground gas migration to the surface, this needs to be considered through the design process, such as through a foundation works risk assessment.

Should foundation solutions or building design change within the design process, then this gas risk assessment and mitigation should be reviewed and where applicable updated.

8 PRELIMINARY WASTE ASSESSMENT

In accordance with the definition provided in the Waste Framework Directive (WFD), materials are only considered waste if 'they are discarded, intended to be discarded or required to be discarded, by the holder'. Naturally occurring soils are not considered waste if reused on the site of origin for the purposes of development. Soils such as made ground that are not of clean and natural origin (irrespective of whether they are contaminated or not) and other materials such as recycled aggregate, do not become waste until the criteria above are met. Further background information is provided in **Appendix G**.

Excavation arisings from the development may therefore be classified as waste if surplus to requirements or unsuitable for reuse. The following assessments assume the material tested is classified subsequently as waste.

8.1 Hazardous waste assessment

Technical Guidance WM3 (EA, 2018) sets out in Appendix D requirements for waste sampling. It is a legal requirement to correctly assess and classify waste. The level of sampling should be proportionate to the volume of waste and its heterogeneity. The preliminary assessment provided below is based only upon the available sample results and may not be sufficient to adequately classify the waste.

8.1.1 Chemical contaminants

Envirolab, an RSK company, has developed a waste soils characterisation assessment tool (HASWASTE), which follows the guidance within Technical Guidance WM3. The analytical results have been assessed using this tool to assess the hazardous properties to support potential off-site disposal of materials in the future. Note that it is ultimately for landfills to confirm what wastes they are able to accept within the constraints of their permit.

The results of samples which identified hazardous properties are summarised in **Table 19** and presented in full in **Appendix R**. The remaining samples did not identify any hazardous properties.

Table 19 Results of waste soils characterisation assessment (HASWASTE)

Sample ref/ depth	Hazardous properties identified
TP4 (0.80m)	Ecotoxic HP14
TP13 (0.40m)	Carcinogenic HP7
	Mutagenic HP11

Samples TP4 (0.80m) and TP13 (0.40m) representing Made Ground and Subsoil respectively are classified as having hazardous properties. This suggests that some of the waste would require disposal at a suitably permitted hazardous waste landfill or treatment facility.

It is noted that sample TP4 (0.80m) was obtained from above ground level within a bunded area of soft landscaping within the southern part of site, identified as a contamination

hotspot. It is considered likely that this will require removal and subsequent disposal following landscaping works in this area.

8.1.2 Asbestos within waste soils

Technical Guidance WM3 requires that within a mixed waste the separately identifiable wastes be assessed separately.

For instance, where waste soil contains identifiable pieces of asbestos (visible to the naked eye) the asbestos should, where feasible, be separated from the soil and classified separately. This should be disposed of within a hazardous, stable non-reactive hazardous waste landfill or a special cell in a non-hazardous waste landfill.

Samples of potential asbestos containing material were collected from site and analysed for the presence of asbestos, the results of which are presented in **Appendix J**. Analysis confirmed that asbestos is not present within any of the samples analysed. Visible asbestos containing material was not identified on-site.

8.2 WAC assessment

The following combined samples detailed in **Table 20** were submitted for waste acceptance criteria (WAC) testing for 'Full 1 Batch Waste Suite', the results of which are presented in **Appendix J**.

Table 20 Combined WAC sample analysis

Sample Reference	Site Location	Sample ID	Sample Depth (m)
Combined Sample 1	Adjacent to southern boundary, within bunded area of soft landscaping.	TP3	0.75
		TP4	0.80
Combined Sample 2	Within soft landscaping area of school grounds, east of the main building.	TP7	0.50
		TP8	0.50
Combined Sample 3	North of the central pond feature.	TP11	0.50
		TP13	0.40
Combined Sample 4	Large bund within the northern part of site.	TP15	0.80
		TP16	0.50

The results of the WAC testing on Combined Sample 1 indicate that the leaching limit values and total content of organic parameters for inert waste have been exceeded and therefore the waste is not suitable for disposal within an inert landfill but should be disposed of at a landfill or treatment facility which is permitted to take non-hazardous waste.

The results of the WAC testing for Combined Samples 2 – 4 indicate that the leaching limit values and total content of organic parameters for inert waste have not been exceeded. Therefore, this waste would be suitable for disposal at an inert landfill or a site that has a valid exemption from the Environmental Permitting (England and Wales) Regulations 2016 (as amended) registered with the EA.

Based on the above, due to the size of the site, varying composition of made ground soils and the requirement for mass landscaping works for the proposed development, further sampling and testing is likely to be required for waste characterisation purposes at the development stage.

RSK recommends that a Sampling Plan be prepared to support any waste classifications and hazardous waste assessments, prior to any material being excavated. Given the level of data obtained, scale of the development and heterogeneity of the site soils, the following assessment should be considered indicative and further assessment should be undertaken following the preparation of a waste sampling plan.

9 GEOTECHNICAL ASSESSMENT

9.1 Proposed development

It is understood that the proposed development is to involve the relocation of the existing school and the development of residential units. A total of 5No residential blocks are proposed along the western boundary of site, ranging between 3No and 8No storeys with the inclusion of some basements.

Information regarding change of site levels has not been provided at the time of writing. It is anticipated that localised reprofiling of the site will be required.

From information provided by the client, it is understood that the proposed development will adopt a piled foundation solution within the underlying London Clay Formation and potentially the Lambeth Group. At this stage no specific information relating to building loads has been provided.

9.2 Key geotechnical hazards / development constraints

The key risks identified from the available ground investigation data are detailed below:

- Variable Made Ground deposits that may be unstable in open excavations and generally unsuitable as founding strata;
- London Clay soils of high-volume change potential and numerous mature trees present in parts of the site leading to a risk of swelling/shrinkage of the clay soils that will have implications for the design of foundations, floor slabs and pavements. In addition, any desiccated site won clay fill would be prone to swelling and cause problems if used below structures or pavements;
- Silt-rich soils susceptible to rapid loss of strength in wet conditions;
- Relatively high perched groundwater levels in the Made Ground and underlying London Clay;
- Adverse ground chemistry due to elevated sulphates in the London Clay;
- Variation in topography across the site; and
- Existing and historical sub-structures associated with current and historical site developments (e.g. tunnels, foundations, basements and adjacent sub-structures).

9.3 Ground model and characteristic values

The preliminary ground model summarised in **Table 21** has been adopted for the purpose of the preliminary foundation design recommendations.

The ground model is based on the representative ground conditions across the site, to provide the most conservative assessment with respect to the distribution of loadings for the new structures. It should be noted that

In summary, the ground model comprises made ground underlain by the London Clay Formation, before encountering a cohesive succession of the Lambeth Group.

Table 21 Ground model derived from ground investigation

Stratum	Depth to top of stratum (m bgl)	Thickness (m)
Made Ground	Ground level	0.2 - 2.5
London Clay Formation	2.5	23.8
Lambeth Group	26.3	Not proven +40.0m bgl

During the intrusive works groundwater strikes were noted as minor seepages. Rest groundwater levels recorded during return monitoring visits ranged from 0.80m to 4.83m bgl and are considered to be representative of perched groundwater bodies within shallow made ground and London Clay Formation deposits.

The geotechnical design parameters presented in **Table 22** are based on the results of the fieldwork, in-situ and laboratory testing, and reflect RSK's understanding of the proposed construction at the time of reporting. The Designer should assess the applicability of the characteristic values provided below for the design situation under consideration and to ensure that it is a cautious estimate of the value affecting the occurrence of the relevant limit state(s).

Table 22 Summary of characteristic geotechnical design parameters

Design parameter	Stratum		
	Made Ground	London Clay Formation	Lambeth Group
Unit weight - $\gamma_{,k}$ (kN/m^3)	18.0[1]	19.0 – 20.0[4]	20.0[4]
Undrained shear strength – $c_{u,}$ (kN/m^2)	-	40 @1mbgl + 9.73 z[4]	280 + 5.19 z[4]
Peak Effective Angle of Friction - $\varphi'_{pk,k}$ (◦)	27[2]	23[2]	23[2]
Critical State Angle of Friction - $\varphi'_{cv,k}$ (◦)	25[2]	21[3]	21[3]
Effective cohesion - $c'_{,k}$ (kN/m^2)	0[2]	2[2]	5[2]

Notes:
[1]Estimated from soil descriptions using Figure 1 & 2 of BS 8002:2015
[2]Assumed empirical values in the absence of testing
[3]Estimated using Table 2 for fine soils and equations 3 & 4 for coarse soils from BS 8002:2015
[4]Based on geotechnical laboratory testing carried out on site derived soil samples

9.4 Foundations

9.4.1 Foundation options

Given the anticipated relatively high column loadings associated with the proposed multi-storey residential blocks and need to mitigate ground movements associated with the extensive areas of basement, piled foundations are recommended to support the new buildings. In additional, restraint piles may be required to resist clay heave on the underside of the basement slab in podium garden or other similar areas where there is no

imposed loads from the superstructure above or potential for desiccated clay soils to remain at formation level.

9.4.2 Piled foundations

Recommendations for the design and construction of pile foundations in relation to the ground conditions are set out in **Table 23**.

Table 23 Design and construction of piled foundations

Design/construction considerations	Design/construction recommendations	
Pile type	The construction of both bored/CFA piles is considered technically feasible at this site.	
Possible constraints on choice of pile type	Driven piles will not be suitable due to ground vibration, noise and heave related issues.	
Temporary casing	Given the presence of groundwater strikes over the full depth of the investigation bored piles will require temporary casing throughout their depth. Alternatively, the use of continuous-flight-auger (CFA) injected bored piles usually overcomes this issue. It is recommended that a specialist piling contractor be consulted with respect to the most suitable piling technique for the prevailing ground and groundwater conditions.	
Made ground / potentially desiccated soils / proposed basements	For the purpose of assessing preliminary pile capacities the top 4m has been presumed not to contribute to the load-carrying capacity for the piles to account for the presence of made ground / potentially desiccated clay soils and proposed basement levels. This will need to be refined during detailed design to take account of variation in ground and basement levels for individual blocks.	
Man-made obstructions	The presence of buried sub-structures or other obstructions within made ground may lead to some difficulty during piling. It is recommended that once the proposed pile layout has been determined, pre-pile probing be carried out at each of the pile positions. Where buried obstructions are encountered, it will be necessary to either relocate the pile(s) or make allowance for removing the obstruction.	
Hard strata	An allowance should be made for chiselling thin 'rock' bands (claystone or siltstone) within the London Clay or underlying Lambeth Group.	
Pile design parameters for London Clay Formation	Pile design parameter	Bored/CFA
	Undrained shear strength c_u (kN/m^2)	Cu = 68 kN/m^2 @4m + 9.41 z kN/m^2 where z = depth into clay
	Adhesion factor α	0.5
	Bearing capacity factor, N_c	9

Design/construction considerations	Design/construction recommendations	
Pile design parameters for Lambeth Group	Undrained shear strength c_u (kN/m^2)	Cu = 280 kN/m^2 + 5.19 z kN/m^2 where z = depth into clay
	Adhesion factor α	0.4
	Bearing capacity factor, N_c	9
SLS Check	Factor of 1.2 on ultimate shaft friction	
Special precautions relating to bored pile shafts and bases	Bored pile concrete should be cast as soon after completion of boring as possible and in any event the same day as boring. Prior to casting the base of the pile bore should be clean, otherwise a reduced safe working load will be required. Similarly, if the pile bore is left open the shaft walls may relax/soften, leading to a reduced safe working load.	

The design resistance has been calculated in accordance with BS EN 1997-1 and the UK National Annex, using partial resistance factors for bored piles, given in **Table 24**.

Table 24 Partial resistance factors (γ_R)

Resistance	Set	
	DA1 C1	DA1 C2
Base - γ_b	1.0	2.0
Shaft (compression) - γ_s	1.0	1.6
Total (compression) - γ_t	1.0	2.0

The design procedure for piles varies considerably, depending on the proposed type of pile. However, for illustrative purposes, **Table 25** gives indicative factored pile resistances in accordance with EC7 for traditional bored/CFA, cast-in-situ concrete piles of various diameters and lengths based upon the characteristic design parameters given in **Tables 22** and **23**.

Table 25 Typical pile design resistances for bored/CFA cast-in-situ piles

Typical Design resistance for DA1 – Combinations C1 & C2 & SLS (kN)									
Pile toe depth	Pile diameter								
m bgl	450 mm			600 mm			750 mm		
	C1	C2	SLS	C1	C2	SLS	C1	C2	SLS
16	943	566	631	1341	796	841	1779	1047	1052
18	1156	697	792	1633	975	1056	2156	1276	1320
20	1388	839	969	1951	1169	1293	2564	1524	1616
22	1630	988	1154	2282	1372	1539	2988	1783	1924

Typical Design resistance for DA1 – Combinations C1 & C2 & SLS (kN)									
Pile toe depth	Pile diameter								
m bgl	450 mm			600 mm			750 mm		
	C1	C2	SLS	C1	C2	SLS	C1	C2	SLS
24	1872	1137	1340	2613	1574	1786	3413	2041	2233
26	2113	1285	1525	2944	1777	2033	3837	2300	2541
28	2371	1442	1710	3303	1994	2280	4307	2581	2850
30	2632	1600	1895	3668	2213	2527	4784	2866	3159

The geotechnical capacity should be taken as the minimum of the DA1-C2 or SLS resistances, which in this instance is the DA1-C2 resistances throughout.

It should be stressed that the above capacities do not take into consideration limiting concrete stress nor pile group effects, the latter of which is more pronounced for a large number of closely spaced piles.

Settlement of new piles designed on the basis of the working loads outlined above would typically be anticipated to be in the range of 0.5% to 1.0% of the pile diameter. It should be noted, however, that this range is for individual piles and could increase significantly if piles are installed in closely spaced groups. As such, it may be necessary to determine the overall settlement of the foundation system once the final pile layout is known.

The piles should be appropriately reinforced to mitigate the risk of heave induced by the proposed basement excavation. Further, for piles located within areas of tree influence, it is recommended that piles are designed to resist uplift forces over the top 4.0m, subject further to design considerations in accordance with NHBC standards or similar (i.e. heave protection to pile caps and ground beams).

Notwithstanding the above, it is recommended that the detailed advice of a specialist-piling contractor be sought as to the most suitable type of pile for the prevailing ground conditions and as to their lengths and diameters to support the required design loads.

9.4.3 Foundation works risk assessment

It is not anticipated that a foundation works risk assessment report will be required for the development because:

- The type of foundation proposed does not have the potential to create preferential pathways for migration of ground gas to surface or groundwater to depth;
- A considerable thickness of cohesive London Clay Formation has been encountered beneath the site is likely to significantly retard migration pathways and the foundations proposed will not affect this; and
- There are no identified ground gas sources present at depth that could be affected by the type of foundation proposed.

9.5 Floor slabs

9.5.1 Ground floor slabs

The site is generally underlain by more than 600mm of existing Made Ground and the underlying London Clay sub-grade soils have a high volume change potential. Therefore, it is recommended that ground floor slabs should be suspended. The NHBC standards should be referenced in respect to the minimum void dimensions required to accommodate potential ground movement beneath ground floor slabs and ground beams.

9.5.2 Basement floor slabs

The formation level of the new basements to Block 1A, Blocks 1C & 1D and Blocks 1E & 1F will lie within the London Clay Formation. Perched groundwater levels have been recorded within the Made Ground and surface of the London Clay at depths ranging between 1.0m to 4.8m bgl, i.e. in some instances above the underside of the proposed basement slab levels.

It is estimated that the excavation of the proposed single and double basement levels to the blocks above will require the removal of some 3.50m up to a maximum of 7.20m of overburden soil. The removal of soil to form the basement excavations will lead to an unloading in the order of 70 to 144 kN/m^2, which will result in short term elastic heave and longer term swelling of the London Clay. These ground movements will be mitigated in part by the loads imposed by the proposed multi-storey buildings, but will likely result in some longer-term heave movement that will affect the ground outside of the immediate construction envelope and could potentially affect adjoining properties and infrastructure.

A preliminary ground movement assessment has been completed to estimate the potential magnitude of short and long term heave associated with the unloading due to excavation of the proposed basement structures. The results of the preliminary analysis for each of the blocks are summarised below and plots are presented in **Appendix S**. These preliminary results are only indicative because no detailed sections where available showing the variation in the relationship between existing ground levels and the proposed basement formation levels. In addition, the analysis doesn't consider the reimposed loads from the proposed development and further detailed analysis will be required once a foundation schemes have been developed.

Block 1A

Estimates of 20mm and 50mm of short and long term heave, respectively, at the centre of the basement excavation. Assuming the majority of the short term heave movement occurs immediately following excavation / prior to the construction of the basement slab, it would leave approximately 25 to 30mm of remaining long term heave.

Blocks 1C & 1D

Estimated short term heave of 20mm at the centre of Block 1C and 40mm at the centre of Block 1D and long term heave of 70 mm and 135 mm, respectively. Based on the assumption above this would leave approximately 50 to 100mm of remaining long term heave beneath Block 1C and 1D, respectively.

Blocks 1E & 1F

Estimated short term heave of 20 to 25mm at the centre of Blocks 1E and 1F, 40 to 45mm at the centre of the overlap of Blocks 1E and 1F and long term heave of 55 to 60mm and 80 to 85mm, respectively. Based on the assumption above this would leave approximately 35 to 40mm of remaining long term heave beneath Block 1C and 1D, respectively.

Consideration will need to be given to designing the basement slab to withstand heave of the underlying clay soils resulting from unloading due to excavation and hydrostatic pressures, which should allow for groundwater levels to rise at some point in the future. The greater of the heave or hydrostatic pressure should be used in design.

The heave pressures exerted by heave of the underlying clay will depend on many issues not least the time delay from excavation to slab construction. For preliminary purposes it may be expected that the heave pressure will be equivalent to approximately 25% of the unloading indicated above. Alternatively, pressures associated with clay heave may be mitigated by suspending the slab with a proprietary void former beneath the slab.

9.6 Roads and hardstanding

In the 1 m to 1.5 m below the proposed finished ground level the exploratory holes have revealed a soil profile comprising variable made ground over firm medium strength high to very high plasticity clays.

In pavement design terms, the groundwater conditions are anticipated to comprise a low water table, i.e. at least 1 m below the pavement formation level.

The estimated minimum, equilibrium soil-suction, California bearing ratio (CBR) value for the soils and groundwater conditions described above under a completed pavement is 2.5 to 3.0%, based upon Table C1 in TRRL (1984) Report LR1132.

The results of in-situ testing dynamic cone penetration (DCP) tests are summarised in **Table 26**.

Table 26 Summary of CBR values derived from in-situ DCP tests

Test location	Minimum CBR value determined at or just below anticipated formation level
TP2	Typically 5% or greater
TP4	Typically 5% or greater
TP5	Typically 5% or greater
TP6	Typically 5% or greater
TP10	Typically 5% or greater
TP13	Typically 5% or greater
BH1	Typically 5% or greater
BH5	Typically 5% or greater

The recommended sub-grade soil CBR value for road pavement design is therefore 2% to 3% %. This value assumes that during construction the formation level will be carefully compacted and any soft spots removed and replaced with well-compacted granular fill.

The sub-grade condition at the time of construction should be confirmed by testing at the final formation level by in situ CBR testing.

Due to the variability observed within the made ground, the sub-grade soils can be regarded as frost-susceptible, based upon the criteria given in Appendix 1 of TRRL (1970) Report Road Note 29. When the sub-grade is frost-susceptible the thickness of sub-base must be sufficient to give a total thickness of non-frost-susceptible pavement construction over the soil of not less than 450 mm.

We note the presence of numerous mature trees in some areas of the site, which if removed will likely lead to some heave of the high volume change potential soils within their zone influence. This heave movement could continue for many years after removal of the tree(s) and the resulting movements could be sufficient to cause damage or result in uneven surfaces to roads/pavements/sports pitches leading to the requirement for some on-going long term maintenance.

Similarly, if desiccated site won clay soils are reused beneath surfaced areas these will be prone to swelling as soil moisture contents return to equilibrium values giving rise to similar issues. It is therefore recommended that all site won clay material excavated within the influence of trees (as defined by the NHBC guidance) should only be reused in non-structural landscaping applications where swelling would not cause any future problems.

9.7 Excavations

Generally, the trial pits remained stable during excavation which indicates that relatively shallow/small excavations should also remain stable in the short term. In the event that excavations are to remain open for longer periods or for larger excavations, consideration should be given to the use of appropriate support systems or battering back excavation sides to a safe slope angle.

The recommended maximum safe slope angles for the strata encountered are provided in **Table 27** and parameters for retaining wall design are presented in the following section.

Table 27 Recommended maximum safe slope angles for temporary excavations

Strata	Temporary (Short Term)
Made ground	1v : 2h - 1v : 1.5h[1]
Kempton Park Gravel	1v : 1h
Note:	[1]Steeper slope angle may be achievable subject to observations on site Safe slope angles above assume relatively 'dry' conditions. Excavations will require support and dewatering where perched groundwater is encountered

Suitably trained and experienced personnel should be present on site during the formation of temporary excavations to confirm suitability of the safe slope angles for the conditions encountered. It should also be noted that the safe slope angles given above do not take

account of any applied loadings at or near the crest of the slope, presence of groundwater or restrictions on lateral movement to protect adjacent utilities or other infrastructure.

A detailed assessment should be undertaken by the temporary works designer for all proposed excavation slopes to account for factors such as any imposed live loadings and protection of nearby assets/infrastructure.

Man entry into any excavations should not be undertaken without provision of suitable shoring and support and dewatering or suitable regrading and battering of side slopes to safe angles. Confined spaces protocols for the Health and Safety of personnel should always be used where man entry into excavations is to be undertaken as low oxygen conditions may be present.

The cohesive nature of the soils encountered suggests that pumping from open sumps should be sufficient to keep the excavations reasonably dry.

Excavation should be possible using conventional site plant. Breakers may be necessary to remove any concrete obstructions within the Made Ground.

9.8 Retaining wall design

The following soil parameters in **Table 28** may be used for retaining wall design purposes.

Table 28 Retaining wall design parameters

Soil type	Unit weight γ_k (kN/m^3)	Short Term Parameters		Long Term Parameters	
		$c_{u,k}$ (kN/m^2)	$\phi'_{cv,k}$ (°)	$c'_{,k}$ (kN/m^2)	$\phi'_{cv,k}$ (°)
Made ground (mixed soils)	18.0	-	27*	0	27*
London Clay	19.0 - 20.0	40 @1mbgl + 9.73 z^4	-	2*	23*
Lambeth Group	20.0	280 + 5.19 z^4	-	2*	23*
Notes: *Assumed from soil descriptions, published literature and/or previous experience					

Perched groundwater levels have been encountered within the Made Ground and London Clay, therefore allowance should be made for hydrostatic pressures acting behind retaining structures. The design groundwater level should take account for a potential future rise in groundwater levels and accidental events, such as a burst water main. Furthermore, the new basement construction must be designed to be fully sealed to prevent any future groundwater ingress.

In order to prevent damage to adjacent structures and road infrastructure, the design of the retaining wall must address the risk of excessive deformation of the wall. Bracing, both in the temporary and permanent condition will therefore be required, to ensure that the horizontal and vertical soil movement remain within acceptable levels.

9.9 Chemical attack on buried concrete

This assessment of the potential for chemical attack on buried concrete at the site is based on BRE Special Digest 1: Concrete in aggressive ground, which represents the most up-to-date guidance on this topic currently available in the UK.

The desk study and site reconnaissance indicate that, for the purposes of assessing the aggressive chemical environment of the site, the site should be considered as comprising natural ground likely to contain pyrite.

Based on testing results, **Table 29** gives the characteristic pH, water-soluble and total sulphate content values for soils from Made Ground and London Clay Formation soils encountered on-site.

Table 29 Characteristic pH, water soluble sulphate and total sulphate values

Stratum	pH	Water Soluble Sulphate (mg/l)	Total Potential Sulphate (%)
Made Ground	10.84 – 6.73	<1 – 450	-
London Clay Formation	7.74 – 8.64	72 – 2370	0.00 – 1.07

Based on the results above and following the steps outlined in the BRE guidance, the Design Sulphate Classes and Aggressive Chemical Environment for Concrete classifications are summarised in **Table 30**, on the basis of water soluble sulphate and total potential sulphate, respectively.

Table 30 Concrete design class

Stratum	Ground water	Water Soluble Sulphate		Total Potential Sulphate	
		DS Class	AC Class	DS Class	AC Class
Made Ground	Mobile	DS-1	AC-1	-	-
London Clay Formation	Static	DS-3	AC-3	DS-3	AC-3

The recommended ACEC Classification is therefore AC-3 with a Design Sulphate Class of DS-3.

However, if the proposals include the reuse of the pyritic London Clay Formation, i.e. cutting and filling, or excavation and backfill, it is recommended ACEC Classification will increase to AC-3 with a Design Sulphate Class of DS-3.

10 CONCLUSIONS

10.1 Ground model

The ground investigation has identified a profile comprising either topsoil and/or Made Ground underlain by natural cohesive deposits of the London Clay Formation. The Lambeth Group was encountered at depth underlying the London Clay Formation comprising a cohesive nature, with some siltstone bands encountered at greater depths.

Groundwater was generally encountered as minor seepages throughout the majority of the boreholes. Resting groundwater reported during return monitoring of shallow monitoring well installations were considered to represent shallow perched groundwater bodies.

Whilst the field observations to the made ground soils reported the presence of some anthropogenic content, there was no significant evidence to suggest any widespread and/or persistent contamination.

10.2 Geo-environmental assessment

Based upon the results of the site investigation and GQRA, no site-wide contamination issues have been identified and the site appears suitable for the residential development subject to the use of remedial measures.

Some limited contamination issues have been identified, particularly within earth bunds within the southern part of site (TP4). The identified contamination currently poses potential risks to human health, consequently remediation measures will be required to mitigate and/or accommodate these risks.

Based on the ground gas monitoring completed to date, it is considered appropriate that the site is characterised as CS2, due to marginally elevated (>5%) ground gas levels of carbon dioxide at a number of locations.

Should unforeseen contamination be encountered during the development then specialist advice should be sought to determine the appropriate course of action. Imported material (e.g. topsoil, subsoil) should be validated before use on-site to confirm its suitability.

10.3 Waste

With respect to waste disposal, samples of made ground and shallow subsoil were found to contain hazardous properties based on the hazardous waste assessment.

No visual asbestos containing material was identified on site. In addition, laboratory analysis confirmed that asbestos is not present within any of the samples analysed. Due to the size of the site and the limited testing undertaken to date, it is not considered appropriate to discount the potential presence of asbestos within the wider site area at this stage.

Waste Acceptance Criteria testing indicates that some waste is not suitable for disposal within an inert landfill but should be disposed of at a landfill or treatment facility which is permitted to take non-hazardous waste.

Due to the size of the site, varying composition of made ground soils and the requirement for mass landscaping works for the proposed development, further sampling and testing is likely to be required for waste characterisation purposes at the development stage. A sampling plan should be prepared to support any waste classifications and hazardous waste assessments, prior to any material being excavated.

10.4 Geotechnical assessment

The key risks identified from the available ground investigation data are discussed below:

- Variable Made Ground deposits that may be unstable in open excavations and generally unsuitable as founding strata;
- London Clay soils of high-volume change potential and numerous mature trees present in parts of the site leading to a risk of swelling/shrinkage of the clay soils that will have implications for the design of foundations, floor slabs and pavements. In addition, any desiccated site won clay fill would be prone to swelling and cause problems if used below structures or pavements;
- Silt-rich soils susceptible to rapid loss of strength in wet conditions
- Adverse ground chemistry due to elevated sulphates in the London Clay;
- Variation in topography across the site; and
- Existing and historical sub-structures associated with current and historical site developments (e.g. tunnels, foundations, basements and adjacent sub-structures).

At the time of writing it is understood that the proposed development comprises the relocation of the existing school and the development of residential units. A total of 5No residential blocks are proposed along the western boundary of site, ranging between 3No and 8No storeys with the inclusion of large 1 to 2 level basements.

In view of the relatively high column loadings anticipated for the proposed multi-storey residential blocks and need to control ground movements associated with the extensive areas of basement, a piled foundation solution is recommended. In additional, restraint piles may be required to resist heave pressures on the underside of the basement slab in podium garden or other similar areas where there is no imposed loads from the superstructure above or where potentially desiccated clay soils remain below the formation level. At this stage no specific information relating to building loads has been provided.

Pile foundations should be appropriately reinforced to mitigate the risk of heave induced by the proposed basement excavation. Further, for piles located within areas of tree influence, it is recommended that piles are designed to resist uplift forces over the top 4.0m, subject further to design considerations in accordance with NHBC standards or similar (i.e. heave protection to pile caps and ground beams).

A foundation works risk assessment will not be required for the development.

It is recommended that ground floor slabs should be suspended due to the presence of Made Ground and London Clay sub-grade soils with a high volume change potential.

Consideration will need to be given to designing the basement slab to withstand heave of the underlying clay soils resulting from unloading due to excavation and hydrostatic pressures, which should allow for groundwater levels to rise at some point in the future. The greater of the heave or hydrostatic pressure should be used in design. Pressures associated with clay heave may be mitigated by suspending the slab with a proprietary void former beneath the slab.

In the view of variable made ground and the silt rich and highly plastic nature of the underlying natural strata, the recommended sub-grade soil CBR value for the preliminary road pavement design is 2.5 to 3.0%. Due to the variability within the Made Ground subgrade soils, the materials should be regarded as frost suspectable. The removal of trees will lead to heave movement that could go on for a number of years and affect roads/pavements/sports pitches leading to the requirement for some on-going maintenance.

It is recommended that buried concrete piled foundations are designed in accordance with Design Sulphate Class DS-3 and Aggressive Chemical Environment for Concrete Class AC-3 (ACEC-AC).

Given the impermeable nature of the soils beneath the site, the ground conditions do not appear suitable for the use of pit soakaways. However, consideration could be given to discharging to existing storm water/foul sewer systems.

11 RECOMMENDATIONS

Following the site assessment, the following recommendations are made in relation to redevelopment of the site for a residential end-use:

- Production of Remedial Strategy to confirm mitigation requirements and provide strategy for dealing with unforeseen ground conditions – this may require updating once the development layout is finalised;
- Additional assessment of the earth bunds to provide more confidence on their contents;
- Japanese Knotweed and Giant Hogweed has not been identified. A re-assessment should be undertaken at the start of the growing season (April);
- Re-use of natural arisings on site will be possible but Made Ground will only be able to be re-used if proven to be chemically suitable for use and there is also geotechnical suitability (if required). Made Ground could be re-used beneath buildings and hardstanding;
- Production of a Materials Management Plan (MMP) if re-use of soils is proposed on site;
- Ground gas design report together with a verification plan (in line with C735) should be prepared for the NHBC and Local Authority approval prior to implementing the mitigation measures;
- Discussion with Local Authority and Environment Agency as needed to confirm the conclusions and recommendations are accepted;
- Verification report following ground remediation and installation of ground gas protection measures;
- It is recommended that the detailed advice of a specialist-piling contractor be sought at the earliest opportunity to determine the most suitable type of pile for the prevailing ground conditions and lengths and diameters required to support the required design loads;
- A detailed ground movement assessment should be undertaken for the development once the proposed loading information and foundation layout is known;
- The sub-grade condition at the time of construction should be confirmed by testing at the final formation level by in situ CBR testing.

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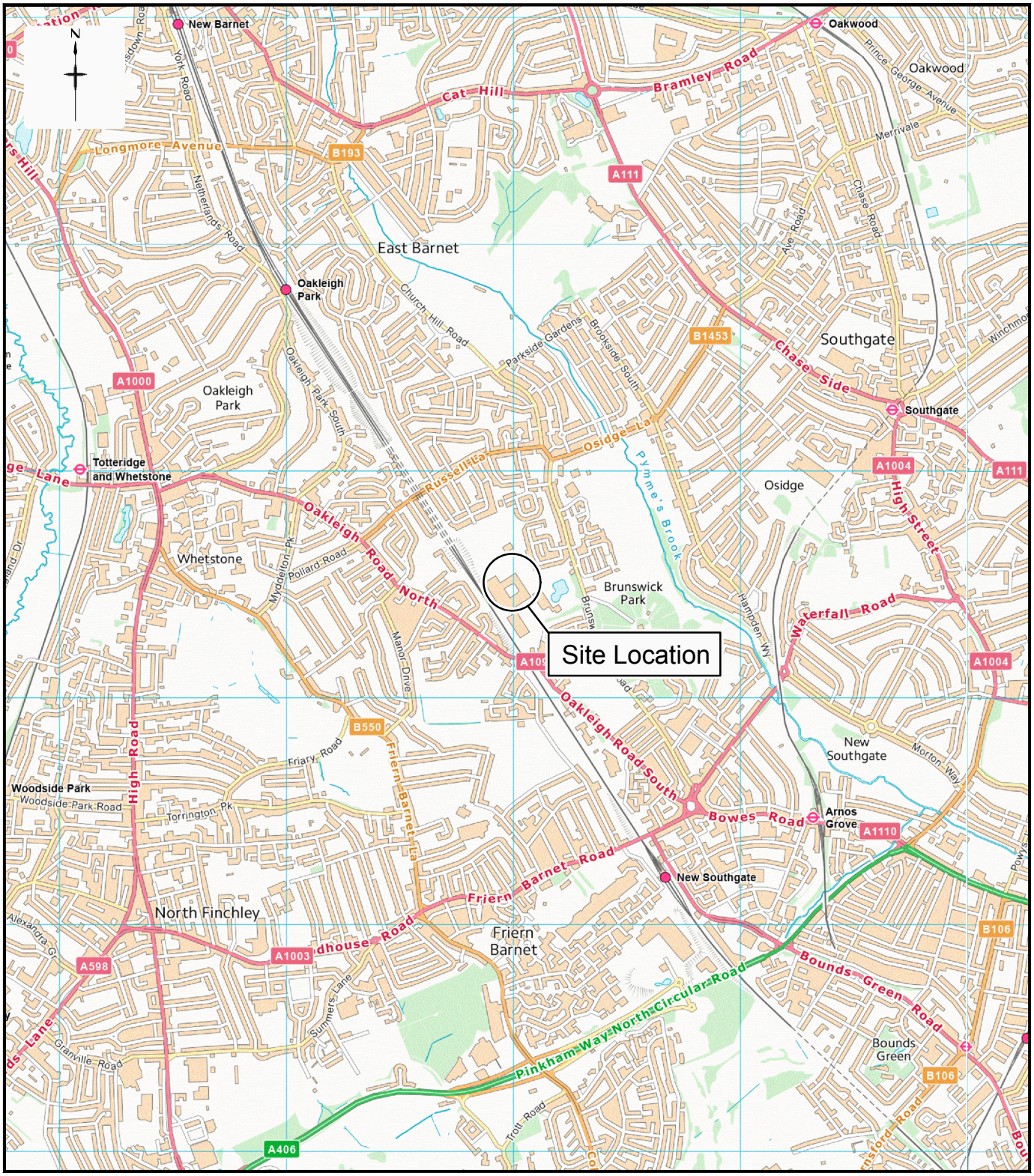
FIGURES



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Client: COMER HOMES GROUP

Project Title: NORTH LONDON BUSINESS PARK, BRUNSWICK PARK RD, LONDON, N11 1GN

Drawing Title: SITE LOCATION PLAN

Rev	Drawn	Date	Checked	Date	Approved	Date
01	LN	20.10.20	AM	20.10.20	AM	20.10.20

Dimensions	Scale	Original Size
m	1:25,000	A4

Project Number	Drawing File	Drawing Number
1921321 - R01 (00)	1921321 (R01-00) Figure 1.dwg	FIGURE 1

Key:

- Cable Percussive Borehole
- Mechanically Excavated Trial Pit
- Site Store, Skip and Welfare Point

RSK	**Provisional Exploratory hole location plan rev2**	**Client:**	**Comer Homes Group**	**Figure No:**	**2**
		Site:	**North London Business Park**	**Job No:**	**1921321**
		Scale:	**Not to scale**	**Source:**	**Client**

APPENDIX A
SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Comer Homes Group (the "Client") in accordance with the terms of a contract [RSK Environment Standard Terms and Conditions] between RSK and the Client, dated 16th July 2020. The Services were performed by RSK with the reasonable skill and care ordinarily exercised by an environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the Client.
2. Other than that, expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the Client. RSK is not aware of any interest of or reliance by any party other than the Client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the Client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the Client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, invasive plants, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials, unless specifically identified in the Services.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a visual inspection of the site together with RSK's interpretation of information, including documentation, obtained from third parties and from the Client on the history and usage of the site, unless specifically identified in the Services or accreditation system (such as UKAS ISO 17020:2012 clause 7.1.6):

a. The Services were based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely.

b. The Services were limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the visual inspection.

c. The Services did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services.

RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the Client and RSK.

8. The intrusive environmental site investigation aspects of the Services are a limited sampling of the site at pre-determined locations based on the known historic / operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the properties of the materials adjacent and local conditions, together with the position of any current structures and underground utilities and facilities, and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters (as stipulated in the scope between the client and RSK, based on an understanding of the available operational and historical information) and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (intrusive and sample locations etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.

10. The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels and ground gas concentrations and flows, may vary from those reported due to seasonal, or other, effects and the limitations stated in the data should be recognised.

11. Asbestos is often observed to be present in soils in discrete areas. Whilst asbestos-containing materials may have been locally encountered during the fieldworks or supporting laboratory analysis, the history of brownfield and demolition sites indicates that asbestos fibres may be present more widely in soils and aggregates, which could be encountered during more extensive ground works.

12. Unless stated otherwise, only preliminary geotechnical recommendations are presented in this report and these should be verified in a Geotechnical Design Report, once proposed construction and structural design proposals are confirmed.

APPENDIX B
DEVELOPMENT DRAWINGS

BLOCK 4C
Max. Storey Height: 9
GEA: 27,946 sqm
No. Units: 158

BLOCK 4B
Max. Storey Height: 9
GEA: (Retail) : 503 msq
GEA: (Resi): 15,048
No. Units: 84

BLOCK 5B
Max. Storey Height: 9
GEA: 10,500 sqm
No. Units: 59

BLOCK 5A
Max. Storey Height: 9
GEA (Resi): 32,902
GEA (Office) : 2,354
No. Units: 197

BLOCK 3B
Max. Storey Height: 9
GEA: 20,913 msq
No. Units: 115

BLOCK 2C
Max. Storey Height: 4
GEA: 4,561 sqm
No. Units: 22

BLOCK 2F
Max. Storey Height: 3
GEA: 1,948 sqm
No. Units: 9

BLOCK 4A
Max. Storey Height: 9
GEA: 16, 693 sqm
No. Units: 94

BLOCK 3C
Max. Storey Height: 5
GEA: 5,760 sqm
No. Units: 32

BLOCK 3A
Max. Storey Height: 9
GEA (Resi): 17,724 sqm
GEA (Community) : 510 msq
GEA (Retail) : 650 msq
GEA (Office) : 660 msq
GEA (Childcare): 300msq
No. Units: 115

BLOCK 2E
Max. Storey Height: 3
GEA: 3,528 sqm
No. Units: 16

BLOCK 1B
Max. Storey Height: 3
GIA: 965 sqm
No. Units: 07

BLOCK 1C
Max. Storey Height: 7
GIA: 17,553 sqm
No. Units: 114

BLOCK 1D
Max. Storey Height: 7
GIA: 24,809 sqm
No. Units: 123

BLOCK 1E
Max. Storey Height: 8
GIA: 10,273 sqm
No. Units: 58

BLOCK 1F
Max. Storey Height: 8
GIA: 9,617 sqm
No. Units: 58

BLOCK 2B
Max. Storey Height: 4
GEA: 6,188 sqm
No. Units:28

BLOCK 2A
Max. Storey Height: 5
GEA: 7,624 sqm
No. Units: 42

BLOCK 2D
Max. Storey Height: 3
GEA: 4,680 sqm
No. Units: 22

BLOCK 1A
Max. Storey Height: 3
GIA: 12,429 sqm
Education/Sports:

Phase 1
Phase 2
Phase 3
Phase 4
Phase 5

1A Hall
1A Changing
1A Main School Building
1B
1C
1D
1E
1F
2A
2B
2C
2D
2E
2F
3A
3B
3C
4A
4B
4C
5A
5B

3-Storey
3-Storey
3-Storey
3-Storey

OAKLEIGH ROAD NORTH
HAYNES CLOSE
BRUNSWICK CRESCENT
BRUNSWICK PARK GARDENS
HOWARD CLOSE
PINE ROAD
WEIRDALE AVENUE
New Southgate Cemetery and Crematorium

General Notes

1. Developmentment Zones (within which development can occur) and public open spaces are identified on drawing number 211_WS_02_01
2. Access and circulation routes are identified on Drawing number 211_WS_02_02.
3. Landscape treatments are identified on drawing number 211_WS_02_03
4. Allowable uses at ground floor frontages are identified on Drawing number 211_WS_02_04
4. Allowable uses at ground floor frontages are idnetified on Drawing number 211_WS_02_04
5. Allowable horizontal limits of deviations are identified on Drawing number 211_WS_02_05
6. Proposed site ground levels and allowable vertical deviations are identified on Drawing number 211_WS_02_06
7. Heights and allowable vertical deviations are identified on Drawing number 211_WS_02_07
8. Basement extents and allowable horizontal and vertical deviation are identified on drawing number 211_WS_02_08

Additional Notes

1. Refer to Section 5 of the Design Principles Document for further guidance on the Development Zone.
2. Refer to section 4 of the Design Principles Document for further guidance on the Public Open Space Zones, access routes typologies , and landscaping treatments of streets and spaces.
3. Refer to section 3 of the Design Principles Document for further guidance on the streets and circulation routes.

NOTES:

REV.	DATE:	DETAILS:	INITIALS:
A	27/04/2016	General revision	DT
B	10/03/2017	General revision	SDG

Legend

- Planning Application Boundary
- Public Open Space
- Detailed Application Zone Blocks
- Phase 1 — Detailed Application Zone Reference
- 1A — Detailed Application Zone Block Reference
- + 57.00 — Proposed Site Basement Level_(AOD) Limit of Deviation +/- 2.0m
- Phasing of Outline Component of Application

NORTH POINT:

KEY PLAN:

PLUS ARCHITECTURE
Exchequer Chambers, Exchequer Street, Dublin 2, Ireland.
W: www.plusarchitecture.ie T: 353 (0) 1 521 3378

PROJECT:	North London Business Park	PROJECT: 211	DATE: 10/03/17
CLIENT:	The Corner Group	DRAWING NO.: 211_WS_02_01	REVISION NO.: B
TITLE:	Proposed Development Zone Plan	DRAWN BY.: SDG	SCALE AT A1 .: 1 : 1000
ISSUE TYPE:	Planning	CHECKED BY.: DT	SCALE AT A3 .: 1 : 2000

APPENDIX C
SUMMARY OF LEGISLATION AND POLICY RELATING TO LAND CONTAMINATION

Part IIA of the Environmental Protection Act 1990

Part IIA of the Environmental Protection Act 1990 (Part IIA) and its associated Contaminated Land Regulations 2000 (SI 2000/227), which came into force in England on 1 April 2000, formed the basis for the current regulatory framework and the statutory regime for the identification and remediation of contaminated land. Part IIA of the EPA 1990 defines contaminated land 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 that there is significant possibility of significant harm being caused, or that pollution of controlled waters is being or is likely to be caused'. Controlled waters are considered to include all groundwater, inland waters and estuaries.

In August 2006, the Contaminated Land (England) Regulations 2006 (SI 2006/1380) were implemented, which extended the statutory regime to include Part IIA of the EPA as originally introduced on 1 April 2000, together with changes intended chiefly to address land that is contaminated by virtue of radioactivity. These have been replaced subsequently by the Contaminated Land (England) (Amendment) Regulations 2012, which now exclude land that is contaminated by virtue of radioactivity.

The intention of Part IIA is to deal with contaminated land issues that are considered to cause significant harm on land that is not undergoing development (see Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, April 2012). This document replaces Annex III of Defra Circular 01/2006, published in September 2006 (the remainder of this document is now obsolete).

Planning Policy

Contaminated land is often dealt with through planning because of land redevelopment. This approach was documented in Planning Policy Statement: Planning and Pollution Control PPS23, which states that it remains the responsibility of the landowner and developer to identify land affected by contamination and carry out sufficient remediation to render the land suitable for use. PPS23 was withdrawn early in 2012 and has been replaced by much reduced guidance within the National Planning Policy Framework (NPPF), reference ISBN: 978-1-5286-1033-9, February 2019.

The new framework has only limited guidance on contaminated land, as follows:

Chapter 11. Making effective use of land

117 Planning policies and decisions should promote an effective use of land in meeting the need for homes and other uses, while safeguarding and improving the environment and ensuring safe and healthy living conditions. Strategic policies should set out a clear strategy for accommodating objectively assessed needs, in a way that makes as much use as possible of previously-developed or 'brownfield' land.

118. Planning policies and decisions should:

c) give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land.

Chapter 15. Conserving and enhancing the natural environment

170. Planning policies and decisions should contribute to and enhance the natural and local environment by:

e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and

f) remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.

Ground conditions and pollution

178. Planning policies and decisions should ensure that:

a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);

b) after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990; and

c) adequate site investigation information, prepared by a competent person, is available to inform these assessments.

179. Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.

Water Resources Act (WRA)

The Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009 updated the Water Resources Act 1991, which introduced the offence of causing or knowingly permitting pollution of controlled waters. The Act provides the Environment Agency with powers to implement remediation necessary to protect controlled waters and recover all reasonable costs of doing so.

Water Framework Directive (WFD)

The Water Framework Directive 2000/60/EC is designed to:

- enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands that depend on the aquatic ecosystems
- promote the sustainable use of water
- reduce pollution of water, especially by ‘priority’ and ‘priority hazardous’ substances
- ensure progressive reduction of groundwater pollution.

The WFD requires a management plan for each river basin be developed every six years.

Groundwater Directive (GWD)

The 1980 Groundwater Directive 80/68/EEC and the 2006 Groundwater Daughter Directive 2006/118/EC of the WFD are the main European legislation in place to protect groundwater. The 1980 Directive is due to be repealed in December 2013. The European legislation has been transposed into national legislation by regulations and directions to the Environment Agency.

Priority Substances Directive (PSD)

The Priority Substances Directive 2008/105/EC is a 'Daughter' Directive of the WFD, which sets out a priority list of substances posing a threat to or via the aquatic environment. The PSD establishes environmental quality standards for priority substances, which have been set at concentrations that are safe for the aquatic environment and for human health. In addition, there is a further aim of reducing (or eliminating) pollution of surface water (rivers, lakes, estuaries and coastal waters) by pollutants on the list. The WFD requires that countries establish a list of dangerous substances that are being discharged and EQS for them. In England and Wales, this list is provided in the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. In order to achieve the objectives of the WFD, classification schemes are used to describe where the water environment is of good quality and where it may require improvement.

Environmental Permitting Regulations (EPR)

The Environmental Permitting (England and Wales) Regulations 2016 (as amended) provide a single regulatory framework that streamlines and integrates waste management licensing, pollution prevention and control, water discharge consenting, groundwater authorisations, and radioactive substances regulation. Schedule 22, paragraph 6 of EPR 2016 states: 'the regulator must, in exercising its relevant functions, take all necessary measures - (a) to prevent the input of any hazardous substance to groundwater; and (b) to limit the input of non-hazardous pollutants to groundwater so as to ensure that such inputs do not cause pollution of groundwater.'

Notes:

1. *The above information is provided for background but does not constitute site-specific advice*
2. *The above summary applies to England only. Variations exist within other countries of the United Kingdom*

APPENDIX D
SUPPORTING INFORMATION

Phase I Geo - Environmental Assessment

North London Business Park and Land at Oakleigh Road South, New Southgate, UK

Comer Homes

December 2007

WSP

QM

Issue/revision	Issue 1	Revision 1	Revision 2	Revision 3
Remarks	Draft			
Date	December 2007			
Prepared by	A Reeder			
Signature				
Checked by	M Wheeler			
Signature				
Authorised by	M Wheeler			
Signature				
Project number	12220279			
File reference				

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Contents

Part 1: North London Business Park

Executive Summary

WSP Environmental Ltd (hereafter referred to as WSPE) was instructed by Comer Homes to undertake a Phase I Geo - Environmental Assessment of the land at North London Business Park (referred to by Comer Homes as Brunswick Park). The report highlights environmental considerations, predominantly with respect to ground conditions, and is required as part of the planning application associated with the site. Please refer to Appendix E for WSP's Methodology and Limitations.

Key Findings

The subject site comprises North London Business Park, and includes commercial buildings ranging from single to three storey buildings (ground plus two), surface and multi storey car parking areas, overgrown sports grounds, soft landscaped areas and a lake. There are significant changes in levels across the site, and a number of bunds are present from previous phases of redevelopment.

The site is located in New Southgate, within Barnet, adjacent to the east of the overland train station, in a predominantly residential area with the occasional commercial property.

Historical maps indicate that the site was partially associated with the cemetery in 1863. By 1879 railway sidings and gravel pits were noted on the site. New Southgate Works and a sports ground were present by 1936 and during the 1990s and 2000s building layouts changed. Surrounding land uses include a railway, residential properties, a cemetery, industrial properties and a sewage works.

The Local Authority has provided information relating to nearby historic landfills. In addition it indicated that an intrusive phase II investigation is likely to be required and contamination issues will be dealt with during the planning process associated with redevelopment.

It is understood that the site was subject to bombing in the Second World War, and as such there is a potential for unexploded ordnance to be present on site.

Liability

Based on the information contained within this report and with due regard to redevelopment (including residential with gardens), it is the opinion of WSPE that the site represents a **medium** risk with respect to environmental considerations.

Based on the information contained within this report, it is the opinion of WSPE that the site represents a **medium** risk with respect to geotechnical considerations.

Recommendations

No further work is considered necessary for the ongoing current use of the site. However, the following recommendations should be considered prior to redevelopment:

- An intrusive phase II investigation should be undertaken to provide information relating to contamination issues, provide preliminary geotechnical advice and a ground gas assessment.
- An unexploded ordnance desk study.

1 Site Information

1.1 SITE DETAILS

Site Address	North London Business Park, Brunswick Park Road, Barnet, N11 1HB, UK
National Grid Reference	528050, 193450
Size	Approximately 16 hectares
Site Location	The site is located in New Southgate, within Barnet, adjacent to the east of the overland train station, in a predominantly commercial and residential area. A site location plan is included as Appendix A.
Current Site Use	The subject site is utilised for a mixed development of commercial properties.

1.2 SITE RECONNAISSANCE

A walk over survey of the site was carried out on 28th November 2007, including an inspection of the exterior and interior of the site and buildings.

An annotated site plan, and associated site photographs are presented in Appendix B and C, respectively.

The following key observations were made during the site reconnaissance:

Site Description

The subject site comprises North London Business Park, and includes commercial buildings ranging from single to three storey buildings (ground plus two), surface and multi storey car parking areas, overgrown sports grounds, soft landscaped areas and a lake. There are significant changes in topographical levels across the site, and a number of bunds are present from previous phases of redevelopment.

Specific on-site activities

- The commercial units are generally located in the west of the site and are occupied by London Borough of Barnet (offices and meeting rooms), Barnet College (classrooms and lecture theatres), Middlesex University (offices, classrooms and lecture theatres), philip ADVENT (offices) and a sports and social club. An additional building was being constructed at the time of the walkover, located to the west of the lake. The site representative indicated that this new building would be occupied by Barnet College.
- A number of former air raid shelters are present across the site. The site representative indicated that a number of the air raid shelters have since been infilled with surplus material following previous phases of redevelopment, most noteworthy being the shelters in the north west of the site, to the rear of the commercial buildings. The site representative inferred that the roofs had been removed, but that the floors, walls and foundations were likely to remain. Ground level access to two small air raid shelters, located in the south east of the site, to the north east of the multi storey car park, was noted during the site walkover (see photo C1).

- Three bunds were noted on site, primarily located within the north and centre of the site (see photo C2). The site representative stated that the bunds were constructed during previous phases of redevelopment as surplus material was not permitted to be disposed off site. It is unknown at this stage, exactly what is contained in these stockpiles.

External Areas

- A multi storey car park is present on site, located to the south east of the commercial buildings, with surface car parking noted around the majority of the site. In addition, a stepped surface car park is located to the north west of the commercial buildings; above where the site representative stated the former below ground air raid shelters were located.
- A former sports ground, including a sports pitch, a rifle range and a tennis court were noted in the north of the site, elevated above the commercial development. It was noted that at the time of the walkover the sports ground had not been used in a long time, and had become overgrown (see photo C3). In addition to this, the tennis courts were being utilised as a storage facility for construction materials (see photo C4).
- A lake and associated soft landscaped areas were present in the east of the site (see photo C5).

Bulk Hazardous Materials Storage

- The site representative stated that there are currently no below ground storage tanks and no evidence of such tanks was noted during the site reconnaissance.
- The site representative stated that a former below ground fuel tank was located beneath one of the current commercial buildings, located in the centre of the site. The site representative inferred that the tank had been removed during the redevelopment and construction of the current commercial building.
- An above ground storage tank, fuelling the back up generator was noted adjacent to one of the commercial buildings. The tank was raised above a concrete base. No ground staining was noted in the surrounding area (see photos C6 and C7).

Other Hazardous Materials

- The site representative stated that there are no hazardous materials stored on-site. No such materials were observed on site during the site walkover.

Polychlorinated Biphenyls (PCBs)

- An electricity sub station is located within the site's boundary, in the south of the site, adjacent to the main site entrance. It was not possible to access the compound in which the sub station is located and therefore the condition could not be determined.
- In addition to the main sub station, located at the main site entrance, a number of smaller transformers were noted across the site associated with individual commercial buildings, and a mast and associated transformer was noted adjacent to the former rifle range in the north of the site (see photo C8).

Ozone Depleting Substances (ODS)

- The site representative stated that all air conditioning units had been recently refurbished, and no longer utilise the refrigerant R22, which is an ozone depleting substance.
- Further to this, former units were noted within the immediate external areas to some of the commercial buildings, however the site representative stated that these units were no longer in use.

Wastes Management

-Non Hazardous

- Waste produced on site comprises cardboard, packaging, office waste, catering waste and general wastes, which are compacted before being stored in a number of skips and removed regularly by reportedly licensed waste contractors.

-Hazardous

- The site representative stated that no hazardous waste was generated on site. No such materials were observed on site during the site walkover.

Drainage Issues

-Surface Water

- The site representative stated that all surface water drained into the lake on site.

-Foul Water

- Foul water on site is limited to sewage and domestic waste water. The site representative did not report any issues associated with on site foul water, and no issues were observed during the site walkover.

-Trade Effluent

- No trade effluent discharges were identified during the site visit.

Asbestos Containing Materials (ACMs)

The site representative stated that asbestos containing materials were historically found to be present within one of the buildings on site, the site representative stated that this has since been cleared, and that no asbestos containing materials are currently present on site, however WSPE has not received confirmation of this. It is understood that Asbestos Registers are held for the commercial buildings present on site, however these have not been reviewed by WSPE.

1.3 SURROUNDING LAND USE

The site is located in New Southgate, within Barnet, in a predominantly residential area, with occasional commercial properties, predominantly to the south of the site. Residential properties are located adjacent to the northeast, east and south east of the site, and the overland railway runs adjacent to the western boundary of the site.

2 Historical Land Use

2.1 SITE HISTORY

A study of historical Ordnance Survey maps has been undertaken to identify any potentially contaminative former land uses. Reference to historical maps provides invaluable information regarding the land use history of the site, but historical evidence will be incomplete for the period pre-dating the first edition and between successive maps. A selection of historical map extracts is included as Appendix D.

Historical maps indicate that the site comprised land associated with the adjacent cemetery from the earliest OS map dated 1863. The western boundary is marked by the cutting for the adjacent railway, with associated sidings noted on the 1879 map in the south west of the site. Also in 1879 gravel pits were noted in the north of the site, however were cleared by 1896. The Cemetery Station was noted in the east of the site on the 1866 map associated with the adjacent cemetery; however this was cleared by 1897. By 1936 the north and east of the site are occupied by a sports ground, including tennis courts, a pavilion, a miniature rifle range and a tank, whereas the south of the site is occupied by New Southgate Works (Telephones and Cables), with a number of large warehouse structures across the site. Two pond features were noted in the east of the site in 1981, with a weir separating them. The 1991 map shows the northern sports field to comprise the former pavilion and a new rifle range in the extreme north of the site, all other features have been cleared. Within the 1990s and 2000s the building layout within the works changes, and the map dated 2007 indicates the current layout.

Anecdotal Information

The site representative stated that a number of former air raid shelters were present across the site; two shelters are still present, with access at ground level located in the centre of the site, adjacent to the multi storey car park. Further to this, the site representative stated that additional shelters have since been infilled, and as such associated walls and foundations are likely to remain underground. The historic, infilled air raid shelters were located to the north of the remaining shelters and to the north of the commercial buildings.

2.2 SURROUNDING AREA

A study of historical Ordnance Survey maps has been undertaken to identify any potentially contaminative former land uses. A selection of relevant historical map extracts is included as Appendix D. The following represents a summary of the available map information:

Surrounding Features	Dates	Distance (m)	Direction
Great Northern Cemetry (including Mortuary Chapel) *Then* New Southgate Cemetry and Crematorium	Pre 1881 – pre 1989 . Pre 1989 - present	Adjacent	South east
Railway line – Great Northern (including tunnel to north west)	Pre 1881 – present	Adjacent	West
East Barnet Sewage Farm *Then* Sewage Disposal Works	Pre 1897 – pre 1938 Pre 1938 – pre 1962	300	East

Surrounding Features	Dates	Distance (m)	Direction
Then Works	Pre 1962 – pre 1973		
Then Scrub land	Pre 1973 – pre 1989		
Then Cleared	Pre 1989 – pre 1999		
Then Brunswick Park	Pre 1999 – present		
Photographic Works	Pre 1897 – pre 1962	200	South
Then Works	Pre 1962 – present		
Unnamed building	Pre 1962 – pre 1963	100	East
Then Works (with electricity sub station)	Pre 1963 – pre 1994 .		
Then cleared, with a depot	Pre 1994 – pre 2007		
Then Residential properties	Pre 2007 – present		

3 Regulatory Information & Consultations

3.1 REGULATORY DATABASE

The following environmental data has been obtained from a summary of information databases.

	0-250m	250-500m	Details
Registered landfills	0	0	Not applicable (N/A)
Closed landfill facilities	2	0	Great Northern Cemetery (now New Southgate) was located approximately 100m to the east of the site and held a waste license for a year (1979). In addition to the cemetery, East Barnet Sewage Works, was formerly located approximately 125m to the north east of the site, held a license for fifteen years (1950-1965) including inert, commercial and household waste.
Registered transfer stations/ treatment facilities	1	1	GBN Services Ltd is located approximately 200m to the south east of the site, and accepts inert commercial and household waste. Further to this, a second transfer station (Winters Haulage) is located approximately 380m to the south east of the site, and accepts household, commercial and industrial waste.
Closed transfer stations/ treatment facilities	0	0	N/A
Authorised industrial processes (IPC/IPPC).	1	4	Oakleigh Dry Cleaners are located approximately 120m to the south west of the site. The remaining authorised processes relate to the cemetery, additional dry cleaners and a petrol filling station.
Fuel Stations Entries	1	1	The closest fuel station is approximately 70m to the south of the site and is recorded as obsolete. Further to this, Barnet service station is approximately 300m to the north west of the site and recorded as open.
Licensed radioactive substances	0	0	N/A
Enforcements, prohibitions or prosecutions	0	0	N/A
Discharge Consents	0	0	N/A
Pollution Incidents	0	1	The nearest pollution incident occurred 340m to the southeast of the site. The incident comprised the release of oil to a drainage ditch and was classified as minor. This has not been attributed to the subject site.
Natural Cavities	0	0	N/A
Consents issued under the Planning (Hazardous Substances) Act 1990	0	0	N/A

3.2 CONSULTEES

Local Authority Building Control

The Building Control Officer at London Borough of Barnet was contacted with regard to ground conditions beneath the subject site. A response has not yet been received by WSPE.

Local Authority Contaminated Land Office

The Contaminated Land Officer at London Borough of Barnet was contacted for environmentally pertinent information relating to the site. The Officer confirmed that the site has had numerous potentially contaminative uses, however stated that for continued current use the site was not considered as high priority for classification as contaminated land under Part IIa of the Environmental Protection Act (1990). The Officer indicated that prior to redevelopment of the site, particularly if the proposed redevelopment comprised an end use change, to residential, an intrusive investigation would be required, and that contamination issues would be dealt with through the planning process.

In addition to this the Officer was consulted on the former landfills identified in the surrounding area. The Officer stated that in relation to Great Northern Cemetery, London Borough of Barnet are not aware of any waste that has been deposited there historically. The Officer indicated that the license the cemetery held (1 year, 1979) may relate to the deposition of soil, permitting an additional layer of viable land. The Officer confirmed that this site is not considered to represent a significant risk to the subject site.

The second landfill license was related to East Barnet Sewage Works. The Officer stated that prior to the closure of the works materials may have been used to backfill holes and excavations across the site. Further to this, the Officer stated that a number of reports (including site investigations and gas assessments) are available for the sewage works as a portion of the works has been redeveloped for residential end use. The Officer stated that gas reports have identified low amounts of gas, and that in 1995 the Environment Agency (EA) classified the site as 'green' in relation to ground gas, and that low to no risk is anticipated. The Officer indicated that in addition to the sewage works materials present, there is a potential that household waste may have been deposited briefly at the site.

Petroleum Officer

No issues have been identified which warrant further consultation with the Petroleum Officer.

Environment Agency

The Environment Agency has been contacted in relation to landfills in the surrounding area. A response has not yet been received by WSPE. The Environment Agency confirmed the presence of the two landfills within the vicinity of the site, however have stated that as both sites were closed before the Environment Agency became the regulatory body for waste sites no further information is held.

Environment Agency Flooding Data

The site is not located within an Environment Agency indicative floodplain.

Health Protection Agency

The site is located within an area where no radon protection measures are considered necessary.

British Geological Survey

The site is located within an area where there is low to very low risk of landslip subsidence hazards and moderate risk of swelling clay subsidence hazards.

Coal Authority Report

The site is not located within an area affected by Coal Mining. From the information currently available to the Coal Authority, a mining report is not required for this site.

4 Other Relevant Information

4.1 PLANNING BRIEF

The London Borough of Barnet, Planning Brief for North London Business Park and land adjacent to Coppices Grove has been provided by the client and includes details of the site development. A summary of the relevant information has been provided below.

- The site's history has comprised New Southgate Works (telephone and cable), followed by Northern Telecom (Nortel) occupying part of the site in 1989. An optical centre of excellence was present in 2000 and by 2003 Nortel relocated off site;
- During the Second World War it is reported that the site was bombed, due to its strategic industrial use;
- A number of underground air raid shelters are present across the site;
- An underground public sewer crosses the site; and
- Fly tipping is reported to have occurred in the north of the site within and to the east of the former sports ground.

5 Environmental Setting

5.1 GEOLOGY AND HYDROGEOLOGY

The published 1:50,000 scale geological map of the area (Sheet No 256 "North London") indicates the site to be underlain by London Clay, with a potential for Head Deposits to be present overlying the London Clay.

On the basis of the published geological maps of the full succession of natural strata in the vicinity of the site is likely to comprise:

Conjectural Geological Model

Geological Unit	Description	Anticipated Thickness (m)
Superficial Soils / Drift		
Head deposits	Variable deposit	Anticipated to be of limited thickness
Solid Geology		
London Clay	Clay, silty in part	Anticipated to be in the order of 30m
Lambeth Beds	Mottled clay with sand and pebble beds	Unknown
Thanet Sands	Fine grained sand	Unknown
White Chalk Group	Chalk	Unknown

The Dollis Hill River Terrace Deposits were noted off site to the south west of the site, as a gravel, sandy and clayey in part.

The existing topography and history of development of the site suggests that, in addition to these natural strata, Made Ground is likely to be present on the site. Further to this, there is an area of Made Ground noted on the BGS map, located to the east of the site, anticipated to be associated with the former East Barnet Sewage Works.

The published Environment Agency Groundwater Vulnerability Map of the area (Sheet 39 "West London") indicates the site to be predominantly underlain by a Non Aquifer (London Clay). Therefore, groundwater resources are perceived not to be at risk from activities carried out on site.

The following current licensed groundwater abstractions have been identified within a 1km radius of the site, although the abstraction below is likely to be from the deeper chalk aquifer and therefore protected by a thickness of relatively impermeable London Clay:

Source	Use	Distance (m)	Direction
Groundwater	Potable water supply	700	South east

In terms of aquifer protection, the Environment Agency generally adopt a three-fold classification of Source Protection Zones for public supply abstraction wells

- Zone I - or 'inner source protection' is located immediately adjacent to the groundwater source. It is based on a 50-day travel time and is designed to protect

against the effects of human activity and biological/chemical contaminants that may have an Immediate effect on the source

- Zone II - or 'outer source protection' is larger than Zone I and is defined by a 400-day travel time to the source. The travel time is designed to provide delay and attenuation of slowly degrading pollutants
- Zone III - or 'source catchment' covers the complete catchment areas of a groundwater resource

Information available on the Environment Agency's web-site indicates that the site does not lie within a Source Protection Zone.

5.2 HYDROLOGY

Surface water features in the vicinity of the subject site are as follows:

Surface Water Feature	Quality*	Distance (m)	Direction
Unnamed lake	-	On site	-
Pymme's Brook	C	400	East

*Chemical water quality as classified under the EA's General Quality Assessment (GQA) Scheme.

No surface water abstractions have been identified within a 1km radius of the subject site.

5.3 5.3 SURROUNDING FEATURES

Sensitive surrounding land uses in the immediate vicinity of the subject site are as follows:

Sensitive Land Use	Approx. Distance	Direction
Residential properties with gardens	Adjacent	North, East, South

5.4 ENVIRONMENTAL SENSITIVITY

Overall, the site setting is considered to be of **low / moderate** sensitivity, due to the following reasons:

- The presence of on-site surface water features (lake in the east of the site);
- The residential land uses within the surrounding area;
- The presence of groundwater abstractions within a 1km radius of the site (potable supply, approximately 700m) – although this is considered to be protected by impermeable London Clay;
- The underlying Non Aquifer; and
- The absence of an unprotected minor aquifer underlying the site.

6 Geotechnical Considerations

6.1 PROPOSED DESIGN

WSPE understands that the site will be redeveloped for a mixed use purposes, including additional commercial buildings in the centre and south of the site and residential properties in the north and east of the site; however planning approval has, as yet, not been received. It is understood that current plans include underground parking across large portions of the site. Based on the desk study information obtained and a walkover survey of the site, several areas of geotechnical risk have been identified as outlined below:

The following ground-related hazards have been identified during the investigation:

Hazard	Justification
Lateral changes in ground conditions	Given the changes in levels across the site, and the possible presence for former air raid shelters, it is considered that the depth to natural ground will vary significantly across the site.
Shrinkable clay soils	London Clay is considered to be a material with a medium to high volume change potential.
Desiccation	Given the shrinkage potential of the London Clay and any existing / proposed trees on site, desiccation should be considered.
Soft clay – low bearing capacity	The Head deposits overlying the London Clay have the potential of being soft.
High groundwater / poor drainage	Unknown at this stage.
Potential for below ground obstructions.(foundations / air raid shelters)	Historic development of the site and former air raid shelters indicate the potential for below ground obstructions.
Made Ground / infilled ponds	The historical gravel pits in the north of the site are likely to have been infilled. In addition to this, significant earthworks have occurred on site, resulting in potentially significant thicknesses of Made Ground across the site.
Adverse ground chemistry (weathering of sulphides to sulphates / acidic pH)	Unknown at this stage.

6.2 FOUNDATIONS

From past experience, the London Clay is likely to have a safe bearing capacity in the region of 125kN/m^2 to 150kN/m^2. This generally proves suitable for pad foundations for structures up to three storeys in height. This solution will be subject to confirmatory tests undertaken during an intrusive site investigation. However, the thickness of Made Ground and the thickness and composition of the Head deposits may also preclude the use of shallow foundations.

Footings should be taken deeper where structures are located within influencing distance of any existing or future trees. In these circumstances reference should be made to NHBC Chapter 4.2.

For four storey structures, foundations could be excessively wide and piled foundations may be a more appropriate solution.

It is considered that suspended floor slabs are likely to be required across the site, based on the potential for a significant thickness of Made Ground being present.

The anticipated sub-grade soil CBR value for road pavement design is 2%.

6.3 OBSTRUCTIONS/RELIC STRUCTURES

There is the possibility of relict substructures, possibly including areas of underground air raid shelters and former foundations, being present on the site. In addition to any effect on foundation construction, such features may lead to increased costs for the groundworks operations and delays in programming.

It is recorded within the planning brief that the site was bombed during World War II. It is therefore possible that unexploded ordnance be present across the site.

7 Risk Assessment

7.1 OUTLINE ENVIRONMENTAL CONCEPTUAL MODEL

The methods used within this risk assessment follow a risk-based approach, with the potential environmental risk assessed qualitatively using the 'source-pathway-target pollutant linkage' concept introduced in the Environmental Protection Act 1990. For a site to be designated as Contaminated Land a plausible linkage between the identified Sources, Pathways and Targets must be demonstrated, this is further discussed within Appendix E.

Potential Contaminant Sources

On-Site Contaminant Sources	■ Possibility of infilled former gravel pits in the north of the site, may give rise to deep areas of Made Ground or ground gas generation. ■ The site has had a long history of development, including railway sidings, the telephones / cables works, electricity sub stations and tanks, which could have resulted in contamination across the site. ■ A number of bunds are present as a result of previous phases of redevelopment. ■ The site is thought to have been bombed during World War II which could have resulted in unexploded ordnance being present across the site. ■ Previous phases of redevelopment at the site have resulted in bunds / infilled air raid shelters which could have resulted in deep areas of Made Ground.
Off-Site Contaminant Sources	■ Neighbouring sites and land have had a commercial/industrial history, including the sewage works and photo works. ■ Two landfill sites are located within 250m of the site. Two waste transfer stations are located within 500m of the site.

Potential Contaminant Pathways

■ Potentially granular soils in the underlying superficial geology (Head Deposits) have the potential to permit the transport of pollutants. However the underlying solid geology is London Clay and is predominantly cohesive and is likely to restrict the widespread transport of pollutants.

Potential Receptors

Controlled Waters	■ The lake on site.
Human Health Risks	■ The proposed redevelopment plans include residential properties with gardens in the north and east of the site, there is unlikely to be a barrier between any subsurface contamination and the end users. ■ Third Party neighbours are primarily residential in nature and as such a barrier between any subsurface contamination is unlikely to be present.

Pollutant Linkages

■ Migration of contamination through potentially granular soils within the Head deposits

migrating towards surface water receptors.

- Direct contact with contaminated soils (ingestion, inhalation and dermal contact).
- Ground gas migration from historic filling activities on site.

7.2 ENVIRONMENTAL RISK ASSESSMENT MATRIX

Having evaluated the information gathered during this study and described in the previous sections, WSP Environmental Ltd has produced the following assessment of risk primarily focused on contaminated land issues:

	ISSUE	RISK CATEGORY	REASON
Contamination Potential:	Potential for significant on-site contamination	Medium	Potential sources of contamination have been identified across the site, including Made Ground, unexploded ordnance, and the sites predominantly industrial development history.
	Potential for contaminants migrating off the site	Low/Medium	The migration of any potential contaminants present is likely to be restricted due to the nature of the underlying geology. This is dependent on the thickness and composition of the Head deposits on site.
	Potential for contaminants migrating onto the site	Low/Medium	The migration of any potential contaminants present is likely to be restricted due to the nature of the underlying geology. This is dependent on the thickness and composition of the Head deposits on site.
Other Liability Issues:	Potential for 'other' environmental issues to give rise to liabilities	Medium	There is a potential for unexploded ordnance to be present on site, as a result of World War II bombing.
Environmental Consequences	Risk of Pollution of Controlled Waters	Low/Medium	It is considered that in light of the underlying cohesive geology, controlled waters are not considered a significant risk at the site. However there is a lake on site that may have been directly impacted.
	Risk of Damage to Property	Low	No significant issues identified.
	Risk of Harm to Human Health	Medium	The residential redevelopment in the north and east of the site present the highest risk of harm to human health, and certified clean topsoil will need to be imported for the garden areas if materials on site are not suitable.
Business Consequences:	Likelihood of designation as Contaminated Land under EPA 1990	Low/Medium	Consultations with the relevant Contaminated Land Officer have identified that the site is not considered a priority for further investigation under the Contaminated Land Regime for continued use, however prior to redevelopment (including residential end use) issues relating to contaminated land will be dealt with through the planning process.
	Risk of Site Value and/or Saleability being affected.	Medium	Source – pathway – receptor linkages have been identified on site, and as such it is recommended that an intrusive phase II investigation is undertaken.
	Likelihood of a Future Purchaser requesting further investigations.	Low/Medium	No further contamination assessment works are considered necessary for a continued use. However, in the event of redevelopment further works will be required as part of the planning process.
	Risk of Liability for Owner	Medium	Source – pathway – receptors have been identified on site, and as such it is recommended that an intrusive phase II investigation is undertaken. It should be noted that the Waste Licence may be required if the removal of the stockpiles is required.
	OVERALL RISK FOR REDEVELOPMENT		**MEDIUM**

7.3 GEOTECHNICAL RISK ASSESSMENT MATRIX

Based on anticipated ground conditions, potential geotechnical risks that may influence current or future land use are summarised below:

	ISSUE	RISK CATEGORY	REASON
Geotechnical Issue:	Potential for variable depth of Made Ground.	Medium/High	There is potential for infilled former gravel pits in the north of the site, and earthworks from previous phases of redevelopment is anticipated to have generated a significant thickness of Made Ground across the site.
	Potential for below ground obstructions.	Medium/High	Former air raid shelters and former foundations are anticipated to be present across the site.
	Potential for shallow mine workings and coal shafts and adits.	Low	The site is not in an area affected by coal mining.
	Potential for 'other' issues to give rise to liabilities.	Medium	There is a potential for unexploded ordnance to be present on site, as a result of World War II bombing.
Construction Consequences	Risk of Damage to Property	Low/Medium	Identified hazards include high shrinkage potential clay, desiccation and filled areas. The risk rating assumes appropriate investigation and remedial action / foundation solutions have been adopted during the development
	Risk of Harm to Human Health	Low	Structural damage is likely to be detected prior to damage to health.
	Implications for redevelopment	Medium	Above issues are likely to require consideration should the site be redeveloped.
Business Consequences:	Risk of Site Value and/or Saleability being affected.	Low/Medium	The above will require consideration and are likely to result in additional insurance / maintenance costs.
	Risk of Liability for Owner	Low	There is unlikely to be a liability risk to the owner assuming appropriate remedial actions / foundation solutions have been adopted during development.
	OVERALL RISK		**MEDIUM**

8 Summary, Conclusions & Recommendations

Site Address	North London Business Park, Oakleigh Road South, Barnet, N11 1HB, UK
Current Land Use	The subject site comprises North London Business Park, and includes commercial buildings ranging from single to three storey buildings (ground plus two), surface and multi storey car parking areas, overgrown sports grounds, soft landscaped areas and a lake. There are significant changes in levels across the site, and a number of bunds are present from previous phases of redevelopment. The site is located in New Southgate, within Barnet, adjacent to the east of the overland train station, in a predominantly residential area with the occasional commercial property.
Historical Land Use	Historical maps indicate that the site was partially associated with the cemetery in 1863. By 1879 railway sidings and gravel pits were noted on the site. New Southgate Works and a sports ground were present by 1936 and during the 1990s and 2000s building layouts changed. Surrounding land uses include a railway, residential properties, a cemetery, industrial properties and a sewage works.
Regulatory Enquiries	The Local Authority has provided information relating to nearby historic landfills. In addition it indicated that an intrusive phase II investigation is likely to be required and contamination issues will be dealt with during the planning process associated with redevelopment.
Other Information	It is understood that the site was subject to bombing in the Second World War, and as such there is a potential for unexploded ordnance to be present on site.
Environmental Setting	The site setting is considered to be of low / moderate sensitivity, due to the residential properties in the area, and the on site surface water feature.
Geotechnical Hazards	The primary geotechnical hazards are considered to be lateral changes in ground conditions, shrinkable clay soils, soft clay soils, desiccation, potential for below ground obstructions and Made Ground.
Conclusions	Based on the information contained within this report and with due regard to redevelopment (including residential with gardens), it is the opinion of WSPE that the site represents a **medium** risk with respect to environmental considerations. Based on the information contained within this report, it is the opinion of WSPE that the site represents a **medium** risk with respect to geotechnical considerations.
Recommendations	No further work is considered necessary for the ongoing current use of the site. However, the following recommendations should be considered prior to redevelopment: ■ An intrusive phase II investigation should be undertaken to provide information relating to contamination issues, provide preliminary geotechnical advice and a ground gas assessment. ■ An unexploded ordnance desk study.

Please Note: This summary forms part of WSP Environmental Ltd Phase I Environmental Assessment (ref.: 12220279) and as such this should be read in conjunction with the full report.

Appendix A Site Location Plan

Appendix B Annotated Site Plan

Appendix C Photographic Record

PLATE C1:

PLATE C2:

PLATE C3:

PLATE C4:

PLATE C5:

PLATE C6:

PLATE C7:

PLATE C8:

Appendix D Selection of Historical Map Extracts

Appendix E Methodology & Limitations

Methodology

This Environmental Assessment has been designed to provide information relating to:

- the current and former land uses on and surrounding the site;
- the environmental sensitivity of the site location as determined by factors including geology, hydrogeology, surface watercourses and neighbouring land uses; and,
- relevant records held by the environmental regulators.

Any relevant information provided by the client has been reviewed, with appropriate action taken to ensure this information is taken into account and/or verified where necessary. All information is then assessed to define the potential for the site to give rise to environmental liabilities for the freehold/leasehold owner (as appropriate). Recommendations are made for additional work where this is necessary to fully define the site's environmental liabilities, and cost estimates of the financial implications of the findings can be provided under separate cover, where appropriate.

Risk Classification

This assessment has been undertaken with due regard to Contaminated Land Guidance documents issued by the Department for Environment, Food and Rural Affairs (and its Predecessors), the British Standards Institute (the BSi), the Royal Institution of Chartered Surveyors (RICS) and the American Society for Testing and Materials (ASTM) Standard E 1527-00. The methods used follow a risk-based approach, with the potential environmental risk assessed qualitatively using the 'source-pathway-target pollutant linkage' concept introduced in the Environmental Protection Act 1990.

Specific comment is made regarding the site's status under the Contaminated Land Regime implemented on the 1st April 2000 as Part IIA of the Environmental Protection Act 1990, and the actual or potential designation of the site as 'Contaminated Land' as defined in Section 78A(2). Unless specifically stated as relating to this definition, references to 'contamination' and 'contaminants' relate in general terms to the Presence of potentially hazardous substances in, on or under the site.

In addition, consideration has been given to a wide range of related topics including (where appropriate): environmental processes; current and foreseeable environmental legislation; the practices and duties of environmental regulators; the health and safety of occupiers and neighbours as affected by contamination; effects on the structure of buildings; and financial implications. References to risk classifications are made according to the following definitions:

Low Risk

It is unlikely that the issue will arise as a liability/cost for the freehold/leasehold owner (as appropriate) of the site.

Medium Risk

It is possible that the issue could arise as a liability/cost for the freehold/leasehold owner (as appropriate) of the site. Further work is usually required to clarify the risk.

High Risk

It is likely that the issue will arise as a liability/cost for the site freehold/leasehold (as appropriate) owner of the site.

Environmental Risk Assessment

The presence of contaminated materials on a site is generally only of concern if an actual or potentially unacceptable risk exists. Within the context of current UK Legislation (i.e. Section 57 of the Environment Act 1995), the interpretation of a "significant risk" is termed to be one where:

- Significant harm is being caused or there is a significant possibility of such harm being caused, (where harm is defined as harm to health of living organisms or other interference with the ecological systems of which they form a part and, in the case of man, includes harm to his property); and / or, pollution of Controlled Waters is being caused.

The potential for harm to occur requires three conditions to be satisfied:

- Presence of substances (potential contaminants/pollutants) that may cause harm (Source of Pollution).
- The presence of a receptor which may be harmed, e.g. the water environment or humans, buildings, fauna and flora (The Receptor).
- The existence of a linkage between the source and the receptor (The Migration Pathway).

Therefore, the presence of measurable concentrations of contaminants within the ground and subsurface environment does not automatically imply that a contamination problem exists, since contamination must be defined in terms of pollutant linkages and unacceptable risk of harm.

The nature and importance of both pathways and receptors, which are relevant to a particular site, will vary according to the intended use of the site, its characteristics and its surroundings.

In order to assess the contamination risk at the subject site the above rational has been applied and is discussed within section 6 in the context of Contamination Sources and Potential Pollutant Linkages.

Limitations

WSP Environmental Limited has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from WSP Environmental Limited; a charge may be levied against such approval.

WSP Environmental Limited accepts no responsibility or liability for:

a) the consequences of this document being used for any purpose or project other than for which it was commissioned, and

b) this document to any third party with whom an agreement has not been executed.

The work undertaken to provide the basis of this report comprised a study of available documented information from a variety of sources (including the Client) and discussions with relevant authorities and other interested parties. The opinions given in this report have been dictated by the finite data on which they are based and are relevant only to the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, WSP Environmental Limited reserves the right to review such information and, if warranted, to modify the opinions accordingly.

Where no site inspection is undertaken (for example a Desk Study Assessment or due to restricted site access), WSPE cannot comment on the potential for environmental concerns associated with the current use or structure including the Presence of asbestos.

It should be noted that any risks identified in this report are perceived risks based on the information reviewed; actual risks can only be assessed following a physical investigation of the site.

Appendix F Report References

Environment Agency Aquifer Classifications

The Environment Agency (EA) Groundwater Vulnerability Map and Regional Appendices, which make up part of the published Policy and Practice for the Protection of Groundwater, divide the underlying strata in England and Wales into major, minor and non aquifers dependent upon their potential for potable water supply. The following table is derived from the main policy document. The division of the rock formations into major, minor and non aquifer reflects the Regional importance and vulnerability of the formation.

Major Aquifer

Highly permeable formations usually with the known or probable Presence of significant fracturing. Highly productive strata of Regional importance. Often used for large potable abstractions. E.g. Upper Chalk, Permo-Triassic Sandstones

Minor Aquifer

Fractured or potentially fractured but without high intergranular permeability. Generally only support locally important abstractions E.g. Coal Measures

Variable porosity and permeability but without significant fracturing. Generally only support locally important abstractions. E.g. River Terrace Gravels

Non Aquifer

Formations with negligible permeability. Only support very minor abstractions if any. E.g. Mercia Mudstones, igneous rocks

Regulatory Information Sources

Reference has been made to the Landmark Information Group data provision service. This includes information and data collated from several organisations, including the Environment Agency (EA), Department for Environment, Food & Rural Affairs (DEFRA), Health & Safety Executive (HSE), the Health Protection Agency (HPA), and the Coal Authority

Part 2: Land at Oakleigh Road South

Executive Summary

WSPE was instructed by Comer Homes to undertake a Phase I Geotechnical and Environmental Assessment of the portion of land at Oakleigh Road South. The report highlights environmental considerations, predominantly with respect to ground conditions, and is required as part of the planning application associated with the site. Please refer to Appendix K for WSPE's Methodology and Limitations.

Key Findings

The subject site comprises a warehouse and a two storey office building. To the rear of the warehouse (south) an above ground fuel tank, with associated filling point was noted, and a large above ground water tank. The land in the extreme south of the site was overgrown with vegetation; in addition the land in the east of the site was also overgrown and sloping steeply down to the road.

The site is located in New Southgate, within Barnet, adjacent to the north east of the overland train station, in a predominantly residential area, with the occasional commercial / industrial property.

Historical maps indicate that the site was vacant until 1881, railway sidings were present by 1897, and the current warehouse layout was present by 1966. Surrounding historical land uses include a railway, residential properties, a cemetery, and industrial properties.

No significant issues have been identified for continued use, however an intrusive phase II investigation is likely to be required and contamination issues will be dealt with during the planning process associated with redevelopment.

Unexploded ordnance may be present on site as a result of World War II bombing in the surrounding area.

Liability

Based on the information contained within this report and with due regard to redevelopment to residential with gardens, it is the opinion of WSPE that the site represents a **medium** risk with respect to environmental considerations.

Based on the information contained within this report, it is the opinion of WSPE that the site represents a **low / medium** risk with respect to geotechnical considerations.

Recommendations

No further work is considered necessary for the current ongoing use of the site. However, the following recommendations should be considered prior to redevelopment:

- An intrusive phase II investigation should be undertaken to provide information relating to contamination issues, provide preliminary geotechnical advice and a ground gas assessment.
- An unexploded ordnance desk study.

9 Site Information

9.1 SITE DETAILS

Site Address	Land at Oakleigh Road South
National Grid Reference	528430, 192720
Size	Approximately 2 hectares
Site Location	The site is located in New Southgate, within Barnet, adjacent to the north east of the overland railway line, in a predominantly commercial and residential area. A site location plan is included as Appendix G.
Current Site Use	The subject site is currently vacant, occupied by a derelict building formerly used as a packaging factory.

9.2 SITE RECONNAISSANCE

A walk over survey of the site was carried out on 28th November 2007, including an inspection of the exterior of the site. An annotated site plan and associated site photographs have been presented in Appendix H and I respectively.

The following key observations were made during the site reconnaissance:

Site Description

The subject site comprises a warehouse and a two storey office building. To the rear of the warehouse (south) an above ground fuel tank, with associated filling point was noted, and a large above ground water tank. The land in the extreme south of the site was overgrown with vegetation; in addition the land in the east of the site was also overgrown and sloping steeply down to the road.

Specific on-site activities

- The northern most building comprised two storeys of office space.
- The main building in the centre of the site was a single storey warehouse.
- A large above ground water tank was noted to the south west of the main warehouse building (see photo I1).
- An above ground fuel tank, and associated pipework was enclosed within a brick bund to the south of the main warehouse building (see photo I2 and I3).
- Temporary containers were noted across the site, utilised by contractors associated with London Borough of Barnet.

External Areas

- The land immediately to the west of the entrance to the site was being used by Winters (adjacent property) for vehicle / skip storage.
- The land in the east of the site was overgrown. This portion of the site was sloping significantly downwards to the road.

- The land in the extreme south of the site was also overgrown and at a higher elevation than the rest of the site.

Bulk Hazardous Materials Storage

- The site representative indicated that there are no below ground storage tanks and no evidence of such tanks was noted during the site reconnaissance.
- An above ground fuel oil storage tank was observed to the south of the main warehouse building (see photos I2 and I3). The tank was noted to be placed within a brick bund. Due to overgrown vegetation, full inspection of the bund was not achieved, however no significant ground staining was noted within or surrounding the bund. It was not possible to determine if the tank contained fuel at the time of the walkover.

Other Hazardous Materials

- The site was vacant at the time of the walkover. No such materials were observed on site.

Polychlorinated Biphenyls (PCBs)

- There was no evidence observed at the time of the walkover that would indicate that PCBs are likely to be present on site.
- PCBs are generally associated with electricity sub stations and transformers.

Ozone Depleting Substances (ODS)

- ODSs are generally associated with air conditioning units (refrigerant R22).
- The buildings on site were in a partial state of disrepair, it is considered that prior to redevelopment the current structures will be demolished and should any old air conditioning units be present it is likely that they will be disposed of in an appropriate manner.

Wastes Management

-Non Hazardous

- As the site is vacant no wastes are currently being produced.

-Hazardous

- Five plastic containers were noted in the south of the site, not located in any form of secondary containment (see photo I4). The former contents of the containers are unknown.

Drainage Issues

-Surface Water

- The site representative stated that surface water was formerly directed to the off site pumping station, located to the east of the site.

- The site representative stated that there had been issues in the past relating to a blockage associated with the drainage underneath the railway. The representative stated that this has since been resolved.

-Foul Water

- Foul water on site is limited to sewage and domestic waste water. The site representative did not report any issues associated with on site foul water, and no issues were observed during the site walkover.

-Trade Effluent

- No trade effluent discharges were identified during the site visit.

Asbestos Containing Materials (ACMs)

- Given the age of the property on-site (1966) the presence of asbestos containing materials can not be discounted.

9.3 SURROUNDING LAND USE

The site is located in New Southgate, within Barnet, in a predominantly residential area, with the occasional commercial / industrial building, primarily to the north of the site. Residential properties are located adjacent to the northeast, east and south east of the site, and the overland railway runs adjacent to the west of the site.

10 Historical Land Use

10.1 SITE HISTORY

A study of historical Ordnance Survey maps has been undertaken to identify any potentially contaminative former land uses. Reference to historical maps provides invaluable information regarding the land use history of the site, but historical evidence will be incomplete for the period pre-dating the first edition and between successive maps. A selection of historical map extracts is included as Appendix J.

Historical maps indicate that the site comprised open land on the earliest OS map dated 1881. A slight depression was noted in the south of the site, and a well was noted in the east. By 1897 the site levels had changed and a significant slope was noted along the eastern boundary, sloping down to the site boundary, and railway sidings were present in the western part of the site. The next significant change was noted on the 1966 map, in the form of a warehouse present in the central part of the site. Two small buildings were noted to the north and south of the site, with the northern building being called Gordon House by 1985. An additional slope, to the south of the warehouse was noted, sloping down to the south of the site.

Anecdotal information

The site representative indicated that the warehouse has been vacant for at least five years.

Further to this it is understood that the site is elevated compared to Oakleigh Road South as a result of fill from the adjacent railway cutting being placed and compacted on site.

10.2 SURROUNDING AREA

A study of historical Ordnance Survey maps has been undertaken to identify any potentially contaminative former land uses. A selection of relevant historical map extracts is included as Appendix J. The following represents a summary of the available map information:

Surrounding Features	Dates	Distance (m)	Direction
Great Northern Railway	Pre 1881 – present	15	West
Residential properties *Then* extending south *Then* redeveloped	Pre 1881 Pre 1897 Pre 1966 – present	Adjacent	East
Great Northern Cemetery *Then* New Southgate Cemetery and Crematorium	Pre 1881 – pre 1999 Pre 1999 – present	300	North east
Cemetery Monumental Works *Then* lodge	Pre 1881 – pre 1897 Pre 1897 – present	180	East
Photographic works *Then* Works	Pre 1897 – pre 1938 Pre 1938 – present	350	North
Tank (associated with railway)	Pre 1914 – pre 1936	60	North

Surrounding Features	Dates	Distance (m)	Direction
Then railway sidings *Then* builders yard	Pre 1936 – pre 1985 Pre 1985 – present		
Pumping station *Then* factory	Pre 1916 – pre 1962 Pre 1962 – present	300	East
Boot polish factory *Then* factory	Pre 1916 – pre 1962 Pre 1962 – present	300	East
Works *Then* depot	Pre 1950 – pre 1981 Pre 1981 – present	200	south

11 Regulatory Information & Consultations

11.1 REGULATORY DATABASE

The following environmental data has been obtained from a summary of information databases.

	0-250m	250-500m	Details
Registered landfills	0	0	Not applicable (N/A)
Registered transfer stations/ treatment facilities	1	1	Winters Haulage Ltd is a transfer station located approximately 50m to the north west of the site and is licensed to accept household, commercial and industrial waste. A second transfer station is located 275m to the north of the site, operated by GBN Services Ltd.
Authorised industrial processes (IPC/IPPC).	0	2	These both relate to authorisations associated with petrol filling stations. Both are located to the south east of the site, however one has since been revoked. The current operational station is approximately 260m from the site boundary.
Fuel Stations Entries	1	0	There is one petrol filling station located approximately 175m to the south east of the site.
Licensed radioactive substances	0	0	N/A
Enforcements, prohibitions or prosecutions	0	0	N/A
Discharge Consents	1	0	A temporary license was issued in November 1989 for a Thames Water Utilities pumping station located approximately 10m to the east of the site.
Pollution Incidents	1	0	The nearest pollution incident occurred approximately 170m to the north west of the site. The incident comprised the release of oil in April 1996 and was classified as minor.
Natural Cavities	0	0	N/A
Consents issued under the Planning (Hazardous Substances) Act 1990	0	0	N/A

11.2 CONSULTEES

Local Authority Building Control

The Building Control Officer at London Borough of Barnet was contacted with regard to ground conditions beneath the subject site. A response has not yet been received by WSP E

Local Authority Contaminated Land Office

The Contaminated Land Officer at London Borough of Barnet was contacted for environmentally pertinent information relating to the site. The Officer confirmed that the

site has had a potentially contaminative use, however stated that for continued current use the site was not considered as high priority for classification as contaminated land under Part IIa of the Environmental Protection Act (1990). The Officer indicated that prior to redevelopment of the site, particularly if the proposed redevelopment comprised an end use change, to residential, an intrusive investigation would be required, and that contamination issues would be dealt with through the planning process.

Petroleum Officer

No issues have been identified which warrant further consultation with the Petroleum Officer.

Environment Agency

The Environment Agency has been contacted in relation to landfills in the surrounding area (more than 500m away). A response has not yet been received by WSP E.

Environment Agency Flooding Data

The site is not located within an Environment Agency indicative floodplain.

Health Protection Agency

The site is located within an area where no radon protection measures are considered necessary.

British Geological Survey

The site is located within an area where there is a low to very low risk of landslip subsidence hazards; and a moderate risk of swelling clay subsidence hazards.

Coal Authority Report

The site is not located within an area affected by Coal Mining. From the information currently available to the Coal Authority, a mining report is not required for this site.

12 Other Relevant Information

12.1 PLANNING BRIEF

The London Borough of Barnet, Planning Brief for North London Business Park and land adjacent to Coppices Grove has been provided by the client and includes details of the site development. A summary of the relevant information has been provided below.

- The site was subject to a landslip on part of the vegetated bank in the 1960s. The problem was reportedly overcome by sheet steel piling and limited bank re-grading.

13 Environmental Setting

13.1 GEOLOGY AND HYDROGEOLOGY

The published 1:50,000 scale geological map of the area (Sheet No 256 “North London”) indicates the site to be underlain by London Clay, with a potential for Head Deposits to be present overlying the London Clay.

On the basis of the published geological maps of the the full succession of natural strata in the vicinity of the site is likely to comprise:

Conjectural Geological Model

Geological Unit	Description	Anticipated Thickness (m)
Superficial Soils / Drift		
Head deposits	Variable deposit	Anticipated to be limited in thickness
Solid Geology		
London Clay	Clay, silty in part	Anticipated to be in the order of 30m
Lambeth Beds	Mottled clay with sand and pebble beds	Unknown
Thanet Sands	Fine grained sand	Unknown
White Chalk Group	Chalk	Unknown

The Dollis Hill River Terrace Deposits were noted off site to the south of the site, as a gravel, sandy and clayey in part.

The existing topography and history of development of the site suggests that, in addition to these natural strata, Made Ground is likely to be present on the site.

The published Environment Agency Groundwater Vulnerability Map of the area (Sheet 39 “West London”) indicates the site to be predominantly underlain by a Non Aquifer (London Clay). The Dollis Hill, River Terrace Deposits are classified as a Minor Aquifer, however are likely to be limited in nature. Therefore, groundwater resources are perceived not to be at risk from activities carried out on site.

The following current licensed groundwater abstraction has been identified within a 1km radius of the site, although the abstraction below is likely to be from the deeper chalk aquifer and therefore protected by a thickness of relatively impermeable London Clay:

Source	Use	Distance (m)	Direction
Groundwater	Potable water supply	200	East

In terms of aquifer protection, the Environment Agency generally adopt a three-fold classification of Source Protection Zones for public supply abstraction wells

- Zone I - or ‘inner source protection’ is located immediately adjacent to the groundwater source. It is based on a 50-day travel time and is designed to protect against the effects of human activity and biological/chemical contaminants that may have an Immediate effect on the source

- Zone II - or 'outer source protection' is larger than Zone I and is defined by a 400-day travel time to the source. The travel time is designed to provide delay and attenuation of slowly degrading pollutants
- Zone III - or 'source catchment' covers the complete catchment areas of a groundwater resource

Information available on the Environment Agency's web-site indicates that the site does not lie within a Source Protection Zone.

13.2 HYDROLOGY

Surface water features in the vicinity of the subject site are as follows:

Surface Water Feature	Quality*	Distance (m)	Direction
Unnamed lake	-	600	north
Pymmes Brook	C	670	east

*Chemical water quality as classified under the EA's General Quality Assessment (GQA) Scheme.

No surface water abstractions have been identified within a 1km radius of the subject site.

13.3 13.3 SURROUNDING FEATURES

Sensitive surrounding land uses in the immediate vicinity of the subject site are as follows:

Sensitive Land Use	Approx. Distance	Direction
Residential properties with gardens	Adjacent	South and east

13.4 ENVIRONMENTAL SENSITIVITY

Overall, the site setting is considered to be of **low to moderate** sensitivity, due to the following reasons:

- The presence of groundwater abstractions (potable supply, approximately 200m) within a 1km radius of the site – although this is considered to be protected by impermeable London Clay;
- The residential land uses within the surrounding area;
- The underlying Non Aquifer;
- The absence of an unprotected aquifer underlying the site.
- The absence of on-site surface water features; and
- The absence of nearby surface water features (nearest surface water feature, approximately 600m).

14 Geotechnical Considerations

14.1 PROPOSED DESIGN

WSP Environmental Limited understands that sites will be redeveloped to a residential end use, however planning approval has as yet not be received. It is understood that current plans include underground parking across large portions of the site. Based on the desk study information obtained and a walkover survey of the site, several areas of geotechnical risk have been identified as outlined below:

The following ground-related hazards have been identified during the investigation:

Hazard	Justification
Lateral changes in ground conditions	Given the historic earthworks that have occurred on site there is likely to be variable thicknesses of Made Ground across the site.
Shrinkable clay soils	London Clay is considered to be a material with a medium to high volume change potential.
Desiccation	Given the shrinkage potential of the London Clay and any existing / proposed trees on site, desiccation should be considered.
Soft clay – low bearing capacity	The Head deposits overlying the London Clay have the potential of being soft.
High groundwater	Unknown at this stage.
Potential for below ground obstructions.(foundations)	Historic development of the site indicate the potential for below ground obstructions.
Made Ground / infilled ponds	Given the historic earthworks that have occurred on site there is likely to be variable thicknesses of Made Ground across the site.
Adverse ground chemistry (weathering of sulphides to sulphates / acidic pH)	Unknown at this stage.
Slope stabilisation	A steep slope, with history of landslips is present in the east of the site.

14.2 FOUNDATIONS

From past experience, the London Clay is likely to have a safe bearing capacity in the region of 125kN/m2 to 150kN/m2. This generally proves suitable for pad foundations for structures up to three storeys in height. This solution will be subject to confirmatory tests undertaken during an intrusive site investigation. However, the thickness of Made Ground and the thickness and composition of the Head deposits may also preclude the use of shallow foundations.

Footings should be taken deeper where structures are located within influencing distance of any existing or future trees. In these circumstances reference should be made to NHBC Chapter 4.2.

For four storey structures, foundations could be excessively wide and piled foundations may be a more appropriate solution.

It is considered that suspended floor slabs are likely to be required across the site, based on the potential for a significant thickness of Made Ground being present.

The anticipated sub-grade soil CBR value for road pavement design is 2%.

14.3 OBSTRUCTIONS/RELIC STRUCTURES

There is the possibility of relict substructures, including former foundations, being present on the site. In addition to any effect on foundation construction, such features may lead to increased costs for the groundworks operations and delays in programming.

A site located within 500m of the subject site is known to have experienced bombing during the Second World War. It is therefore possible that unexploded ordnance may be present across the site.

15 Risk Assessment

15.1 OUTLINE ENVIRONMENTAL CONCEPTUAL MODEL

The methods used within this risk assessment follow a risk-based approach, with the potential environmental risk assessed qualitatively using the 'source-pathway-target pollutant linkage' concept introduced in the Environmental Protection Act 1990. For a site to be designated as Contaminated Land a plausible linkage between the identified Sources, Pathways and Targets must be demonstrated, this is further discussed within Appendix K.

Potential Contaminant Sources

On-Site Contaminant Sources	■ The site has had a history of development, including railway sidings, which could have resulted in contamination across the site. ■ Previous phases of redevelopment at the site could have resulted in deep areas of Made Ground. ■ An above ground fuel tank with associated pipework and filling point was located in the south of the site. This could have resulted in localised hydrocarbon spills. ■ The surrounding area is thought to have been bombed during World War II which could have resulted in unexploded ordnance being present across the site.
Off-Site Contaminant Sources	■ Neighbouring sites and land have had a commercial/industrial history, including a haulage company. ■ Two waste transfer stations are located within 500m of the site, one is the adjacent property to the north west.

Potential Contaminant Pathways

■ Potentially granular soils in the underlying superficial geology (Head Deposits) have the potential to permit the transport of pollutants. However the underlying solid geology is London Clay and is predominantly cohesive and is likely to restrict the widespread transport of pollutants.

Potential Receptors

Controlled Waters	■ Potable water supply well (approximately 200m east), although this is considered to be protected by the London Clay. ■ Unnamed lake (approximately 600m, north).
Human Health Risks	■ The proposed redevelopment plans include residential properties with gardens, there is unlikely to be a barrier between any subsurface contamination and the end users. ■ Third Party neighbours are residential in nature and as such a barrier between any subsurface contamination is unlikely to be present.

Pollutant Linkages

■ Migration of contamination through potentially granular soils within the Head deposits migrating towards surface water receptors. ■ Direct contact with contaminated soils (ingestion, inhalation and dermal contact).

15.2 ENVIRONMENTAL RISK ASSESSMENT MATRIX

Having evaluated the information gathered during this study and described in the previous sections, WSP Environmental Ltd has produced the following assessment of risk primarily focused on contaminated land issues:

	ISSUE	RISK CATEGORY	REASON
Contamination Potential:	Potential for significant on-site contamination	Medium	Potential sources of contamination have been identified, including Made Ground, an AST and the sites predominantly industrial development history.
	Potential for contaminants migrating off the site	Low/Medium	The migration of any potential contaminants present is likely to be restricted due to the nature of the underlying geology. This is dependent on the thickness and composition of the Head deposits on site.
	Potential for contaminants migrating onto the site	Low/Medium	The migration of any potential contaminants present is likely to be restricted due to the nature of the underlying geology. This is dependent on the thickness and composition of the Head deposits on site.
Other Liability Issues:	Potential for 'other' environmental issues to give rise to liabilities	Low/Medium	There is a potential for unexploded ordnance to be present on site, as a result of World War II bombing.
Environmental Consequences	Risk of Pollution of Controlled Waters	Low	It is considered that in light of the underlying cohesive geology, controlled waters are not considered a significant risk at the site.
	Risk of Damage to Property	Low	No significant issues identified.
	Risk of Harm to Human Health	Medium	The residential redevelopment in the north and east of the site present the highest risk of harm to human health, and certified clean topsoil will need to be imported for the garden areas if materials on site are not suitable.
Business Consequences:	Likelihood of designation as Contaminated Land under EPA 1990	Low/Medium	Consultations with the relevant Contaminated Land Officer have identified that the site is not considered a priority for further investigation under the Contaminated Land Regime for continued use, however prior to redevelopment (residential end use) issues relating to contaminated land will be dealt with through the planning process.
	Risk of Site Value and/or Saleability being affected.	Medium	Source – pathway – receptor linkages have been identified on site, and as such it is recommended that an intrusive phase II investigation is undertaken.
	Likelihood of a Future Purchaser requesting further investigations.	Low/Medium	No further contamination assessment works are considered necessary for a continued use. However, in the event of redevelopment further works will be required as part of the planning process.
	Risk of Liability for Owner	Medium	Source – pathway – receptor linkages have been identified on site, and as such it is recommended that an intrusive phase II investigation is undertaken.
	OVERALL RISK FOR REDEVELOPMENT		**MEDIUM**

15.3 GEOTECHNICAL RISK ASSESSMENT MATRIX

Based on anticipated ground conditions, potential geotechnical risks that may influence current or future land use are summarised below:

	ISSUE	RISK CATEGORY	REASON
Geotechnical Issue:	Potential for variable depth of Made Ground.	Medium	There is potential for significant thicknesses of Made Ground across the site, as a result of the earthworks that have occurred associated with the arisings from the railway cutting.
	Potential for below ground obstructions.	Low/Medium	Former foundations are anticipated to be present across the site.
	Potential for shallow mine workings and coal shafts and adits.	Low	The site is not in an area affected by coal mining.
	Properties for 'other' issues to give rise to liabilities.	Low/Medium	There is a potential for unexploded ordnance to be present on site, as a result of World War II bombing.
Construction Consequences	Risk of Damage to Property	Low/Medium	Identified hazards include high shrinkage potential clay, desiccation, slope instability and filled areas. The risk rating assumes appropriate investigation and remedial action / foundation solutions have been adopted during the development
	Risk of Harm to Human Health	Low	Structural damage is likely to be detected prior to damage to health.
	Implications for redevelopment	Medium	Above issues are likely to require consideration should the site be redeveloped.
Business Consequences:	Risk of Site Value and/or Saleability being affected.	Low/Medium	The above will require consideration and are likely to result in additional insurance / maintenance costs.
	Risk of Liability for Owner	Low	There is unlikely to be a liability risk to the owner assuming appropriate remedial actions / foundation solutions have been adopted during development.
	OVERALL RISK		**LOW / MEDIUM**

16 Summary, Conclusions & Recommendations

Site Address	Land at Oakleigh Road South, Barnet
Current Land Use	The subject site comprises a warehouse and a two storey office building. To the rear of the warehouse (south) an above ground fuel tank, with associated filling point was noted, and a large above ground water tank. The land in the extreme south of the site was overgrown with vegetation; in addition the land in the east of the site was also overgrown and sloping steeply down to the road. The site is located in New Southgate, within Barnet, adjacent to the north east of the overland train station, in a predominantly residential area, with the occasional commercial / industrial property.
Historical Land Use	Historical maps indicate that the site was vacant until 1881, railway sidings were present by 1897, and the current warehouse layout was present by 1966. Surrounding historical land uses include a railway, residential properties, a cemetery, and industrial properties.
Regulatory Enquiries	No significant issues have been identified for continued use, however an intrusive phase II investigation is likely to be required and contamination issues will be dealt with during the planning process associated with redevelopment.
Other Information	Unexploded ordnance may be present on site as a result of World War II bombing in the surrounding area.
Environmental Setting	The site setting is considered to be of low to moderate sensitivity, due to the residential properties in the area and the presence of a potable water supply borehole approximately 200m from the site.
Geotechnical Hazards	The primary geotechnical hazards are considered to be lateral changes in ground conditions, shrinkable clay soils, soft clay soils, desiccation, potential for below ground obstructions and Made Ground.
Conclusions	Based on the information contained within this report and with due regard to redevelopment to residential with gardens, it is the opinion of WSPE that the site represents a **medium** risk with respect to environmental considerations. Based on the information contained within this report, it is the opinion of WSPE that the site represents a **low / medium** risk with respect to geotechnical considerations.
Recommendations	No further work is considered necessary for the ongoing current use of the site. However, the following recommendations should be considered prior to redevelopment: ■ An intrusive phase II investigation should be undertaken to provide information relating to contamination issues, provide preliminary geotechnical advice and a ground gas assessment. ■ An unexploded ordnance desk study.

Please Note: This summary forms part of WSP Environmental Ltd Phase I Environmental Assessment (ref.: 12220279) and as such this should be read in conjunction with the full report.

Appendix G Site Location Plan

Appendix H Annotated Site Plan

Appendix I Photographic Record

PLATE I1:

PLATE I2:

PLATE I3:

PLATE I4:

Appendix J Selection of Historical Map Extracts

Appendix K Methodology & Limitations

Methodology

This Environmental Assessment has been designed to provide information relating to:

- the current and former land uses on and surrounding the site;
- the environmental sensitivity of the site location as determined by factors including geology, hydrogeology, surface watercourses and neighbouring land uses; and,
- relevant records held by the environmental regulators.

Any relevant information provided by the client has been reviewed, with appropriate action taken to ensure this information is taken into account and/or verified where necessary. All information is then assessed to define the potential for the site to give rise to environmental liabilities for the freehold/leasehold owner (as appropriate). Recommendations are made for additional work where this is necessary to fully define the site's environmental liabilities, and cost estimates of the financial implications of the findings can be provided under separate cover, where appropriate.

Risk Classification

This assessment has been undertaken with due regard to Contaminated Land Guidance documents issued by the Department for Environment, Food and Rural Affairs (and its Predecessors), the British Standards Institute (the BSi), the Royal Institution of Chartered Surveyors (RICS) and the American Society for Testing and Materials (ASTM) Standard E 1527-00. The methods used follow a risk-based approach, with the potential environmental risk assessed qualitatively using the 'source-pathway-target pollutant linkage' concept introduced in the Environmental Protection Act 1990.

Specific comment is made regarding the site's status under the Contaminated Land Regime implemented on the 1st April 2000 as Part IIA of the Environmental Protection Act 1990, and the actual or potential designation of the site as 'Contaminated Land' as defined in Section 78A(2). Unless specifically stated as relating to this definition, references to 'contamination' and 'contaminants' relate in general terms to the Presence of potentially hazardous substances in, on or under the site.

In addition, consideration has been given to a wide range of related topics including (where appropriate): environmental processes; current and foreseeable environmental legislation; the practices and duties of environmental regulators; the health and safety of occupiers and neighbours as affected by contamination; effects on the structure of buildings; and financial implications. References to risk classifications are made according to the following definitions:

Low Risk

It is unlikely that the issue will arise as a liability/cost for the freehold/leasehold owner (as appropriate) of the site.

Medium Risk

It is possible that the issue could arise as a liability/cost for the freehold/leasehold owner (as appropriate) of the site. Further work is usually required to clarify the risk.

High Risk

It is likely that the issue will arise as a liability/cost for the site freehold/leasehold (as appropriate) owner of the site.

Environmental Risk Assessment

The presence of contaminated materials on a site is generally only of concern if an actual or potentially unacceptable risk exists. Within the context of current UK Legislation (i.e. Section 57 of the Environment Act 1995), the interpretation of a "significant risk" is termed to be one where:

- Significant harm is being caused or there is a significant possibility of such harm being caused, (where harm is defined as harm to health of living organisms or other interference with the ecological systems of which they form a part and, in the case of man, includes harm to his property); and / or, pollution of Controlled Waters is being caused.

The potential for harm to occur requires three conditions to be satisfied:

- Presence of substances (potential contaminants/pollutants) that may cause harm (Source of Pollution).
- The presence of a receptor which may be harmed, e.g. the water environment or humans, buildings, fauna and flora (The Receptor).
- The existence of a linkage between the source and the receptor (The Migration Pathway).

Therefore, the presence of measurable concentrations of contaminants within the ground and subsurface environment does not automatically imply that a contamination problem exists, since contamination must be defined in terms of pollutant linkages and unacceptable risk of harm.

The nature and importance of both pathways and receptors, which are relevant to a particular site, will vary according to the intended use of the site, its characteristics and its surroundings.

In order to assess the contamination risk at the subject site the above rational has been applied and is discussed within section 6 in the context of Contamination Sources and Potential Pollutant Linkages.

Limitations

WSP Environmental Limited has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from WSP Environmental Limited; a charge may be levied against such approval.

WSP Environmental Limited accepts no responsibility or liability for:

a) the consequences of this document being used for any purpose or project other than for which it was commissioned, and

b) this document to any third party with whom an agreement has not been executed.

The work undertaken to provide the basis of this report comprised a study of available documented information from a variety of sources (including the Client) and discussions with relevant authorities and other interested parties. The opinions given in this report have been dictated by the finite data on which they are based and are relevant only to the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, WSP Environmental Limited reserves the right to review such information and, if warranted, to modify the opinions accordingly.

Where no site inspection is undertaken (for example a Desk Study Assessment or due to restricted site access), WSPE cannot comment on the potential for environmental concerns associated with the current use or structure including the Presence of asbestos.

It should be noted that any risks identified in this report are perceived risks based on the information reviewed; actual risks can only be assessed following a physical investigation of the site.

Appendix L Report References

Environment Agency Aquifer Classifications

The Environment Agency (EA) Groundwater Vulnerability Map and Regional Appendices, which make up part of the published Policy and Practice for the Protection of Groundwater, divide the underlying strata in England and Wales into major, minor and non aquifers dependent upon their potential for potable water supply. The following table is derived from the main policy document. The division of the rock formations into major, minor and non aquifer reflects the Regional importance and vulnerability of the formation.

Major Aquifer

Highly permeable formations usually with the known or probable Presence of significant fracturing. Highly productive strata of Regional importance. Often used for large potable abstractions. E.g. Upper Chalk, Permo-Triassic Sandstones

Minor Aquifer

Fractured or potentially fractured but without high intergranular permeability. Generally only support locally important abstractions E.g. Coal Measures

Variable porosity and permeability but without significant fracturing. Generally only support locally important abstractions. E.g. River Terrace Gravels

Non Aquifer

Formations with negligible permeability. Only support very minor abstractions if any. E.g. Mercia Mudstones, igneous rocks

Regulatory Information Sources

Reference has been made to the Landmark Information Group data provision service. This includes information and data collated from several organisations, including the Environment Agency (EA), Department for Environment, Food & Rural Affairs (DEFRA), Health & Safety Executive (HSE), the Health Protection Agency (HPA), and the Coal Authority

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Version 2.0.6

BGS ID: 593939 : BGS Reference: TQ29SE121
British National Grid (27700) : 528810,192920
Report an issue with this borehole

TQ 29 /18

TQ 29 SE 121

2881 9292

EAST BARNET Herts 46 S.W.

2. East Barnet Pumping Station of the Barnet District Water Co. 1899.
From the Local Government Board and from F. J. BANCROFT, Engineer to the Co.

131 ft. above Ordnance Datum.

Shaft. Cast iron cylinders of 14 ft. diameter, 25½ ft.; of 13 ft. diameter, 58½ ft., of 12 ft. diameter, 50 ft., unlined, of 11½ ft. diameter.

Headings, at the depth of 215 ft. (extended) 2,026½ ft. long; at the depth of 280 ft., 95 ft. long; total 3,021½ ft.

Average daily supply 791,000 gallons.

		Thickness. Ft.	Depth. Ft.
Soil ...	... ...	1	1
? Wash	Ballast [gravel]	½	
	Clay	1½	
	Ballast [gravel]	½	3½
London Clay, 604 ft.	Mixed clay	13½	
	Dark clay and sand	24	
	Blue clay and sand, most sand ...	5	
	Blue clay and sand	16	
	Blue clay	2	64
	Mottled clay	2	
	Blue clay	½	
	Mottled clay	8½	
Reading Beds, 64 ft.	Rock	1	
	Rock and clay	2	
	Mottled sandy clay	22	
	Black pebbles	1	
	Clay sand and black pebbles ...	26½	
	Flints	½	128
[Upper] Chalk		172	300

J. M. WOOD states that the pumping at this well affects to a considerable extent the water-level in the bore-hole of the Betstile Well of the Metropolitan Water Board, about a quarter of a mile to the south, in Middlesex.

Water-levels: see chart with 256/8

Present yield 80,000 gallons per day — letter from J.F. Hazeldine 24,10,40. (9509/30), see 256/8.

Yield 230,000 g.p.d, pumping 8 hrs. / day.
R.W.L. 188' down.
Pump @ 219' from bottom with diesel engine & steam also. Herts 46 SW/W. if necessary.
Sited D on ~~Middlesex / Bedfordshire~~
Visited 15/4/47.
Info. coming by post.

Water Supply of
Bucks. & Herts.
Page 182

APPENDIX E
UTILITY SERVICE PLANS

Network Records NetMAP Symbols Booklet - East of England

This symbol booklet is intended as a general guide only - some local variations of these symbols may be found.

Version 1.2

Released October 2010

Always check with your local Network Records office or the UK Power Networks server to ensure that you are using the most up to date copy of this booklet - Tel: 08000 565866.

Index:-

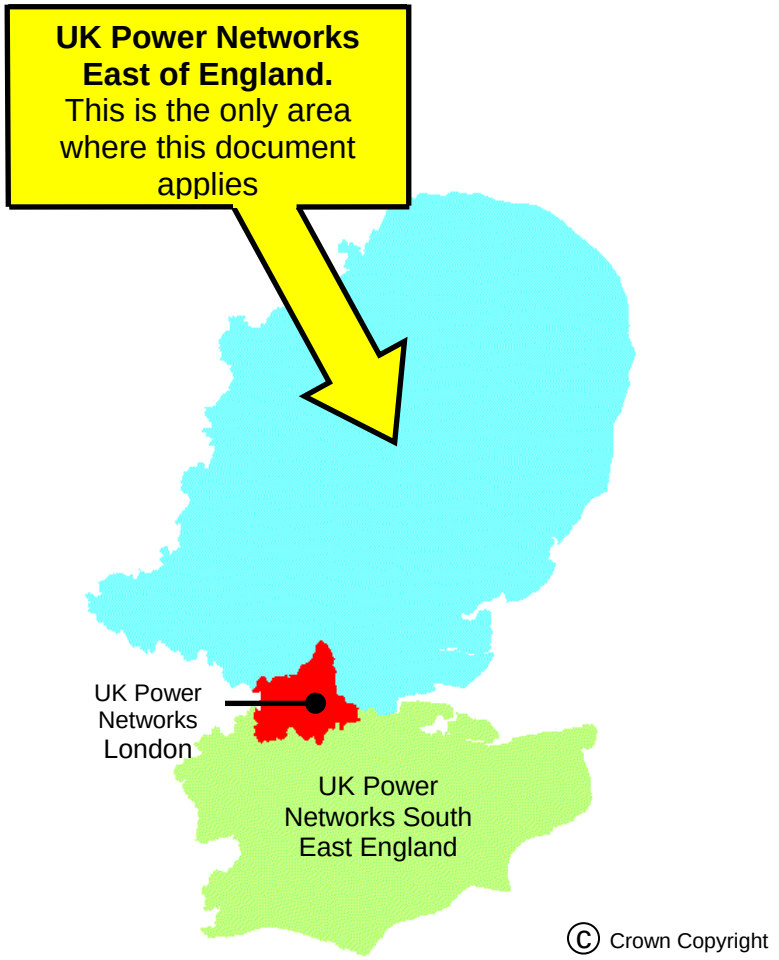
Guidance notes.

Important notice:
If you do not understand the NetMAP record that you are using, please contact the UK Power Networks Network Records team for guidance
Tel: 08000 565866.

- The position of apparatus shown on NetMAP is believed to be correct, but the original landmarks may have altered since the apparatus was installed.
- It must be assumed that there is at least one service to each property, lamp column, street sign etc.
- All cables must be treated as live, unless proven otherwise by an authorised UK Power Networks representative.
- Third party cables are not usually shown. In cases of doubt, please telephone 08000 565866.
- When two or more maps are supplied for the same area, the maps must be read in conjunction with each other and with this symbol document.
- All LV cables are assumed to be 4 core, and all HV cables assumed to be 3 core unless otherwise stated.

Plan Provision Team
Fore Hamlet
Ipswich
Suffolk IP3 8AA
Tel: 08000 565866

The area covered by this guide:



1:500 view - underground network

Scenery

NetMAP system	Scanned image	Description
		100 metre Ordnance Survey grid line (on O/S based maps only.)
		Property fence line
		Building line
		Kerb line
		Electrical Boundary

Scenery - for UK Power Networks use only - boxed in red

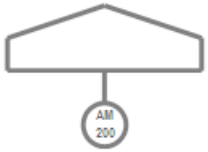
NetMAP system	Scanned image	Description
 Inset Network – Contact xxxx IDNO for further information	Not applicable	Area of inset network - not the asset of UK Power Networks (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Proposed Cross Rail route (only visible to UK Power Networks and their immediate contractors)
	Not applicable	High pressure pipelines in the general vicinity (only visible to UK Power Networks and their immediate contractors)

Note: Pipelines are only viewable on NetMAP by UK Power Networks staff and their immediate contractors. Do not carry out any excavation without consent from the relevant agency - legally protected high pressure petroleum products pipeline route in the general vicinity - consult www.linewatch.co.uk for contacts and guidance. Pipeline contact numbers can also be found on the intranet – out of hours, contact our Control Centre.

	Not applicable	Water - surface water (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Water - Source Protection Zone 1 (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Water - Source Protection Zone 2 (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Water - Source Protection Zone 3 (only visible to UK Power Networks and their immediate contractors)

section continued on next page

Scenery for UK Power Networks use only - boxed in red

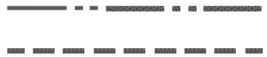
NetMAP system	Scanned image	Description
	Not applicable	Historical - Scheduled Monuments (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Historical - Parks and Gardens (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Historical - Areas of Archaeological Potential (AAP) (only visible to E UK Power Networks and their Immediate contractors)
	Not applicable	Nature - Ramsar Wetlands of International Importance (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Nature - Special Area of Conservation (SAC) (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Nature - Special Protected Area (SPA) (only visible to UK Power Networks and their immediate contractors)
		Nature - Site of Special and Scientific Interest (SSSI) (only visible to UK Power Networks and their immediate contractors)

section continued on next page

Scenery for UK Power Networks use only - boxed in red

NetMAP system	Scanned image	Description
	Not applicable	Nature - Local Nature Reserve (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Nature - National Nature Reserve (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Nature - Area of Outstanding Natural Beauty (AONB) (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Nature - National Park (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Fluid filled cables - very high sensitivity (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Fluid filled cables - high sensitivity (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Fluid filled cables - medium sensitivity (only visible to UK Power Networks and their immediate contractors)
	Not applicable	Fluid filled cables - low sensitivity (only visible to UK Power Networks and their immediate contractors)

Primary distribution cables (1:500 view)

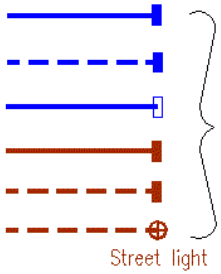
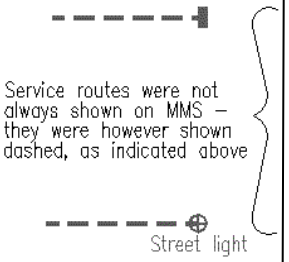
NetMAP system	Scanned image	Description
		Over 33kV and up to 132kV
		Over 11kV and up to 33kV

Secondary distribution cables (1:500 view)

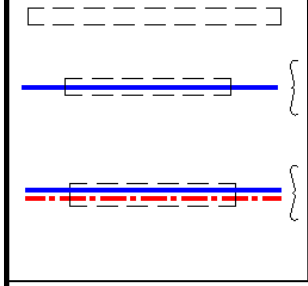
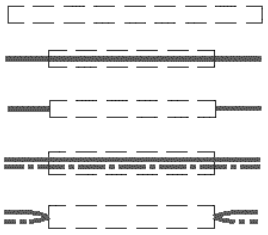
NetMAP system	Scanned image	Description
		Over 230/400V and up to 11kV (HV) cable route
		230/400V (LV) cable route
	(Only shown this way if independent from HV cable route)	Pilot cable route

Abandoned cables are shown and labelled as such when applicable

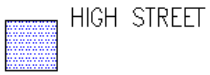
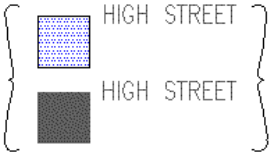
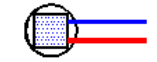
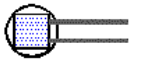
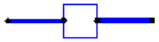
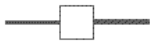
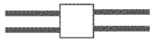
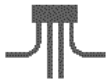
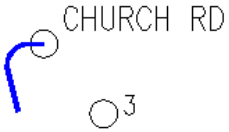
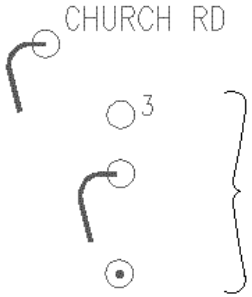
Service cables and terminations (1:500 view)

NetMAP system	Scanned image	Description
		3 phase service with termination 3 phase service with termination (unknown route) 3 phase service with multi-head termination Single phase service with termination Single phase service with termination (route unknown) Street lighting cable and termination

Cable ducts (1:500 view)

NetMAP system	Scanned image	Description
		Empty duct Cable(s) in duct(s) Cable(s) in duct(s) (on some raster maps) Multiple cables in ducts Multiple cables in ducts (on some raster maps)

EHV, HV and LV sites (1:500 view)

NetMAP system	Scanned image	Description
		Primary substation
		Secondary substation
		Pad mounted substation
		Link box – 2 way
		Link box – 4 way (6 way etc shown similarly)
		Feeder pillar – 4 way (6 way etc shown similarly)
		Pole transformer Poles on underground records
		H pole, any voltage
		Service turret (solid type)

section continued on next page

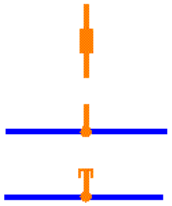
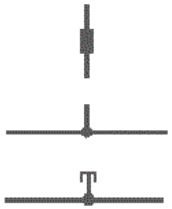
EHV, HV and LV sites continued (1:500 view)

NetMAP system	Scanned image	Description
No NetMAP equivalent  CAUTION Missing Information	 No equivalent	Service turret (with link facility on LV main) Missing data in or near this location
	Not applicable	Contaminated land reference

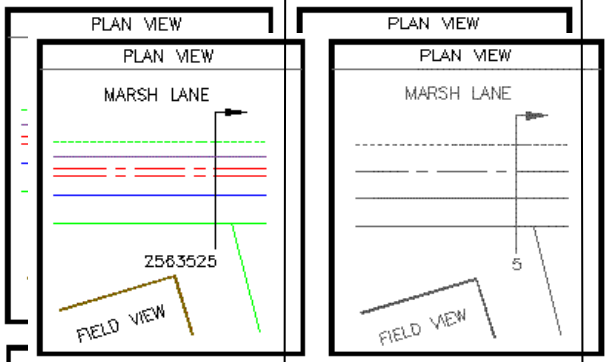
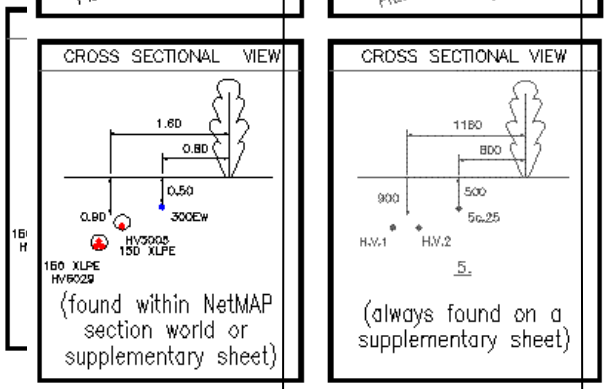
Mains joints (1:500 view)

NetMAP system	Scanned image	Description
(voltage indicated by colour/line-style)		
		Straight joint
		Crutch joint
		Straight crutch joint
		Pot end
		Pot end – on one of several cables – single line representation
		Branch joint/pot end – (humpty back joint, back to back joint, bull nose joint or stub joint
		Sleeve repair or repair joint
		Cut end
		Capped end
		Tee joint
	NetMAP/vector only	Sicame joint box

Service joints (1:500 view)

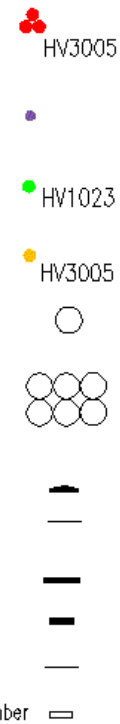
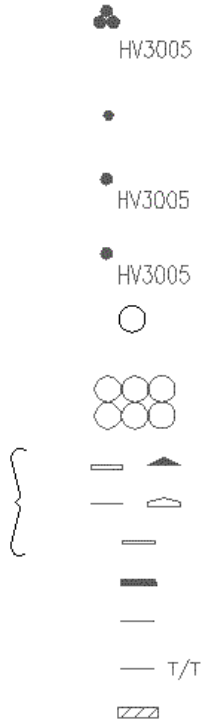
NetMAP system	Scanned image	Description
Please note that 3 phase services are shown blue, and single phase services are shown brown		
		Straight joint
		Service joint to main
		Pot end

Cross sections (1:500 view)

NetMAP system	Scanned image	Description
		Single line representational plan view with NetMAP equivalent (please note the use of seperate line for each voltage on the raster/MMS data)
		Cross sectional view of above
		Section arrow with old/new numbering system – points in direction section is viewed
		LV/3 phase service cable
		Single phase service cable with size annotation
		HV cable – 3 core with route number annotation

section continued on next page

Cross sections continued (1:500 view)

NetMAP system	Scanned image	Description
		HV cable – modern EPR, Plam and Triplex with route number annotation Pilot cable 33kV cable 132kV cable Single duct 6 way duct formation – irrespective of duct type and material, all are displayed similarly Protective slab Tiles Concrete slabs 33kV fibre warning board Steel plate Plastic tile tape Timber

Common abbreviations and terminology (all views)

Abbrev.	Description
1c	Single core
1ph	Single phase
2c	Two core
3c	Three core
3ph	Three phase
ABC	Aerial bunched (bundled) conductor (modern LV overhead line)
ABI	Air break isolator (no fuses)
ABSD	Air break switch disconnector
ACCS	Aluminium concentric copper sheathed
Al	Aluminium
AR	Auto recloser
ASL	Automatic sectionalising links
ax	Triplex (aluminium)
	2 x 22mm AL PVC (example) Duplex
	3 x 22mm AL PVC (example) Triplex
CB	Circuit breaker
c/c	Concentric cores
ccc	Compact covered conductor
CCT	Circuit
CNE	Combined neutral and earth
Cross phased	The core colour may be different to originating transformer phasing
CS	Consac
CSE	Cable sheath earth
Cu	Copper

Abbrev.	Description
Cut out or C/O	Meter/main fuse position
cx	Triplex (copper)
DE	Direct earth
DSTA	Double steel tape armoured
Ea	Alpex cable
EFI	Earth fault passage indicator
EHV	Extra high voltage (11,001 Volts and over)
ELCB	Earth leakage circuit breaker
ELT	Earth leakage trip
EPR	Ethylene propylene rubber
Ew	Waveform cable
E/W	Earthenware duct or earth wire
Fdr or Feeder	LV or HV cable fed by or feeding a substation
F/G	Fuse gear
F/P	Feeder pillar
GRP	Fibreglass substation
GVR	Gas vacuum recloser or pole mounted circuit breaker
HV	High voltage (1,001–11,000 Volts incl)
HYBRID	Modern plastic cable with mixed conductor material (Al/Cu)
Insulation	Electrically protective material surrounding a conductor
Insulator	Porcelain or glass over–head line support (on poles)
ITC	Instrument traced cable or ITC - cable traced electronically using Cable Avoidance Tool (CAT) or similar

section continued on next page

Common abbreviations and terminology continued (all views)

Abbrev.	Description
Jumper	Connecting lead between open points, section points and overhead plant
kV	Kilovolt (or 1,000 Volts) – unit of electrical pressure
kW	Kilowatt (1,000 Watts) – unit of electrical power
kVA	Kilovolt Amps or power
Link box or LB	Means of connecting LV feeders together using links or fuses
LSF	Low smoke & fume
LV	Low voltage (up to 1,000 Volts incl)
LV Pillar	Low voltage fuse distribution board
Neutral	Return path of live cable
O/H or OHL	Overhead line
OYS	Oil filled pole mounted sectionaliser
OYT	Oil filled pole mounted recloser
PC400	Pole mounted LV fuse unit
PE	Pot end or potential end – joint on cable end
Phase	Usually the core colour of a cable (caution – may be cross phased) – Red, Yellow, Blue on old cables, or L1, L2, L3 on new cables, for example

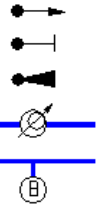
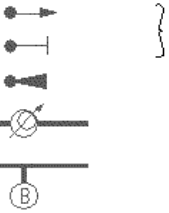
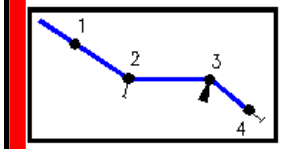
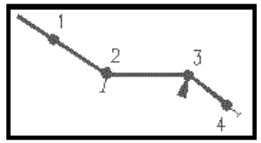
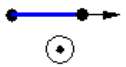
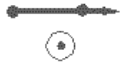
Abbrev.	Description
PICAS	Paper insulated corrugated aluminium sheath armoured
PILC	Paper insulated lead covered
PILSTA	Paper insulated lead covered steel tape armoured cable
PL	Plain lead or public lighting
PME	Protected multiple earth or CNE
PMT	Pole mounted transformer
PMR	Pole mounted recloser (generic term for OYT/GVR)
PT	Pole transformer
PVC	Polyvinyl chloride
RMU	Ring main unit
RN	Reduced neutral
s/c	Split concentric or single core
S/L	Street light
S/S	Substation
STA	Steel tape armoured
SWA	Steel wire armoured
T1 or T2 etc	Substation TX setup where more than one TX exists
T/F or TX	Transformer
Volts	Unit of electrical pressure
Watts	Unit of electrical power
XLPE	Cross linked polyethylene

1:2500 & 1:10000 view - overhead networks - for UK Power Networks use only - boxed in red

General

NetMAP system	Scanned image	Description
		H pole Pole

1:2500 scale LV network

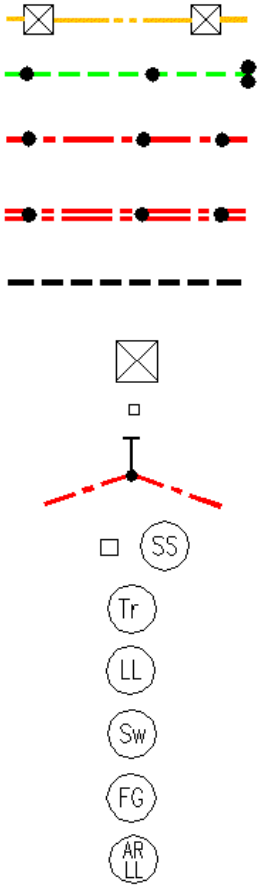
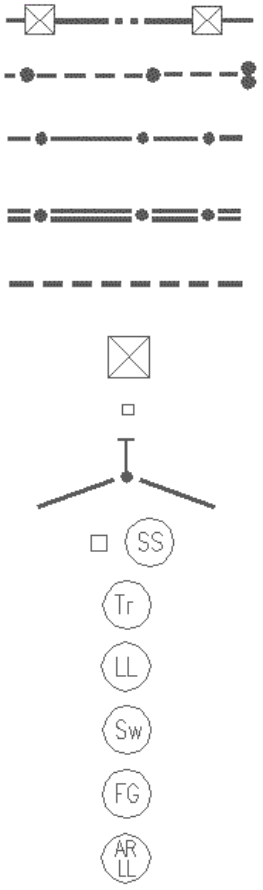
NetMAP system	Scanned image	Description
No NetMAP equivalent		132kV cable route
No NetMAP equivalent		33/22kV cable route
No NetMAP equivalent		11kV underground cable
		132kV overhead line
		33kV overhead line dots mark pole position
		11kV overhead line – dots mark pole position
		Dual construction – dots mark pole position
		LV overhead line – dots mark pole position
No NetMAP equivalent		LV underground cable
		Pole and stay Pole and strut Voltage regulator Static balancer
		Example of struts and stays
		Flying stay
		Earthed pole in PME system
261	261	Pole number
□	□	Ground type substation
S.P.	S.P.	Section pole
S.L.	S.L.	Street light

section continued on next page

1:2500 scale LV network continued

NetMAP system	Scanned image	Description
O.R. Stay Ext. Brkt P. Box N.E. O.R. Brkt	O.R. Stay Ext. Brkt P. Box N.E. O.R. Brkt	Outrigger stay Extension bracket Pole box Neutral and earth Outrigger bracket

1:10000 scale HV network

NetMAP system	Scanned image	Description
		132kV overhead line 33kV overhead line dots mark pole position 11kV overhead line – dots mark pole position 11kV overhead line – dual circuit – dots mark pole position 11kV underground cable and EHV Pylon HV or EHV Grid line tower Stay Ground type substation Pole type transformer Live line taps Switchgear – all types Fuse gear Auto recloser – live line connected

The above circular substation/switchgear symbols may be found that contain different combinations of apparatus (see last example)

LV network diagram view-for UK Power Networks use only-boxed in red

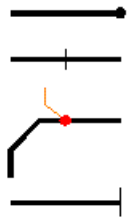
Overhead lines

NetMAP system	Description
	Unknown
	Al
	Cu
	ABC
	Pole link

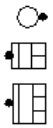
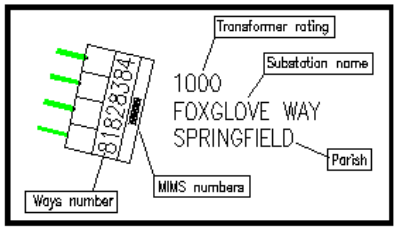
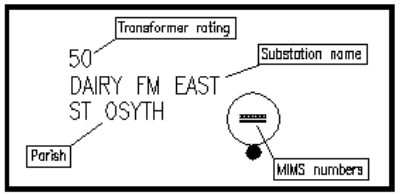
Underground cables (LV network diagram view)

NetMAP system	Description
	Unknown
	Al
	Cu
	CC
	TCC
	Ea
	Ec
	Ecx
	Ew
	LSF
	Other

Joints (LV network diagram view)

NetMAP system	Description
	Pot end or Sicame Box Straight joint Crutch joint 3 phase termination

Substations/pole transformers (LV network diagram view)

NetMAP system	Description
There are many substation combinations – these are merely a sample of configurations that can be found.	
	2 way substation
	4 way substation
	4 way twin busbar substation
	10 way back to back substation
	Pole transformer (normal) Pole transformer 2 way Pole transformer 3 way
	Substation with rating, name, Parish and MIMS identifying number
	Pole transformer with rating, name, Parish and MIMS identifying number
	Intermediate pole
	Section pole
	Overhead fuse

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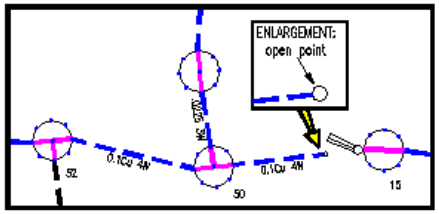
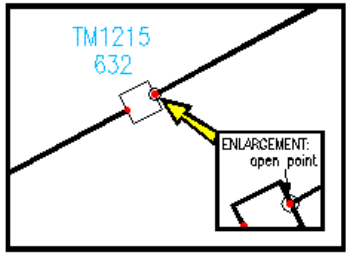
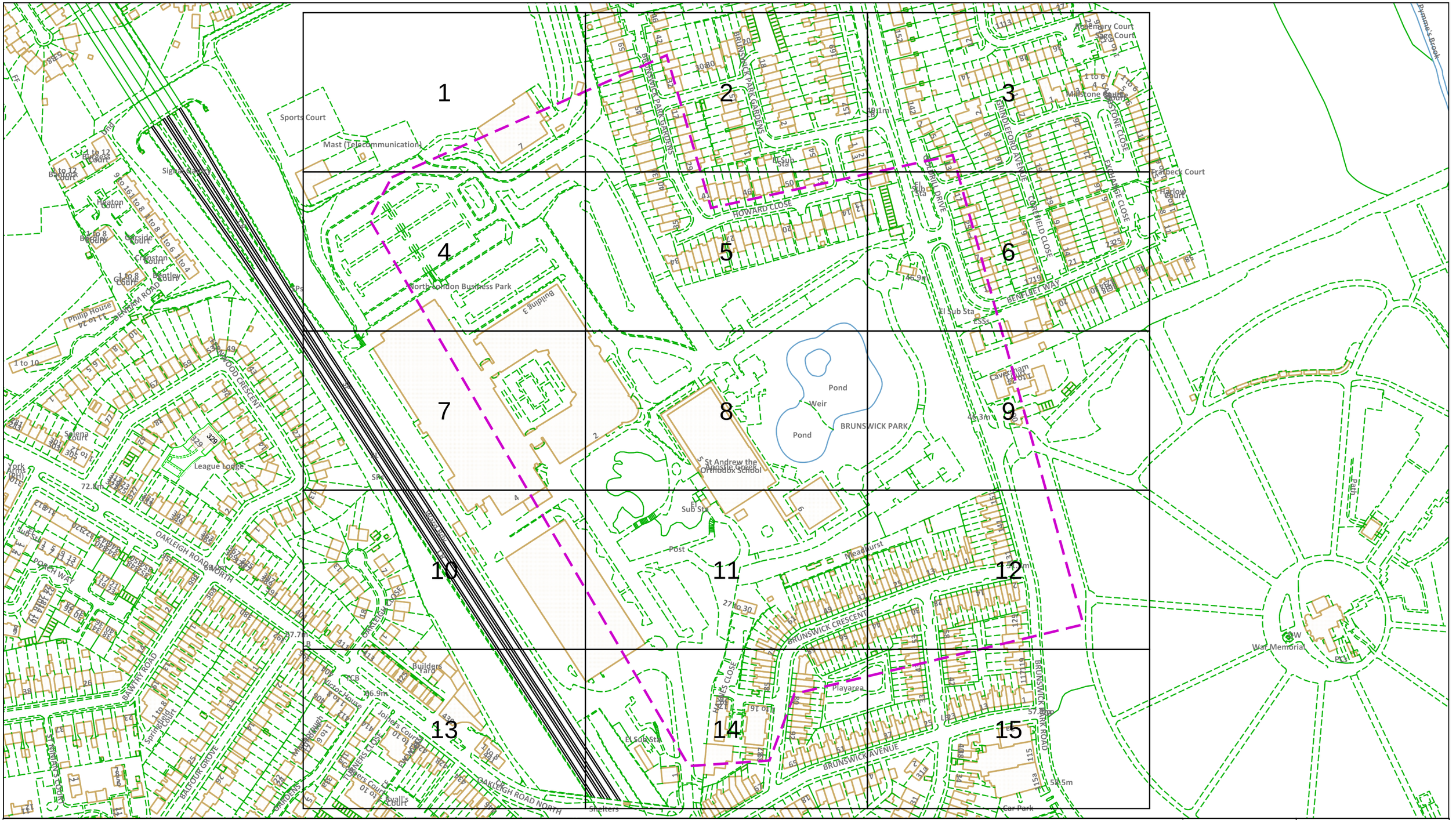
Substations/pole transformers cont'd (LV network diagram view)

NetMAP system	Description
	Overview – the purple lines through the section poles are pole links – these indicate how the network is linked together
	2 way link box
	3 way link box
	4 way link box
	4 way double busbar link box
	4 way BICC link box
	5 way link box
	6 way link box
	6 way double busbar link box
	A two way link box with identification number, connected to a cable with an open point
	Feeder pillars – these range from 2 ways through to 9 ways – a 9 way and a 2 way are shown as examples
	



Dig Sites Area: Line:

The quality and accuracy of any print will depend on your printer, your computer and its print settings. Measurements scaled from this plan may not match measurements between the same points on the ground.

This plan must be used with the attached 'Symbols' document.

Date Requested: 05/08/2020
Job Reference: 19594059
Site Location: 527622 193078
Requested by:
Miss Monique Elsom
Your Scheme/Reference: 2190242

Scale: 1:2563 (When plotted at A3)

1. The position of the apparatus shown on this drawing is believed to be correct but the original landmarks may have been altered since the apparatus was installed.
2. The exact position of the apparatus should be verified – use approved cable avoidance tools prior to excavation using suitable hand tools.
3. It is essential that trial holes are carefully made avoiding the use of mechanical tools or picks until the exact location of all the cables have been determined.
4. It must be assumed that there is a service cable into each property, lamp column and street sign, etc.
5. All cables must be treated as being live unless proved otherwise by UK Power Networks.
6. The information proved must be given to all people working near UK Power Networks plant and equipment. Do not use plans more than 3 months after the issue date for excavation purposes.
7. Please be aware that electric cables/lines belonging to other owners of licensed electricity distribution systems may be present and it is your responsibility to identify their location.

1. UK Power Networks does not warrant that the information provided to you is correct. You rely upon it at your own risk.
2. UK Power Networks does not exclude or limit its liability if it causes the death of any persons or causes personal injury to a person.
3. Subject to paragraph 2 UK Power Networks has no liability to you in contract, in tort (including negligence), for breach of statutory duty or otherwise for any loss, damage, cost, claims, demands, or expenses that you or any third party may suffer or incur as a result of using the information provided whether for physical damage to property or for any economic loss (including without limitation loss of profit, loss of opportunity, loss of savings, loss of goodwill, loss of business, loss of use) or any special or consequential loss or damage whatsoever.
4. This plan has been provided to you on the basis of the terms of use set out in the covering letter that accompanies this plan. If you do not accept and/or do not understand the terms of use set out in the covering letter you must not use the plan and must return it to the sender of the letter.
5. You are responsible for the security of the information provided to you. It must not be given, sold or made available upon payment of a fee to a third party.

UK Power Networks

IF IN DOUBT – ASK!
PHONE 0800 056 5866
EMERGENCY - If you damage a cable or line Phone 0800 783 8838 (24hrs) URGENTLY

LOOK OUT LOOK UP

ALWAYS LOOK UP BEFORE YOU START WORK
Refer to HSE Guidance note GS6

Maps produced at 1:2500 scale are Geo-Schematics which show LV mains cables and overhead lines (in some cases all voltages). Prior to carrying out excavations you must refer to the 1:500 records to determine the location of all known underground plant and equipment.