Coram Community Campus
London WC1N

soiltechnics
environmental and geotechnical consultants

Proposed development at Coram Community Campus Mecklenburg Square London WC1N 2QA

GROUND INVESTIGATION REPORT

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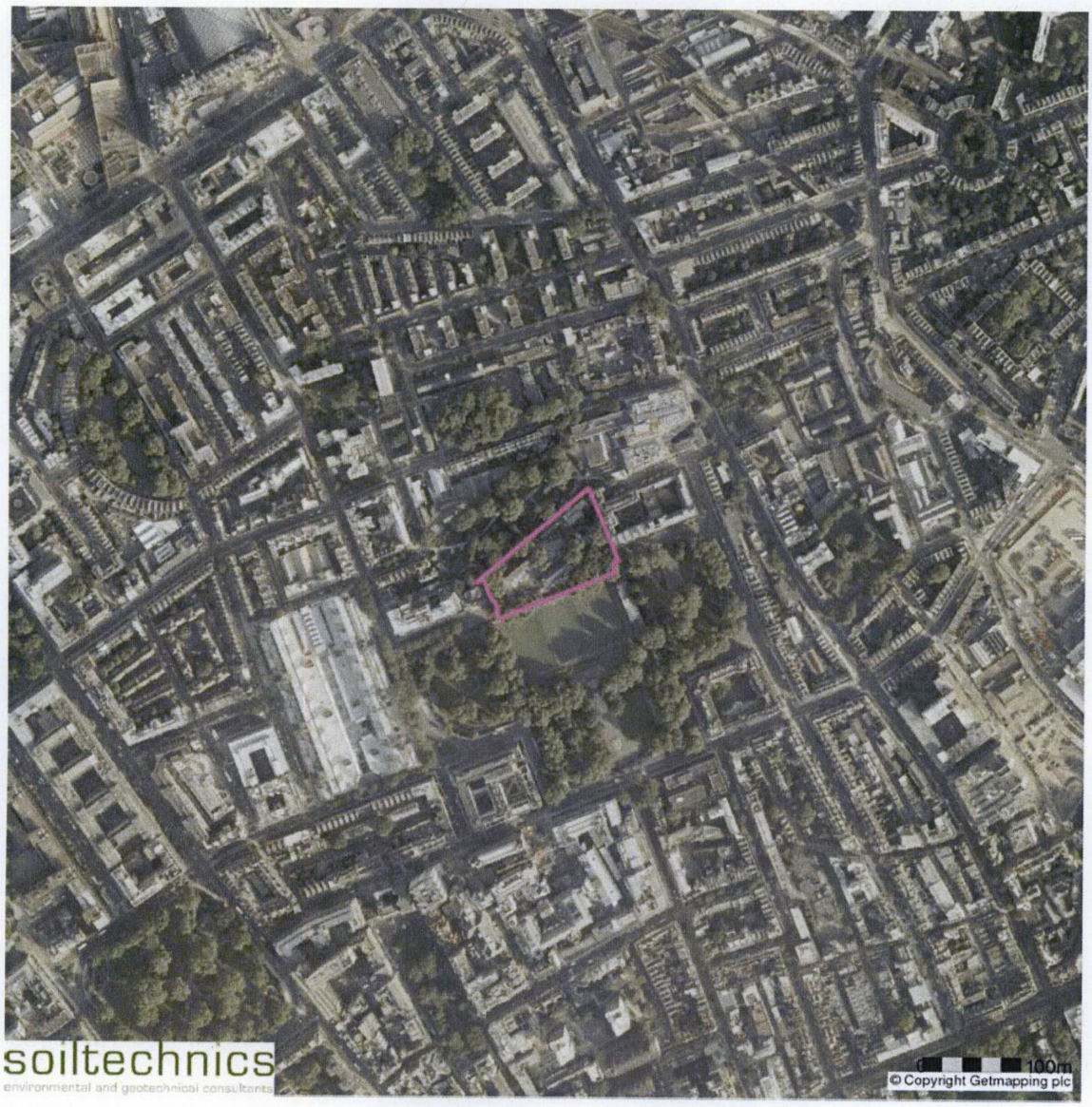
Report issue

Company	Name	Issue	Date	Paper	CD	e-mail
Meadowcroft Griffin	Patrick Quinn	First	21.05.10	✓	✓	✓

Aerial photograph of site



Report status and format

Report section	Principal coverage	Report status	
		Revision	Comments
1	Executive summary		
2	Introduction		
3	Desk study information and site observations		
4	Fieldwork		
5	Ground conditions encountered		
6	Laboratory testing		
7	Engineering assessment		
8	Chemical contamination		
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10	Effects of ground conditions on building materials		
11	Landfill issues		
12	Further investigations		
13	Drawings		

Note: A separate report has been produced on classification of soils for off-site disposal.

List of drawings

Drawing	Principal coverage	Status	
		Revision	Comments
STG1672B-01	Site location plan		
STG1672B-02	Plan showing existing site features, development proposals and location of exploratory holes		
STG1672B-03	Plot summarising insitu density testing		
STG1672B-04	Plot summarising results of pocket penetrometer determinations		
STG1672B-05	Section showing construction of standpipe installed in borehole BH03		

List of appendices

Appendix	Content
A	Definitions of geotechnical terms used in this report
B	Definitions of geo-environmental terms used in this report
C	Trial pit records
D	Borehole records (cable and tool percussion drilling)
E	Record of infiltration test
F	Copies of laboratory test result certificates – classification & physical testing
G	Copies of laboratory test result certificates – concentrations of chemical contaminants
H	Statistical analysis and summary of test data in relation to concentrations of chemical contaminants
I	Record of in-situ gas monitoring results
J	Cover system material supply schedule
K	Copies of Statutory Undertakers replies
L	Copy of desk study information produced by Envirocheck

1 Executive summary

1.1 General

1.1.1 We recommend the following executive summary is not read in isolation to the main report which follows.

1.2 Site description, history and development proposals

1.2.1 The site is located in a predominately residential area of north London approximately 0.5km to the south of Kings Cross terminus. At the time of our investigation, the site was occupied by Coram Community Campus incorporating schools and offices.

1.2.2 A review of historical maps indicates that the site remained undeveloped until around 1895. The current site layout is marked from 1953 onwards.

1.2.3 We understand that proposals are for the demolition of existing buildings in the north of the site followed by the construction of a four-storey building incorporating educational and welfare facilities and offices. We also understand that site use will not change as a result of the development.

1.3 Ground conditions encountered

1.3.1 Our exploratory excavations encountered Made Ground overlying Lynch Hill Gravel and London Clay with the Lambeth Group at depth. Made Ground deposits in excess of 2.5m were encountered adjacent to site boundaries.

1.4 Foundation solution

1.4.1 Lynch Hill Gravel deposits will achieve an allowable bearing capacity of 90kN/m^2 for a 1.5m x 1.5m pad foundation. However, due to the depth of Made Ground and the presence of a large number of trees, we recommend that a piled foundation solution is considered. Preliminary pile design parameters are presented.

1.5 Chemical and gaseous contamination

1.5.1 Due to the nature of the proposed development, critical site users will include both adults and children. Based on the comparison of laboratory test data with the least onerous assessment criteria, soils at the site present a potential risk to the health of site users. Recommendations for remedial measures are presented and we understand that the requirements of the remedial measures will be considered in the landscaping scheme by the landscape architects and arboriculturist.

1.5.2 Based on the results of leachate testing, water resources are at low risk from ground conditions encountered at the site.

1.4.3 **Measures to protect against ground gases are not required for new buildings at the site.**

2 Introduction

2 Introduction & brief

2.1 Objectives

2.1.1 This report describes a ground investigation carried out for a proposed development at Coram Community Campus, 49 Mecklenburg Square, London WC1N 2QA.

2.1.2 The principal objective of the ground investigation was to establish ground conditions at the site, sufficient to identify possible foundation solutions for the development and provide parameters necessary for the design and construction of foundations.

2.1.3 The investigation included an evaluation of potential chemical and gaseous contamination of the site leading to the production of a risk assessment in relation to contamination.

2.1.4 Our brief also included investigations and testing to allow classification of soils at the site to be disposed of to landfill.

2.2 Client instructions and confidentiality

2.2.1 The investigation was carried out in March 2010 and reported in April 2010 acting on instructions received from Adams Kara Taylor on behalf of our mutual client, the Coram Foundation.

2.2.2 This report has been prepared for the sole benefit of our above named instructing client, but this report, and its contents, remains the property of Soiltechnics Limited until payment in full of our invoices in connection with production of this report.

2.2.3 The scope of the investigation was defined by Adams Kara Taylor in their contract / briefing document ref.A056571 dated 21st January 2010.

2.3 Site location and development proposals

2.3.1 The National Grid reference for the site is 530480, 182410. A plan showing the location of the site is presented on Drawing STG1672-01.

2.3.2 We understand that the development will comprise the demolition of existing buildings at the site followed by the construction of a 4 storey building incorporating educational and welfare facilities and offices.

2.4 Report format and investigation standards

2.4.1 Sections 2 to 6 of this report describe the factual aspects of the investigation with Section 7 presenting an engineering assessment of the investigatory data. Section 8 provides a risk assessment of chemical contamination based on readily available historic records, inspection of the soils and laboratory testing. Section 9 provides a similar risk assessment in relation to gaseous contamination with Section 10, a risk assessment relating to construction materials likely to be in contact with the ground. Section 11 discusses issues related to landfill.

2.4.2 This investigation integrates both contamination and geotechnical aspects. The investigation was carried out generally, and where practical following the recommendations of BS EN 1997:2 2007 *'Eurocode 7 – Geotechnical Design – Part 2: Ground Investigation and Testing'*. The investigation process also followed the principles of BS10175: 2001 *'Investigation of potentially Contaminated Sites – Code of Practice'*. In view of the client's requirement for rapid implementation of the investigation, the following elements, defined in BS10175, have been completed and incorporated in this report.

a) Phase I Preliminary investigation (desk study and site reconnaissance)
b) Phase II Exploratory and main (intrusive) investigations

2.4.3 The extent and result of the preliminary investigation (desk study) is reported in Section 3. Fieldwork combined the exploratory investigation and main investigation stages into one phase with the extent of these works described in Sections 4 and 6 of this report. Any supplementary investigations deemed necessary as a result of deficient information obtained by investigations, completed to date, are identified in Section 12. Section 13 provides information on any remedial strategy and specification if required.

2.4.4 Our investigations included testing to allow classification of soils at the site for potential disposal to landfill. Our report on this aspect is separately presented.

2.5 Status of this report

2.5.1 This report is final based on our current instructions.

2.5.2 This investigation has been carried out and reported based on our understanding of best practice. Improved practices, technology, new information and changes in legislation may necessitate an alteration to the report in whole or part after publication. Hence, should the development commence after expiry of one year from the publication date of this report then we would recommend the report be referred back to Soiltechnics for reassessment. Equally, if the nature of the development changes, Soiltechnics should be advised and a reassessment carried out if considered appropriate.

2.6 Report distribution

2.6.1 This report has been prepared to assist in the design and planning process of the development and normally will require distribution to the following parties, although this list may not be exhaustive:

Party	Reason
Client	For information / reference and cost planning
Developer / Contractor / project manager	To ensure procedures are implemented, programmed and costed
Planning department	Potentially to discharge planning conditions
Environment Agency	If ground controlled waters are affected, and obtain approvals to any remediation strategies.
Independent inspectors such as NHBC / Building Control	To ensure procedures are implemented and compliance with building regulations
Project design team	To progress the design
CDM Coordinator	To advise in construction risk identification and management under the Construction (design and management) regulations

3 Desk study information and site observations

3.1 General

3.1.1 We have carried out a desk study which was limited to the collection of readily available information. This included:

a) Retrieval of published Ordnance Survey maps dating back to 1851 at 1:1250, 1:2500, 1:10000 and 1:10560 scales where applicable.

b) Inspection of geological maps produced by the British Geological Survey together with relevant geological memoirs.

c) Consultation with Statutory Undertakers

d) Site reconnaissance

e) Other relevant published documents

3.1.2 Section a) was carried out by Envirocheck. The report prepared by Envirocheck is presented in Appendix L. In addition to retrieval of historical and current Ordnance Survey data, Envirocheck provide information compiled from outside agencies including: -

- Environment Agency
- Institute of Hydrology
- British Geological Survey
- Countryside Council for Wales
- Scottish National Heritage
- English Nature

3.1.3 The study did not extend to research of meteorological information or consultation with other interested parties such as English Heritage (ancient monuments), Ordnance Survey (survey control points), Planning Authorities or Archaeological Units.

3.2 Description of the site

3.2.1 The site is located in a predominately residential area of north London approximately 0.5km to the south of Kings Cross terminus. The nearest surface watercourse is Regent's Canal which is located approximately 850m to the north-west of the site. The channel of the River Thames is located 3.5km to the south of the site.

3.2.2 At the time of our investigation, the site was occupied by Coram Community Campus comprising a number of low-rise buildings grouped around a central courtyard and access road. In the south-west of the site, a two storey L-shaped building fronted onto the courtyard area. The building was in use as a nursery school and offices. The remaining buildings located in the northern part of the site were occupied by a boiler room, offices, a special education unit and general site storage. Temporary Portakabin-type buildings were located in the south-east of the site.

3.2.3 The courtyard area was surfaced in concrete slabs with a bituminous surfaced access road connecting the site to Mecklenburg Square. Planted and grassed areas were present and a small garden area was located at the north-eastern boundary of the site. A number of large, mature, deciduous trees were present. Site topography was generally level.

3.2.4 The site is bound to the north by public open space and to the east by university accommodation. These boundaries are defined by masonry walls. The site is bound to the south by Coram Fields with this boundary defined by post and wire fencing. The western site boundary was defined by the limit of buildings.

3.2.5 A plan showing the observed site features and location of exploratory points is presented on Drawing STG1672B-02.

3.3 Injurious and invasive weeds and asbestos

3.3.1 Injurious and invasive weeds

3.3.1.1 Our investigations exclude surveys to identify the presence injurious and invasive weeds. Under the Weeds Act 1959, the Secretary of State may serve an enforcement notice on the occupier of land on which injurious weeds are growing, requiring the occupier to take action to prevent the spread of injurious weeds. The Weeds Act specifies five Injurious weeds: Common Ragwort, Spear Thistle, Creeping of Field Thistle, Broad leaved Dock and Curled Dock. The Wildlife and Countryside act 1981 provides the primary controls on the release of non native species into the wild in Great Britain. It is an offence under section 14(2) of the act to 'plant or otherwise cause to grow in the wild' any plants listed in schedule 9, part II. The only flowering plants currently listed are Japanese Knotweed and Giant Hogweed. We recommend specialists in the identification and procedures to deal with injurious and invasive weeds are appointed prior to commencement of any works on site or if appropriate purchase of the site. The presence of such weeds on site may have considerable effects on the cost / timescale in developing the site.

3.3.1.2 Good guidance on injurious and invasive weeds is provided on DEFRA and Environment Agency web sites.

3.3.2 Asbestos

3.3.2.1 Our investigations exclude surveys to identify the presence or indeed absence of asbestos on site. We recommend specialists in the identification and control / disposal of asbestos are appointed prior to commencement of any works on site or, if appropriate, purchase of the site. The presence of asbestos on site may have considerable effects on the cost / timescale in developing the site. There is good guidance in relation to Asbestos available on the Health and Safety Executive (HSE) web site.

3.4 History of the site

3.4.1 An attempt to trace the history of the site has been carried out by obtaining copies of old Ordnance Survey maps provided by Envirocheck. These maps are presented in Appendix L, but have been reduced from A3 size to A4 (70%) for ease of presentation. This size reduction affects the scale recorded on the maps. We can provide A3 copies if required.

3.4.2 The recent history of the site based on published Ordnance Survey maps is summarised on the following table: -

Date	Historical Usage	Comment
1851	Map records roads only.	Road layout in the vicinity of the site similar to present day.
1874	Open space	Paths and trees are marked on the site. 'St George the Martyr's Cemetery' is marked adjacent to the north of the site. 'Foundling Hospital' is marked adjacent to the south of the site.
1877 - 1882	As above	No apparent change.
1895 - 1896	Unlabelled buildings are marked on the site considered to be part of 'Foundling Hospital'	The area adjacent to the north of the site is now marked 'St George's Gardens' and 'Cemetery (disused)'.
1911 - 1923	As above	Buildings consistent with the present site layout are marked in the north-east of the site.
1938 - 1940	As above	Buildings comprising 'Foundling Hospital' to the south of the site are no longer marked.
1953 - 1957	Coram's Garden (Child Welfare Centre) is recorded in the west of the site.	Buildings and paths consistent with the present site layout are marked across the site. 'Ruin' is marked in the northern area of the site. The area to the south is now marked 'Coram's Fields Playground'.
1960 - 1966	As above	The building in the northern area of the site is marked 'Gregory House'
1972 - 1979	As above	No apparent change.
1982 - 1983	As above	'St Leonard's Nursery School' is marked in the south of the site.
1991 - 1995	As above	No apparent change.
1999 - 2009	As above	No apparent change.

Table 3.4.1

3.5 Geology and geohydrology of the area

3.5.1 Geology of the area

3.5.1.1 Envirocheck reproduce geological map extracts taken from the British Geological Survey (BGS) digital geological map of Great Britain at 1:50,000 scale (ref Appendix L). A summary of the recorded geological information for the site is presented in Table 3.5.1.below:-

Strata names	Approximate thickness (m)	Typical soil type	Likely permeability
Lynch Hill Gravel	-	Sand and gravel	High
London Clay	20	Clay and silt	Low
Lambeth Group	8 - 28	Clay	Low

Table 3.5.1

3.5.1.2 The London Clay deposits are recorded at crop in the eastern part of the site.

3.5.1.3 The soil types and assessments of permeability are based on geological memoirs, in combination with our experience of investigations in these soil types.

3.5.2 Geohydrology – aquifer designation and groundwater vulnerability

3.5.2.1 Eastern site area

3.5.2.1.1 Envirocheck reports the eastern end of the site is designated a non aquifer, probably reflecting the near surface geology comprising London Clay which are likely to be reasonably impermeable deposits. A non aquifer is generally regarded as not containing groundwater in exploitable quantities. Groundwater flows through such strata, however, although imperceptible, does take place and needs to be considered when assessing the risk associated with very slow degrading pollutants.

3.5.2.2 Western site area

3.5.2.2.1 Envirocheck reports the western end of the site is designated a minor aquifer possibly reflecting the near surface geology comprising Lynch Hill Gravel which are likely to be reasonably permeable deposits containing groundwater as they overlie relatively impermeable London Clay deposits. A minor aquifer defined by the Environment Agency in their publication 'policy and practice for the protection of groundwater' as formations which do not have high primary permeability or variable permeability. Although these aquifers seldom produce large quantities of water for abstractions, they are important for both local suppliers and in supplying base flow for rivers. In certain local circumstances minor aquifer can be highly vulnerable to pollution.

3.5.2.2.2 In addition, Envirocheck provide an extract of the groundwater vulnerability map recording soils containing the minor aquifer as high leaching potential. These soils have little ability to attenuate diffuse source pollutants. Non-absorbed diffuse source pollutants and liquid discharges will percolate rapidly through them. The groundwater vulnerability map also records a sub-class of soil type U (undifferentiated). In such a case there is insufficient information to classify the soils accurately and generally a default class H1 is adopted. A sub-class of H1 is defined as a soil which readily transmits liquid discharges because they are either shallow or susceptible to rapid by-pass flow directly to rock, gravel or groundwater.

3.5.3 Geohydrology – water abstractions

3.5.3.1 Envirocheck reports 2 abstraction points within 1km of the site. The closest abstraction point is located 482m northwest of the site, with water abstracted for from groundwater for public service use. A further 52 abstraction points are recorded within 1km to 2km of the site.

3.5.4 Geohydrology – source protection zone

3.5.4.1 Envirocheck does not record the site is located within a zone protecting a potable water supply abstracting from a major aquifer (i.e. a source protection zone).

3.6 Environmental Study

3.6.1 We have instructed Envirocheck to carry out a search of their records and report on the following aspects: -

Agency and Hydrological

Air Pollution Controls ("APC")
Discharge Consents to Controlled Waters
Enforcement and Prohibition Notices
Integrated Pollution Controls ("IPC")
Nearest Surface Water Feature
Pollution Incidents to Controlled Waters
Prosecutions relating to Authorised Processes
Prosecutions to Controlled Waters
Red List Discharge Consents
Radioactive Substance Authorisations ("RSA")
River Quality Data
Water Abstractions
Groundwater Vulnerability
Drift Deposits
Fluvial Indicative Flood Plain
Tidal Indicative Flood Plain
Source Protection Zones

Waste

BGS Recorded Landfill Sites
Integrated Pollution Control registered Waste Sites
Registered Waste Transfer Sites
Registered Waste Treatment or Disposal Sites
Registered Landfill Sites

Hazardous Substances

Planning Hazardous Substance Consents
Planning Hazardous Substance Enforcements
COMAH Sites
Explosive Sites
NIHHS Sites

Geological

BGS Boreholes
BGS Recorded Mineral Sites
BGS 1:625,000 Surface Geology
Coal Mining Affected Areas
Shallow Mining Hazards
Natural Subsidence Hazard
Radon Affected Area
Radon Protection Measures

Industrial Land Use

Contemporary Trade Directory Entries (of possible contaminative use)
Fuel Station Entries
Post 1995 Planning Applications (of possible contaminative use)
Potentially Contaminative Uses (Past Use)
Potentially Contaminative Uses (Non-Water Related)
Potentially Contaminative Uses (Water Related)
Nearest Overhead Transmission Line

Sensitive Land Use

Adopted Green Belt
Unadopted Green Belt
Areas of Outstanding Natural Beauty
Environmentally Sensitive Areas
Forest Parks
Local Nature Reserves
Marine Nature Reserves
National Nature Reserves
National Parks
National Scenic Areas
Nitrate Sensitive Areas
Nitrate Vulnerable Zones
RAMSAR Sites
Sites of Special Scientific Interest ("SSSI")
Special Areas of Conservation
Special Protection Areas

3.6.2 A copy of records produced by Envirocheck is presented in Appendix L.

3.6.3 Envirocheck produce a wealth of factual database information. Although we can provide a discussion on each of the database topics, this would produce a very lengthy document, but some of these discussions would not be relevant to the aims of this report. As a consequence we have extracted some of the relevant geotechnical topics (including flood risk) and discussed them in this section of the report. Key environmental issues from the Envirocheck database are discussed in Section 8.

3.7 Coal mining records

3.7.1 With reference to "The Coal Mining Searches Law Society Guidance and Directory" (1994), the site is **not** recorded as being within an area, which has been affected by past or present coal mining, or minerals worked in association with coal.

3.8 Radon

3.8.1 With reference to the Building Research Establishment (BRE) publication "Radon: guidance on protective measures for new buildings" (2007), the site is located where **no protection** is considered necessary. In addition, Envirocheck use the British Geological Survey database to review reported radon levels in the area in which the site is located to establish recommended radon protection levels for new dwellings. The database confirms the BRE recommendations.

3.8.2 The Building Research Establishment publication applies to all new buildings, conversions and refurbishments whether they are for domestic or non-domestic use. Delete the following if it's a housing development: For non-domestic buildings, the guidance supplements the requirements for radon protection at work specified in the Ionising Radiations Regulations 1999, legislation made under the Health and Safety at Work Act administered by the Health and Safety Executive (HSE). Further information is contained in the HSE/BRE guide "Radon in the Workplace".

3.8.3 It is noteworthy that the BRE and BGS / HPA information is based on statistical analysis of measurements made in dwellings in combination with geological units, which are known to emit radon. Therefore there is a risk for actual radon levels at the site to exceed the levels assessed by the BGS / HPA / BRE. Currently, the only true method of checking actual radon levels is by measurement within a building on the site over a period of several months. It should be noted that it is not currently a requirement of the Building Regulations to test new buildings for radon, however the BRE recommends testing on completion or occupation of all new buildings (domestic and non-domestic), extensions and conversions. Should you wish to undertake radon monitoring following completion of the development, we can provide proposals and costings upon further request.

3.9 Enquiries with statutory undertakers

3.9.1 We have contacted the following Statutory Undertakers (SUs) to obtain copies of their records in order to avoid damaging their apparatus during our fieldwork activities: -

a) British Telecommunications plc
b) National Grid Gas plc
c) EDF Energy
d) London Underground
e) Thames Water

Copies of responses received prior to publication of this report are presented in Appendix K. These records have been obtained solely for the purposes described above. Some of these records have been obtained from the Internet and from our database without contacting the statutory undertaker direct. Occasionally, SU information is recorded on drawings larger than A3, and thus cannot be easily presented in this report. In such cases we will copy the correspondence but not incorporate the drawing in this report, and maintain the records on our office file.

3.9.2 In addition, we have visited the linesearch web site (www.linesearch.org) which provides a report on national grid networks (National Gas and Electricity Transmission Networks). Again a copy of their report is presented in Appendix K.

3.9.3 Normally Statutory Undertakers drawings record the approximate location of their services. We recommend further on site investigations be undertaken to confirm the position of the apparatus and thus establish the effect on the proposed development and the necessity or otherwise for the permanent or temporary diversion of the service to allow the construction of the development to safely and successfully proceed.

3.9.4 It should be noted that statutory undertakers' records normally exclude private services.

3.10 Flood risk

3.10.1 The Envirocheck report indicates the site is not located within a fluvial or tidal flood plain. It should be noted that this information does not constitute a site specific Flood Risk Assessment (FRA), and a full FRA may be required for the development to satisfy Planning and Policies Statement 25 (PPS25) 'Development and Flood Risk' to support a planning application or satisfy planning conditions.

3.11 Shallow mining and natural subsidence hazards

3.11.1 Envirocheck use the British Geological Survey database to establish hazard ratings for shallow minings and natural subsidence hazards. The database indicates the following ratings for the site.

Hazard	Envirocheck rating
Shallow mining hazard rating	No hazard
Potential for collapsible ground stability hazard	No hazard
Potential for compressible ground stability hazard	No hazard
Potential for ground dissolution stability hazard	No hazard
Potential for landslide ground stability hazard	Very low
Potential for running sand ground stability hazard	Very low
Potential for shrinking or swelling clay ground stability hazard	Low

Table 3.11

3.12 Borehole records

3.12.1 The British Geological Survey (BGS) retain records of boreholes formed from ground investigations carried out on a nationwide basis. The location of boreholes with records held by the BGS is recorded on the borehole map contained in Appendix L.

3.12.2 We do not normally obtain copies of these records but can do on further instructions. There is normally a charge made by the BGS for retrieving and copying these records.

4 Fieldwork

4.1 General

4.1.1 Fieldwork comprised the excavation of 6 trial pits and 3 boreholes. Fieldwork was carried out between 9th and 17th March 2010.

4.1.2 A plan of the site showing observed/existing site features (including site reconnaissance notes) and position of exploratory points is presented on Drawing STG1672B-02. The position of exploratory points shown on these plans is approximate only and confirmation of these positions is subject to dimensional surveys, which is considered outside our brief.

4.1.3 The extent of fieldwork activities and position of exploratory points were defined by Adams Kara Taylor.

4.1.4 Prior to commencement of exploratory excavations an electronic cable locating tool was used to scan the area of the excavation. If we received a response to this equipment then the excavation would be relocated.

4.1.5 All soils exposed in excavations were described in accordance with BS EN ISO 14688 *'Identification and Classification of soil'* and BS EN ISO 14689 *'Identification and classification of rock'*.

4.2 Site restrictions

4.2.1 All exploratory points were pre-agreed and were fully accessible during fieldwork operations.

4.3 Exploratory trial pits

4.3.1 Trial pits TP02a, TP02b and TP07 to TP11 were excavated using hand tools to a maximum depth of 2.6 metres. An electrically-powered breaker was used to loosen surface bituminous bound materials prior to excavation.

4.3.2 The trial pits exposed foundation arrangements to existing buildings within the site and along the site boundaries. The trial pit excavations were backfilled with excavated material, which was compacted using hand held ramming tools. The surface was reinstated to match the original surroundings. A Geotechnical Engineer supervised the excavations.

4.3.3 Soil samples for subsequent laboratory determination of concentration of chemical contaminants were taken from the sides of trial pits using clean stainless steel equipment and stored in new plastic containers, which were labelled and sealed. The stainless steel sampling equipment was cleaned with deionised water between sampling points. If as a consequence of visual or olfactory evidence, a sample was suspected to be contaminated by organic material, the sample was stored in an amber glass jar with a PTFE sealing washer.

4.3.4 Trial pit records are presented in Appendix C.

4.4 Light cable and tool percussion boring

4.4.1 Boreholes BH02, BH03 and BH04 were excavated using light cable percussion boring techniques as described in EN ISO 22475-1:2006 forming 150mm diameter holes. Temporary casing was advanced within the borehole excavation to maintain the stability of the hole. When groundwater was encountered the excavation was temporarily halted to allow for groundwater observations to be made. Following groundwater observations the casing was advanced within the hole and the location of the water strike recorded. The casing was subsequently advanced to maintain the stability of the borehole and seal off the water to prevent further ingress. Additional records were taken when (and if) the casing produced a seal against water ingress. When obstructions were encountered a chisel was employed to break through the obstruction. Time taken to progress the excavation using the chisel is recorded on the borehole logs.

4.4.2 On completion of excavations the boreholes BH02 and BH04 were backfilled with excavated soils compacted using drilling tools.

4.4.3 A groundwater monitoring standpipe was installed in borehole BH03. The standpipe was installed following the recommendations of BS EN ISO 22475-1:2006 'Geotechnical Investigation and Testing – Sampling methods and groundwater measurements – Part 1: Technical Principles for execution'. Details of the standpipe installation are recorded on Drawing STG1672B-05.

4.4.4 Water levels in the standpipe have been measured during a return visit to the site. The water level was measured using a measuring tape calibrated in 1mm intervals with an electronic end piece, which emits an alarm sound in contact with water. Water levels are measured from ground levels at the borehole position. Records of water levels are presented on Drawing STG1672B-05.

4.4.5 Soil samples for subsequent laboratory determination of concentration of chemical contaminants were taken from 'intact' bulk disturbed samples obtained in the cutting shoe of the drilling rig. A sub sample was obtained discarding soil, which would have been in contact with the drilling rig cutting shoe with the subsamples taken using clean stainless steel equipment. In all cases the stainless steel equipment was cleaned with deionised water between sampling with samples stored in new plastic containers, which were labelled and sealed. If as a consequence of visual or olfactory evidence, a sample was suspected to be contaminated by organic material, the sample was stored in an amber glass jar with a PTFE sealing washer.

4.4.6 Bulk soil samples for identification or subsequent 'classification' laboratory testing were taken from borehole cutting equipment. The sample were placed in a plastic bag and subsequently sealed and labelled. Soil samples were obtained under category A to meet laboratory test quality classes 3 to 5 as described in BS EN ISO 22475-1:2006.

4.4.7 'Undisturbed' 100mm diameter samples were taken in cohesive soils when considered appropriate using a general-purpose open tube sampler. These samples were obtained under category A sampling methods to meet quality class 1 as described in BS EN ISO 22475-1: 2006. The undisturbed sample was obtained in a plastic liner and sealed with wax prior to labelling. The number of blows of the standard driving hammer is required to obtain the sample is recorded on borehole records.

4.4.8 Standard Penetration Testing (SPT) was carried out at regular frequencies in the borehole. The test was carried out in accordance with EN ISO 22475-3:2005. Details of the test, as required by BS EN ISO 22475-3 are recorded in borehole records. The drive rods were type AW up to 20m depth and type BW for depths in excess of 20m. Samples taken from the open sampler (SPT) were placed in a plastic bag, sealed and labelled. In coarse granular soils, a solid 60° cone may have been used to replace the SPT cutting shoe. This test is reported as SPT(C). A graphical summary of standard penetration testing is presented on Drawing STG1672B-03.

4.4.9 A pocket penetrometer was used in cohesive soils and is deemed to measure the apparent ultimate bearing capacity of the soil under test. The pocket penetrometer is calibrated in kg/m^2. The reading can be approximately converted to an equivalent undrained shear strength by multiplying the result by a factor of 50. Tests were carried out on 'intact' samples recovered from the cutting shoe. A graphical summary of pocket penetrometer readings is presented on Drawing STG1672B-04.

4.4.10 Borehole excavations were formed by drillers who are NVQ Level 2 qualified in Land Drilling under the Construction Awards Alliance CAA with samples relogged by an experienced Geotechnical Engineer.

4.4.11 Records of boreholes formed by light cable and tool percussion drilling techniques are presented in Appendix D.

4.5 Sampling strategies

4.5.1 Geotechnical

4.5.1.1 In general we adopted a judgemental sampling strategy in relation to geotechnical aspects of the investigation. The location and frequency of sampling was carried out in consideration of the following:-

i) Topography
ii) Geology (including Made Ground)
iii) Nature of development proposals

4.5.2 Environmental

4.5.2.1 Details of sampling with respect to contamination issues are described in Section 8.

4.5.3 Sample retention

4.5.3.1 Samples are stored for a period of one month following issue of this report unless otherwise required.

5 Ground conditions encountered

5.1 Soils

5.1.1 The exploratory excavations encountered a profile of soils considered to be Made Ground overlying Lynch Hill Gravel and London Clay with the Lambeth Group at depth.

5.1.2 Made Ground was encountered in all excavations to a maximum depth of 2.6m at trial pit TP10, although the full depth of Made Ground was not proven in trial pit excavations. Made Ground generally comprised of loose clayey coarse sand and gravel with many cobbles of brick and concrete overlying firm brown gravelly clay. Gravels consisted of brick, concrete, flint, chalk, ash, slate and ceramic. Boulders of concrete were exposed in trial pit TP10.

5.1.3 Lynch Hill Gravel was encountered in all borehole excavations to a maximum depth of 5.4m at borehole BH04. Lynch Hill Gravel generally comprised of stiff and very stiff orange brown sandy gravelly clay with gravels consisting of flint.

5.1.4 London Clay was encountered in all borehole excavations to a maximum depth of 23.6m in borehole BH04. London Clay comprised of stiff and very stiff greyish brown slightly silty clay. A thin bed of very strong claystone was encountered at a depth of 7.2m in borehole BH02 and 6.9m in borehole BH04.

5.1.5 The Lambeth Group was encountered in all boreholes to a depth beyond the limit of our excavations. The Lambeth Group generally comprised of very stiff and hard multi-coloured clay. In borehole BH04, the Lambeth Group was encountered as very dense light brown clayey sand.

5.2 Groundwater

5.2.1 Groundwater inflows were observed in some of the exploratory excavations. A summary of our observations is tabulated below:

Exploratory point	Depth (m) below ground levels	Observations
TP02a	2.0	Slight seepage – no rise observed
BH02	7.2	Rising to 6.95m after 20 minutes
BH03	3.0	Rising to 2.9m after 15 minutes
	6.6	Rising to 6.35m after 15 minutes
BH04	6.9	Rising to 6.65m after 15 minutes
	23.6	Rising to 21.5m after 15 minutes

Table 5.2.1

5.2.2 It should be noted that water levels will vary depending generally on recent weather conditions and only long term monitoring of levels in standpipes will provide a measure of seasonal variations in groundwater levels.

6 Laboratory testing

6.1 Classification and physical testing

6.1.1 Laboratory testing was carried in accordance with BS1377: 1990 "Methods of Test for Soils for Civil Engineering Purposes".

a) Classification tests: (to part 2)

i) Determination of the liquid limit – one point cone penetrometer method (method 4.4)
ii) Determination of the plastic limit and plasticity index (method 5)
iii) Determination of particle size distribution – wet sieving (method 9.2)

b) Shear strength tests (to part 7); determination of undrained shear strength in triaxial compression without measurement of pore pressure (method 8).

6.1.2 Laboratory testing was carried out by an independent specialist testing house, which operates a quality assurance scheme.

6.1.3 Copies of laboratory test result certificates and presented in Appendix F.

6.2 Chemical testing

6.2.1 Laboratory testing was carried out as deemed necessary and included the determination:

- Metals
- Soluble sulphate content
- Using electromagnetic measurement, determination of pH
- Determination of concentration of leachable contaminants

6.2.2 Laboratory testing was carried out by an independent specialist testing house, which operates a quality assurance scheme.

6.2.3 Copies of laboratory test result certificates are presented in Appendix G.

7 Engineering assessment

7.1 General description of the development

7.1.1 The following assessments are made on the investigatory data presented in the preceding sections of this report and are made with reference to specific nature of the development. A brief description of the development is provided in Section 2.

7.1.2 Should the development proposals change then it may be necessary to review the investigation and report.

7.2 Building foundation, design and construction

7.2.1 Definitions of geotechnical terms used in the following paragraphs are provided in Appendix A.

7.2.2 In our opinion naturally deposited Lynch Hill Gravel deposits will adequately support proposed buildings on spread type foundations. Based on laboratory determination of plasticity and following National House Building Council (NHBC) Standards Chapter 4.2, we recommend foundations extend to a minimum depth of 0.75m below existing or proposed ground levels whichever gives the deeper founding level. Made Ground extended to a minimum depth of 1.6m and therefore minimum foundation depths are likely to be significantly deeper than 0.75m. In all cases we recommend that foundations extend a minimum of 0.3m into natural soils. There are a number of large trees on the site and that at least one tree lies in the proposed footprint. Assuming low plasticity soils, foundations will require deepening to a maximum of 2.5m. We recommend that the guidance given in the NHBC Standards Chapter 4.2 is followed in determining depths associated with existing trees.

7.2.3 Laboratory testing indicates the Lynch Hill Gravel deposits are plastic, thus our assessment of bearing values are based on the assumption that these soils predominantly exhibit cohesion. Calculations, based on a conservative undrained shear strength of say 100kNm^{-2} (derived from measured insitu shear strengths taken below proposed founding levels), indicate following bearing values for pad type foundations.

Plan size of pad (m)	Ultimate bearing value kN/m^2	Presumed bearing value kN/m^2	Allowable bearing pressure kN/m^2
1 x 1	755	265	140
1.5 x 1.5	715	250	90
2 x 2	685	240	70

Table 7.3.1

7.2.4 The presumed bearing value has been derived from the ultimate bearing value by applying a factor of safety of 3, and the allowable bearing pressure derived to limit total settlement.

7.2.5 It is difficult to accurately predict the amount of total and differential movement caused by consolidation of the foundation supporting subsoils, however, providing the foundation loads do not exceed the allowable bearing pressure provided in the preceding paragraph, we suggest total settlement will be small, and probably less than 25mm. Differential settlements are totally dependent on the variation of foundation loads and consistency of the supporting ground. Assuming the foundation loads are reasonably uniform, we suggest differential settlement is unlikely to exceed say 15mm between adjacent pads. It is likely settlement will be fully achieved within 20 years of construction.

7.2.6 The Lynch Hill Gravel deposits encountered in exploratory excavations are consistent and will provide uniform support to foundations. In the unlikely event foundation excavations encounter a soft area, we recommend foundation excavations continue to locate stiffer soils.

7.2.7 It is difficult to predict the stability of trench sides from borehole investigations. Generally we anticipate some overbreak/instability in more granular (loose) deposits of the Made Ground producing a wider than planned trench widths resulting in an increase in the quantity of foundation concrete to fill voids produced by instability of trench sides.

7.2.8 Based on groundwater observations in exploratory boreholes, it is considered unlikely that groundwater will be encountered in excavations extending to depths of up to 2.5m. Beyond this depth the risks of encountering groundwater increase with groundwater inflows promoting collapse of trench sides and the construction of a successful spread type foundation difficult. Based on trial pit excavations, there is a possibility that groundwater will be encountered in basal deposits of the Made Ground as they overlie the relatively impermeable Lynch Hill Gravel deposits.

7.2.9 In considerations of the depth of Made Ground and the influence of trees, a piled solution may prove more economical than pads.

7.2.10 Piled foundations

7.2.10.1 A piled foundation would transmit superstructural loads down through the Made Ground into the London Clay at depth to obtain end bearing and shaft adhesion support. The difficulty of driving or boring piles through the Made Ground, Lynch Hill Gravel and London Clay will need to be considered by any specialist piling company and will affect the method of pile installation.

7.2.10.2 Preliminary pile design parameters

7.2.10.2.1 The ultimate shaft adhesion for bored piles in clays is determined by the following relationship.

$$Q_s = \alpha c_a A_s$$

Where,

α = adhesion factor,
c_a= average undrained shear strength
A_s = shaft area.

7.2.10.2.2 The results of standard penetration test data and triaxial undrained shear strength determinations are presented in graphical format on Drawing STG1672B-03. The undrained shear strength determinations have been used to 'calibrate' the conversion of standard penetration test data to undrained shear strength. A suggested shear strength/depth relationship based on test data in the London Clays is shown on Drawing STG1672B-03. This relationship can be used to determine c_a.

7.2.10.2.3 It is important to exclude water from pile bores in the clays to avoid further softening of these soils which would reduce the shaft adhesion support to the pile.

7.2.10.2.4 The ultimate end bearing capacity for bored piles terminating in the London Clays is derived from the following relationship.

$$Q_b = N_c c_u A_b$$

Where,

N_c= end bearing capacity factor = 9
c_u= undrained shear strength (kN/m^2) at the pile toe.
A_b = base area

Again, *cu* can be obtained from Drawing STG1672B-03.

7.2.10.2.5 A summary of standard penetration test data and measured undrained shear strength data is presented on Drawing STG1672B-03. Utilising this information we can provide the following allowable pile capacities for a range of pile lengths. These piles capacities are indicative only and should not be used for construction purposes. We recommend that the contents of this report are passed to an experienced piling contractor for detailed pile design.

7.2.10.2.6 The allowable pile capacities have been calculated for a single pile and the effect of pile groups should be considered if more than one pile is required for a given pile cap. A safety factor of 2.5 has been applied to the sum of ultimate capacities to determine the allowable capacity.

Pile diameter (m)	Pile length (m)	Ultimate shaft capacity (kN)	Ultimate end bearing capacity (kN)	Allowable pile capacity (kN)
0.60	16	1550	455	805
	17	1710	480	875
	18	1875	500	950
	19	2050	525	1030
	20	2230	545	1110
	21	2430	470	1160
	22	2550	475	1210
	23	2685	480	1265
	24	2825	490	1325
	25	2960	495	1380

Table 7.2.5

7.2.10.3 Pile testing

7.2.10.3.1 Methods for load testing of piles including the constant rate of penetration test and maintained load test are described in BS 8004:1986 *'British Standard Code of practice for Foundations'*.

7.2.10.3.2 We recommend pile testing is carried out in advance of the main piling works to verify (or otherwise) pile design parameters and indeed verify ease/difficulty of the selected method of pile installation.

7.2.10.4 Pile design and installation

7.2.10.4.1 We have endeavoured to provide sufficient information to allow detailed design of piles to be completed. The above pile design guidelines have been produced in good faith based on our current understanding of design procedures for the purposes of producing a preliminary foundation layout by a Structural Engineer. We recommend the design and installation of the piles are determined by a specialist piling contractor who has experience in pile installation in these or similar ground conditions, and may be able to interpret the observed ground conditions in a different and potentially more beneficial manner. We recommend the specialist piling contractor assumes responsibility for the choice, design and installation of the piles.

7.2.10.4.2 We recommend piling be carried out following the *"Specification for Piling and Embedded Retaining Walls"* produced by the Institution of Civil Engineers.

7.2.10.4.3 It is likely that a 'piling mat' will have to be constructed in advance of piling operations. This will be designed following the Building Research Establishment publication *'Working Platforms for tracked plant: good practice guide to the design, installation, maintenance and repair of ground supported working platforms'*. We will be pleased to assist in the design and specification of such a platform on further instructions.

7.3 Influence of Trees and other major vegetation

7.3.1 The results of plastic and liquid limit determinations performed on samples of the Lynch Hill Gravel indicates that the deposits are soils of low volume change potential when classified in accordance with National House Building Council (NHBC) Standards, Chapter 4.2. Foundations taken down onto a depth of 0.75m will penetrate the zone of shrinkage and swelling caused by seasonal wetting and drying. Trees and other major vegetation extend this zone and will require deeper foundations. A good guide to this subject is provided in NHBC Standards, Chapter 4.2.

7.3.2 Any planting schemes should also take into account the effect that new trees could have on foundations when they reach maturity. Again a good guide to this subject is provided in NHBC Standards, Chapter 4.2.

7.3.3 There are a number of trees and other major vegetation at the site. We recommend a qualified Arboriculturist (listed in the Arboricultural Association Directory of Consultants – www.trees.org.uk) be appointed to determine the location, height (and mature height) and water demand of all trees/major hedgerows at the site, information, which will be necessary to design foundations in accordance with NHBC Standards, Chapter 4.2.

7.4 Ground Floor Construction

7.4.1 In view of the thickness of Made Ground at the site, we recommend a suspended ground floor is adopted

7.5 Service Trench Excavations

7.5.1 Based on observations in trial pits, we would anticipate a risk of some overbreak/instability in the Made Ground deposits. There is also a possibility that groundwater will be encountered in deeper excavations.

7.5.2 We recommend any trench excavation requiring human entry is shored as necessary to conform to current best practice, and accepted by the Health and safety Executive (HSE) and in particular, following guidance provided in the HSE construction information sheet No 8 (revision 1) "Safety in excavations".

7.6 Infiltration Potential

7.6.1 Requirements for use of infiltration systems

7.6.1.1 It is a requirement under H3 (3) of the current building regulations to discharge stormwater collected by a development to soakaways as a priority (as opposed to water courses and sewers).

7.6.2 Infiltration measurements

7.6.2.1 The Lynch Hill Gravel deposits in borehole BH03 contained groundwater at a depth of 3m suggesting a more permeable deposit at this depth. A falling head test was carried out in a standpipe installed in borehole BH03 following BS 5930: 1999, (Section 25.4) and CIRIA special publication 25 'site investigation manual'. A record of the test is presented in Appendix E. Details of the standpipe installation (in which the test was carried out) is recorded on Drawing STG1672B-05.

7.6.2.2 Water dissipated very slowly and we were unable to complete one full test cycle. The calculated infiltration rate of 4.26×10^{-7} indicates that the soils under test are effectively impermeable for the purposes of soakaway drainage.

7.6.2.3 Based on the above and in our opinion, underlying soils at the site are effectively impermeable and would be able to dispose of stormwater using soakaway systems.

7.7 Pavement Foundations

7.7.1 It is anticipated that the proposed access road and associated hardstanding areas will be located at or about existing ground levels with formation located on Made Ground soils.

7.7.2 Equilibrium CBR (California Bearing Ratio) values (with reference to Transport and Road Research Laboratory (TRRL) Report LR1132 'Structural design of Bituminous Roads') are derived from knowledge of soil classification data (plasticity index for soils exhibiting cohesion (clay type) and particle size distribution for granular soils), the location of the water table pavement thickness, and weather conditions at the time of construction. It is anticipated that excavations to formation levels will encounter a mixture of both granular and cohesive soils. Granular soils will provide numerically high CBR values, but cohesive soils will typically provide significantly lower values.

7.7.3 It is possible to derive the 'insitu' CBR value at formation from undrained shear strength data by applying a conversion factor of 23 (refer TRRL laboratory report LR889). Thus adopting pessimistic undrained shear strength of say $60kN/m^2$ at formation level (based on insitu shear strength measurements) then an equivalent CBR value can be obtained i.e.

$$\text{Insitu CBR} = \text{undrained shear strength } {}^{60}\!/_{23} = 2.6\%$$