Report Title: # Geo-Environmental Site Investigation

Project Name: # 32-33 Torrington Square, London

Report Reference: **BRD2903-OR2-B**

Date: **July 2017**

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REPORT CONTROL SHEET

REPORT TITLE	**GEO-ENVIRONMENTAL SITE INVESTIGATION**
PROJECT	**32-33 TORRINGTON SQUARE, LONDON**
CLIENT	**BIRKBECK UNIVERSITY OF LONDON**

REPORT REFERENCE	ISSUE DETAIL	DATE	PREPARED BY	CHECKED BY
BRD2903-OR2-A	First Issue	12/07/2017	M Wood & A Leon	B Devonshire
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REPORT LAYOUT

This report is divided into the following four sections: Summary Report, Technical Report, Supporting Information and Appendices.

SUMMARY REPORT

This expanded executive summary provides the main findings of the work undertaken in brief non-technical language. This section provides an overview of the key outcomes for the benefit of non-specialists and concludes with the main recommendations. This section should only be relied upon in the context of the whole report and the Technical Report should be referred to with respect to any design decisions.

TECHNICAL REPORT

The main report section is intended to provide the technical detail of the investigation and is intended to provide the level of information required by current guidance documents and practice. The Technical Report is written in a language that, in part, assumes knowledge of subject matter so that it can be written in as concise a form as possible. Its intended audience is peers, regulators and other professionals in related disciplines.

SUPPORTING INFORMATION

This section of the report provides background details of a generic nature together with specific technical approaches adopted by BRD and details of the guidance documents that are commonly referenced in the report. The section also includes explanations of technical terms to assist non-specialist readers in understanding the Technical Report. It should be noted that not all the information within this section is necessarily applicable to this specific report.

APPENDICES

The final section of the report presents the factual data collected and employed as part of the investigation.

APPENDIX 1 SITE PLANS

Site Location Plan	Ref. BRD2903-OP1-A
Revised Conceptual Site Model	Ref. BRD2903-OP4-A
Proposed Development Layout	Webb Yates drawings "General Arrangement Basement Plan" J2889-S-DR-0090 Rev 01, "General Arrangement Sections - Sheet 3" J2889-S-DR-0201 Rev 01, "General Arrangement Sections - Sheet 3" J2889-S-DR-0202 Rev 01, all dated 13/7/17,
Proposed Construction Sequence	'Construction Sequence 10F2 and 20F2', Webb Yates Engineers, drawing ref. J2889-S-SK-0016 and J2889-S-SK-0017 dated 10/04/17
Exploratory Hole Location Plan	Ref. BRD2903-OD1-A

APPENDIX 2 EXPLORATORY HOLE & MONITORING RECORDS

Logs of trial pits	Ref. TP01 & TP02
Logs of boreholes	Ref. WS02 to WS03A & BH01
TRL Dynamic Cone Penetrometer	Ref. CBR01
Groundwater monitoring records	2 x A4 pages

APPENDIX 3	**LABORATORY TEST RESULTS**	
	QTS report 17-60323 & 17-60936	15 x A4 pages
	SPT report S31358	15 x A4 pages

SUMMARY REPORT - GENERAL INFORMATION

SUBJECT	COMMENTS
CURRENT USE & DESCRIPTION	The site comprises the existing and currently vacant five storey Georgian property of No. 32 Torrington Square in the south eastern half and a ramped access road down to the adjacent Warburg Institute across the north western half.
PROPOSED USE	It is proposed to extend the existing property of No.32 Torrington Square across the north western half of the site in the current location of the access road to create a new five storey structure. This will include a new basement extending beneath both properties.
HISTORICAL SUMMARY	The site was originally developed with two terraced residential properties (No. 32 and No. 33 Torrington Square) in the 1820s. Research has shown that No. 33 was demolished in the 1950s to provide the access to the adjacent Warburg Institute building.
PUBLISHED GEOLOGY	The site is shown to be underlain by superficial deposits comprising the Lynch Hill Gravel Member. The shallowest bedrock unit is shown to be London Clay Formation.
ACTUAL GROUND CONDITIONS	The investigation has proved gravels of the Lynch Hill Gravel Formation to be present beneath the site overlying clay soils of the London Clay Formation which extend to depth. Made Ground was encountered beneath the vehicle ramp and within the small garden of No. 32 Torrington Square.
HYDROGEOLOGY	The site is situated upon superficial deposits designated a Secondary A Aquifer. The underlying bedrock geology is designated as Unproductive Strata. The site is not located within a groundwater Source Protection Zone.
HYDROLOGY	The closest surface water feature to the site is an extended culvert shown approximately 400m to the east of the site. The River Thames is approximately 1.6km to the south of the site. The site is not in an area indicated to be at risk of flooding.
UXO	A separate Unexploded Ordnance (UXO) assessment report has been completed by Zetica and has identified that the site has a Low UXO risk.
PREVIOUS GROUND REPORTS	BRD is not aware of any previous ground investigations having been conducted at the site. However, BRD has undertaken geo-environmental desk study research and this has been reported separately.

SUMMARY REPORT - GEOTECHNICAL

SUBJECT	COMMENTS
EXCAVATIONS	It should be possible to forward excavations employing normal equipment. The use of hydraulic breaking equipment will be required for forwarding some excavations at the site. Limited groundwater control in the form of pumping from sumps is likely to be required.
SLOPE STABILITY	The slopes across the site are relatively shallow and show no obvious signs of instability. Any change in levels required by the development should be cut to a shallow slope or should be supported by appropriately designed and constructed retaining walls.
SUB-SURFACE CONCRETE	Lynch Gravel Member: Design Sulphate Class of DS-1 and Aggressive Chemical Environment for Concrete class of AC-1 applies. London Clay Formation: Design Sulphate Class of DS-4 and Aggressive Chemical Environment for Concrete class of AC-4 applies.
SOAKAWAYS	Site is suitable for surface water disposal to soakaways or other forms of infiltration device.
PAVEMENT DESIGN	A preliminary design California Bearing Ratio (CBR) of less than 20% has been recommended.
FOUNDATIONS	
LIKELY FOUNDATION TYPE	The construction need to be in the form of sequential underpinning to extend the existing basement deeper to meet the new basement. The frontage external wall of the basement will require a pile wall to support the excavation. Pile walls to be tied into a reinforced basement floor slab raft.
VOLUME CHANGE POTENTIAL	Lynch Gravel Member: Non shrinkable soils. London Clay Formation: High i.e. significant swelling or shrinking with moisture content changes.
ESTIMATED FOUNDATION DEPTHS	Maximum basement depth is approximately 4.50m. Pile lengths for temporary excavation support to be determined by specialist piling contractor.
HEAVE PROTECTION	Will not be required.

SUMMARY REPORT - CONTAMINATION ISSUES

SUBJECT	COMMENTS
SOIL RISKS TO HUMAN HEALTH	No unacceptable contamination risks to human health identified.
LANDFILL GAS	No plausible sources of landfill gas have been identified.
RADON GAS	The site is not located in an area where radon protection measures are required in new dwellings or extensions.
RISKS TO THE WATER ENVIRONMENT	No unacceptable contamination risks to the water environment have been identified.
RISKS TO BUILDING MATERIALS AND SERVICES	No unacceptable contamination risks to building materials and services have been identified by this investigation.
REMEDIATION	No remediation is necessary.
ASBESTOS	No asbestos has been detected in the soil samples tested.
WASTE SOIL DISPOSAL	It is considered any natural sub-soils disposed of from site would be classified as 'inert waste'. The Made Ground beneath the existing vehicle access ramp and the Made Ground Topsoil within the garden of 32 Torrington Square to 0.60m depth would be classified as 'hazardous waste' due to the concentrations of lead contained within. The Made Ground beneath 0.60m depth in the garden of 32 Torrington Square would be classified as 'non-hazardous waste'.

SUMMARY REPORT - KEY RECOMMENDATIONS

RECOMMENDATIONS
It is recommended that this report is submitted to the planning department of the Local Authority and the organisation undertaking the Building Control function to confirm that the investigation completed to date is satisfactory. It is recommended that groundwater levels are monitored up to the time of construction to assess any variation with seasonal or other weather effects.

1. INTRODUCTION TO TECHNICAL REPORT

1.1. CONTRACT DETAILS

CLIENT	Birkbeck University of London.
SITE	Land situated at 32-33 Torrington Square, London, WC1E 7JL.
CLIENT'S ADVISORS	BRD Environmental Limited (BRD) has been commissioned directly by the Client.
REPORT CONTEXT	It is understood that the Client intends to extend the existing property of 32 Torrington Square across the north western half of the site in the current location of the access road to create a new five storey structure. This will include a new basement extending beneath both properties. The site will form part of the Birkbeck Centre for Brain and Cognitive Development (CBCD) Toddler Laboratory.
REPORT TYPE	Geo-environmental site investigation (i.e. combined geotechnical ground investigation and Phase 2 contamination assessment).
REPORT OBJECTIVES	The site has been the subject of a desk study referenced as follows: • 'Phase 1 Geo-Environmental Desk Study – 32-33 Torrington Square, London', BRD Environmental Ltd, report ref. BRD2903-OR1-A, dated April 2017. The purpose of this report is to present the findings of a ground investigation and present a contamination and geotechnical assessment of the conditions revealed in respect of the proposed development.

1.2. SCOPE OF WORKS

The agreed scope of works was:

- Mobilisation to site and production of health and safety documentation.
- Drilling of 1No. borehole (BH01) to 15m (below existing ground level) using a hand assembled cut down cable percussive drilling rig, ground conditions permitting. Recovery of undisturbed and disturbed samples and in-situ Standard Penetration Testing (SPT) in general accordance with BS5930:2015. Installation of a 10m depth groundwater monitoring well (nominal 50mm diameter), to be finished with a flush fitting metal stopcock cover.
- Drilling of 1No. window sampling borehole (WS02) using a modular percussive drilling rig to a nominal depth of 4m-8m, ground conditions permitting. Undertake Standard Penetration Tests (SPT) at 1m intervals. Installation of up to 8m depth groundwater monitoring wells (nominal 50mm diameter) into the borehole, to be finished with a flush fitting metal stopcock cover.
- Undertake 1No. in-situ TRL dynamic cone penetrometer test at the CBR01 position to a depth of 1.0m below ground level (bgl), ground conditions permitting, to determine equivalent CBR values. In practise this CBR test will be undertaken in immediate proximity to BH01 so that the reinstatement will all be in the same paving slab.

- Undertake 1No. hand dug trial pit (TP01) to expose the existing building wall footings to depths of up to 1.5m below ground surface level and 1No. machine dug trial pit (TP02) to expose the existing building wall footings to depths of up to 2.5m below ground surface level, both at specified locations outside the building. Deeper pits can be progressed but there may be additional costs / delays to the programme. Includes for provision of all necessary lighting equipment, hand tools, compressors and hydraulic breakers.

- All exploratory points will be logged and sampled in general accordance with BS5930:2015 by supervising Geo-Environmental Consultant.

- In-situ geotechnical testing of fine soils using a Hand Shear Vane and/or Pocket Penetrometer.

- Determination of the location and level of exploratory points by tape measurements. We have assumed that a topographic survey can be provided to allow a base level to be determined.

- Reinstatement of exterior investigation points (BH01, TP01 and TP02) to match existing, although the borehole will be finished as a monitoring well with a stopcock cover. All surplus spoil following the site works and reinstatement will be removed from site.

- Geo-Environmental Technician to undertake 2No. return groundwater monitoring visits to determine resting groundwater levels and to collect water samples for geotechnical analysis.

- Chemical testing of soil samples with the budget based on the following testing schedule:

    - 5No. Metals Suite - As, Cd, Cr, CrVI, Hg, Pb, Se, Cu, Ni and Zn.
    - 5No. Inorganics Suite – water soluble sulphate, pH, organic matter.
    - 5No. Speciated Polycyclic Aromatic Hydrocarbons (PAH).
    - 5No. Banded aliphatic/aromatic Total Petroleum Hydrocarbons (TPH).
    - 5No. Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and Methyl Tertiary Butyl Ether (MTBE) compounds.
    - 2No. Semi-Volatile Organic Compounds (SVOC) suite.
    - 5No. Asbestos screen and quantification (if present).

- Chemical testing of 1No. soil sample for Waste Acceptance Criteria (WAC) to assist in establishing the waste classification of the soil for disposal purposes.

- Geotechnical testing as appropriate to the nature of the ground conditions encountered, but the budget is based on the following testing schedule:

    - 7No. Moisture content.
    - 4No. Plasticity indices.
    - 3No. Shear strength by quick undrained triaxial compression test.
    - 1No. One dimensional consolidation tests by oedometer (the additional rate has been provided below should more tests be required).
    - 2No. Particle size distribution by wet sieve and follow on hydrometer.
    - 6No. pH and water soluble sulphate analysis - soil.
    - 6No. Total sulphate and sulphur analysis - soil.
    - 1No. pH and sulphate analysis - water.

- Provision of a combined factual and interpretative investigation report. Factual findings to include all exploratory point records, monitoring and test results. Interpretative reporting to include a summary of information from desk study research, a Generic Quantitative Contamination Risk Assessment (GQRA), waste classification and a Geotechnical Assessment providing comments on pavement design, concrete classification, soakaway feasibility, foundation design recommendations, retaining wall parameters.

1.3. REPORT LIMITATIONS

Any site boundary lines depicted on plans included within this report are approximate only and do not imply legal ownership of land. Any observations of tree species, asbestos containing materials within structures or invasive weeds, such as Japanese Knotweed, does not constitute a formal survey of such features. The identification of such features is therefore tentative only. The report does not consider whether sensitive ecology or archaeology is present as these require consideration by professionals specialising in these matters. It should be recognised that the collection of desk study information may not be exhaustive and that other information pertinent to the site may be available.

The recommendations, interpretations and conclusions of this report are based solely on the ground conditions found at the exploratory holes. Due to the variability in the nature of ground, conditions between exploratory holes can only be interpreted and not defined. The description of the site and the ground conditions is accurate only for the dates of the field works. In particular, groundwater levels can vary due to seasonal and other effects.

The assessment and interpretation of contamination risks is based on the scope of works agreed with the Client together with the budgetary and programme constraints imposed. Further investigation, analysis and assessment of contamination may be required by regulators or other third parties with an interest in the site. An ecological risk assessment of contaminated soils is beyond the scope of this report. This report is concerned with assessing those contamination risks which apply to the future use of the site through the proposed development as part of the planning regime. The assessment does not consider the risk to current site users or continued future use of the site in its current state. If development of the site should occur that differs from that proposed, then the findings of the contamination assessment would need to be re-evaluated.

At the time of writing, detailed information on the proposed structure, such as detailed layout, loadings and serviceability limits, was not available. Accordingly, where geotechnical design advice is provided it is on the prescriptive basis allowed for by Eurocode 7: employing conventional and conservative design rules. The scope of this investigation excludes a formal slope stability study and any observations made regarding slopes are for information only.

2. SITE CHARACTERISTICS

2.1. SITE SETTING

SITE ADDRESS AND POST CODE	32 Torrington Square, London, WC1E 7JL.
NATIONAL GRID REFERENCE	529800E, 182120N.

2.2. SITE SUMMARY

SUBJECT	COMMENTS
CURRENT SITE DESCRIPTION	The site comprises the existing five storey Georgian property of No. 32 Torrington Square in the south eastern half and a ramped access road down to the adjacent Warburg Institute across the north western half. The property of No. 32 has most recently been used as offices and laboratories associated with the Birkbeck College Centre for Brain and Cognitive Development (CBCD), but is currently vacant.
SURROUNDING LAND USE	The site is set in a mainly commercial/academic area of central London with much of the immediate surroundings comprising various buildings associated with the University of London.
PROPOSED DEVELOPMENT	It is proposed to extend the existing property of No.32 Torrington Square across the north western half of the site in the current location of the access road to create a new five storey structure. This will include a new basement extending beneath both properties. The site will form part of the Birkbeck CBCD Toddler Laboratory.
HISTORICAL SUMMARY	From the previous desk study report, the following summary of the site's history is presented. The site was originally developed with two terraced residential properties in the 1820s. No. 32 is still present and is now used by the University. The surrounding area was heavily bombed during the Second World War, however, research has shown that No. 33 was demolished in the 1950s to provide the access to the adjacent Warburg Institute built at this time as opposed to being bomb damaged.
PUBLISHED GEOLOGY	The site is shown to be underlain by superficial deposits comprising the Lynch Hill Gravel Member. The shallowest bedrock unit is shown to be London Clay Formation.
RADON	The site is not located in an area where radon protection measures are required in new dwellings or extensions.
HYDROGEOLOGY	The site is situated upon superficial deposits designated a Secondary A Aquifer. The underlying bedrock geology is designated as Unproductive Strata. The site is not located within a groundwater Source Protection Zone.

HYDROLOGY	The closest surface water feature to the site is an extended culvert shown approximately 400m to the east of the site, presumed to be a section of the River Fleet, which is a tributary to the River Thames. The River Thames itself is 1.6km to the south of the site. The site is not in an area indicated to be at risk of flooding.
UXO	A separate UXO assessment report has been completed by Zetica and has identified that the site has a Low risk. The previous property of No. 33 does not appear to have been bombed during WWII but was demolished in the 1950s to make way for the Warburg Institute which was constructed at this time.

2.3. PREVIOUS INVESTIGATIONS

BRD is unaware of any previous ground investigations having been conducted at the site. However, the site has been the subject of geo-environmental desk study research by BRD and this has been reported separately in "Phase 1 Geo-Environmental Desk Study – 32-33 Torrington Square, London", BRD Environmental Ltd, ref. BRD2903-OR1-A, dated April 2017. This current report should be read in conjunction with the previous desk study report.

2.4. PRELIMINARY ASSESSMENTS

PRELIMINARY CONTAMINATION RISK ASSESSMENT
The only potential contamination source identified relates to the presence of Made Ground which could be present in the north western half of the site, arising from the demolition of the former property and construction of the access ramp. However, this does not give rise to any significant contamination risks as future site users will not be exposed to any of the soils due to the proposed building cover across the entire site. In addition, the construction of the basement and raft foundation will remove any potential Made Ground regardless. Therefore it is not considered that there are any significant contamination risks at the site in the context of the proposed development.
PRELIMINARY GEOTECHNICAL ASSESSMENT
It is anticipated that the requirements of a Party Wall Act will apply in relation to the adjoining properties. The soil underlying the site at depth may have a volume change potential i.e. the soils swells and shrinks with changing moisture content. This property will have an influence on foundation type and depths for the proposed development particularly near existing or proposed trees. There is the potential that any groundwater in the underlying gravels may present construction difficulties and complicate the design of the basement.

3. GROUND INVESTIGATION

3.1. INVESTIGATION DESIGN

METHODOLOGY	A combination of boreholes and trial pits were chosen as the most appropriate methods of investigation. The boreholes revealed the deep ground conditions and allowed for the installation of groundwater monitoring wells. The trial pits allowed the footing of 32 Torrington Square and The Warburg Institute to be proven. Both methods provided a sufficient number of soil samples for contamination and geotechnical assessment purposes.	
DATES OF SITE WORKS	The main field works were undertaken on the 12th, 13th, 14th and 15th June 2017. Return groundwater monitoring visits were undertaken on the 28th June and 11th July 2017.	
CONSTRAINTS TO EXPLORATORY HOLE LAYOUT	There were no significant constraints to the exploratory point layout.	
EXPLORATORY HOLE SPACING	The exploratory points were located in areas specified by Webb Yates Engineers.	
LAYOUT RATIONALE	**SOURCE / FEATURE**	**EXPLORATORY HOLE**
CONTAMINATION SOURCES TARGETED	General site coverage.	TP01, TP02, WS02 to WS03A and BH01.
GROUND FEATURES TARGETED	Deep ground conditions.	BH01 & WS02.
	Foundation depths to the Warburg Institute.	TP01.
	Foundation depths to wall and buttress of 32 Torrington Square.	TP02.
CONTAMINATION SAMPLING PLAN	Based on the proposed end use, the sampling and analysis plan is more positively biased towards near surface Made Ground samples as these represent the soils most likely to be available to future site users.	
ANALYSIS PLAN	Given the site's history as residential properties and more recently an office and access ramp and based on the limited potential for contamination identified within the Hazard Identification section of the Phase 1 contamination assessment, BRD has scheduled a suite of typically occurring contaminants to prove the anticipated lack of contamination at the site.	

3.2. BRD FIELDWORK

TRIAL PITS	
REFERENCES	TP01 to TP02.
DEPTH RANGE	0.82m and 1.30m.
EXCAVATOR	3 Tonne mini digger and hand tools.
BACKFILL	All the trial pits were backfilled with arisings upon completion and compacted with rams of the excavator bucket. The trial pits was reinstated with a combination of the original paving slabs and concrete to match the original condition as closely as possible.

CABLE PERCUSSIVE BOREHOLES	
REFERENCES	BH01.
DEPTH RANGE	15.00m.
RIG TYPE	Telescopic Dando 2000.
INSTALLATION / BACKFILL	Boreholes BH01 had a monitoring well installed. This comprised a 50mm nominal diameter standpipe fitted with a gas tap and finished with a flush metal cover. The slotted response length of the well is shown on the individual log. Bentonite seals are also indicated on the log. The filter medium used was pea gravel.

WINDOWLESS SAMPLING BOREHOLES	
REFERENCES	WS02, WS03 & WS03A.
DEPTH RANGE	From 1.00m to 3.00m.
RIG TYPE	Modular hand assembled Premier Drilling Rig.
INSTALLATION / BACKFILL	Boreholes WS03 and WS03A were backfilled with arisings only. Boreholes WS02 had a monitoring well installed. This comprised a 50mm nominal diameter standpipe fitted with a gas tap and finished with a flush metal cover. The slotted response length of the well is shown on the individual logs. Bentonite seals are also indicated on the logs. The filter medium used was pea gravel.
COMMENTS	Due to the refusal of WS02 at a depth of 3.00m bgl an additional borehole, WS03, was attempted in the garden area of 32 Torrington Square to attempt to confirm if the ground conditions were consistent across the garden. However, WS03 refused on a concrete slab/cobble at 1.40m and was reattempted approximately 0.90m to the south west as WS03A. WS03A also refused on a concrete slab/cobble at 1.00m bgl.

TRL DYNAMIC CONE PENETROMETER	
REFERENCES	CBR01.
DEPTH RANGE	0.97m.
METHODOLOGY	TRL DCP.

MONITORING	
TYPE	Groundwater monitoring.
DATES	28th June 2017.
GROUNDWATER SAMPLING METHOD	Samples were retrieved using a sampling bailer.

3.3. LABORATORY TESTING

GEOTECHNICAL TESTING	
The soil samples for geotechnical testing were forwarded to the laboratory of Soil Property Testing Ltd with pH and sulphate analysis undertaken at the laboratory of QTS Environmental Ltd. The geotechnical testing suite is detailed below. The UKAS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
TEST	**NUMBER OF SAMPLES TESTED**
Moisture content	7
Liquid and plastic limits	4
Particle size distribution by wet sieve and hydrometer	2
Quick undrained triaxial compression	3
One dimensional consolidation	1
pH and Water soluble Sulphate	12
Total Sulphur and Sulphate	6

SOIL CHEMICAL TESTING	
The soil samples for contamination and/or chemical geotechnical testing were forwarded to the laboratory of QTS Environmental Ltd and the testing suite is detailed below. The UKAS or MCERTS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
SOIL TESTS	**NUMBER OF SAMPLES TESTED**
Arsenic, Cadmium, Chromium, Chromium VI, Copper, Lead, Mercury, Nickel, Selenium, Zinc	6
Speciated Polycyclic Aromatic Hydrocarbons (PAH)	6
Total Petroleum Hydrocarbons (TPH) with full carbon banding and aliphatic/aromatic split	5
Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) plus Methyl Tert Butyl Ether (MTBE)	5
Organic Matter	6
Fibrous Material Screen (for Asbestos)	3
Semi-Volatile Organic Compounds (SVOCs)	1
Waste Acceptance Criteria (WAC) testing	1

GROUNDWATER CHEMICAL TESTING	
The water samples for contamination and/or chemical geotechnical testing were forwarded to the laboratory of QTS Environmental Ltd and the testing suite is detailed below. The UKAS or MCERTS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
WATER TESTS	**NUMBER OF SAMPLES TESTED**
pH	1
Water soluble Sulphate	1

4. GROUND CONDITIONS

4.1. OVERVIEW

The ground conditions encountered during the site investigation were generally as expected based on the published geology and known history of the area.

A significant depth of Made Ground was encountered beneath the vehicle ramp and within the garden area of 32 Torrington Square overlying natural gravels of the Lynch Hill Gravel Member. The London Clay Formation was encountered in BH01 underlying the gravels and proven to 15.00m bgl.

Groundwater was not encountered in the Lynch Hill Gravel during drilling, but recorded at 4.00m and 6.00m bgl during drilling BH01within the London Clay Formation. Subsequent monitoring has recorded groundwater resting in the Lynch Hill Gravel.

Details of the various stratigraphic units are given in the following sections.

4.2. ARTIFICIAL GROUND

SURFACE HARDSTANDING	Concrete paving slabs, measuring 0.60m by 0.60m and generally 0.05m thick, were encountered at ground level in BH01, TP01 and TP02. Concrete containing reinforcing bar was encountered beneath the paving slabs in BH01 (between 0.10m and 0.25m depth) and TP01 (between 0.05m and 0.25m depth).
BURIED STRUCTURES	Two hand dug pits were excavated to prove foundation depths of 32No. Torrington Square building and the Warburg Institute building. The latter foundation base was proved at 0.66m bgl. Foundation base of 32No. Torrington Square building was proved at 1.06m depth and wall buttress foundation was recorded at 1.00m depth bgl. What are considered to be the former brick footings to 33No. Torrington Square were encountered beneath the access ramp when excavating TP02, but this buried obstruction foundation depth was unable to be proved.
BURIED SERVICES	Not encountered in exploratory points.

MADE GROUND TOPSOIL				
LOCATION		WS02, WS03 and WS03A located in the garden to 32 Torrington Square.		
DEPTH TO BASE		0.15m to 0.60m bgl.	**THICKNESS**	0.15m to 0.60m.
DESCRIPTION	The Made Ground Topsoil encountered was homogeneous across the three locations and was described as a loose, dark brown, clayey, gravelly, sand with frequent roots and rootlets. The gravel was of fine to coarse, subangular to subrounded flint with frequent brick, concrete, glass, ceramic and charcoal fragments. In WS02 the topsoil was becoming very gravelly with increasing depth.			
COMMENTS	**GEOTECHNICAL**	Nothing significant noted.		
	CONTAMINATION	No visual or olfactory evidence of contamination.		
	GROUNDWATER	Groundwater was not observed in this stratum.		

MADE GROUND				
LOCATION		All exploratory points.		
DEPTH TO BASE		0.25m to 1.50m bgl.	**THICKNESS**	0.15m to 1.05m.
DESCRIPTION	Within trial pit TP02 from 0.11m to 1.10m the Made Ground comprised a loose, orangey and greyish brown, very sandy gravel of fine to coarse, subangular to subrounded flint and quartzite with frequent brick, slate, metal and concrete fragments. The gravel also contained frequent whole and half bricks and concrete blocks up to 0.40m by 0.30m in size. TP02 was undertaken through the vehicle ramp in the location of the former 33 Torrington Square and the Made Ground in this area is likely demolition materials from the former building. Within TP01, from 0.25m to 0.35m, a medium dense, orange brown, very sandy gravel of fine to coarse, subangular to subrounded flint and quartzite was encountered directly underlying the reinforced concrete slab. In BH01, directly beneath the reinforced concrete slab from 0.10m to 0.25m depth, a loose to medium dense, orange brown, slightly clayey, gravelly sand was recorded. The gravel was of flint with occasional concrete fragments. Both of these layers of Made Ground are representative of a thin reworked zone directly beneath the concrete. Made Ground comprising a medium dense, dark brown, clayey, very gravelly sand with occasional rootlets was encountered from 0.60m to 1.50m depth. The gravel was of flint with occasional brick and charcoal fragments. In WS03 and WS03A, from 0.15m to 1.35m and 0.20m to 0.90m respectively, a loose, orange brown, slightly clayey, sandy gravel of fine to coarse, subangular to subrounded flint with occasional brick and concrete fragments was encountered overlying a concrete slab/cobble.			
COMMENTS	**GEOTECHNICAL**	Nothing significant noted.		
	CONTAMINATION	No visual or olfactory evidence of contamination.		
	GROUNDWATER	Groundwater was not observed in this stratum.		

4.3. SUPERFICIAL DEPOSITS

LYNCH HILL GRAVEL MEMBER				
LOCATION		WS02, BH01, TP01 and TP02.		
DEPTH TO BASE		>0.82m to 3.00m bgl.	**THICKNESS**	>0.47m to 2.75m.
DESCRIPTION	The Lynch Hill Gravel Member was encountered as a medium dense to very dense, orange brown, very sandy gravel of fine to coarse, subangular to subrounded flint and quartzite.			
COMMENTS	**GEOTECHNICAL**	The gravels were generally recorded as being medium dense.		
	CONTAMINATION	No visual or olfactory evidence of contamination.		
	GROUNDWATER	Groundwater was not observed in this stratum during drilling.		

4.4. BEDROCK

LONDON CLAY FORMATION				
LOCATION		BH01 which was extended to a greater depth.		
DEPTH TO BASE		>15.00m.	**THICKNESS**	>12.00m.
DESCRIPTION	From 3.00m to 3.30m bgl the London Clay Formation initially comprised a stiff, slightly fissured, light brown, silty clay with occasional fine sand sized selenite crystals. From 3.30m depth the clay became dark grey in colour and became very stiff at approximately 8.00m bgl. The initial light brown colour is representative of a weathered zone.			
COMMENTS	**GEOTECHNICAL**	The London Clay Formation was recorded as stiff becoming very stiff with depth.		
	CONTAMINATION	No visual or olfactory evidence of contamination.		
	GROUNDWATER	Groundwater was observed in this stratum at 4.00m and 6.00m depth within BH01 during drilling.		

4.5. GROUNDWATER MONITORING

DATE	RESTING GROUNDWATER RANGE	COMMENTS
28/06/17	2.47m bgl in BH01.	The groundwater was recorded within the Lynch Hill Gravel Member deposits which were proven to 3.00m bgl in BH01. Borehole WS02 was dry to the base of the well as would be expected as this borehole was located in an area at a greater elevation compared to BH01
11/07/17	2.48m bgl in BH01.	The groundwater was recorded at a similar level to the first visit.

BH01 was situated in an area where the ground level was about 22.8m AOD and so groundwater is at a level of approximately 20.3m AOD.

5. GEOTECHNICAL PROPERTIES

5.1. DYNAMIC CONE PENETROMETER

One Transport Research Laboratory (TRL) dynamic cone penetrometer test was undertaken on site.

The test started approximate 0.45m below ground level and the recorded values were generally greater than 25% CBR from approximately the beginning of the test.

5.2. COARSE SOIL PARAMETERS

5.2.1. Standard Penetration Tests

Four Standard Penetration Tests (SPTs) have been undertaken in the gravelly soils of the Lynch Hill Gravel Member N-values recorded in the WS02 denote very dense gravel deposits (N>50) whereas N-values recorded from the deep borehole BH01 are indicative of medium density soils.

5.2.2. Particle Size Distribution

The grading curves of the two samples of Lynch Hill Gravel Member subject to PSD determination revealed the soil to be relatively well graded, sandy gravel or sandy gravel/gravelly sand. The samples tested recorded less than 1% in fines content.

5.3. FINE SOIL PARAMETERS

5.3.1. Index Property Testing

SOIL TYPE	London Clay Formation.
PLASTICITY INDEX (PI)	46% - 53%
MODIFIED PI	Not applicable – no oversize particles.
NHBC CLASS	High volume change potential.

5.3.2. Undrained Shear Strength

This section discusses all of the laboratory and in-situ tests that produce either direct or indirect measures of undrained shear strength.

5.3.2.1. Hand Penetrometer

SOIL TYPE	London Clay Formation.
DISCUSSION OF CORRECTED RESULTS	The corrected undrained shear strength was in the range between 106kPa to 163kPa. Values between 106kPa and 114kPa which are indicative of high strength soils were recorded up to 7.00m depth. Below values over 163kPa were recorded indicative of very high strength soils.

5.3.2.2. Standard Penetration Test Correlations

The SPT N-values have been converted using industry standard correlations, such as Stroud's method, to equivalent undrained shear strengths of a 100mm-diameter triaxial compression test.

This conversion has been conducted on the N_{60}-values using values for Stroud's conversion factor, f1, selected on the basis of the average measured plasticity index.

Corrected SPTs values (N_{60}) of the clay soils of the London Clay Formation ranging from N_{60}=9 (stiff) to N_{60}=28 (very stiff). Based on the converted SPTs results the clay soils have a Medium strength proved up to 5.00m depth and then High strength have been recorded with depth.

5.3.2.3. Laboratory Tests

The three undisturbed samples of London Clay Formation subjected to triaxial compression without measurement of pore water recorded undrained shear strength in the range of 73kPa to 178kPa which is indicative of Medium strength at shallow depths, weathered London Clay, becoming high strength soil at an approximately tested depth of 10.0m and very high strength soil at final tested depth of 12.50m bgl.

5.3.3. <u>One-dimensional Consolidation</u>

A single one-dimensional consolidation test was performed on a specimen of London Clay Formation, from borehole BH01 at a depth of 6.50m. The test results show this soil to be an over consolidated clay.

A swelling pressure of 60kPa was recorded before the start of consolidation. The measured Coefficient of compressibility (mv) were between 0.04m^2/MN and 0.13m^2/MN.

5.4. WATER SOLUBLE SULPHATE AND PH

	MADE GROUND / LYNCH GRAVEL MEMBER			
	Sulphate		**pH**	
Characteristic Value	100 mg/l		8.0 units	
Justification	Mean of highest two results rounded to nearest 100mg/l.		Mean of lowest 20% results.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	8	10 – 120 mg/l	9	7.9 – 10.3 units
Groundwater	1	65 mg/l	1	8.9 units
Total Potential Sulphate	1	Not applicable as pyrite unlikely in the samples tested.		

	LONDON CLAY FORMATION			
	Sulphate		pH	
Characteristic Value	4.71%		8.1 units	
Justification	Based on Highest Total Potential Sulphate.		Lowest measured value.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	4	230 – 440 mg/l	4	8.1 – 8.9 units
Groundwater	-	Not tested	-	Not tested
Total Potential Sulphate	4	0.06% - 4.65% Potentially pyritic in three out of four samples.		

6. GEOTECHNICAL ASSESSMENT

6.1. INTRODUCTION

The following advice and recommendations are based on the construction of 5No. storey building. The proposed development layout plan is included in Appendix 1. From assessment of the nature of the ground conditions and the type of proposed structures, it is considered that the situation falls within EC7 Geotechnical Category 1.

Should the nature of the development be changed then the results of this investigation would need to be reviewed and reassessed.

6.2. EXCAVATIONS

STABILITY	Any excavation requiring man entry should be battered back to a safe angle, supported by an appropriate proprietary trench support system or adequately shored to provide safe working conditions. Shoring to any excavation requiring man entry must be designed by a suitably qualified and experienced engineer. Any support system will require regular inspection as detailed in published guidelines to ensure the excavation support is adequate and appropriate for the ground conditions present. It is anticipated that narrow trench excavations will remain relatively stable and open for short periods, but minor spalling of side walls could still occur. Where deep Made Ground is present it is anticipated that excavations will be prone to sidewall collapse and will require temporary support to remain open. Trench excavations encountering the groundwater are likely to suffer side wall collapse.
EQUIPMENT	It should be possible to progress excavations with conventional equipment. The removal of sub-surface structures following demolition will require the use of hydraulic breaking equipment.
GROUNDWATER CONTROL	It is anticipated that groundwater control in the form of pumping from sumps formed in the base of excavations may be required. Any groundwater control system should be designed and operated to minimise the loss of fines from the soil matrix as this could adversely affect settlement.
PARTY WALL ISSUES	The proposed development will include excavations adjacent to existing structures. BRD understand that these structures fall under the same ownership and therefore the requirements of a Party Wall Act will not apply. There may still be a requirement for involvement of a party wall surveyor to deal with lease holders.

6.3. SLOPE STABILITY

The site slopes down from Torrington Square street, western boundary, to the southern eastern boundary approximate 7º, which is indicative of an approximate 1V:8H slope. It is a relatively shallow slope whose stability should not be a cause of concern. However, significant changes on site level are expected as part of the future development to accommodate the new basement. Any change should be supported by appropriately designed and constructed retaining walls.

6.4. SUBSURFACE CONCRETE

MADE GROUND / LYNCH HILL GRAVEL MEMBER	
SITE / SOIL CATEGORY	Natural ground: Lynch Gravel Member. Brownfield: Made Ground.
DESIGN SULPHATE CLASS	DS-1
GROUNDWATER REGIME	Mobile.
AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) CLASS	AC-1

LONDON CLAY FORMATION	
SITE / SOIL CATEGORY	Natural ground containing pyrite.
DESIGN SULPHATE CLASS	DS-4
GROUNDWATER REGIME	Static.
AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) CLASS	AC-4
COMMENTS	The initial weathered zone of the London Clay will be free from pyrite and have a much lower sulphate content as proven by the shallowest test result. The restriction to DS-4 has been applied. Concrete in pyritic ground that is initially low in soluble sulphate does not have to be designed to withstand a high potential sulphate class unless ground disturbance is such that pyrite may be oxidised. In this case it is only likely that the piles will encounter the London Clay and so a less conservative design class could be adopted.

6.5. SOAKAWAYS

Drainage requirements for the proposed development have not been provided and soakage tests were not within the scope of the investigation works but, it is considered that the disposal of collected surface water to infiltration devices will be feasible at this site due to the granular nature and therefore anticipated good permeability of the near surface underlying soils.

Traditional soakaways should be located at least 5m away from any foundations. Infiltration devices that do not lead to concentrated water inflows, such as permeable pavements, can be located closer than this offset distance subject to careful design and construction.

The groundwater at the site was relatively shallow and may be subject to seasonal variation. Soakaway design will need to consider the variation of the groundwater table as during periods of elevated groundwater the ability of the soils underlying the site to receive additional water may be limited. In addition, the Environment Agency will object to the use of infiltration devices that lead to the direct input to groundwater and seek that in excess of a 1m thick unsaturated zone is present between the base of the infiltration device and the seasonal high maximum groundwater level. An extended period of groundwater level monitoring is recommended to evaluate the impact on soakaway design.

6.6. PAVEMENT CONSTRUCTION

From consideration of the observed ground conditions below the Made Ground deposits, it is recommended that a preliminary design California Bearing Ratio (CBR) of 20% is assumed.

Increased road pavement construction thickness should be anticipated where paved areas cross over ground disturbed by the removal of the existing structures.

All unsuitable soils, such as topsoil or desiccated soils, should be removed from beneath proposed paved areas. The exposed sub-grade formation should then be proof rolled to reveal any excessively soft or compressible zones and any such features identified also removed by excavation. Where unsuitable materials are removed, the resultant voids should be filled in layers with appropriately compacted suitable granular fill. To reduce the loss of granular construction materials into the sub-grade, consideration should be given to utilising a geotextile starter layer across the formation level.

6.7. BASEMENT

The proposed development includes the construction of a single storey basement, as an extension of the existing one, to an approximately maximum depth of 4.50m, underneath the existing access ramp. The new basement will occupy approximately two thirds in length of 33 Torrington Square. The rear third area of the site will not include a basement. It is anticipated that the proposed basement will be situated within the gravel soils of the Lynch Gravel Member and apparently above the water table.

Ground conditions have been recorded comprising medium dense to very dense competent sandy gravel beneath the Made Ground deposits. The Lynch Gravel Member has been recorded with high SPT values ranging from N=12 to N>50. The particle size distribution of these soils has confirmed the insignificant content in fines deposits. Resting groundwater level in subsequent groundwater monitoring revealed it be 2.47m bgl, which equates with expectations of groundwater perched within the base of the gravel deposits resting upon the London Clay.

The Lynch Gravel Member at 3.00m depths (based on boreholes BH01) is underlain by the competent London Clay Formation. The tests undertaken in these soils have confirmed the high consistency of these soils with medium to very high strength values.

The base of the Lynch Gravel Member has only been recorded in borehole BH01. This borehole is located to the rear of the site. Considering the provided topographic layout and assuming the base of the gravel does not change in elevation, then the London Clay is expected to be at about 6.00m below the site frontage highest point. This area will require the maximum excavation depths.

The main issue with regards to construction of the basement retaining walls is the essential requirement to maintain the stability of the existing foundations/structure during construction of the basement retaining walls. Based on that, the construction of the basement will comprise a combination of sequential underpinning and piling.

Preliminary sketch construction sequence designs have been produced by the client's engineers Webb Yates Engineers (Drawings Ref.J2889-S-SK-0016 and J2889-S-SK-0017 dated 10/04/17) and this is reproduced within Appendix 1.

The preliminary sketches detail the construction stages to be considered. A sheet pile wall to support the front structure will be required. Then, the proposed basement construction will require progressive sequential underpinning and excavation works at both sides of the structure (32 Torrington Square and Warburg Institute walls). The rear of the basement excavation will reduce in depth as a result of the topography and should be able to be formed with an open excavation cut to a safe slope angle.

6.7.1. Excavation / Temporary Works

The groundwater monitoring visits have recorded standing groundwater levels in BH01 at depths about 2.50m bgl. However, these readings were taken in the summer months during a dry period and following a relatively dry winter. As groundwater levels could rise with seasonal and other weather effects, it is recommended to maintain the existing monitoring wells and to continue to monitor groundwater levels up to the construction phase.

Due to the presence of the adjacent structures, 32 Torrington Square and Warburg Institute buildings, there is insufficient room to construct the proposed basement within an open excavation. Temporary/permanent retaining wall support to the excavation will therefore be required in the form of a piled wall in combination with propping/underpinning to minimise the area of open excavation at any time.

A permanent sheet piled retaining wall may provide a suitable retaining structure. The problems of noise and vibrations associated with dynamically-driven sheet piling could be eliminated by adopting a statically-driven (pneumatic) or other modern sound reduced systems. However, the dense Lynch Gravel could prevent successful driving of sheet piling particularly when the size piling equipment will be limited due to the site's access constraints. The advice of a specialist contractor should be sought if sheet piling is to be considered. It is therefore possible that a bored pile wall will be the preferred solution at this site.

The extent of the ground movements that result from the basement excavation will depend on the method of excavation and support together with the overall stiffness of the basement structure in the temporary condition. Both temporary works and the finished structure should, therefore, incorporate appropriate structural support to ensure the necessary rigidity. The timing of the provision of support to the wall for the temporary works will be especially important.

6.7.1.1. Underpinning Foundations

It is understood that the adjacent 32 Torrington Square building already has a basement floor and construction is planned to extend the existing basement at a deeper level along the western wall after removing the existing access ramp located in this area.

Excavations for the extension basement that approach the existing building will tend to undermine the existing foundations and damaging settlement may result. Accordingly, it is considered appropriate to incorporate a precautionary measure into the sequence of construction.

It is likely that underpinning techniques will be used to deepen the existing basement where it provides access to the new basement. The technique involves digging out a short section of the ground beneath the existing basement wall foundations. The excavation so created has reinforcement placed within it, is shuttered and concreted. Steel dowels are employed to ensure the different panels are tied together. Following concreting, further panels could be excavated on a hit and miss basis, to allow sufficient time for the concrete to gain strength before excavation of an adjacent panel.

It is understood that several levels sequences of underpinning will be required to reach the final formation level towards the deepest frontage of the site. Where necessary, the initial sequence of underpinning panels should then be supported by a further 'hit and miss' underpinning taken down to the basement floor level. The subsequent underpinning should incorporate steel dowels to tie the underpinning panes together and the joints staggered. Further reinforcement dowels will be needed to tie the resultant basement side retaining walls into the floor slab. It is anticipated that temporary propping of the existing buildings and underpinning panes will be required.

6.7.1.2. Piling

The front wall to the basement extension between the existing buildings should be formed by piles.

Given the anticipated high permeability of the soils, it is considered that either a sheet pile or bored secant pile would provide suitable support to the external basement excavation. Such pile walls will provide an immediate waterproof wall and maximises the use of space.

As the soils are granular, the drilling for secant bored piles will have to be cased or a hollow stem continuous flight augur technique employed.

For the purposes of pile design, it is recommended that skin friction from the Made Ground is ignored, and that the working load is calculated from a combination of skin friction and end bearing within the underlying Lynch Gravel Member and/or the London Clay Formation.

In order to minimise the impact of the pile wall on groundwater flow, consideration should be given to using a combination of alternate short and long piles. The short piles would just be to the base of the proposed basement for water proofing and yet let groundwater flow beneath them. The long piles would be for structural support.

It is recommended that consultation with a specialist piling contractor is undertaken in order to evaluate likely pile loads, diameter and depths based upon the ground conditions revealed within the context of the specified technical requirements of the chosen piling method. In any event, positive contractual assurances should be sought from the piling contractor in respect of the performance of their proprietary system.

6.7.2. Basement Retaining Walls

Based on the results of this investigation, published guidance and previous experience in comparable ground, the following moderately conservative unfactored effective stress parameters for the design of retaining walls are presented below:

Stratum	Bulk Density γB (kN/m^3)	Undrained Shear Strength Su (kPa)	Angle of Shearing Resistance φ'peak (°)	Apparent Cohesion c' (kPa)	Stiffness *E* (kPa)
Made Ground	18	0	0	0	5,000
Lynch Hill Gravel Member	20	0	35	0	16,000**
London Clay Formation	20	75*	20	0	S_u x 600 + gradient x z

(*) Approximate minimum Undrained Shear Strength value obtains in laboratory tests, greater depth will allow a higher USS to be used.

(**) Correlation between SPT 'N' and Young's modulus used in UK for normally consolidated sands is considered as: E = 'N' (MN/m2) based on ICE manual of geotechnical engineering (2012), Volume II, chapter 53.7. N-value recorded at 2.00m depth bgl has been considered.

Due to the permeability of the Lynch Gravel Member the presence of groundwater should not be discarded at the proposed basement floor level and the potential for groundwater fluctuations, it would be prudent to assume in calculating hydrostatic pressures that they will be the full retained height.

It is presumed that the retaining walls will be structurally tied to the basement floor slab.

6.7.3. Basement Heave and Floor Slab

Excavation for a 4.30m deep basement at the frontage will result in the removal of approximately 86kPa of overburden pressure. This will reduce towards the rear where the depth of excavation will be less due to the topography of the site and be non-existent to the rear third of the proposed building where there is no basement and the structure will be constructed above the ground level. As the soils beneath the basement are granular, heave related to the removal of the overburden pressure are likely to be extremely limited/negligible.

Heave within the deeper London Clay due to the removal of overburden pressure could occur. Heave will likely comprise both an "immediate" elastic component that may be expected to occur within the construction period and theoretically long-term swelling. Long term swelling is in reality likely to be largely mitigated by the presence of a reasonable thickness of the Lynch Gravel Member between the basement slab and the deeper London Clay that will allow the pressures to dissipate. In addition, a large proportion of the pressure will be replaced due to the weight of the new structure.

Following the excavation for the basement, it should be possible to adopt a ground bearing reinforced floor slab. The base of the excavations should be inspected and subject to proof-rolling. Any soft spots should be excavated and replaced with lean-mix concrete or suitably-compacted coarse-grained fill.

For the rear third of the basement, the raft will be situated near existing ground level and therefore there will be a reasonable thickness of Lynch Gravel Member present and so a design bearing pressure of 180kN/m^2 should be available.

For the frontage two thirds, the removal of soils for basement construction will reduce the thickness of Lynch Gravel Member present and so the bearing capacity will be limited by consideration of the greater proportion of the pressure bulb falling within the underlying London Clay. However, taking into account the removal of overburden pressure that can be replaced, allows a consistent design bearing pressure of 180kN/m^2 to be employed for the whole structure.

6.7.4. Waterproofing

Whilst groundwater is likely to be below the basement, it still be necessary to waterproof or "tank" the walls and floor of the basement in order to prevent the ingress of water through its walls and base. Whichever form of water proofing is employed it is emphasised that manufacturer's recommendations for installation of any proprietary products must be followed. Consideration should be given to providing combined protection. It is also prudent to include an internal sump and pump as a backup to the water proofing of the basement

6.8. RECOMMENDATIONS FOR FURTHER GEOTECHNICAL WORK

No further geotechnical ground investigation is recommended at this stage.

7. RISK ESTIMATION - SOILS

7.1. HUMAN HEALTH

Although children will visit the site, it is not considered that they will spend any significant length of time at the site in the long term. Therefore, adult workers/academics who frequent the site will be the most appropriate receptor. As such the Generic Assessment Criteria (GAC) employed below are for commercial use as this is appropriate to the proposed academic land use.

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
Arsenic	mg/kg	6	36	640	0
Cadmium	mg/kg	6	1.2	410	0
Chromium (hexavalent)	mg/kg	6	<2	49	0
Chromium (total)	mg/kg	6	24	8,600	0
Copper	mg/kg	6	114	68,000	0
Lead	mg/kg	6	1850	2,330	0
Mercury	mg/kg	6	4.7	320	0
Nickel	mg/kg	6	29	980	0
Selenium	mg/kg	6	<3	12,000	0
Zinc	mg/kg	6	459	730,000	0
pH	Units	12	7.9-10.8	<5-10>	2
Naphthalene	mg/kg	6	<0.1	190	0
Acenaphthylene	mg/kg	6	<0.1	83,000	0
Acenaphthene	mg/kg	6	<0.1	84,000	0
Fluorene	mg/kg	6	<0.1	63,000	0
Phenanthrene	mg/kg	6	0.17	22,000	0
Anthracene	mg/kg	6	<0.1	520,000	0
Fluoranthene	mg/kg	6	0.44	23,000	0
Pyrene	mg/kg	6	0.39	54,000	0
Benzo(a)anthracene	mg/kg	6	0.30	170	0
Chrysene	mg/kg	6	0.31	350	0
Benzo(b)fluoranthene	mg/kg	6	0.52	44	0
Benzo(k)fluoranthene	mg/kg	6	0.21	1,200	0
Benzo(a)pyrene	mg/kg	6	0.35	35	0
Indeno(1,2,3-cd)pyrene	mg/kg	6	0.30	500	0
Dibenzo(a,h)anthracene	mg/kg	6	<0.1	3.5	0
Benzo(ghi)perylene	mg/kg	6	0.22	3,900	0
TPH Aliphatic C5-C6	mg/kg	5	<0.01	3,200	0
TPH Aliphatic C6-C8	mg/kg	5	<0.05	7,800	0
TPH Aliphatic C8-C10	mg/kg	5	<2	2,000	0
TPH Aliphatic C10-C12	mg/kg	5	<2	9,700	0
TPH Aliphatic C12-C16	mg/kg	5	<3	59,000	0

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
TPH Aliphatic C16-C35	mg/kg	5	19	1,600,000	0
TPH Aliphatic C35-C44	mg/kg	5	<10	1,600,000	0
TPH Aromatic C5-C7	mg/kg	5	<0.01	26,000	0
TPH Aromatic C7-C8	mg/kg	5	<0.05	56,000	0
TPH Aromatic C8-C10	mg/kg	5	<2	3,500	0
TPH Aromatic C10-C12	mg/kg	5	<2	16,000	0
TPH Aromatic C12-C16	mg/kg	5	<2	36,000	0
TPH Aromatic C16-C21	mg/kg	5	<3	28,000	0
TPH Aromatic C21-C35	mg/kg	5	<10	28,000	0
TPH Aromatic C35-C44	mg/kg	5	<10	28,000	0
Benzene	mg/kg	5	<0.002	98	0
Toluene	mg/kg	5	<0.005	56,000	0
Ethylbenzene	mg/kg	5	<0.002	5,700	0
Xylene (total of all types)	mg/kg	5	<0.002	5,900	0
Methyl Tert Butyl Ether (MTBE)	mg/kg	5	<0.005	7,900	0
Semi-Volatile Organic Compounds (SVOCs)	mg/kg	1	None above limit of detection	LOD*	0
Asbestos	Presence	3	Not detected	Fibres Present	0

Notes: *Limit Of Detection: Given the large amount of compounds in this group, coupled with the lack of GAC for certain compounds, any concentrations above the limit of detection will be highlighted in the first instance.

RESULTS EXCEEDING HUMAN HEALTH ASSESSMENT CRITERIA	
pH	Two samples of near surface Made Ground within BH01 at 0.30m and TP02 at 0.40m recorded alkaline pH values of 10.8 and 10.3 units which are marginally above the GAC of 10.0 units. These alkaline values are considered to be a consequence of an intrinsic alkaline nature of fragments of concrete or mortar within the Made Ground and are not considered to offer any risk to human health. As such they are not considered further.

7.2. WATER ENVIRONMENT

It is not appropriate to consider human health assessment criteria for human health in relation to the risk to the water environment, but currently there are no generic soil assessment criteria in respect of the water environment. In the absence of any groundwater sampling data, the soil results are assessed on the basis of professional judgement.

Concentrations of lead have been recorded in WS02 at 0.20m of 1450mg/kg, TP02 at 0.40m of 1,810mg/kg and at 0.80m of 1,850mg/kg within two samples of Made Ground and a sample of Made Ground Topsoil. At such concentrations the presence of this lead is considered to be a potential risk to the groundwater.

However, the sample with the highest total lead concentration in TP02 was also subjected to leaching tests as part of the Waste Acceptance Criteria (WAC) test. This recorded that the lead leached at a concentration of 43µg/l. This is less than the 50µg/l Generic Assessment Criteria employed by BRD for lead (as discussed in supporting information at rear of report). Accordingly, it is not considered that this lead contamination presents a valid risk to water resources.

In any event, the Made Ground and Made Ground Topsoil will be removed from the site in order to facilitate the proposed development and so the potential risk to the groundwater will also be removed. The remaining soil at the site will be natural gravels of the Lynch Hill Gravel Member which is uncontaminated.

7.3. BUILDING MATERIALS

Contaminant	Units	Number of tests	Maximum Concentration	GAC	Number exceeding GAC
pH	units	12	7.9 (minimum value)	<5.5	0
Sulphate (w/s)	mg/l	12	436	500	0
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	mg/kg	1	None above limit of detection	2	0
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	mg/kg	5	None above limit of detection	10	0
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	mg/kg	5	19	500	0
Sum of BTEX + MTBE above detection limits	mg/kg	5	None above limit of detection	0.1	0
Phenols	mg/kg	1	None above limit of detection	2	0
Cresols and chlorinated phenols	mg/kg	1	None above limit of detection	2	0
Naphthalene	mg/kg	6	<0.1	0.5	0
Benzo(a)pyrene	mg/kg	6	0.35	0.5	0

None of the samples record any contaminants at concentrations exceeding their respective assessment criteria.

8. RISK EVALUATION

8.1. REVISED CONCEPTUAL MODEL

The revised conceptual site model plan is presented in the Appendices.

ADDITIONAL POLLUTANT LINKAGES	During the ground investigation, no additional sources of contamination were identified.
INVALID POLLUTANT LINKAGES	As suggested in the Phase 1 Desk Study it was considered that the Made Ground at the site, specifically beneath the vehicle access ramp, could be contaminated. This investigation has proven that the Made Ground and Made Ground Topsoil contains elevated concentrations of lead, but not at such levels that they could present a cause for concern if they were to remain at the site. It is worth noting that the Made Ground and Made Ground Topsoil will be removed to facilitate the proposed development this is further enforcement that there are no valid pollutant linkages at the site.
LIMITATIONS AND UNCERTAINTIES	Due to access restrictions, it was not possible to undertake any exploratory holes under the building floor slab. However, all of the potential contamination sources have been targeted by the exploratory holes and therefore it is considered that a sufficient number of exploratory points have been completed for contamination assessment purposes.

8.2. UPDATED CONTAMINATION RISK ASSESSMENT

The pollutant linkages identified in the revised conceptual site model will now be evaluated as to their severity.

SOURCES AND CONTAMINANTS	PATHWAYS	RECEPTORS	POTENTIAL RISK
Made Ground at the site associated with previous demolition and Made Ground Topsoil. - Metals (Lead).	Direct contact	Human health	Negligible risk
	Direct contact	Building materials and services	
	Migration through permeable strata	Groundwater	

The contamination risks that are presented to the various receptor groups are discussed further in the following sections:

RISK TO HUMAN HEALTH
No unacceptable risks to human health have been identified by this investigation.

RISK TO WATER ENVIRONMENT
No unacceptable risks to the water environment have been identified by this investigation.

RISK TO BUILDING MATERIALS AND SERVICES
No unacceptable risks to building materials or services have been identified by this investigation.

8.3. RISK MANAGEMENT

GENERAL	No unacceptable contamination risks have been identified. It is worth noting that the Made Ground from beneath the existing vehicle access ramp and Made Ground Topsoil from the garden of 32 Torrington Square will be removed to facilitate the new extension. It is recommended that this report is submitted to the planning department of the Local Authority and the organisation undertaking the Building Control function to confirm that the investigation completed to date is satisfactory.
FURTHER INVESTIGATION	No further investigation is considered necessary for contamination assessment purposes.
OUTLINE REMEDIATION STRATEGY	No remediation is required.

WASTE SOILS CLASSIFICATION	It is considered that the any natural soils disposed of from the site would be classified as 'inert waste'. However, the chemical results should be forwarded to the proposed landfill site and the waste classification confirmed prior to disposing of any surplus soils. Waste Acceptance Criteria (WAC) testing of the soils will also be required where the soil is to be disposed of at a landfill permitted to accept inert waste. The waste code from the European Waste Catalogue (EWC) 2002 for the soils would be 17 05 04 'Soil and Stones, not containing dangerous substances'. The identified Made Ground soils from beneath the vehicle access ramp and within the garden of 32 Torrington Square to 0.60m bgl disposed of from the site would be classified as 'hazardous waste' due to the concentrations of lead contained within. Such waste will require pre-treatment prior to off-site treatment or disposal. Waste Acceptance Criteria (WAC) testing of the soils for disposal will also be required if the soil is to be disposed of to landfill. The waste code from the European Waste Catalogue (EWC) 2002 for the soils would be 17 05 03 'Soil and Stones, containing dangerous substances'. WAC testing has been undertaken on a sample from TP02 at 0.80m and shown that the Made Ground is stable non-reactive hazardous waste and can therefore be disposed of in a non-hazardous landfill. The Made Ground beneath 0.60m depth in the rear garden of 32 Torrington Square would be classified as 'non-hazardous waste' and as such the waste will require pre-treatment prior to off-site disposal. The chemical results should be forwarded to the proposed landfill site and the waste classification confirmed prior to disposing of any surplus soils. The waste code from the European Waste Catalogue (EWC) 2002 for the soils would be 17 05 03 'Soil and Stones, containing dangerous substances'.

9. HEALTH AND SAFETY FILE INFORMATION

9.1. INTRODUCTION

The aim of the following sections is to present pertinent Health and Safety information that has arisen from the current investigation/survey works discussed in this report. The aim is to identify health and safety controls that may be necessary during any subsequent maintenance, refurbishment, demolition or construction works.

Where BRD has been appointed as a Principal Contractor, then this information shall form the Health and Safety Files as required by the Construction Design and Management (CDM) Regulations 2015.

Reports are always forwarded to the Client and they shall be responsible for ensuring this safety information is disseminated to those who need it.

9.2. WORK UNDERTAKEN

Detail on the works undertaken and the information gained about the site are discussed in previous sections of this report.

In summary, BRD's work comprised the drilling of 1No. cable percussive borehole, 3 No. windowless sampling boreholes and the excavation of 2No. trial pits to expose foundations.

9.3. HAZARDS

The investigation has revealed the following hazards:

9.3.1. Contamination

Soils containing elevated concentrations of lead are present at the site. Construction workers could be at risk where they are exposed to these soils in high intensity activities, for example during demolition, utility services work and foundation construction. During the redevelopment of the site, the presence of contaminated soils should be considered within health and safety plans. Measures to protect the health and safety of site workers should be implemented including use of appropriate personal protective equipment, education and good hygiene procedures.

If during the redevelopment any anomalous material is encountered that is different to the conditions revealed by this investigation, then expert environmental advice should be sought.

9.3.2. Asbestos

No asbestos containing materials were detected in the samples tested.

In accordance with Health and Safety Executive (HSE) guidance, a 'Refurbishment Demolition Survey' (RDS) should be undertaken to identify whether or not asbestos containing materials are present in the existing structure(s) prior to demolition or refurbishment. The results of the survey should then be used to plan for the safe management, removal and disposal of asbestos containing materials from the existing buildings and infrastructure should such materials be present.

9.4. STRUCTURES

BRD recommend that advice on existing structures is gained from a qualified and experienced Building Surveyor or Structural Engineer.

9.5. HAZARDOUS MATERIALS USED

BRD did not construct anything with hazardous materials.

Any soils to be imported to the site, in particular topsoil, should be tested to confirm their suitability in the development.

9.6. UTILITY SERVICES

No previously unidentified utility services were encountered during the BRD works.

The utility services plans held by the Client should be referred to.

REPORT SPECIFIC REFERENCES

- British Geological Survey sheet 256 "North London" Solid and Drift edition (1:50,000) published 2006.
- 'Phase 1 Geo-Environmental Desk Study – 32-33 Torrington Square, London', BRD Environmental Ltd, report ref. BRD2903-OR1-A, dated April 2017.

SUPPORTING INFORMATION

GROUND INVESTIGATION

Exploratory holes are logged by an experienced Geo-Environmental Consultant in general accordance with 'Code of practice for site investigations' BS5930:1999 +A2:2010, BSi, August 2010. Soil samples for chemical and geotechnical analysis are taken from the exploratory holes at intervals dictated by the nature of the soils and the objectives of the investigation.

Where stated on the logs of inspection pits, trial pits or boreholes (where insitu testing has not been undertaken), the relative density of coarse (sand and gravel) soils is tentative only. Such assessments of density are on the basis of visual inspection only taking into consideration such factors as drilling rates, stability of pit side walls, appearance and behaviour under excavation.

Where Chalk strata is encountered it is logged and graded in general accordance with CIRIA guidance 'C574 - Engineering in Chalk'. It should be recognised that where percussive drilling methods are employed, the structure of the Chalk is destroyed and therefore the grading stated on such logs is either tentative or absent where it is not possible to assess the grade.

Hand Dug Inspection Pits

Hand tools are used to forward shallow inspection pits as a cost effective method of describing and sampling near surface soils. The technique is also used where exposure of existing footings is required. The depth reached by such techniques is a function of the nature of the ground and generally does not exceed 1.5m

Trial Pits

Mechanically excavated trial pits allow detailed inspection of near surface ground due to the large volume of soil exposed. A wheeled backhoe loader is the usual machine for digging trial pits that are typically 3 to 4.5m deep, 0.5m wide and 3m long.

Windowless Sampling Boreholes

This type of borehole is formed by a small tracked dynamic percussion drilling rig with samples retrieved in thin plastic liners within the narrow diameter steel sampling tubes. Borehole depths of up to 5m are typical, but in exceptional circumstances up to 15m depth can be achieved. This is the smallest type of rig that is capable of undertaking Standard Penetration Tests (SPTs).

Hand Held Window Sampling

Hand held window sampling is a useful method of drilling narrow diameter boreholes particularly where access is difficult. Hand held mechanical percussive hammers are used to drive the sampling tube into the ground. The soil samples are collected within the hollow metal sampling tubes and inspected via the open window along one side. Window sampling boreholes can be forwarded to depths of 3m to 6m depending upon ground conditions.

Cable Percussive Boreholes

This form of drilling involves repetitive dropping of a tube into the soil under its own weight from a tripod support. The sample is obtained from the clay cutter head in fine soils or a bailer for wet granular soils. As the borehole progresses SPTs can be undertaken and relatively undisturbed samples can be obtained. Typically these boreholes are 15 to 25m

deep, but depths of double that can be achieved in soils, but only thin weak rock layers can be penetrated.

Rotary Boreholes

Where competent rock is required to be drilled then rotary drilling techniques are required. The drilling rigs can vary in size from small tracked units to larger units mounted on four wheel drive trucks. Rotary open hole drilling techniques break the rock into small fragments and so recovery of any samples is limited. In contrast, rotary coring retrieves excellent samples. Some rigs also allow windowless sampling to be undertaken through soil layers. There are no practical limits to the depths that this drilling method can achieve.

Dynamic Probing

Dynamic probing comprises a sectional rod with a sacrificial cone at the base of slightly larger diameter than the rod. The rod is driven into the ground by a constant mass falling through a set distance. The number of blows required to forward the rod per 100mm is then recorded and presented in a graph of N_{10} values. The standard applicable to dynamic probing is "BS EN ISO 22476-2:2005 Incorporating corrigendum no. 1, Geotechnical investigation and testing — Field testing — Part 2: Dynamic probing" BSi, February 2007.

Dynamic Penetrometer

The Transport Research Laboratory Dynamic Cone Penetrometer (TRL DCP) uses an 8 kg hammer dropping through a height of 575mm to drive a 60° cone of 20mm maximum diameter into the ground. The depth driven either per blow or per several blows is recorded. The strength of each of the soil layer encountered is then calculated by converting the penetration rate (mm per blow) into an approximate California Bearing Ratio (CBR) value employing the correlation proposed by TRL.

Gas Monitoring

Gas monitoring is undertaken with a portable gas monitor for oxygen, Methane, Carbon Dioxide, Hydrogen Sulphide and Carbon Monoxide together with recording of atmospheric pressure and any flow rate.

Vapour Monitoring

Headspace tests and monitoring for Volatile Organic Compounds (VOC) or Semi Volatile Organic Compounds (SVOC) is undertaken using a Photo Ionisation Detector (PID). The MiniRAE models used have a 10.6 eV lamp calibrated for isobutylene. The PID is useful tool to indicate the presence of a wide range of volatile compounds, but only provides semi-quantitative data as different compounds provide a different response and thus the reading is not a true reflection of the actual concentration present.

Low PID readings can be recorded in natural uncontaminated organic soils or even as a result of atmospheric pollution. It is generally accepted by consultants and regulators that recorded values in excess 50 parts per million (ppm) represents the presence of organic compound pollutants and in excess of 100 ppm such contamination may be significant.

The headspace test procedure involves the collection of a sample of suspected contaminated soils and placing within a sample bag. A tight seal to the bag is formed with a similar volume of air trapped to that of the soil and the sample is left for fifteen minutes to allow volatilisation of any contaminants. The bag is then pierced by, and sealed around, the sample probe of the PID and a reading taken.

Borehole well monitoring is undertaken by connecting the PID directly to the gas tap on the monitoring well installation.

Groundwater Level Monitoring

Groundwater levels are recorded with an electronic dip meter that has a detector end that is lowered into the borehole well. An audible signal is made when water is reached and the depth recorded from the graduated tape used to lower the detector. Where there is potential for a separate Light Non Aqueous Phase Liquid (LNAPL) to be present floating on the groundwater an oil/water interface meter is used in preference to a conventional dip meter so that any such floating product can be detected.

Geotechnical Sampling

BRD schedule a range of geotechnical testing as appropriate to the identified ground conditions, available budget and the proposed development. Different types of soil samples are obtained as appropriate to the ground conditions and planned testing.

SAMPLE TYPE	SYMBOL USED ON LOGS	DESCRIPTION
Disturbed	D	Small disturbed soil samples of about 1 to 2 kg are collected in plastic bags.
Bulk	B	Large disturbed bulk samples up to about 30 kg are collected in plastic bags
Undisturbed	U	'Undisturbed' samples generally collected in plastic or metal tubes within cable percussive boreholes of 100mm diameter for samples of fine soils of firm to stiff consistency. Can also be representative of samples taken by cutting plastic sample liners from windowless sampling drilling methods. It is recognised that such samples do not generally meet Eurocode sample quality requirements for the tests commonly employed. However, given the wealth of experience with these sampling methods this continues to be common in United Kingdom practice particularly for less sensitive developments where more expensive sampling techniques are not economically justifiable.
Undisturbed	UT	A thin walled steel sampler developed by Archway Engineering called a UT100 in an attempt to gain better quality samples of soft to firm fine soils when using cable percussive drilling methods.

Contamination Sampling

BRD schedule contamination testing as appropriate to the ground conditions, available budget, potential contaminants and the proposed development. Samples are collected in single use laboratory supplied containers.

Soil samples are retrieved in plastic containers and/or amber glass jars with a lined plastic cap. Contamination samples are indicated by a 'J' on exploratory hole logs.

Water samples are collected in plastic bottles and/or amber glass jars with a lined plastic cap then placed in cool boxes together with freezer packs. Water samples are indicated by a 'W' on exploratory hole records, but generally such samples are not tested as testing from dedicated monitoring wells is preferred for sample quality reasons.

Samples retrieved from the exploratory holes are dispatched to the laboratory by overnight courier. Where samples cannot be transported directly from site they are temporarily stored in the BRD dedicated sample storage facility which includes refrigeration where necessary. The individual accreditation of the test methods is detailed in the laboratory test report.

GEOTECHNICAL ASSESSMENT

Under Eurocode 7 (EC7) the following risk ranking is applied to geotechnical projects:

GEOTECHNICAL CATEGORY	***DESCRIPTION***
1	*Small and relatively simple structures for which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations with negligible risk. For example, straightforward ground conditions, local experience, no excavation below the water table unless this will be straight forward.*
2	*Conventional types of structures and foundations. No difficult soil or loading conditions. Quantitative geotechnical data and laboratory testing. Routine procedures for field and laboratory testing. Conventional structures and no exceptional geotechnical risk. For example, spread, raft and piled foundations, retaining walls, bridge piers and abutments, embankments, ground anchors, tunnels and excavations.*
3	*Those structures not in Categories 1 and 2 such as very large or unusual structures, structures involving abnormal risks, or unusual or exceptionally difficult ground or loading conditions. Structures in highly seismic areas. Structures in areas of probable site instability or persistent ground movements that require separate investigation or special measures.*

GEOTECHNICAL PARAMETERS

Soakage Tests

Soakage tests comprise the filling of a test pit with water and recording the time taken for the water to drain away. The test are undertaken in general accordance with 'BRE Digest 365: Soakaway design', Building Research Establishment, 1991. Water is generally supplied by a tanker to allow fast filling of the pits with water. Repeat tests are undertaken where possible within the time available on site with the investigation budget.

Standard Penetration Tests

The standard penetration test (SPT) determines the resistance of soils at the base of a borehole to the dynamic penetration of a split barrel sampler and the recovering of disturbed samples for identification purposes. In gravelly soils and some soft rocks a solid cone is used in preference to the sampler.

The basis of the test consists in driving a sampler by dropping a hammer of 63.5 kg mass on from a height of 760 mm. The number of blows (N value) necessary to achieve a penetration of the sampler of 300 mm is recorded. The test is described in 'Geotechnical investigation and testing — Field testing — Part 3: Standard penetration test - BS EN ISO 22476-3:2005 Incorporating corrigendum no. 1', BSi, 2007.

The uncorrected N values of the SPT tests are recorded upon the borehole logs together with a record of blows for each 75mm test portion including the seating blows. Where the full test depth cannot be achieved due to refusal on hard stratum, the number of blows and the distance achieved is recorded and the N value given as >50. The abbreviation SPT(c) is used upon the logs indicates that the test was performed with a solid cone rather than a split spoon sampler.

It is necessary to apply a correction to the N values to account for the effects of energy delivery using the equation: $N_{60} = \frac{E_r}{60} N$ *where* E_r *is the energy ratio of the specific test equipment.*

In the case of tests in sand, for the effects of overburden and rod length the equation is modified to $N_{60} = \frac{E_r}{60} \; x \; \lambda \; x \; C_N \; x \; N$ *where* λ *is the correction factor for energy losses due to the rod length and* C_N *is the correction factor for vertical stress due to overburden of the soil.*

Sulphate

In order to compare the laboratory soil test results with 'Concrete in aggressive ground. BRE Special Digest 1: 2005' (BRE, 2005) laboratory results are converted to SO_4 *mg/l. QTS Environmental Ltd results are expressed as* SO_4 *g/l and so are multiplied by a factor of 1000 to convert to mg/l. Soil Property Testing Ltd laboratory results are expressed as* SO_3 *g/l and are multiplied by a factor of 1200 to express the results as* SO_4 *mg/l.*

Index Property Tests

In accordance with National House Building Council (NHBC) Standards Chapter 4.2 – Building near trees, the laboratory plasticity indexes are assessed against their volume change potential. The Modified Plasticity Index is defined as the Plasticity Index of the soil multiplied by the percentage of particles with a nominal diameter of less than 425µm. Whilst the NHBC Standards were developed for residential buildings, the advice is equally applicable to a large number of other types of low rise structures.

Hand Shear Vane

The undrained shear strength of the fine (i.e. clay) soils at the site can be established using hand shear vane apparatus. Usually three readings are taken at every depth tested and the uncorrected results recorded on the exploratory point log. Shear vane readings from depths below 1.2m depth in trial pits are from tests performed on excavated soil. In accordance with Eurocode 7 — Geotechnical design — Part 2: Ground investigation and testing EN 1997-2:2007 the results should be corrected. BRD employ only simple correction methods as the more complex correction methodologies imply undue accuracy to a test that has distinct disadvantages and limitations.

Pocket Penetrometers

The Pocket Penetrometer is a lightweight instrument for use by field personnel to check visual classification of soils. It is a simple test and there is inherent uncertainty related to the small volume of soil being tested and so the results should be used with appropriate caution. Pocket penetrometers are calibrated in terms of unconfined compressive strength and once converted to undrained shear strength (divide by two) the results are further reduced by a factor of 1.5 - 2.0 as the device tends to overestimate strengths.

Instrument Reading (uncompressive strength in kg/cm^2)	*Indicative Undrained Shear Strength (kN/m^2)*	*Indicative Consistency*	*Indicative strength*
1.0	*25 – 33*	*Soft*	*Low*
1.5	*38 – 50*	*Soft to firm*	*Low to medium*
2.0	*50 - 67*	*Firm*	*Medium*
2.5	*63 – 83*	*Firm to stiff*	*Medium to high*
3.5	*88 – 116*	*Stiff*	*High*
4.5	*113 – 150*	*Stiff to very stiff*	*High to very high*

CONTAMINATION ASSESSMENT METHODOLOGY

UK Policy

The UK Government's policy in relation to land affected by historic contamination is based on a 'suitable for use' approach. The approach recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Contamination risks therefore need to be assessed on a site-by-site basis. The 'suitable for use' approach limits requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to either the current use or future use of the land.

The three main drivers for contamination assessment and remediation are:

- *Voluntary action.*
- *Development as part of the planning regime.*
- *Regulatory action to mitigate unacceptable risks e.g. Part 2A of the Environmental Protection Act 1990.*

Pollutant Linkages

For a contamination risk to exist there must be a 'pollutant linkage' from the contaminant (source) via a pathway (the route from contaminant to receptor) to a receptor (the entity that could be harmed). The absence of a contaminant, pathway or receptor breaks the pollutant linkage and therefore no contamination risk exists.

Contamination is typically present at a site (in the ground and/or in the underlying groundwater) as a result of a historic or current industrial use, usually as a result of leaks, spills or disposal of residues, wastes and excess raw materials from the industrial processes. Contamination may also be present due to:

- *The deliberate application of chemicals e.g. the spraying of herbicide/pesticide.*
- *Migration of pollutants from adjacent land.*

Naturally occurring processes e.g. elevated concentrations of particular heavy metals associated with specific geological strata.

Conceptual Site Model

The conceptual site model can be defined as a textual or graphical representation of the identified pollutant linkages for a given site. The model forms the basis for designing the investigation as the aim will be to target all of the potential pollutant linkages to determine, through the subsequent phases of risk assessment, whether or not they pose an actual risk.

It is important that the conceptual site model is updated with new information as the various investigation, risk assessment and remediation works are completed.

Technical Guidance

The technical and legal framework for contamination assessment is complex. The process adopted through this report for assessing contamination risks is in general accordance with the following guidance, as listed below:

- *'Investigation of Potentially Contaminated Sites - Code of Practice - BS 10175: 2011', BSi, 2011.*
- *'Model Procedures for the management of Land Contamination - CLR Document No. 11', Environment Agency, 2004.*
- *'Guidance for the safe development of housing on land affected by contamination - R&D66: 2008', NHBC/Environment Agency, 2008.*

Risk Assessment Methodology

In line with the technical guidance, the contamination risk assessment follows a series of phased stages for each particular site:

PHASE	DESCRIPTION	RISK ASSESSMENT STAGE
PHASE1	*Generally limited to desk based research and a site walkover survey to develop an initial conceptual site model and identify what risks, if any, are likely to be presented by the site.*	***Hazard Identification and Assessment*** *A preliminary stage of risk assessment concerned with identifying and characterising the hazards that may be associated with a particular site and identifying potential pollutant linkages.*
PHASE 2	*This phase is concerned with establishing whether contamination is present, usually through intrusive ground investigation, and then evaluating the degree and magnitude of the associated risks.*	***Risk Estimation*** *A stage concerned with estimating the likelihood that receptors will suffer adverse effects if they come into contact with, or are otherwise affected by, a hazardous substance or agent under defined conditions.* ***Risk Evaluation*** *A stage of risk assessment concerned with evaluating the acceptability of estimated risks, taking into account the nature and scale of the risk estimates, any uncertainties associated with the assessment and the broad costs and benefits of taking action to mitigate risks.*
PHASE 3	*The appraisal and selection of remediation techniques, their implementation and verification.*	***Risk Management*** *The process whereby decisions are made to accept a known or assessed risk and/or the implementation of action to reduce the consequences or probabilities of occurrence.*

Risk Classification

The objective of risk assessment is to identify the nature and magnitude of the potential risks and should be based on a consideration of both:

- *The likelihood/probability of an event [taking into account both the presence of the hazard and receptor and the integrity of the pathway].*
- *The severity of the potential consequence [taking into account both the potential severity of the hazard and the sensitivity of the receptor].*

There is a need for a logical, transparent and repeatable system in defining the categories of severity of consequence and likelihood as well as for the risk itself and therefore the following risk rating matrix is employed:

		SEVERITY OF CONSEQUENCE			
		SEVERE	***MEDIUM***	***MILD***	***MINOR***
PROBABILITY	***HIGH LIKELIHOOD***	*Very High Risk*	*High Risk*	*Moderate Risk*	*Moderate/Low Risk*
	LIKELY	*High Risk*	*Moderate Risk*	*Moderate/Low Risk*	*Low Risk*
	LOW LIKELIHOOD	*Moderate Risk*	*Moderate/Low Risk*	*Low Risk*	*Negligible Risk*
	UNLIKELY	*Moderate/Low Risk*	*Low Risk*	*Negligible Risk*	*Negligible Risk*

These risk classifications are defined as follows:

- *Very High Risk - There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remediation action.*
- *High Risk - Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remediation action.*
- *Moderate Risk - It is possible that without appropriate remediation action harm could arise to a designated receptor. It is relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely that such harm would be relatively mild.*
- *Low Risk - It is possible that harm could arise to a designated receptor from an identified hazard. It is likely that, at worst if any harm was realised any effects would be mild.*
- *Negligible Risk - The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.*

This risk assessment matrix and classification system is based on guidance produced by Department for Environment, Food and Rural Affairs (Defra) and the Environment Agency in connection with contaminated land assessment.

RISK ESTIMATION - SOILS

Introduction to Soil Human Health Generic Assessment Criteria (GAC)

The Environment Agency (EA) and Department of Environment Food and Rural Affairs (DEFRA) had previously issued revised guidance following the consultation about the DEFRA publication "Assessing risks from land contamination – a proportionate approach. Soil Guideline Values: the Way Forward". This resulted in a revised version of the Contaminated Land Exposure Model (CLEA) model (version 1.06) and a few of the previously published Soil Guideline Values (SGVs) were revised.

The main legislative driver for dealing with historical land affected by contamination is Part 2A of the Environmental Protection Act 1990. Revised Statutory Guidance to support Part 2A was published in April 2012. This Guidance introduced a new four-category system for classifying land under Part 2A for cases of a Significant Possibility of Significant Harm to human health,1 where Category 1 includes land where the level of risk is clearly unacceptable and Category 4 includes land where the level of risk posed is acceptably low. The impact assessment for the new Statutory Guidance stated "The new statutory guidance will bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land". The C4SLs are still derived using the CLEA model, but adopt a slightly different approach to toxicological assessment and exposure modelling.

In March 2014, the outcome of "SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination - Final Project Report" (CL:AIRE) was published. Due to slightly ambiguous wording within this report, Lord de Mauley, Parliamentary Under Secretary, DEFRA wrote to all local authorities on 3 September 2014 to confirm that the published C4SLs were final and that they can be used in risk assessment undertaken under the planning regime.

Whilst there are proposals for the industry to develop C4SLs for other contaminants, these have yet to produce any new values. BRD do not believe that C4SLs could be developed by a single organisation with sufficient confidence. BRD has therefore employed other, more conservative guidance based on the CLEA model (detailed below) within this assessment for compounds where C4SLs are not available. However, it should be noted that the results of this investigation may need to be reinterpreted as new C4SLs become available.

Due to the limited number of published C4SL values at this time, the Chartered Institute of Environmental health (CIEH) and Land Quality Management Ltd (LQM) have produced Generic Assessment Criteria (GAC) known as Suitable for Use Levels (S4ULs), for use in contaminated land human health risk assessment. These S4ULs (2014) have been derived for a large number of substances using the current CLEA model and are therefore consistent with current guidance. They also incorporate the revised exposure parameters as adopted by the C4SL programme, but have not adopted the revised toxicological approach adopted by the C4SLs and so remain a more conservative assessment criteria. The substances for which SGVs were previously published have also been revised as new S4ULs in light of the new exposure parameters proposed by the C4SL programme, and therefore effectively replace the existing SGVs.

In addition, in December 2009, other GAC for less common substances were produced by the Environmental Industries Commission (EIC), The Association of Geotechnical and Geoenvironmental Specialists (AGS) and Contaminated Land: Applications in Real Environments (CL:AIRE) using the CLEA model. These are referred to as the EIC/AGS/CLAIRE GAC.

In summary, C4SLs have been used where these are available. For those substances where C4SLs have yet to be issued, then the S4ULs have been adopted or in some cases, the EIC/AGS/CLAIRE GAC. All of the previously produced SGVs have now either been withdrawn, or superseded by the respective C4SLs or S4ULs.

The only exception to this approach is the PAH compound benzo(a)pyrene (BaP) where a C4SL guideline value has been produced, whereas BRD has adopted the S4UL value. The C4SL for BaP relates to its use as a surrogate marker compound representing all of the genotoxic PAH compounds as a mixture, rather than this individual compound. BRD has therefore adopted the compound specific S4UL value as the initial screening value, for consistency with the other PAH compounds before then employing the C4SL is necessary.

It should be noted that unless otherwise stated, all the assessment criteria adopted within this report have been derived based on a sandy loam soil at pH 7 and the values quoted are for a conservative soil organic matter content of 1% where applicable (i.e. organic contaminants).

Human Health - Soil Generic Assessment Criteria

The results of the soils analysis have been compared to generic assessment criteria for the default exposure scenarios comprising either residential land with plant uptake, residential land without plant uptake, or commercial/industrial land use. The criteria values selected are listed in the table below and full details on the source are referred to above. Where applicable, the results have also been assessed with reference to the required statistical tests presented within CLAIRE document "Guidance on comparing soil contamination data with a critical concentration".

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
Arsenic	37	40	640	C4SL
Cadmium	22	150	410	
Chromium (total)[$]	910	910	8,600	S4UL
Chromium VI	21	21	49	C4SL
Lead	200	310	2,330	
Mercury*	11	15	320	S4UL
Selenium	250	430	12,000	
Nickel	180	180	980	
Copper	2400	7,100	68,000	
Zinc	3,700	40,000	730,000	
pH	<5 - 10> units			Professional judgement
Naphthalene	2.3	2.3	190	S4UL
Acenaphthylene	170	2,900	83,000	
Acenaphthene	210	3,000	84,000	
Fluorene	170	2,800	63,000	
Phenanthrene	95	1,300	22,000	
Anthracene	2,400	31,000	520,000	
Fluoranthene	280	1,500	23,000	
Pyrene	620	3,700	54,000	
Benzo(a)anthracene	7.2	11	170	
Chrysene	15	30	350	
Benzo(b)fluoranthene	2.6	3.9	44	
Benzo(k)fluoranthene	77	110	1,200	
Benzo(a)pyrene	2.2	3.2	35	
Indeno(1,2,3-cd)pyrene	27	45	500	

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
Dibenzo(a,h)anthracene	0.24	0.31	3.5	S4UL
Benzo(ghi)perylene	320	360	3,900	
TPH Aliphatic C5-C6	42	42	3,200	
TPH Aliphatic C6-C8	100	100	7,800	
TPH Aliphatic C8-C10	27	27	2,000	
TPH Aliphatic C10-C12	130	130	9,700	
TPH Aliphatic C12-C16	1,100	1,100	59,000	
TPH Aliphatic C16-C35	65,000	65,000	1,600,000	
TPH Aliphatic C35-C44	65,000	65,000	1,600,000	
TPH Aromatic C5-C7	70	370	26,000	
TPH Aromatic C7-C8	130	860	56,000	
TPH Aromatic C8-C10	34	47	3,500	
TPH Aromatic C10-C12	74	250	16,000	
TPH Aromatic C12-C16	140	1,800	36,000	
TPH Aromatic C16-C21	260	1,900	28,000	
TPH Aromatic C21-C35	1,100	1,900	28,000	
TPH Aromatic C35-C44	1,100	1,900	28,000	
Benzene	0.87	3.3	98	C4SL
Toluene	130	880	56,000	S4UL
Ethylbenzene	47	83	5,700	
Xylene^	56	79	5,900	
MTBE	49	73	7,900	EIC/AGS/CL:AIRE GAC

Notes:
** The S4UL for methyl mercury has been adopted as the worst case mercury compound as generally there is no desk study evidence to suggest the potential for elemental mercury on the majority of sites.*
^ The lowest S4UL of either p-xylene, o-xylene or m-xylene has been adopted for each land use as a conservative measure.
$ S4UL for Chromium III adopted, as in the absence of Chromium VI it is likely that all of the chromium will be in this form as these are the two most common and stable forms of chromium in the soil environment.

Where no GAC is available, any concentrations exceeding the laboratory limit of detection are identified and discussed in more detail.

Water Environment - Soil Generic Assessment Criteria

There are no UK published Generic Assessment Criteria for soil test results in respect of the risk to the water environment and therefore risk estimation is on the basis of the professional judgement and experience of BRD to employ values that are a reasonable concentration above which concern for water resources is valid.

The Total PAH GAC employed is the sum of the 16No. priority PAH compounds regularly tested for in contaminated land analysis (i.e. US EPA 16PAHs). BRD employ a soil screening based upon the total PAH limit for 'inert waste' of 100mg/kg. The rationale is based on PAHs are recognised to be generally of low solubility and the risk to the water environment is correspondingly low.

In respect of Total Petroleum Hydrocarbons, BRD employ a value of 500 mg/kg as a screening value in comparison to the sum of the component aliphatic and aromatic TPH carbon bands. The employed soil screening value is based upon:

- *In common with some other consultants, the professional judgement and experience of BRD suggests that this value is a reasonable concentration above which concern for water resources is valid. The rationale is based on the fact that lower concentrations of fuel based contaminants are more likely to naturally degrade than migrate any great distance.*

- *BRD is aware of regional Environment Agency groundwater and contaminated land teams that employ 500 mg/kg as a screening value for considering whether or not TPH could represent a risk to water resources.*

- *The value mirrors the mineral oil Waste Acceptance Criteria limits for what is considered 'inert waste'.*

Should elevated contaminants that pose a potential risk to the water environment be identified then site specific assessment criteria should be developed.

Building Materials and Services – Soil Generic Assessment Criteria

Some hydrocarbon compounds are known to both attack and permeate through certain plastic pipe materials, with the primary concern being the degradation and tainting of water supplies. The UK Water Industry Research (UKWIR) has therefore produced a document 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' (ref. 10/WM/03/21) that specifies threshold criteria for the adoption of 'standard' polythene (PE) or PVC pipes, protective barrier pipe and ductile iron/steel/copper pipes.

The UKWIR threshold assessment criteria from Table 3.1 of this document for standard PE pipes have been employed. It should be noted that the approach taken by UKWIR is very conservative, and both the document and research are flawed. However, it is these values that are being using to specify water pipe materials and therefore it is appropriate to consider them.

The UKWIR guidance is particularly flawed in respect of the chemical analysis it expects as it seeks a limit of detection that is generally below limits that are reasonable or commonly employed in contaminated land assessment. The UKWIR seeks that where a substance is below the limit of detection it should be taken as being present at half this concentration. For the larger suite of chemicals where the limit is against a sum of compounds, this approach would mean that a sample of virgin sub-soil from a greenfield site with absolutely no contamination would actually fail the criteria for using standard PE pipes. To avoid this situation, BRD have adopted the approach of summing only those compounds detected above their respective limits of detection.

In terms of building materials, the primary concern is in respect of concrete as certain commonly occurring natural ground conditions can adversely impact on buried concrete as discussed in 'Special digest 1:2005 Concrete in aggressive ground', BRE, 2005.

ANALYSIS	GENERIC ASSESSMENT CRITERIA	SOURCE
pH	<5.5	BRE Special Digest 1:2005
Sulphate (w/s)	500 mg/l	BRE Special Digest 1:2005
Sum of any VOC above detection limits	0.5 mg/kg	Relevant compounds adapted from UKWIR Table 3.1
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	2 mg/kg	
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	10 mg/kg	
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	500 mg/kg	
Sum of BTEX + MTBE above detection limits	0.1 mg/kg	
Phenols	2 mg/kg	
Cresols and chlorinated phenols	2 mg/kg	
Naphthalene	0.5 mg/kg	
Benzo(a)pyrene	0.5 mg/kg	

RISK ESTIMATION – GROUNDWATER

The initial assessment of the contamination risk to groundwater is by comparing dissolved groundwater concentrations with screening values that are protective of groundwater resources.

The reference source for the target concentrations is generally the EA's Environmental Quality Standards (EQS), the Water Supply (Water Quality) Regulations (WSR) 1989 / 2000 and the DW1/DW2 criteria from the Surface Water (Abstraction for drinking water)(classification) Regulations 1996. The target concentrations are outlined in the table overleaf.

ANALYSIS	GENERIC ASSESSMENT CRITERIA	SOURCE
Arsenic	50 µg/l	EQS
Cadmium	5 µg/l	EQS
Chromium (total)	50 µg/l	DW2
Copper	50 µg/l	DW2
Nickel	20 µg/l	WSR
Lead	50 µg/l	DW2
Mercury	1 µg/l	EQS
Selenium	10 µg/l	WSR
Zinc	5 mg/l	DW2
Cyanide	50 µg/l	WSR
pH	6 to 9 units	EQS
Benzene	30 µg/l	EQS
Toluene	50 µg/l	EQS
Ethylbenzene	30 µg/l	EQS for benzene as a guide
Xylene	30 µg/l	EQS for benzene as a guide
Naphthalene	2.4 µg/l	EQS
Benzo(a)pyrene	0.05 µg/l	EQS
Total PAH	0.2 µg/l	DW1
TPH (dissolved or emulsified hydrocarbons)	50 µg/l	DW1

There are no available generic assessment criteria for some of the analytical parameters which have been scheduled, for example hexavalent chromium, and individual TPH and PAH and some VOC compounds. These parameters will be assessed based on professional judgement should they exceed the limit of detection.

RISK ESTIMATION - GROUND GAS

Introduction

A variety of potentially hazardous gases occur in naturally in the ground environment. Microbial decay of organic matter under anaerobic conditions and geological processes can lead to the generation of Methane and Carbon Dioxide, but can also include traces gases such as Hydrogen sulphide and Carbon monoxide.

Methane is a colourless and odourless gas that has the hazardous properties of being flammable and, at certain air/Methane mixtures, explosive. Methane has a low toxicity, but can be a simple asphyxiant due to the displacement of oxygen.

Carbon Dioxide is a colourless, odourless and non-combustible gas that has the hazardous property of being a highly toxic chemical. At concentrations of 3% by volume, shortness of breath and headaches will occur becoming acute by 6%. At levels of above 10% by volume headache, visual distortion, tremors and rapid loss of consciousness occur. Concentrations of Carbon Dioxide above 22% by volume are likely to be fatal. The effects of Carbon Dioxide poisoning are made more severe if there is accompanying reduction in oxygen concentrations.

Hydrogen sulphide is a colourless and flammable gas that has an odour of rotten eggs. It is important to that the sense of smell is over powered at higher concentrations. The gas is toxic and can be an asphyxiant.

Carbon monoxide is a colourless, odourless and explosive gas in air mixtures that has the hazardous property of being a highly toxic chemical.

Radon is a naturally occurring colourless and odourless gas that is radioactive. It is formed by the radioactive decay of radium which in turn is derived from the radioactive decay of uranium, both of which are minerals that can be found in many soil types. Whilst it is recognised that the air inside every house contains radon, some houses built in certain defined areas of the country might have unacceptably high concentrations and require special precautions to be taken. The maps contained within BRE211:2007 'Radon: guidance on protective measures for new buildings' identify areas where no radon protection measures are necessary or where higher concentrations are present that either basic or full radon protection measures are required to be fitted to all new dwellings.

Basis of Gas Assessment

In order to classify the level of risk and need, if any, for gas protection measures at a site with the potential for a gas problem, consideration of each of the following is necessary:

- *The source of the gas.*
- *The generation potential of the gas.*
- *The location of the source and the geological setting.*
- *Boreholes flow rate and estimated surface emission rate.*

- *The nature of the proposed development.*
- *Confidence in the knowledge of the gas regime.*

The gas assessment is made with reference to 'C665 - Assessing risks posed by hazardous ground gases to buildings', Construction Industry Research and Information Association (CIRIA), 2007.

Gas Screening Value

The method within CIRIA C665 uses both the gas concentrations and borehole flow rates to define a characteristic situation for a site based on the limiting borehole gas volume flow for Methane and Carbon Dioxide. This limiting borehole gas volume flow is called the Gas Screening Value (GSV) and is expressed below:

Gas Screening Value (l /hr) = borehole flow rate (l/hr) x gas concentration (fraction)

The calculation of GSV is completed for both Methane and Carbon Dioxide and then the 'worse case' maximum values are used in the assessment. The assessment is to determine the gas regime at the site is dependent upon the nature of the development.

Situation A – All development types except low rise housing with gardens.

The characteristic situation for many sites is determined from evaluation of the Gas Screening Value derived against the criteria in the following table.

Characteristic situation	Risk classification	Gas Screening Value (CH4 or CO2 l/hr)	Additional factors	Typical sources of generation
1	Very low risk	<0.07	Typically Methane ≤1% and/or Carbon Dioxide ≤5%. Otherwise consider an increase to characteristic situation 2.	Natural soils with low organic matter content and 'typical' made ground.
2	Low risk	<0.7	Borehole air flow rate not to exceed 70 l/hr. Otherwise consider an increase to characteristic situation 3.	Natural soil with high organic peat/organic content and 'typical' made ground.
3	Moderate risk	<3.5		Old landfill, inert waste and flooded mine working.
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protection measures.	Mine working susceptible to flooding and landfill completed to WMP 26B criteria.
5	High risk	<70		Mine working unflooded inactive with shallow workings near surface.
6	Very high risk	>70		Recent landfill site.

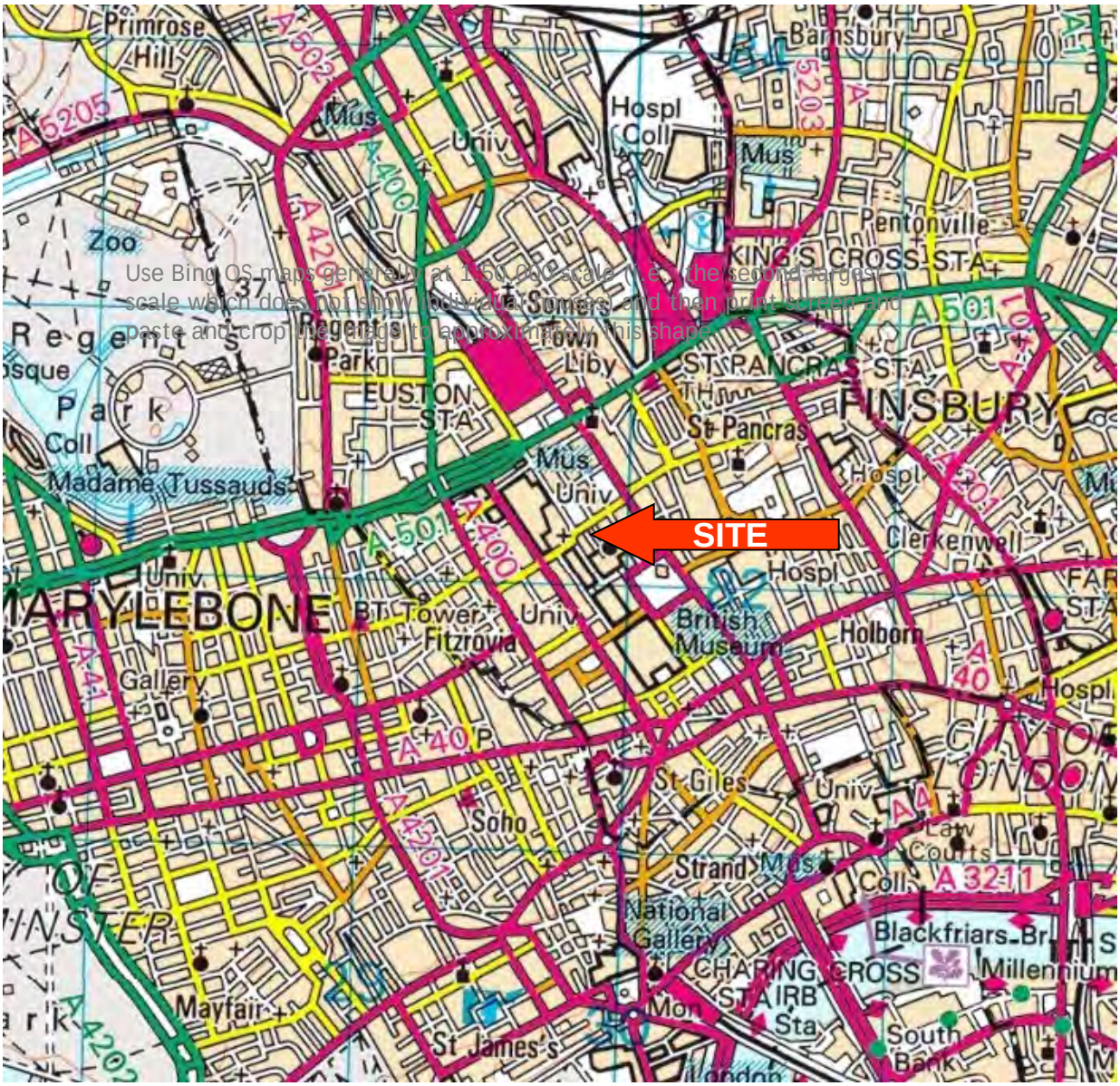
Situation B – Low rise housing with gardens – NHBC 'Traffic Lights'

The NHBC model for low rise housing development considered a typical residential house with a ground floor area of 64m^2, suspended floor and ventilated sub-floor void of height 150mm. Where the proposed development of a site is consistent with this model, the NHBC traffic light situation of the site is determined from evaluation of the Gas Screening Value against the criteria in the following table.

Traffic Lights	Methane		Carbon Dioxide	
	Typical maximum concentrations (%)	Gas Screening Value (l/hr)	Typical maximum concentrations (%)	Gas Screening Value (l/hr)
Green	≤1	≤0.16	≤5	≤0.78
Amber 1	1> to ≤5	>0.16 to ≤0.63	>5 to ≤10	>0.78 to ≤1.56
Amber 2	5> to ≤20	>0.63 to ≤1.56	>10 to ≤30	>1.56 to ≤3.13
Red	>20	>1.56	>30	>3.13

APPENDIX 1

Site Location Plan



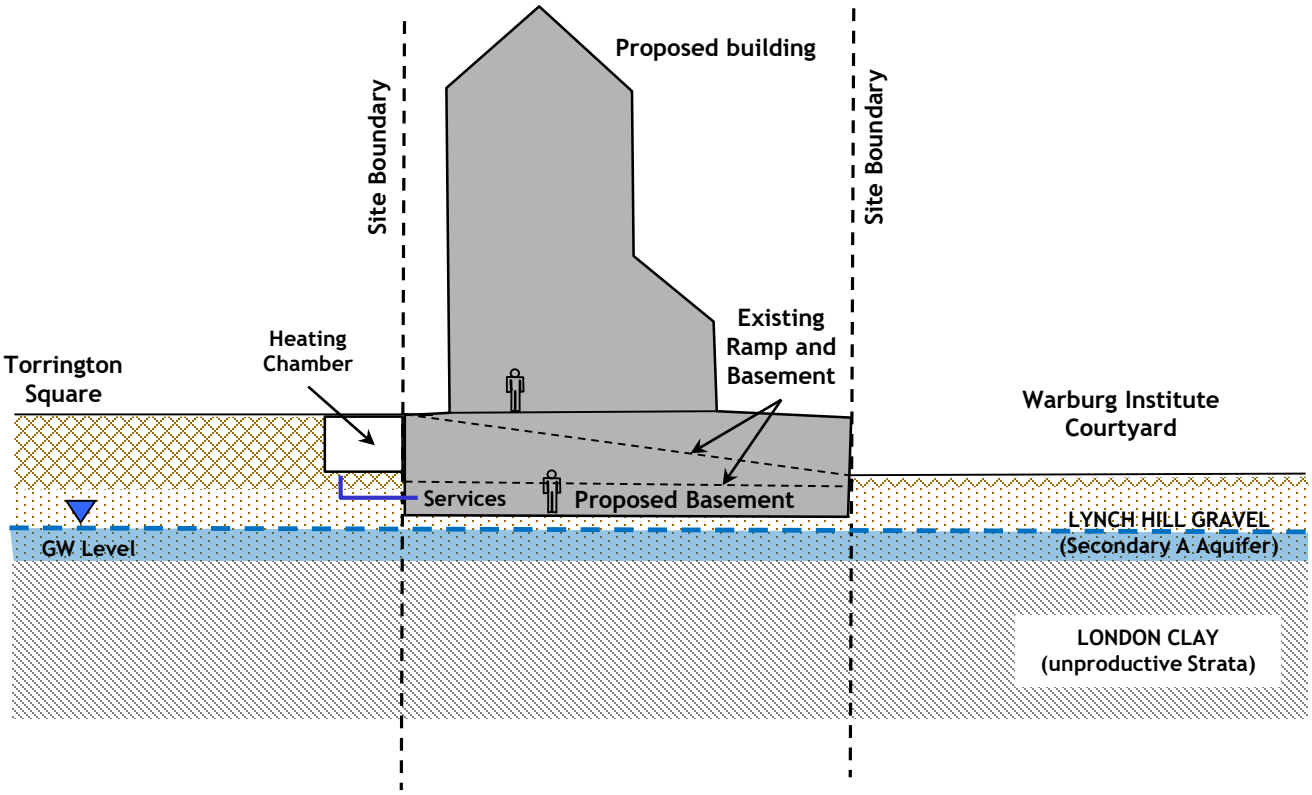
Not to scale.

Project Title:	32-33 Torrington Square, London
Client:	Birkbeck University of London
BRD Reference:	BRD2903-OP1-A
Date Issued:	April 2017

BRD
01295 272244
info@brduk.com

Revised Conceptual Model

No Pollutant Linkages Identified



No Pollutant Linkages Identified

Made Ground containing elevated concentrations of lead beneath ramp and in rear garden, but this will be removed as part of the basement construction.

Project Title:	32-33 Torrington Square, London
Client:	Birkbeck University of London
BRD Reference:	BRD2903-OP4-A
Date Issued:	July 2017

BRD
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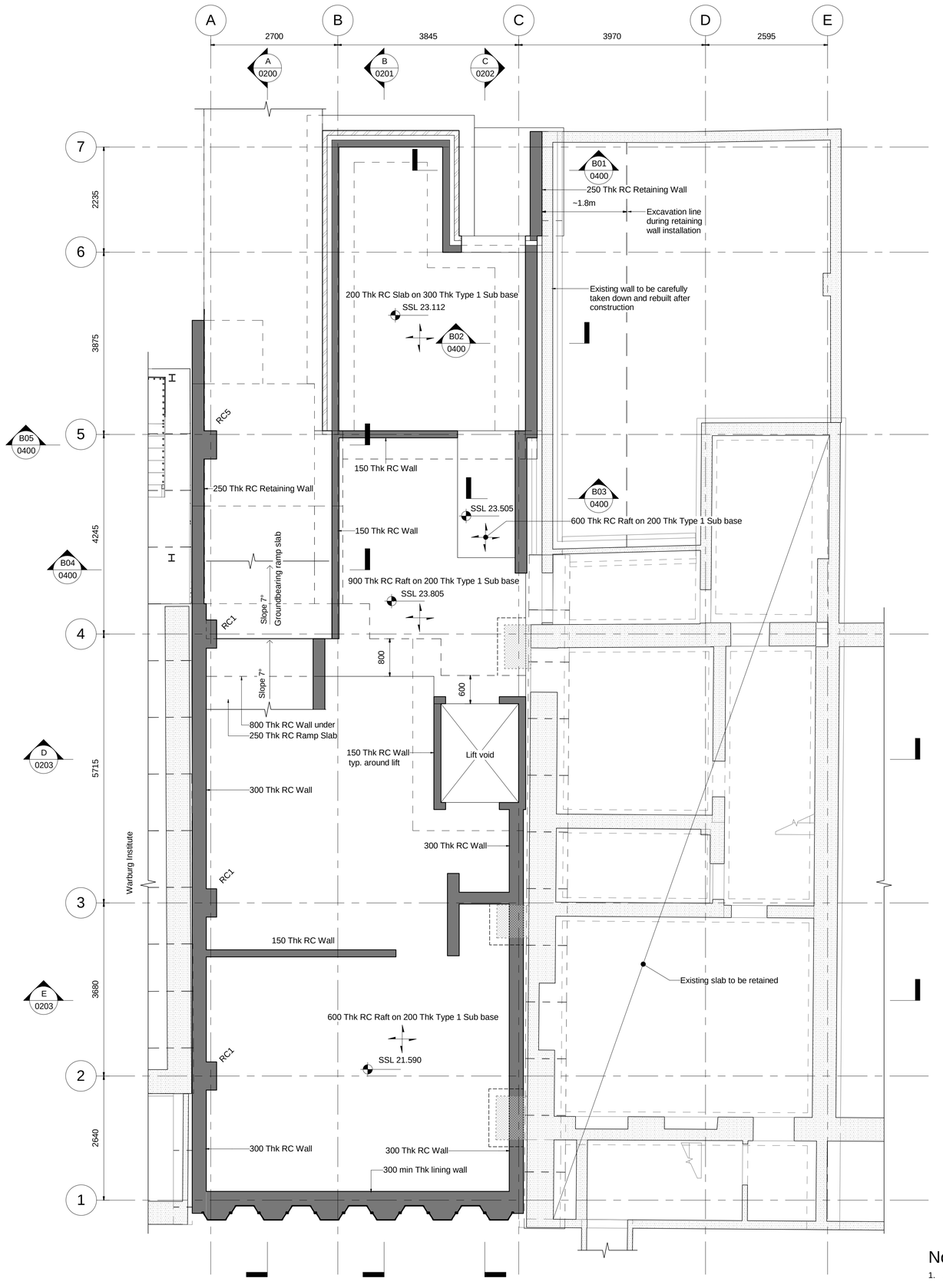

Legend

- 100 Thk 20N/mm² Brickwork
- 150 Thk RC wall
- Cavity
- 250 Thk (UNO) RC wall Base't to L00
  150 Thk (UNO) RC wall L00 & above
- Existing wall to be retained
- Existing masonry butresses to remain during construction
- insitu concrete installed after buttress removal
- Ref — Denotes floor span - refer to Floor Schedule for description

Column Schedule

Reference	Description
RC1	220x600 RC Column
RC2	250x600 RC Column
RC3	200x600 RC Column
RC4	200x300 RC Column
RC5	270x600 RC Column

Note:

1. All SSL's ,TOC's & slopes TBC by Architect

Notes

1. For general notes refer to J2889-S-DR-0001
2. Do not scale the drawing
3. This drawing to be read in conjunction with all other Architects and Engineers drawings and specifications including outline structural specification
4. All dimensions are in millimetres unless noted otherwise
5. Any discrepancies between structural and architectural setting out dimensions must be brought to the attention of the Architect and Engineers
6. Refer to Architects drawings for grid setting out relative to existing

SAFETY, HEALTH AND ENVIRONMENT
In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following :
Construction
Maintenance & Cleaning
Decommissioning & Demolition
It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

Rev	Date	Description	Drn	App
01	13.07.17	Preliminary Stage 3	JD	TW
00	07.07.17	Developed Design	JD	CP

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Project
32-33 Torrington Square

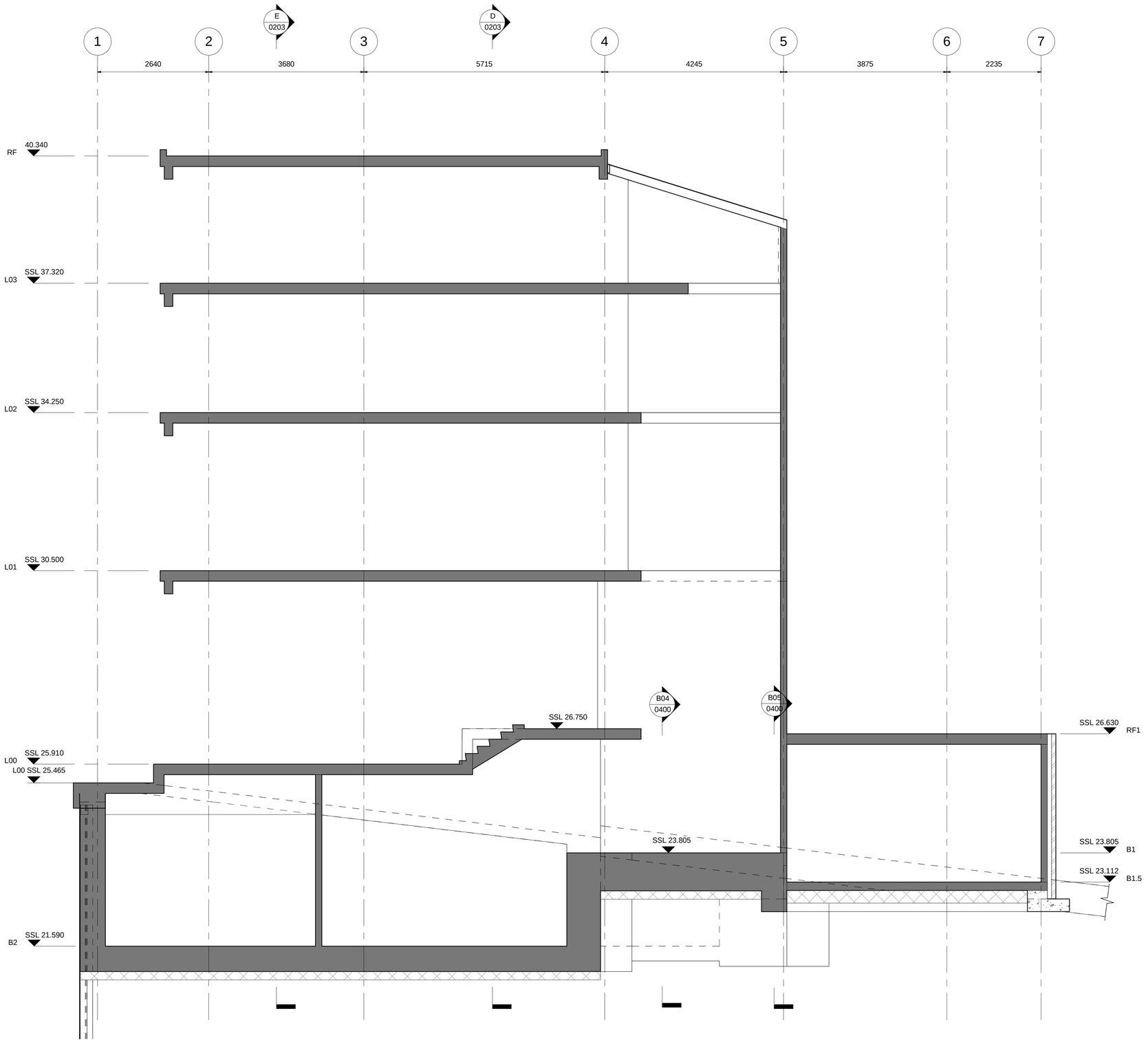
Drawing Title
General Arrangement
Basement Plan

Drawing Status
Developed Design

Drawn by	Checked by	Sheet size	Scale	Rev Status
JD	TW	A1	1 : 50	S3

Drawing Number
J2889-S-DR-0090

Revision
01



Section - B

Notes

1. For general notes refer to J2889-S-DR-0001
2. Do not scale the drawing
3. This drawing to be read in conjunction with all other Architects and Engineers drawings and specifications including outline structural specification
4. All dimensions are in millimetres unless noted otherwise
5. Any discrepancies between structural and architectural setting out dimensions must be brought to the attention of the Architect and Engineers
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SAFETY, HEALTH AND ENVIRONMENT
In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following :
Construction
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Decommissioning & Demolition
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Rev	Date	Description	Drn	App
01	13.07.17	Preliminary Stage 3	JD	TW
00	07.07.17	Developed Design	JD	CP

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Drawing Title
General Arrangement
Sections - Sheet 2

Drawing Status
Developed Design

Drawn by	Checked by	Sheet size	Scale	Rev Status
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Drawing Number
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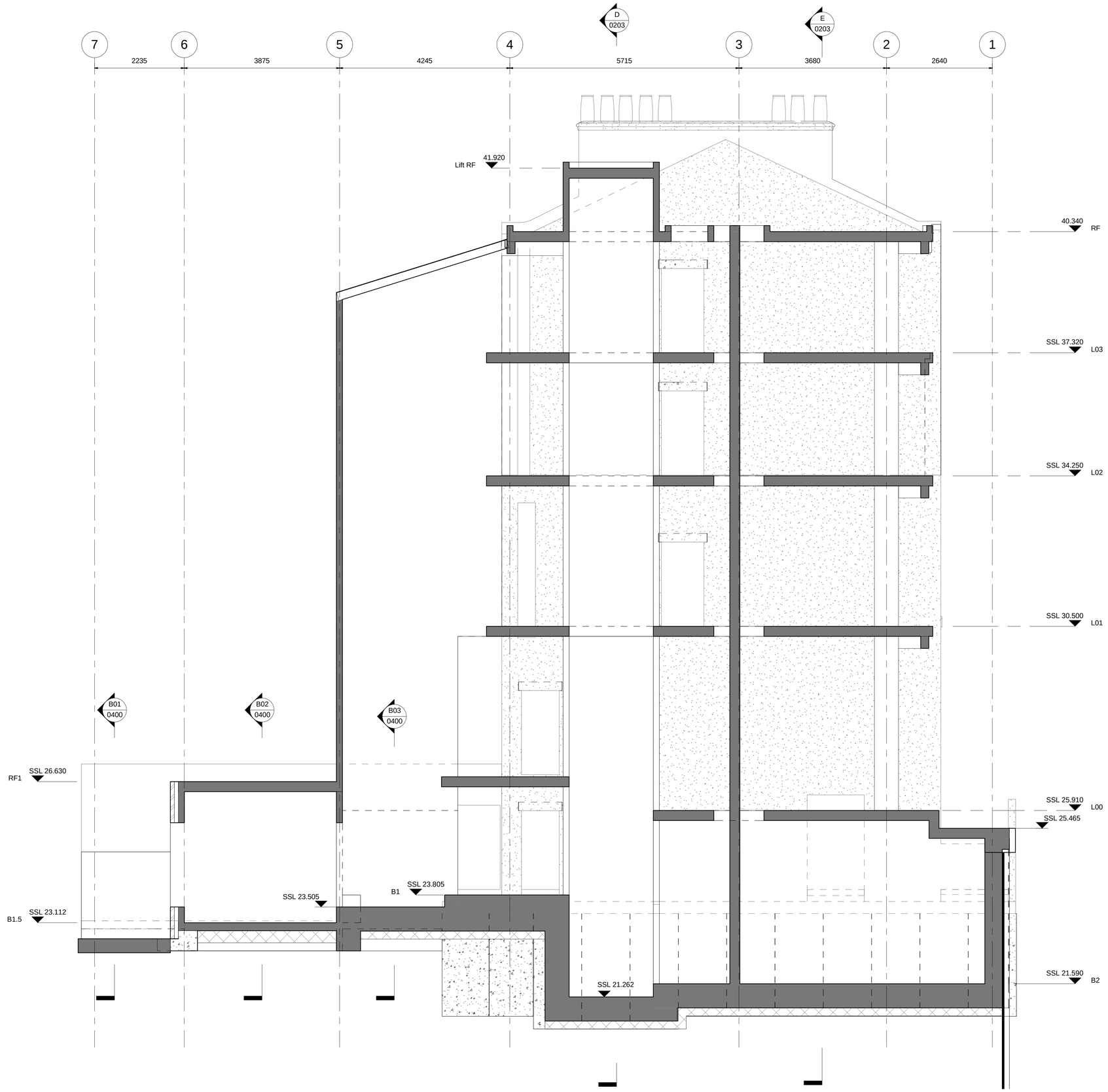
Revision
01



Section - C

Notes

1. For general notes refer to J2889-S-DR-0001
2. Do not scale the drawing
3. This drawing to be read in conjunction with all other Architects and Engineers drawings and specifications including outline structural specification
4. All dimensions are in millimetres unless noted otherwise
5. Any discrepancies between structural and architectural setting out dimensions must be brought to the attention of the Architect and Engineers
6. Refer to Architects drawings for grid setting out relative to existing

SAFETY, HEALTH AND ENVIRONMENT
In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following :
Construction
Maintenance & Cleaning
Decommissioning & Demolition
It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

Rev	Date	Description	Drn	App
01	13.07.17	Preliminary Stage 3	JD	TW
00	07.07.17	Developed Design	JD	CP

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Project
32-33 Torrington Square

Drawing Title
General Arrangement
Sections - Sheet 3

Drawing Status
Developed Design

Drawn by	Checked by	Sheet size	Scale	Rev Status
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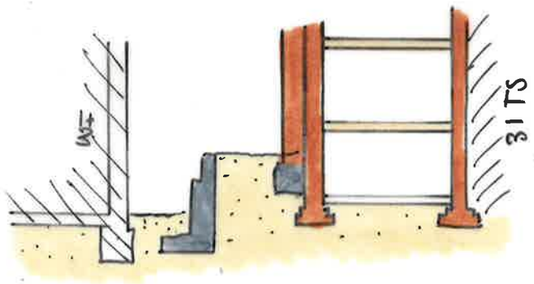
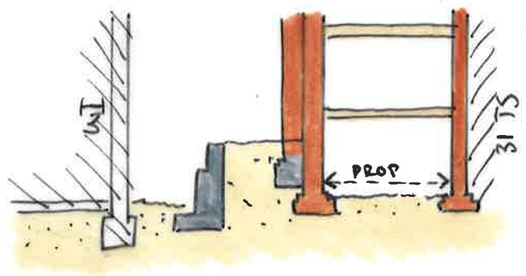
Drawing Number
J2889-S-DR-0202

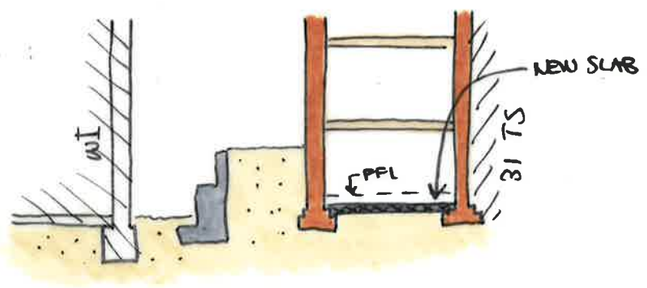
Revision
01



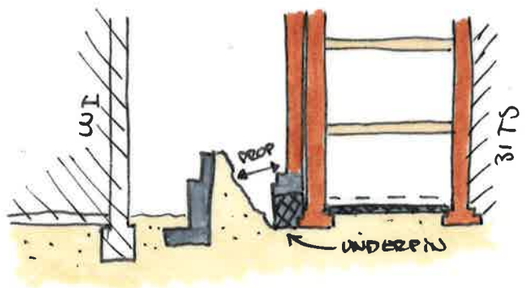
① SITE. INSTALL SHEET PILES & REMOVE GARDEN WALLS.



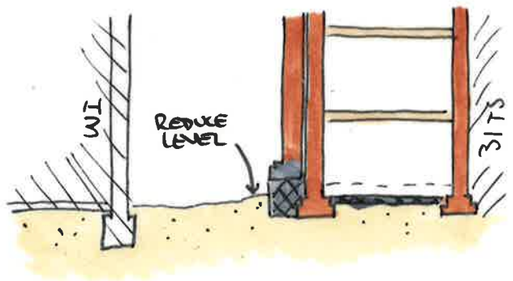
② EX. BASEMENT SLAB
REMOVE BASEMENT SLAB, PROP IF NECESSARY.



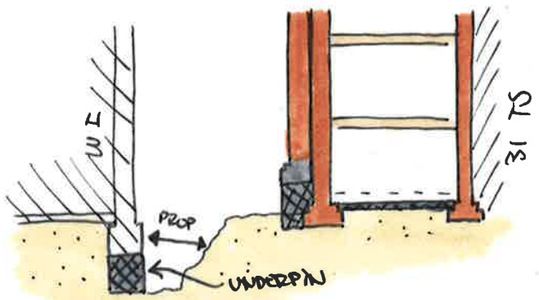
③ NEW BASEMENT SLAB
INSTALL NEW BASEMENT SLAB IN 32 TORRINGTON SQUARE.



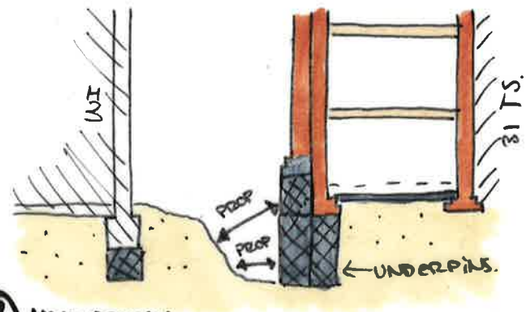
④ UNDERPIN BUTTRESSES



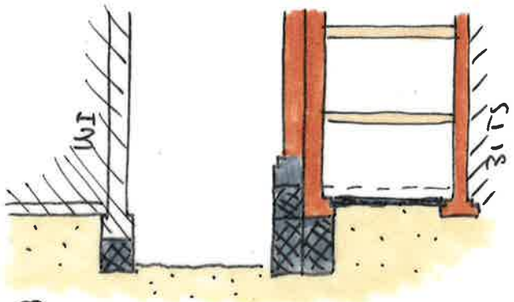
⑤ REDUCE LEVEL - RAMP



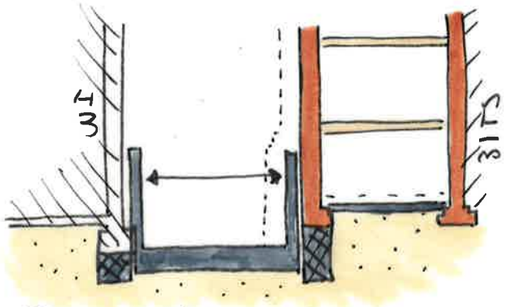
⑥ UNDERPIN WARBURG INSTITUTE IF REQUIRED.



⑦ UNDERPIN BUTTRESSES AND GABLE END WALL.
CUT BACK BRICK FOOTING.



⑧ EXCAVATE FOR NEW BASEMENT SLAB.



⑨ FORM NEW BASEMENT SLAB + WALLS.

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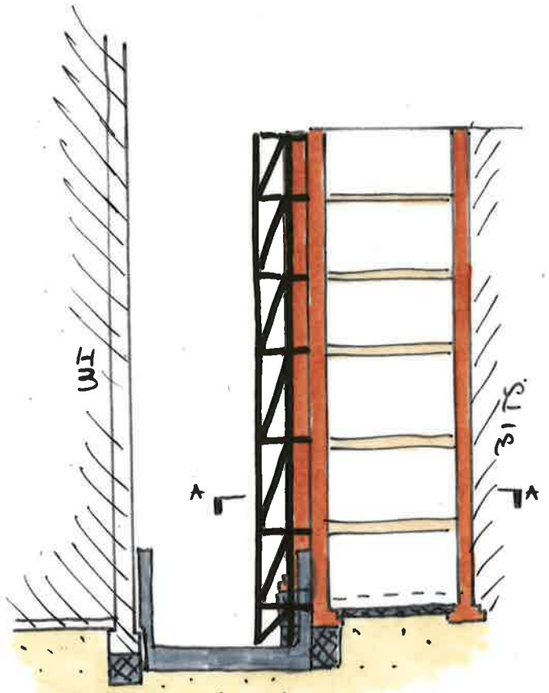
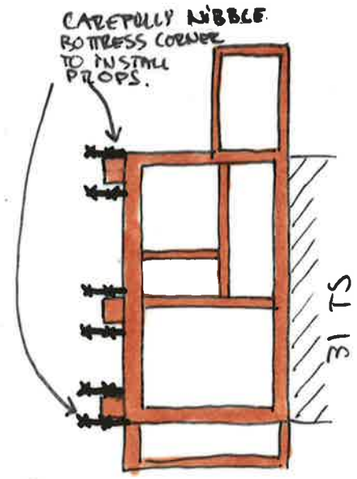
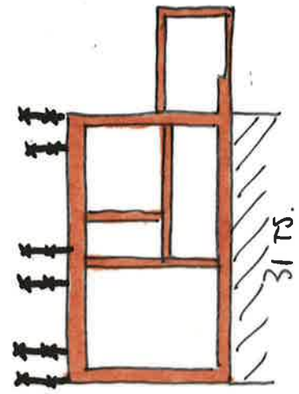
Drawing No	J2889-S-SK-0016		
Project	TORRINGTON SQUARE	Status	INFORMATION
Drawing Title	CONSTRUCTION SEQUENCE 1 OF 2		
Date	Drawn by	Scale	Revision
10.04.2017	CP	NTS	00



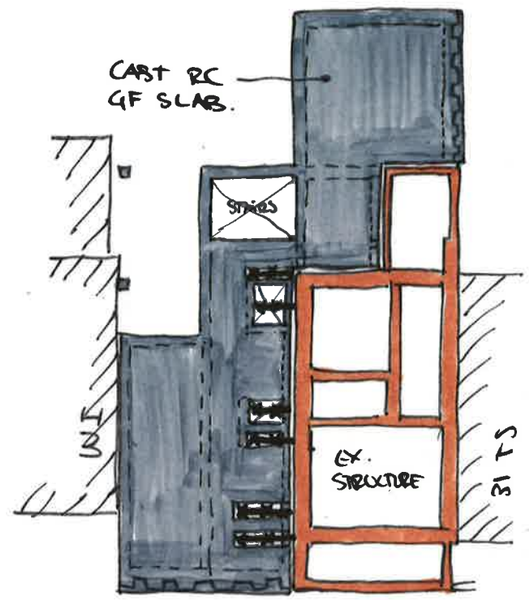
(10) INSTALL TEMP. PROPPING BY BUTTRESSES.



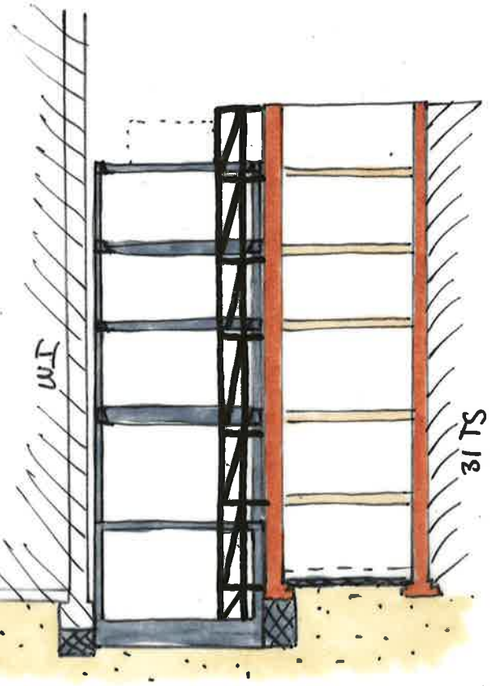
(10) SECTION A-A



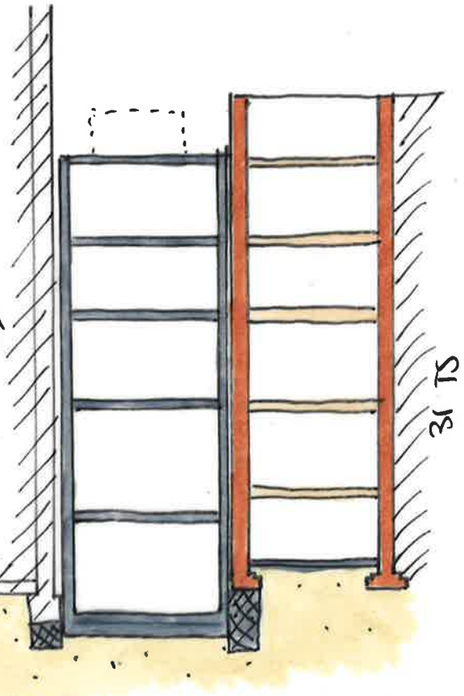
(11) DEMOLISH BUTTRESSES



(12) CAST GROUND FLOOR SLAB.



(13) INSTALL NEW SUPERSTRUCTURE



(14) REMOVE TEMP. SUPPORTS AND CLOSE VOIDS.

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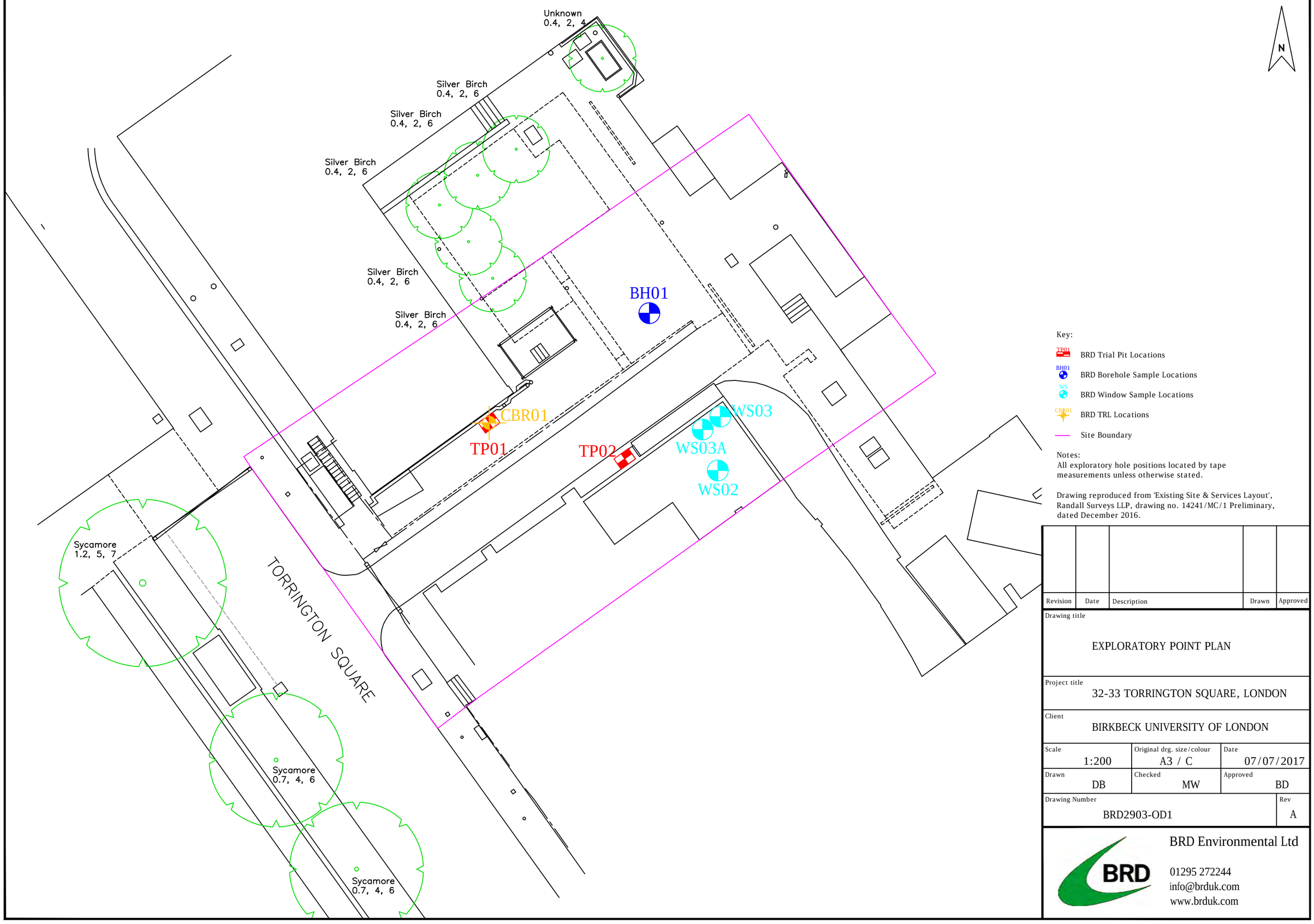
Drawing No: J2889-S-SK-0017			
Project: TORRINGTON SQUARE			Status: INFORMATION
Drawing Title: CONSTRUCTION SEQUENCE 2OF 2			
Date: 10.04.2017	Drawn by: CP	Scale: NTS	Revision: 00



Key:

- TP01 — BRD Trial Pit Locations
- BH01 — BRD Borehole Sample Locations
- WS — BRD Window Sample Locations
- CBR01 — BRD TRL Locations
- Site Boundary

Notes:
All exploratory hole positions located by tape measurements unless otherwise stated.

Drawing reproduced from 'Existing Site & Services Layout', Randall Surveys LLP, drawing no. 14241/MC/1 Preliminary, dated December 2016.

Revision	Date	Description	Drawn	Approved

Drawing title
EXPLORATORY POINT PLAN

Project title
32-33 TORRINGTON SQUARE, LONDON

Client
BIRKBECK UNIVERSITY OF LONDON

Scale	Original drg. size/colour	Date
1:200	A3 / C	07/07/2017
Drawn	**Checked**	**Approved**
DB	MW	BD

Drawing Number	Rev
BRD2903-OD1	A

BRD Environmental Ltd
01295 272244
info@brduk.com
www.brduk.com

APPENDIX 2

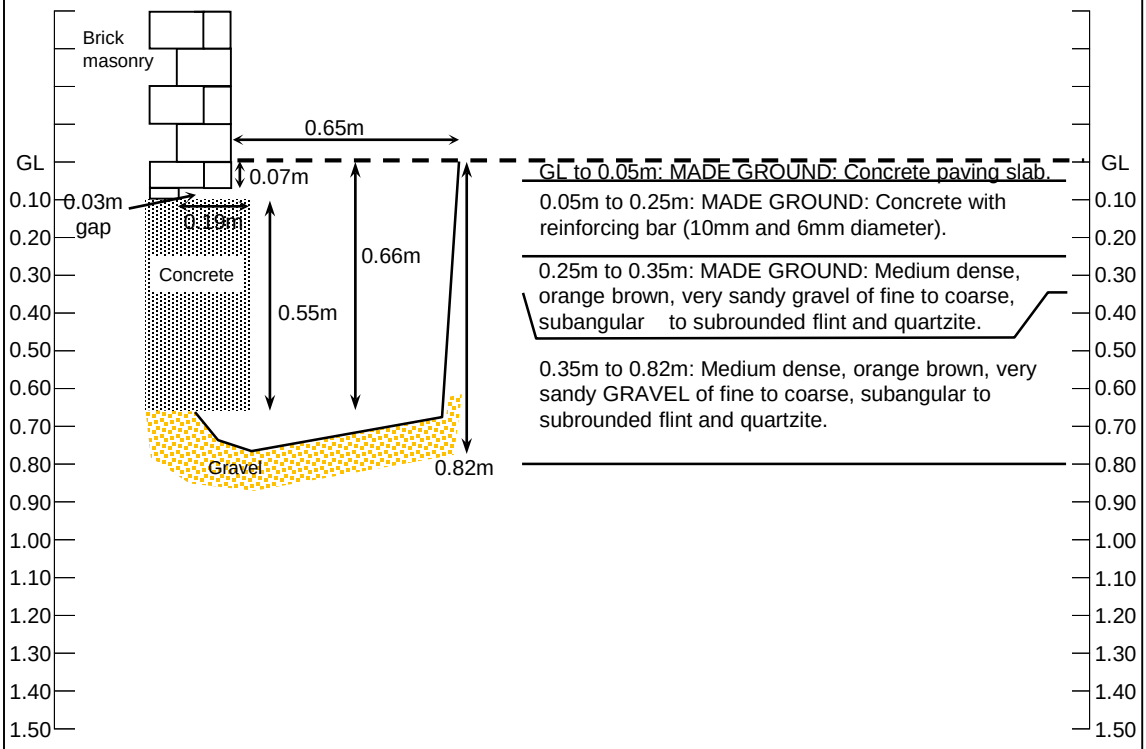
TRIAL PIT RECORD

Client:	Birkbeck University of London
Project Title:	32-33 Torrington Square, London
Project No:	BRD2903
Logged By:	M Wood
Date Completed:	14/06/2017
Method Used:	Hand tools & mini excavator

Trial Pit No.

TP01

Sheet 1 of 1



General Remarks:

No visible damp-proof course

Pit dry and stable

All dimension in metres

Vertical scale (at A4) 1:20

BRD

01295 272244

info@brduk.com

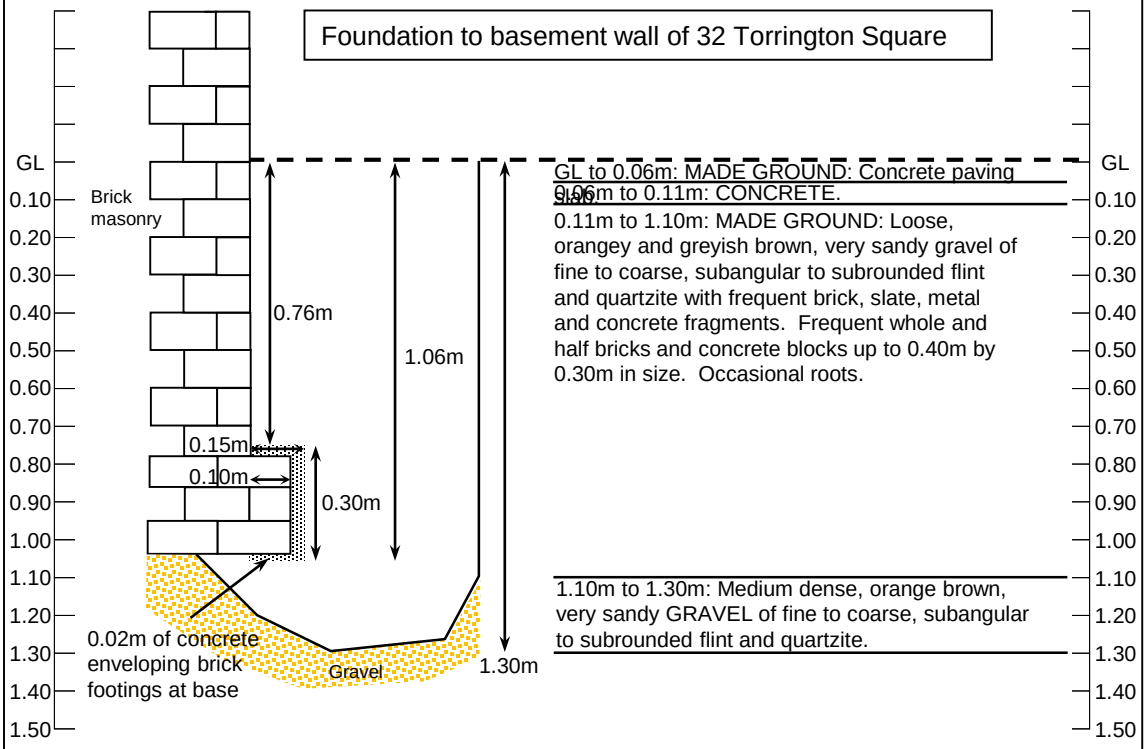
TRIAL PIT RECORD

Client:	Birkbeck University of London
Project Title:	32-33 Torrington Square, London
Project No:	BRD2903
Logged By:	M Wood
Date Completed:	15/06/2017
Method Used:	Hand tools & mini excavator

Trial Pit No.

TP02

Sheet 1 of 2



General Remarks:

No visible damp-proof course

Pit dry and stable

All dimension in metres

Vertical scale (at A4) 1:20

BRD

01295 272244

info@brduk.com

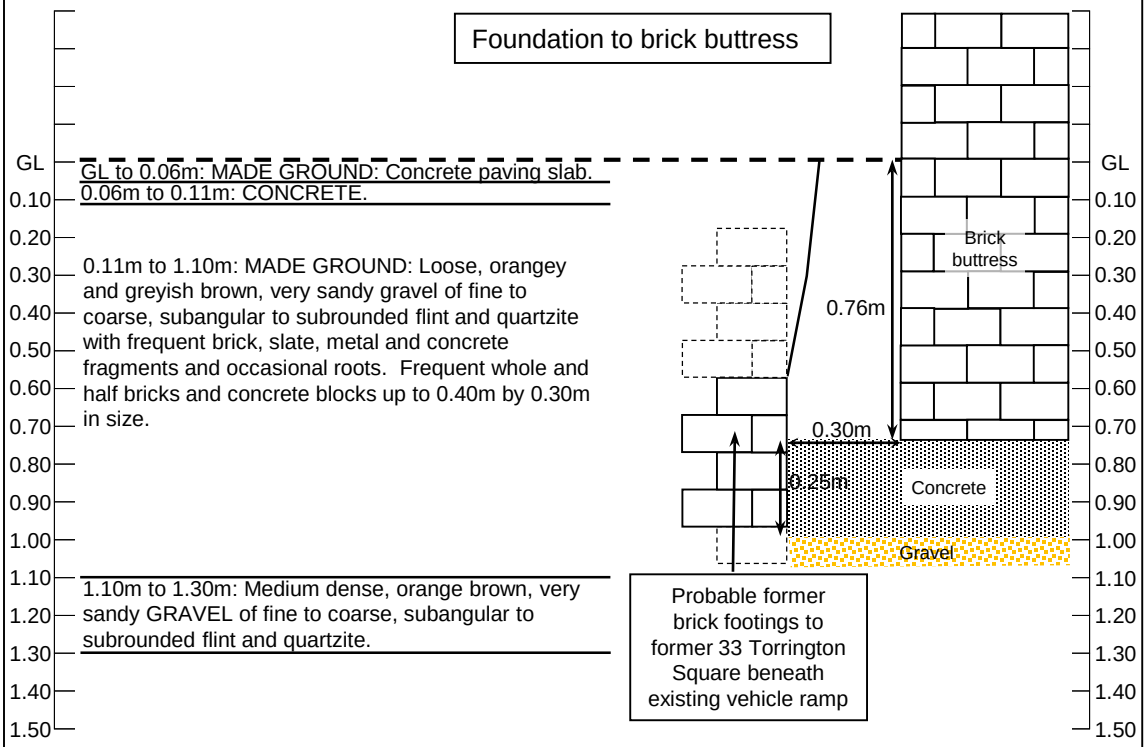
TRIAL PIT RECORD

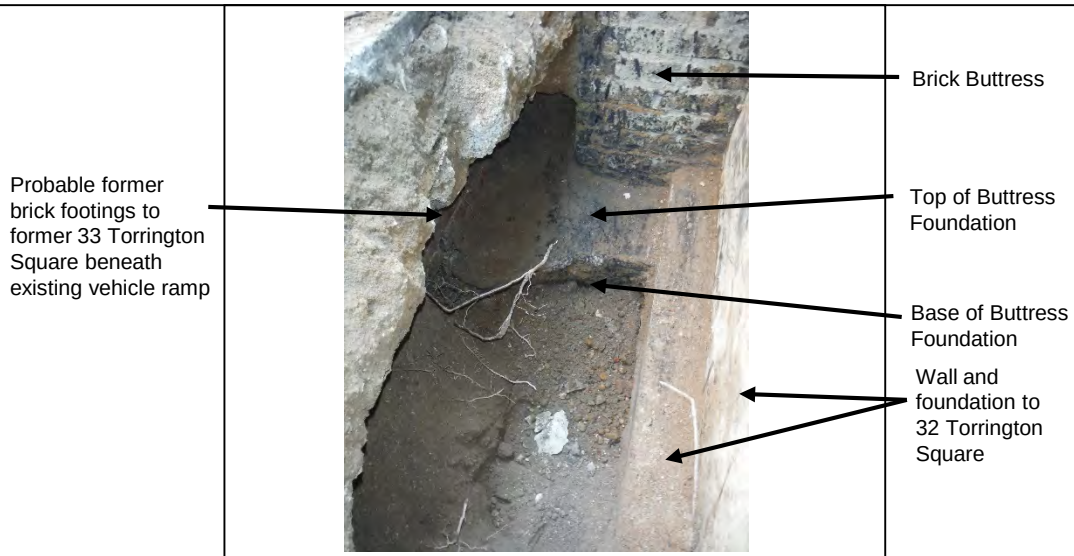
Client:	Birkbeck University of London
Project Title:	32-33 Torrington Square, London
Project No:	BRD2903
Logged By:	M Wood
Date Completed:	15/06/2017
Method Used:	Hand tools & mini excavator

Trial Pit No.

TP02

Sheet 2 of 2





General Remarks:

No visible damp-proof course

Pit dry and stable

All dimension in metres

Vertical scale (at A4) 1:20

BRD

01295 272244

info@brduk.com

PROBEHOLE RECORD

Client: Birkbeck University of London
Project Title: 32-33 Torrington Square, London
Project No: BRD2903
Logged By: M Wood
Date Commenced: 13/06/2017
Date Completed: 13/06/2017
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS02

Sheet 1 of 1

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			MADE GROUND: Decorative gravel over: Loose, dark brown to black, clayey, gravelly, sand topsoil with frequent roots and rootlets. Gravel of fine to coarse, subangular to subrounded flint with frequent brick, concrete, glass, ceramic and charcoal fragments. Becoming very gravelly with depth.	0.60		MADE GROUND	
0.95	J2			MADE GROUND: Medium dense, dark brown, clayey, very gravelly sand with occasional rootlets. Gravel of fine to coarse, subangular to subrounded flint with occasional brick and charcoal fragments.	1.0			
1.20	SPT	25 N		1.20 m: SPT: 2,2/3,5,7,10	1.50			
1.80	B1			Medium dense to dense, orange to yellow brown, very gravelly SAND. Gravel is fine to coarse, subangular to subrounded flint and quartzite.	2.0		LYNCH HILL GRAVEL MEMBER	
2.00	SPT(C)	>50 N		2.00 m: SPT(C): 11,13/12,13,13,12 for 60mm	3.0			
3.00	SPT(C)	>50 N		3.00 m: SPT(C): 14,11 for 50mm/16,17,17 for 50mm	3.00			
					4.0			

General Remarks:
Boreholer terminated at 3.00m bgl due to refusal in dense gravels.
No groundwater encountered during drilling.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Email: info@brduk.com

PROBEHOLE RECORD

Client: Birkbeck University of London
Project Title: 32-33 Torrington Square, London
Project No: BRD2903
Logged By: M Wood
Date Commenced: 13/06/2017
Date Completed: 13/06/2017
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS03

Sheet 1 of 1

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.10	J1			MADE GROUND: Loose, dark brown, slightly clayey, gravelly, sand topsoil with frequent rootlets. Gravel of fine to coarse, subangular to subrounded flint with frequent brick, charcoal, clinker, metal, glass and concrete fragments.	0.15		MADE GROUND	
				MADE GROUND: Loose, orange brown, slightly clayey, sandy gravel of fine to coarse, subangular to subrounded flint with occasional brick and concrete fragments.				
1.00	SPT J2	4 N		1.00 m: 1,0/1,1,1,1	1.0			
				MADE GROUND: Concrete slab/cobble.	1.35 1.40			
					2.0			
					3.0			
					4.0			

General Remarks:
Borehole terminated at 1.40m bgl due to concrete obstruction.
No groundwater encountered during drilling.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Email: info@brduk.com

PROBEHOLE RECORD

Client: Birkbeck University of London
Project Title: 32-33 Torrington Square, London
Project No: BRD2903
Logged By: M Wood
Date Commenced: 13/06/2017
Date Completed: 13/06/2017
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS03A

Sheet 1 of 1

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
				MADE GROUND: Loose, dark brown, slightly clayey, gravelly, sand topsoil with frequent rootlets. Gravel of fine to coarse, subangular to subrounded flint with frequent brick, charcoal, clinker, metal, glass and concrete fragments.	0.20		MADE GROUND	
				MADE GROUND: Loose, orange brown, slightly clayey, sandy gravel of fine to coarse, subangular to subrounded flint with occasional brick and concrete fragments.	0.90			
				MADE GROUND: Concrete slab/cobble.	1.0 1.00			
					2.0			
					3.0			
					4.0			

General Remarks:
Borehole terminated at 1.00m bgl due to concrete obstruction.
No groundwater encountered during drilling.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:25

BRD
Telephone: 01295 272244
Email: info@brduk.com

BOREHOLE RECORD

Client: Birkbeck University of London
Project Title: 32-33 Torrington Square, London
Project No: BRD2903
Logged By: M Wood
Date Commenced: 13/06/2017
Date Completed: 13/06/2017
Method Used: Cable Percussive Drilling Rig

Borehole No.

BH01

Sheet 1 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
				MADE GROUND: Concrete paving slab.	0.05 ()		MG	
0.30	J1			MADE GROUND: Sharp sand.	0.10 ()			
0.50	B1			MADE GROUND: Concrete with reinforcement bars (6mm and 20mm in diameter).	0.25 ()			
0.80	J2			MADE GROUND: Loose to medium dense, orange brown, slightly clayey, gravelly sand. Gravel is fine to coarse, subangular to subrounded flint with occasional concrete fragments.	0.45 ()		LYNCH HILL GRAVEL MEMBER	
1.00	D2				1			
1.20	B3	12 N		Medium dense, orange brown, very sandy GRAVEL of fine to coarse, subangular to subrounded flint and quartzite. 1.20 m: SPT(C): 1,1/2,3,3,4				
	SPT(C)							
	B5							
2.00	SPT(C)	16 N		2.00 m: SPT(C): 2,3/3,4,4,5	2			
	D6							
	B8							
3.00	SPT	9 N			3			
	D9			Stiff, slightly fissured, light brown, silty CLAY with occasional sand sized selenite crystals. 3.00 m: SPT: 1,1/2,2,3,2	3.00 ()			
3.50	PEN	3.75/2.0/3.25 kg/cm²	1		3.30 ()			
				Stiff, slightly fissured, dark grey, silty CLAY with occasional fine sand sized selenite crystals.			LONDON CLAY FORMATION	
4.00	D11				4			
4.20	U12	40 Blow						
4.50	PEN	3.5/3.25/3.75 kg/cm²						
5.00	SPT	12 N		5.00 m: SPT: 1,2/2,3,3,4	5			
	D13							
			2					
6.00	D15				6			
6.50	PEN	3.5/3.25/3.75 kg/cm²						
	U16	51 Blow						
7.00	D17				7			
7.50	PEN	4.5 kg/cm²						
					8 8.00			

Drilling Progress

Date	Hole Depth	Casing Depth	Casing Dia (mm)	Water Depth	Water depth after 20mins / Type of test
13-06-17	1.20	-	-	Dry	SPT
13-06-17	2.00	2.00	150	1.20	SPT
13-06-17	3.00	3.00	150	2.80	SPT
13-06-17	4.00	3.20	150	4.00	3.70
13-06-17	5.00	3.20	150	Dry	SPT
13-06-17	6.00	3.20	150	6.00	5.80
13-06-17	8.00	3.20	150	Dry	SPT

Chiselling

From	To	Hours

General Remarks:

Borehole terminated at 15.00m bgl.
Water added during drilling from 2.00m to 3.00m.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:50

BRD
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Email: info@brduk.com

BOREHOLE RECORD

Client: Birkbeck University of London
Project Title: 32-33 Torrington Square, London
Project No: BRD2903
Logged By: M Wood
Date Commenced: 13/06/2017
Date Completed: 13/06/2017
Method Used: Cable Percussive Drilling Rig

Borehole No.

BH01

Sheet 2 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
8.00	SPT D18	20 N		Continued from 3.30m bgl: Stiff, slightly fissured, dark grey, silty CLAY with occasional fine sand sized selenite crystals.	()			
8.50	PEN	4.5 kg/cm²		8.00 m: SPT: 2,3/4,5,5,6 8.00 m: Becoming very stiff.				
9.00	D20				9			
9.50	U21	56 Blow						
10.00	D22				10			
11.00	PEN SPT D23	4.5 kg/cm² 25 N		11.00 m: SPT: 2,4/4,6,7,8	11		LONDON CLAY FORMATION	
12.00	D25				12			
12.50	U26	64 Blow						
13.00	PEN D27	4.5 kg/cm²			13			
14.00	SPT D28	28 N		14.00 m: SPT: 2,4/4,6,8,9	14			
15.00	D30				15 15.00 ()			
					16			

Drilling Progress

Date	Hole Depth	Casing Depth	Casing Dia (mm)	Water Depth	Water depth after 20mins / Type of test
13-06-17	11.00	3.20	150	Dry	SPT
13-06-17	14.00	3.20	150	Dry	SPT
13-06-17	15.00	3.20	150	Dry	SPT
13-06-17	15.00	-	-	Dry	-

Chiselling

From	To	Hours

General Remarks:

Borehole terminated at 15.00m bgl.
Water added during drilling from 2.00m to 3.00m.

Surface Elevation Level:

All dimensions in metres
Log Scale 1:50

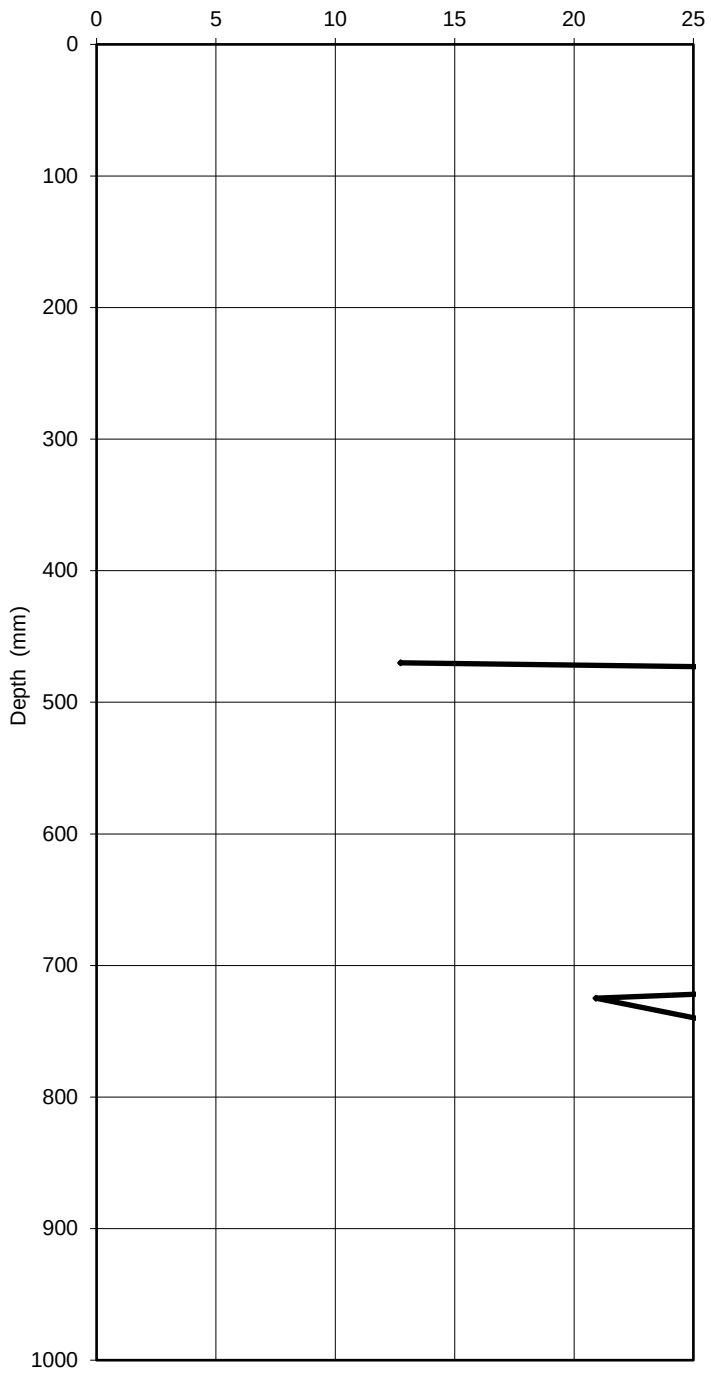
BRD
Telephone: 01295 272244
Email: info@brduk.com

TRL DYNAMIC CONE PENETROMETER TEST

Client Name:	Birkbeck University of London	**Test No:**
Project Name:	32-33 Torrington Square, London	**CBR01**
Project No:	BRD2903	
Tested By:	M Wood	
Date:	14/06/2017	

Blow Count	Depth (mm)	mm per blow	CBR %
0	450	0	-
1	470	20	13
3	480	5	55
4	490	10	26
5	496	6	45
6	500	4	70
7	505	5	55
9	510	3	110
10	515	5	55
11	520	5	55
12	525	5	55
14	530	3	110
16	535	3	110
18	540	3	110
20	550	5	55
22	560	5	55
24	565	3	110
26	575	5	55
28	580	3	110
30	590	5	55
32	600	5	55
34	605	3	110
36	615	5	55
38	625	5	55
40	630	3	110
42	640	5	55
44	650	5	55
46	660	5	55
48	675	8	36
50	690	8	36
52	700	5	55
54	725	13	21
56	745	10	26
58	760	8	36
60	775	8	36
62	785	5	55
64	800	8	36
66	815	8	36
68	820	3	110
70	830	5	55
72	840	5	55
74	850	5	55
76	860	5	55
78	865	3	110
80	875	5	55
86	890	3	110
90	900	3	110
96	930	5	55
100	945	4	75
106	970	4	67

Plot of CBR (%) against Depth (mm)



Notes:

California Bearing Ratio (CBR) values calculated on the basis of *Operating instructions for the TRL dynamic cone penetrometer (2nd ed*). Transport Research Laboratory, 1991, wherein:

$\text{Log}_{10}(\text{CBR}) = 2.48 - 1.057 \log_{10}(\text{penetration rate})$

Values more than 25% CBR are plotted as 25% CBR.

Groundwater Monitoring Record

Project: 32-33 Torrington Square, London
Client: Birkbeck University of London
Project No: BRD2903

Borehole name	Date	Monitored by (initials)	Borehole depth (m)	Qty free product detected (mm)	Groundwater level below ground surface (m)	Groundwater level below top of standpipe (m)	Amount purged (l)	Post purge groundwater level below top of standpipe (m)	Comments
WS02	28/06/2017	DB	2.78	N/A	Dry	Dry	N/A	N/A	
BH01	28/06/2017	DB	10.23	0.00	2.47	2.25	10.00	3.84	Orange brown slightly sandy water with no odour or sheen.

Groundwater Monitoring Record

Project: 32-33 Torrington Square, London
Client: Birkbeck University of London
Project No: BRD2903

Borehole name	Date	Monitored by (initials)	Borehole depth (m)	Qty free product detected (mm)	Groundwater level below ground surface (m)	Groundwater level below top of standpipe (m)	Amount purged (l)	Post purge groundwater level below top of standpipe (m)	Comments
WS02	11/07/2017	DB	N/A	N/A	N/A	N/A	N/A	N/A	Unable to access area.
BH01	11/07/2017	DB	10.22	N/A	2.48	2.28	10.00	3.62	Borehole water level rose back to 2.48m after 15 minutes.

APPENDIX 3

Matt Wood
BRD Environmental Ltd
Hawthorne Villa
1 Old Parr Road
Banbury
Oxfordshire
OX16 5HT

QTS Environmental Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410
russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 17-60323

Site Reference:	Torrington Square, London
Project / Job Ref:	BRD2903
Order No:	None Supplied
Sample Receipt Date:	19/06/2017
Sample Scheduled Date:	19/06/2017
Report Issue Number:	1
Reporting Date:	23/06/2017

Authorised by:

Russell Jarvis
Associate Director of Client Services

Authorised by:

Dave Ashworth
Deputy Quality Manager

QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate							
QTS Environmental Report No: 17-60323	Date Sampled	13/06/17	13/06/17	13/06/17	14/06/17	14/06/17
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Torrington Square, London	TP / BH No	BH01	WS02	WS02	TP01	TP01
Project / Job Ref: BRD2903	Additional Refs	J1	J1	J2	J1	J2
Order No: None Supplied	Depth (m)	0.30	0.20	0.95	0.30	0.60
Reporting Date: 23/06/2017	QTSE Sample No	274380	274381	274382	274383	274384

Determinand	Unit	RL	Accreditation					
Asbestos Screen (S)	N/a	N/a	ISO17025			Not Detected	Not Detected	
pH	pH Units	N/a	MCERTS	10.8	8.0	7.9		9.3
Total Sulphate as SO_4	mg/kg	< 200	NONE					
Total Sulphate as SO_4	%	< 0.02	NONE					
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	61	17	69		14
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.06	0.02	0.07		0.01
Total Sulphur	%	< 0.02	NONE					
Organic Matter	%	< 0.1	MCERTS	0.1	5.6	2.8		0.2
Arsenic (As)	mg/kg	< 2	MCERTS	4	36	18		7
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2	1.2	0.5		< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS	8	24	18		10
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2		< 2
Copper (Cu)	mg/kg	< 4	MCERTS	4	114	53		8
Lead (Pb)	mg/kg	< 3	MCERTS	11	1450	471		16
Mercury (Hg)	mg/kg	< 1	NONE	< 1	4.7	1.4		< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	5	29	14		8
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3		< 3
Zinc (Zn)	mg/kg	< 3	MCERTS	12	459	212		35

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

This report refers to samples as received, and QTS Environmental Ltd, takes no responsibility for the accuracy or competence of sampling by others.
The material description shall be regarded as tentative and is not included in our scope of UKAS Accreditation.
Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.
Asbestos Analyst: Javeed Malik
RL: Reporting Limit
Pinch Test: Where pinch test is positive it is reported "Loose Fibres - PT" with type(s).
Subcontracted analysis (S)

QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate							
QTS Environmental Report No: 17-60323	Date Sampled	15/06/17	15/06/17	13/06/17	13/06/17	13/06/17
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Torrington Square, London	TP / BH No	TP02	TP02	BH01	BH01	BH01
Project / Job Ref: BRD2903	Additional Refs	J1	J2	J2	D	None Supplied
Order No: None Supplied	Depth (m)	0.40	0.80	0.80	2.00	3.00 - 3.45
Reporting Date: 23/06/2017	QTSE Sample No	274385	274386	274387	274388	274389

Determinand	Unit	RL	Accreditation					
Asbestos Screen (S)	N/a	N/a	ISO17025		Not Detected			
pH	pH Units	N/a	MCERTS	10.3	9.2	9.5	8.2	10.0
Total Sulphate as SO_4	mg/kg	< 200	NONE			285	309	309
Total Sulphate as SO_4	%	< 0.02	NONE			0.03	0.03	0.03
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	117	123	15	16	43
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.12	0.12	0.02	0.02	0.04
Total Sulphur	%	< 0.02	NONE			< 0.02	< 0.02	< 0.02
Organic Matter	%	< 0.1	MCERTS	0.7	0.8			
Arsenic (As)	mg/kg	< 2	MCERTS	9	10			
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	0.2	0.3			
Chromium (Cr)	mg/kg	< 2	MCERTS	12	12			
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2			
Copper (Cu)	mg/kg	< 4	MCERTS	16	19			
Lead (Pb)	mg/kg	< 3	MCERTS	1810	1850			
Mercury (Hg)	mg/kg	< 1	NONE	< 1	1.1			
Nickel (Ni)	mg/kg	< 3	MCERTS	8	8			
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3			
Zinc (Zn)	mg/kg	< 3	MCERTS	153	166			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

This report refers to samples as received, and QTS Environmental Ltd, takes no responsibility for the accuracy or competence of sampling by others.
The material description shall be regarded as tentative and is not included in our scope of UKAS Accreditation.
Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.
Asbestos Analyst: Javeed Malik
RL: Reporting Limit
Pinch Test: Where pinch test is positive it is reported "Loose Fibres - PT" with type(s).
Subcontracted analysis (S)

QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate							
QTS Environmental Report No: 17-60323	Date Sampled	13/06/17	13/06/17	13/06/17		
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Torrington Square, London	TP / BH No	BH01	BH01	BH01		
Project / Job Ref: BRD2903	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	Depth (m)	5.00 - 5.45	8.00 - 8.45	11.00 - 11.45		
Reporting Date: 23/06/2017	QTSE Sample No	274390	274391	274392		

Determinand	Unit	RL	Accreditation					
Asbestos Screen (S)	N/a	N/a	ISO17025					
pH	pH Units	N/a	MCERTS	8.1	8.7	8.9		
Total Sulphate as SO_4	mg/kg	< 200	NONE	786	1530	1549		
Total Sulphate as SO_4	%	< 0.02	NONE	0.08	0.15	0.15		
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	227	436	377		
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.23	0.44	0.38		
Total Sulphur	%	< 0.02	NONE	0.70	1.57	1.55		
Organic Matter	%	< 0.1	MCERTS					
Arsenic (As)	mg/kg	< 2	MCERTS					
Cadmium (Cd)	mg/kg	< 0.2	MCERTS					
Chromium (Cr)	mg/kg	< 2	MCERTS					
Chromium (hexavalent)	mg/kg	< 2	NONE					
Copper (Cu)	mg/kg	< 4	MCERTS					
Lead (Pb)	mg/kg	< 3	MCERTS					
Mercury (Hg)	mg/kg	< 1	NONE					
Nickel (Ni)	mg/kg	< 3	MCERTS					
Selenium (Se)	mg/kg	< 3	NONE					
Zinc (Zn)	mg/kg	< 3	MCERTS					

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

This report refers to samples as received, and QTS Environmental Ltd, takes no responsibility for the accuracy or competence of sampling by others.
The material description shall be regarded as tentative and is not included in our scope of UKAS Accreditation.
Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.
Asbestos Analyst: Javeed Malik
RL: Reporting Limit
Pinch Test: Where pinch test is positive it is reported "Loose Fibres - PT" with type(s).
Subcontracted analysis (S)

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Soil Analysis Certificate - Speciated PAHs							
QTS Environmental Report No: 17-60323	Date Sampled	13/06/17	13/06/17	13/06/17	14/06/17	15/06/17
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Torrington Square, London	TP / BH No	BH01	WS02	WS02	TP01	TP02
Project / Job Ref: BRD2903	Additional Refs	J1	J1	J2	J2	J1
Order No: None Supplied	Depth (m)	0.30	0.20	0.95	0.60	0.40
Reporting Date: 23/06/2017	QTSE Sample No	274380	274381	274382	274384	274385

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	0.17	< 0.1	< 0.1	< 0.1
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	0.44	< 0.1	< 0.1	< 0.1
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1	0.39	< 0.1	< 0.1	< 0.1
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	0.30	< 0.1	< 0.1	< 0.1
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	0.31	< 0.1	< 0.1	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	0.52	< 0.1	< 0.1	< 0.1
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	0.21	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	0.35	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	0.30	< 0.1	< 0.1	< 0.1
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	0.22	< 0.1	< 0.1	< 0.1
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	3.2	< 1.6	< 1.6	< 1.6

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - Speciated PAHs							
QTS Environmental Report No: 17-60323	Date Sampled	15/06/17					
BRD Environmental Ltd	Time Sampled	None Supplied					
Site Reference: Torrington Square, London	TP / BH No	TP02					
Project / Job Ref: BRD2903	Additional Refs	J2					
Order No: None Supplied	Depth (m)	0.80					
Reporting Date: 23/06/2017	QTSE Sample No	274386					

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1				
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1				
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1				
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1				
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1				
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1				
Fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1				
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1				
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1				
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1				
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1				
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1				
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1				
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1				
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1				
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1				
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - TPH LQM Banded							
QTS Environmental Report No: 17-60323	Date Sampled	13/06/17	13/06/17	14/06/17	15/06/17	15/06/17
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Torrington Square, London	TP / BH No	BH01	WS02	TP01	TP02	TP02
Project / Job Ref: BRD2903	Additional Refs	J1	J2	J2	J1	J2
Order No: None Supplied	Depth (m)	0.30	0.95	0.60	0.40	0.80
Reporting Date: 23/06/2017	QTSE Sample No	274380	274382	274384	274385	274386

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3	< 3	< 3	< 3	< 3
Aliphatic >C16 - C35	mg/kg	< 10	MCERTS	19	< 10	< 10	< 10	< 10
Aliphatic >C35 - C44	mg/kg	< 10	NONE	< 10	< 10	< 10	< 10	< 10
Aliphatic (C5 - C44)	mg/kg	< 30	NONE	< 30	< 30	< 30	< 30	< 30
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3	< 3	< 3	< 3
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	< 10	< 10	< 10	< 10	< 10
Aromatic >C35 - C44	mg/kg	< 10	NONE	< 10	< 10	< 10	< 10	< 10
Aromatic (>C5 - C44)	mg/kg	< 30	NONE	< 30	< 30	< 30	< 30	< 30
Total >C5 - C44	mg/kg	< 60	NONE	< 60	< 60	< 60	< 60	< 60

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Soil Analysis Certificate - BTEX / MTBE							
QTS Environmental Report No: 17-60323	Date Sampled	13/06/17	13/06/17	14/06/17	15/06/17	15/06/17
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Torrington Square, London	TP / BH No	BH01	WS02	TP01	TP02	TP02
Project / Job Ref: BRD2903	Additional Refs	J1	J2	J2	J1	J2
Order No: None Supplied	Depth (m)	0.30	0.95	0.60	0.40	0.80
Reporting Date: 23/06/2017	QTSE Sample No	274380	274382	274384	274385	274386

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Toluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Ethylbenzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
p & m-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
o-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
MTBE	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - Semi Volatile Organic Compounds (SVOC)							
QTS Environmental Report No: 17-60323	Date Sampled	14/06/17					
BRD Environmental Ltd	Time Sampled	None Supplied					
Site Reference: Torrington Square, London	TP / BH No	TP01					
Project / Job Ref: BRD2903	Additional Refs	J2					
Order No: None Supplied	Depth (m)	0.60					
Reporting Date: 23/06/2017	QTSE Sample No	274384					

Determinand	Unit	RL	Accreditation					
Phenol	mg/kg	< 0.1	NONE	< 0.1				
1,2,4-Trichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1				
2-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1				
Nitrobenzene	mg/kg	< 0.1	MCERTS	< 0.1				
0-Cresol	mg/kg	< 0.1	NONE	< 0.1				
bis(2-chloroethoxy)methane	mg/kg	< 0.1	MCERTS	< 0.1				
bis(2-chloroethyl)ether	mg/kg	< 0.1	MCERTS	< 0.1				
2,4-Dichlorophenol	mg/kg	< 0.1	MCERTS	< 0.1				
2-Chlorophenol	mg/kg	< 0.1	ISO17025	< 0.1				
1,3-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1				
1,4-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1				
1,2-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1				
2,4-Dimethylphenol	mg/kg	< 0.15	ISO17025	< 0.15				
Isophorone	mg/kg	< 0.1	NONE	< 0.1				
Hexachloroethane	mg/kg	< 0.1	MCERTS	< 0.1				
p-Cresol	mg/kg	< 0.15	MCERTS	< 0.15				
2,4,6-Trichlorophenol	mg/kg	< 0.1	MCERTS	< 0.1				
2,4,5-Trichlorophenol	mg/kg	< 0.15	MCERTS	< 0.15				
2-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1				
4-Chloro-3-methylphenol	mg/kg	< 0.1	NONE	< 0.1				
2-Methylnaphthalene	mg/kg	< 0.1	MCERTS	< 0.1				
Hexachlorocyclopentadiene	mg/kg	< 0.1	NONE	< 0.1				
Hexachlorobutadiene	mg/kg	< 0.1	ISO17025	< 0.1				
2,6-Dinitrotoluene	mg/kg	< 0.1	MCERTS	< 0.1				
Dimethyl phthalate	mg/kg	< 0.1	NONE	< 0.1				
2-Chloronaphthalene	mg/kg	< 0.1	MCERTS	< 0.1				
4-Chloroanaline	mg/kg	< 0.15	NONE	< 0.15				
4-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1				
4-Chlorophenyl phenyl ether	mg/kg	< 0.1	MCERTS	< 0.1				
3-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1				
4-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1				
4-Bromophenyl phenyl ether	mg/kg	< 0.1	MCERTS	< 0.1				
Hexachlorobenzene	mg/kg	< 0.1	MCERTS	< 0.1				
2,4-Dinitrotoluene	mg/kg	< 0.1	MCERTS	< 0.1				
Diethyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1				
Dibenzofuran	mg/kg	< 0.1	MCERTS	< 0.1				
Azobenzene	mg/kg	< 0.1	NONE	< 0.1				
Dibutyl phthalate	mg/kg	< 0.1	ISO17025	< 0.1				
Carbazole	mg/kg	< 0.1	ISO17025	< 0.1				
bis(2-ethylhexyl)phthalate	mg/kg	< 0.15	MCERTS	< 0.15				
Benzyl butyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1				
Di-n-octyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1				

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mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING 4480

Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3

QTS Environmental Report No: 17-60323		Date Sampled	15/06/17				Landflll Waste Acceptance Criteria Limits		
BRD Environmental Ltd		Time Sampled	None Supplied				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Site Reference: Torrington Square, London		TP / BH No	TP02						
Project / Job Ref: BRD2903		Additional Refs	J2						
Order No: None Supplied		Depth (m)	0.80						
Reporting Date: 23/06/2017		QTSE Sample No	274386						
Determinand	Unit	MDL							
TOC[MU]	%	< 0.1	0.5				3%	5%	6%
Loss on Ignition	%	< 0.01	2				--	--	10%
BTEX[MU]	mg/kg	< 0.05	< 0.05				6	--	--
Sum of PCBs	mg/kg	< 0.1	< 0.1				1	--	--
Mineral Oil[MU]	mg/kg	< 10	< 10				500	--	--
Total PAH[MU]	mg/kg	< 1.7	< 1.7				100	--	--
pH[MU]	pH Units	N/a	9.2				--	>6	--
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	2.6				--	To be evaluated	To be evaluated
Eluate Analysis			2:1 mg/l	8:1 mg/l		Cumulative 10:1 mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)		
Arsenic[U]			< 0.01	< 0.01		< 0.2	0.5	2	25
Barium[U]			0.09	0.03		0.4	20	100	300
Cadmium[U]			< 0.0005	< 0.0005		< 0.02	0.04	1	5
Chromium[U]			0.022	0.007		< 0.20	0.5	10	70
Copper[U]			0.01	< 0.01		< 0.5	2	50	100
Mercury[U]			< 0.005	< 0.005		< 0.01	0.01	0.2	2
Molybdenum[U]			0.004	0.001		< 0.1	0.5	10	30
Nickel[U]			< 0.007	< 0.007		< 0.2	0.4	10	40
Lead[U]			0.043	0.065		0.6	0.5	10	50
Antimony[U]			0.010	< 0.005		< 0.06	0.06	0.7	5
Selenium[U]			< 0.005	< 0.005		< 0.1	0.1	0.5	7
Zinc[U]			0.017	< 0.005		< 0.2	4	50	200
Chloride[U]			70	9		146	800	15000	25000
Fluoride[U]			< 0.5	< 0.5		< 1	10	150	500
Sulphate[U]			55	11		146	1000	20000	50000
TDS			229	74		875	4000	60000	100000
Phenol Index			< 0.01	< 0.01		< 0.5	1	-	-
DOC			4.2	2.8		29.4	500	800	1000
Leach Test Information									
Sample Mass (kg)			0.20						
Dry Matter (%)			88.9						
Moisture (%)			12.6						
Stage 1									
Volume Eluate L2 (litres)			0.33						
Filtered Eluate VE1 (litres)			0.15						

Results are expressed on a dry weight basis, after correction for moisture content where applicable
Stated limits are for guidance only and QTS Environmental cannot be held responsible for any discrepencies with current legislation
M Denotes MCERTS accredited test
U Denotes ISO17025 accredited test

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Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 17-60323	
BRD Environmental Ltd	
Site Reference: Torrington Square, London	
Project / Job Ref: BRD2903	
Order No: None Supplied	
Reporting Date: 23/06/2017	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
274380	BH01	J1	0.30	4.5	Brown sandy clay with stones
274381	WS02	J1	0.20	7.3	Black sandy clay
274382	WS02	J2	0.95	5.5	Brown sandy clay with stones
274384	TP01	J2	0.60	4.5	Brown sandy gravel with stones
274385	TP02	J1	0.40	13.4	Brown sandy gravel with stones
274386	TP02	J2	0.80	11.1	Brown sandy gravel with stones and concrete
274387	BH01	J2	0.80	3.6	Brown sandy gravel with stones and concrete
274388	BH01	D	2.00	4.7	Brown sandy gravel with stones
274389	BH01	None Supplied	3.00 - 3.45	15.2	Brown clayey sand with stones
274390	BH01	None Supplied	5.00 - 5.45	15.1	Brown clay
274391	BH01	None Supplied	8.00 - 8.45	14	Brown clay
274392	BH01	None Supplied	11.00 - 11.45	11.9	Brown clayey sand

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

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UKAS TESTING 4480

Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 17-60323
BRD Environmental Ltd
Site Reference: Torrington Square, London
Project / Job Ref: BRD2903
Order No: None Supplied
Reporting Date: 23/06/2017

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10 C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

Matt Wood
BRD Environmental Ltd
Hawthorne Villa
1 Old Parr Road
Banbury
Oxfordshire
OX16 5HT

QTS Environmental Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410
russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 17-60936

Site Reference:	Torrington Square, London
Project / Job Ref:	BRD2903
Order No:	None Supplied
Sample Receipt Date:	03/07/2017
Sample Scheduled Date:	03/07/2017
Report Issue Number:	1
Reporting Date:	06/07/2017

Authorised by:

Kevin Old
Associate Director of Laboratory

Authorised by:

Russell Jarvis
Associate Director of Client Services

QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

UKAS TESTING
4480

Water Analysis Certificate							
QTS Environmental Report No: 17-60936	Date Sampled	28/06/17					
BRD Environmental Ltd	Time Sampled	None Supplied					
Site Reference: Torrington Square, London	TP / BH No	BH01					
Project / Job Ref: BRD2903	Additional Refs	None Supplied					
Order No: None Supplied	Depth (m)	None Supplied					
Reporting Date: 06/07/2017	QTSE Sample No	277117					

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	ISO17025	8.9				
Sulphate as SO_4	mg/l	< 1	ISO17025	65				

Subcontracted analysis (S)
Insufficient sample I/S
Unsuitable Sample U/S

QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

UKAS TESTING
4480

Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 17-60936
BRD Environmental Ltd
Site Reference: Torrington Square, London
Project / Job Ref: BRD2903
Order No: None Supplied
Reporting Date: 06/07/2017

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Water	UF	Alkalinity	Determination of alkalinity by titration against hydrochloric acid using bromocresol green as the end point	E103
Water	UF	BTEX	Determination of BTEX by headspace GC-MS	E101
Water	F	Cations	Determination of cations by filtration followed by ICP-MS	E102
Water	UF	Chemical Oxygen Demand (COD)	Determination using a COD reactor followed by colorimetry	E112
Water	F	Chloride	Determination of chloride by filtration & analysed by ion chromatography	E109
Water	F	Chromium - Hexavalent	Determination of hexavalent chromium by acidification, addition of 1,5 diphenylcarbazide followed by co	E116
Water	UF	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E115
Water	UF	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through liquid:liquid extraction with cyclohexane	E111
Water	F	Diesel Range Organics (C10 - C24)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	Dissolved Organic Content (DOC)	Determination of DOC by filtration followed by low heat with persulphate addition followed by IR detect	E110
Water	UF	Electrical Conductivity	Determination of electrical conductivity by electrometric measurement	E123
Water	F	EPH (C10 – C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E104
Water	F	Fluoride	Determination of Fluoride by filtration & analysed by ion chromatography	E109
Water	F	Hardness	Determination of Ca and Mg by ICP-MS followed by calculation	E102
Leachate	F	Leachate Preparation - NRA	Based on National Rivers Authority leaching test 1994	E301
Leachate	F	Leachate Preparation - WAC	Based on BS EN 12457 Pt1, 2, 3	E302
Water	F	Metals	Determination of metals by filtration followed by ICP-MS	E102
Water	F	Mineral Oil (C10 - C40)	Determination of liquid:liquid extraction with hexane followed by GI-FID	E104
Water	F	Nitrate	Determination of nitrate by filtration & analysed by ion chromatography	E109
Water	UF	Monohydric Phenol	Determination of phenols by distillation followed by colorimetry	E121
Water	F	PAH - Speciated (EPA 16)	Determination of PAH compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E105
Water	F	PCB - 7 Congeners	Determination of PCB compounds by concentration through SPE cartridge, collection in dichloromethane	E108
Water	UF	Petroleum Ether Extract (PEE)	Gravimetrically determined through liquid:liquid extraction with petroleum ether	E111
Water	UF	pH	Determination of pH by electrometric measurement	E107
Water	F	Phosphate	Determination of phosphate by filtration & analysed by ion chromatography	E109
Water	UF	Redox Potential	Determination of redox potential by electrometric measurement	E113
Water	F	Sulphate (as SO4)	Determination of sulphate by filtration & analysed by ion chromatography	E109
Water	UF	Sulphide	Determination of sulphide by distillation followed by colorimetry	E118
Water	F	SVOC	Determination of semi-volatile organic compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E106
Water	UF	Toluene Extractable Matter (TEM)	Gravimetrically determined through liquid:liquid extraction with toluene	E111
Water	UF	Total Organic Carbon (TOC)	Low heat with persulphate addition followed by IR detection	E110
Water	F	TPH CWG (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C35. C5 to C8 by headspace GC-MS	E104
Water	F	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10 C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C44. C5 to C8 by headspace GC-MS	E104
Water	UF	VOCs	Determination of volatile organic compounds by headspace GC-MS	E101
Water	UF	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E101

Key

F Filtered
UF Unfiltered

TEST REPORT.

ISSUED BY : **SOIL PROPERTY TESTING LTD.**

DATE OF ISSUE : 03/07/17 **PAGE 1 of 15 Pages**

Contract Torrington Square, London

Serial No. S31358

UKAS TESTING 0998

CLIENT:

BRD Environmental Ltd
Hawthorne Villa
1 Old Parr Road
Banbury
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OX16 5HT

Soil Property Testing Ltd.

15,16 & 18 Halcyon Court, St Margarets Way,
Stukeley Meadows, Huntingdon,
Cambs. PE29 6DG.

Telephone (01480) 455579 Fax (01480) 453619
Email enquiries@soilpropertytesting.com

SAMPLES SUBMITTED BY:

BRD Environmental Ltd

APPROVED SIGNATORIES:

☑ **J.C.GARNER B.Eng (Hons.) FGS**
Technical Director

☐ **S.P.TOWNEND FGS**
Quality Manager

☐ **W.JOHNSTONE**
Materials Lab Manager

SAMPLES LABELLED:

Torrington Square, London

DATE RECEIVED: 19/06/17 **SAMPLES TESTED BETWEEN** 19/06/17 **and** 03/07/17

REMARKS: For the attention of Mr M Wood
Your reference BRD2903

NOTES:

1. All remaining samples or remnants from this contract will be disposed of after 21 days from today, unless we are notified to the contrary.
2. (a) UKAS - United Kingdom Accreditation Service.
   (b) Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.
3. Tests marked "NOT UKAS ACCREDITED" in this test report are not included in the UKAS Accreditation Schedule for this testing laboratory.
4. This test report may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 **PAGE** 2 of 15

Contract Torrington Square, London

Serial No. S31358

SCHEDULE OF LABORATORY TESTS

Bh./ Tp No.	Sample Ref	Depth (from)	7:PSD by Wet Sieve BS1377	1:Moisture Content Determination	4:Liquid/Plastic limit 1 point	13:Triaxial Test single stage	31:One Dimensional Consolidation	32:Consol extra 24 hr increment	Remarks
BH01	B1.0	1.00	*						
	B2.0	2.00	*						
	D3.0	3.00		*	*				
	U4.2	4.20				*			
	D5.0	5.00		*	*				
	D6.0	6.00		*					
	U6.5	6.50					*	*	
	D8.0	8.00		*	*				
	U9.5	9.50				*			
	D11.0	11.00		*					
	U12.5	12.50				*			
	D14.0	14.00		*	*				
	D15.0	15.00		*					
-	-	-	2	7	4	3	1	1	<— Total Number of Tests ——

Scheduled by: BRD Environmental Ltd

Target Date: 03/07/17

TEST REPORT.

ISSUED BY : **SOIL PROPERTY TESTING LTD.**

DATE OF ISSUE : As page 1 **PAGE** 3 of 15

Contract Torrington Square, London

Serial No. S31358

UKAS TESTING 0998

SUMMARY OF MOISTURE CONTENT, LIQUID LIMIT, PLASTIC LIMIT, PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)	SAMPLE PREPARATION				Description	CLASS
								Method S/N	Ret'd 0.425mm (%)	Corr'd M/C <0.425mm	Curing Time (hrs.)		
BH01	3.00	D3.0	34	70	24	46	0.22	N	0(A)		27	Firm slightly fissured orangish brown CLAY with occasional brown and dark grey mottling	CH/ CV
BH01	5.00	D5.0	34	77	26	51	0.16	N	0(A)		27	Firm slightly fissured orangish brown CLAY with occasional brown and dark grey mottling	CV
BH01	6.00	D6.0	26	-	-	-						Stiff slightly fissured dark grey CLAY	-
BH01	8.00	D8.0	29	78	25	53	0.08	N	0(A)		27	Stiff slightly fissured dark greyish brown CLAY with occasional very dark grey mottling	CV
BH01	11.00	D11.0	28	-	-	-						Stiff slightly fissured dark grey CLAY	-
BH01	14.00	D14.0	26	74	25	49	0.02	N	0(A)		27	Stiff slightly fissured dark grey CLAY with occasional dark greyish brown mottling	CV
BH01	15.00	D15.0	26	-	-	-						Stiff fissured dark grey CLAY with occasional dark greyish brown mottling	-

METHOD OF PREPARATION : BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2 S = Wet Sieved Specimen
N = prepared from Natural

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter. A = Assumed, M = Measured

COMMENTS :

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

TEST REPORT.

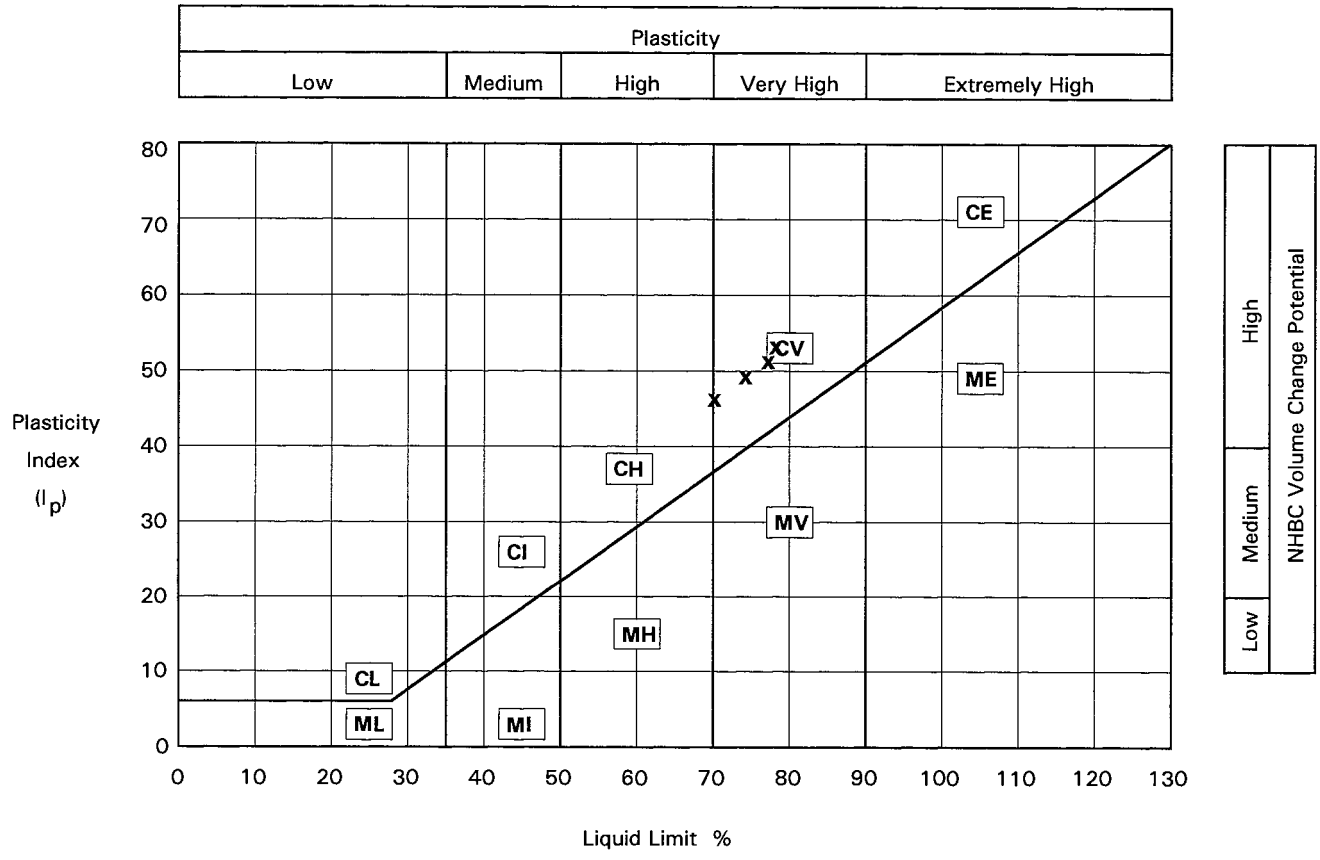
ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 **PAGE** 4 of 15

Contract Torrington Square, London

Serial No. S31358

PLOT OF PLASTICITY INDEX AGAINST LIQUID LIMIT USING CASAGRANDE CLASSIFICATION CHART



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index PLASTICITY CHART BS5930:1999:Figure 18

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 **PAGE** 5 of 15

Contract Torrington Square, London

Serial No. S31358

UKAS TESTING 0998

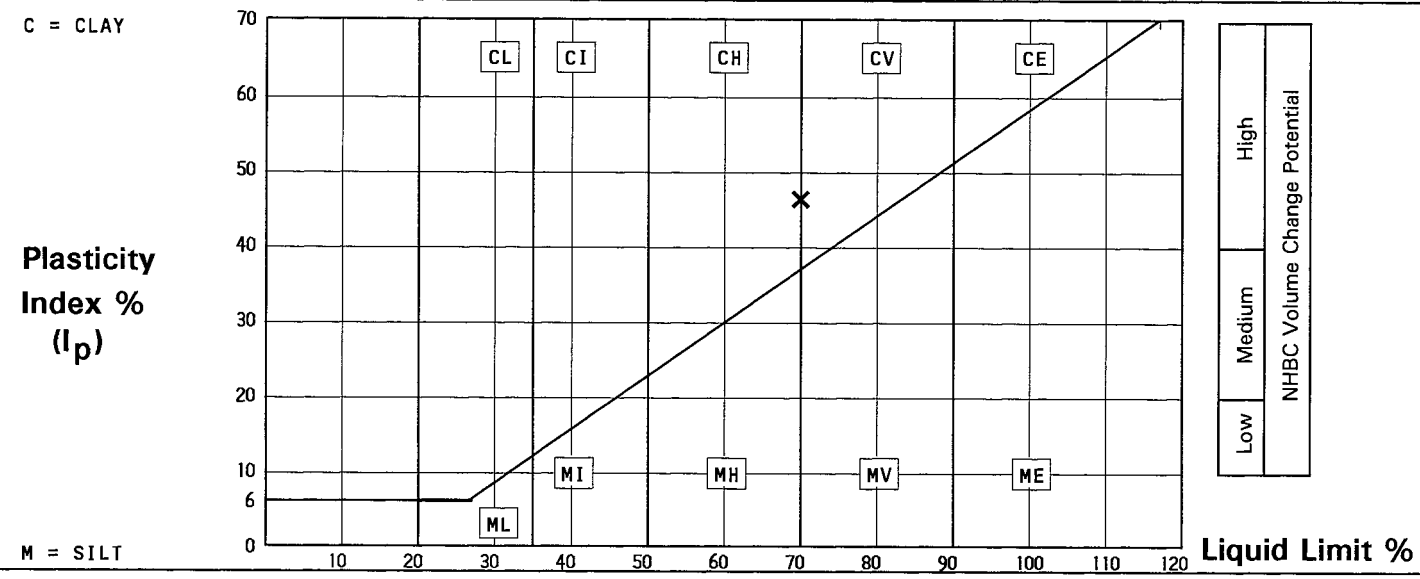
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
BH01	3.00	D3.0	34	Firm slightly fissured orangish brown CLAY with occasional brown and dark grey mottling	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve	(Assumed) 0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	27 Hours

Liquid Limit	70 %
Plastic Limit	24 %
Plasticity Index	46 %
Liquidity Index	0.22
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4 , 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : **SOIL PROPERTY TESTING LTD.**

DATE OF ISSUE : As page 1 **PAGE** 6 of 15

Contract Torrington Square, London

Serial No. S31358

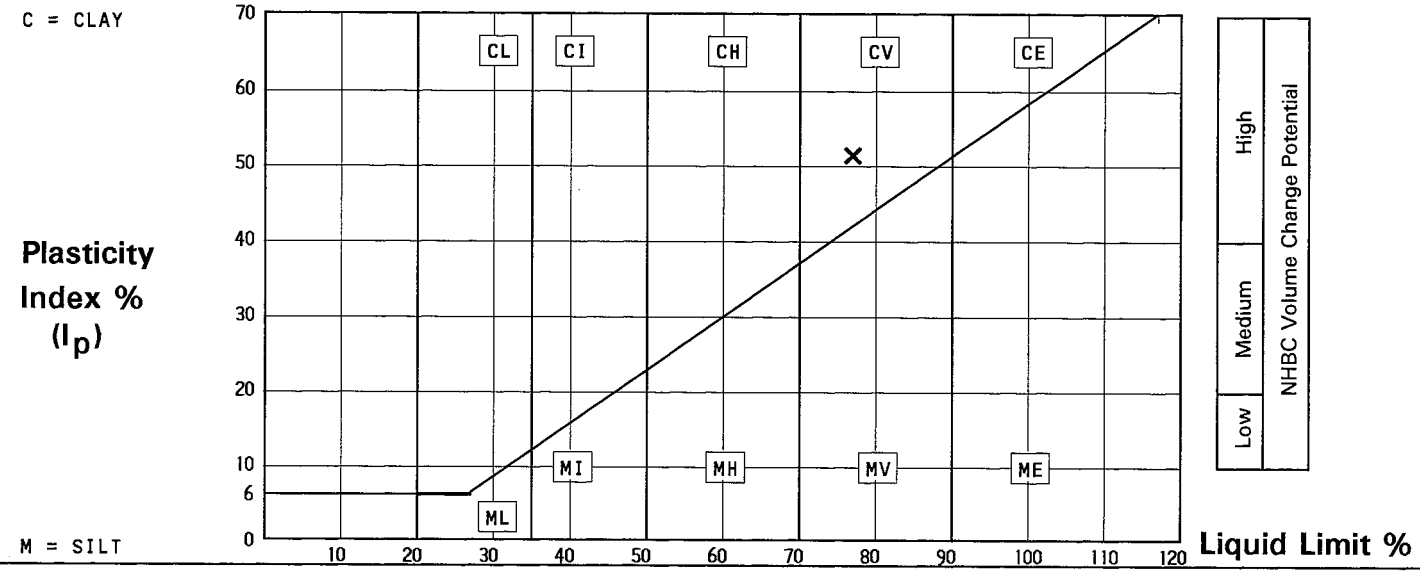
UKAS TESTING 0998

DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
BH01	5.00	D5.0	34	Firm slightly fissured orangish brown CLAY with occasional brown and dark grey mottling	

PREPARATION

Method of Preparation	Specimen from Natural Soil	Liquid Limit	77 %
Sample retained 0.425 sieve	(Assumed) 0 %	Plastic Limit	26 %
Corrected moisture content for material passing 0.425mm	%	Plasticity Index	51 %
Curing Time	27 Hours	Liquidity Index	0.16
		Clay Content	Not analysed. %
		Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4 , 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 **PAGE** 7 of 15

Contract Torrington Square, London

Serial No. S31358

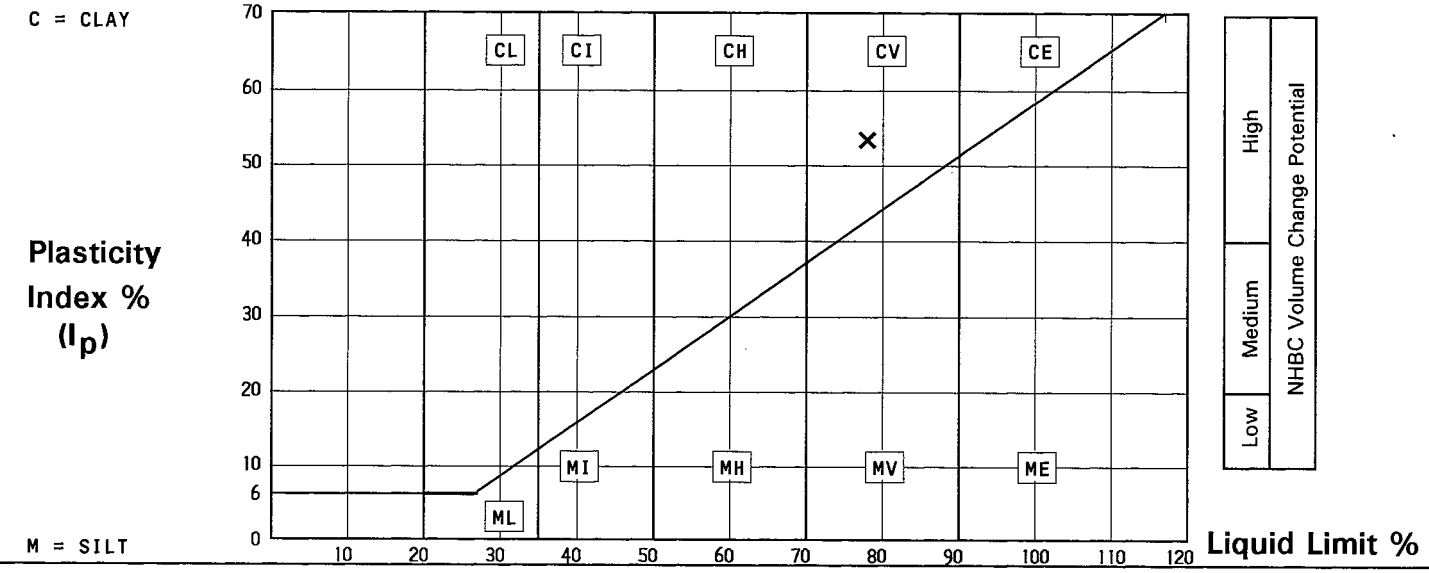
UKAS TESTING 0998

DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
BH01	8.00	D8.0	29	Stiff slightly fissured dark greyish brown CLAY with occasional very dark grey mottling	

PREPARATION

Method of Preparation	Specimen from Natural Soil	Liquid Limit	78 %
Sample retained 0.425 sieve	(Assumed) 0 %	Plastic Limit	25 %
Corrected moisture content for material passing 0.425mm	%	Plasticity Index	53 %
Curing Time	27 Hours	Liquidity Index	0.08
		Clay Content	Not analysed. %
		Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4, 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 **PAGE** 8 of 15

Contract Torrington Square, London

Serial No. S31358

UKAS TESTING 0998

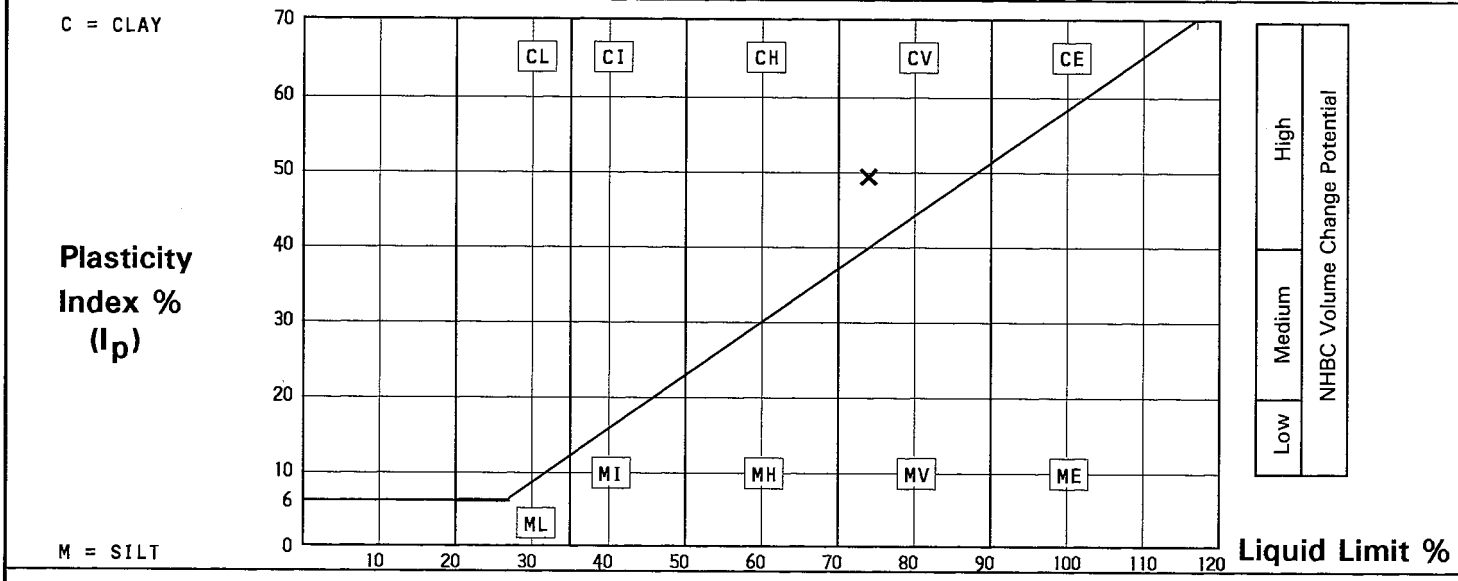
DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX

Borehole/ Pit No.	Depth m.	Sample	Moisture Content %	Description	Remarks
BH01	14.00	D14.0	26	Stiff slightly fissured dark grey CLAY with occasional dark greyish brown mottling	

PREPARATION

Method of Preparation	Specimen from Natural Soil
Sample retained 0.425 sieve	(Assumed) 0 %
Corrected moisture content for material passing 0.425mm	%
Curing Time	27 Hours

Liquid Limit	74 %
Plastic Limit	25 %
Plasticity Index	49 %
Liquidity Index	0.02
Clay Content	Not analysed. %
Derived Activity (PI/CC)	Not analysed.



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.4 & PART 2:1990:4.2

METHOD OF TEST : BS 1377:PART 2:1990:3.2, 4.4 , 5.3, 5.4

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : PLASTICITY CHART BS5930:1999:Figure 18
VOLUME CHANGE POTENTIAL: NHBC Standards Chapter 4.2 Unmodified Plasticity Index
NOTE: Modified Plasticity Index I'p = Ip x (% less than 425 microns/100)

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 **PAGE** 9 **of** 15

Contract Torrington Square, London

Serial No. S31358

UKAS TESTING 0998

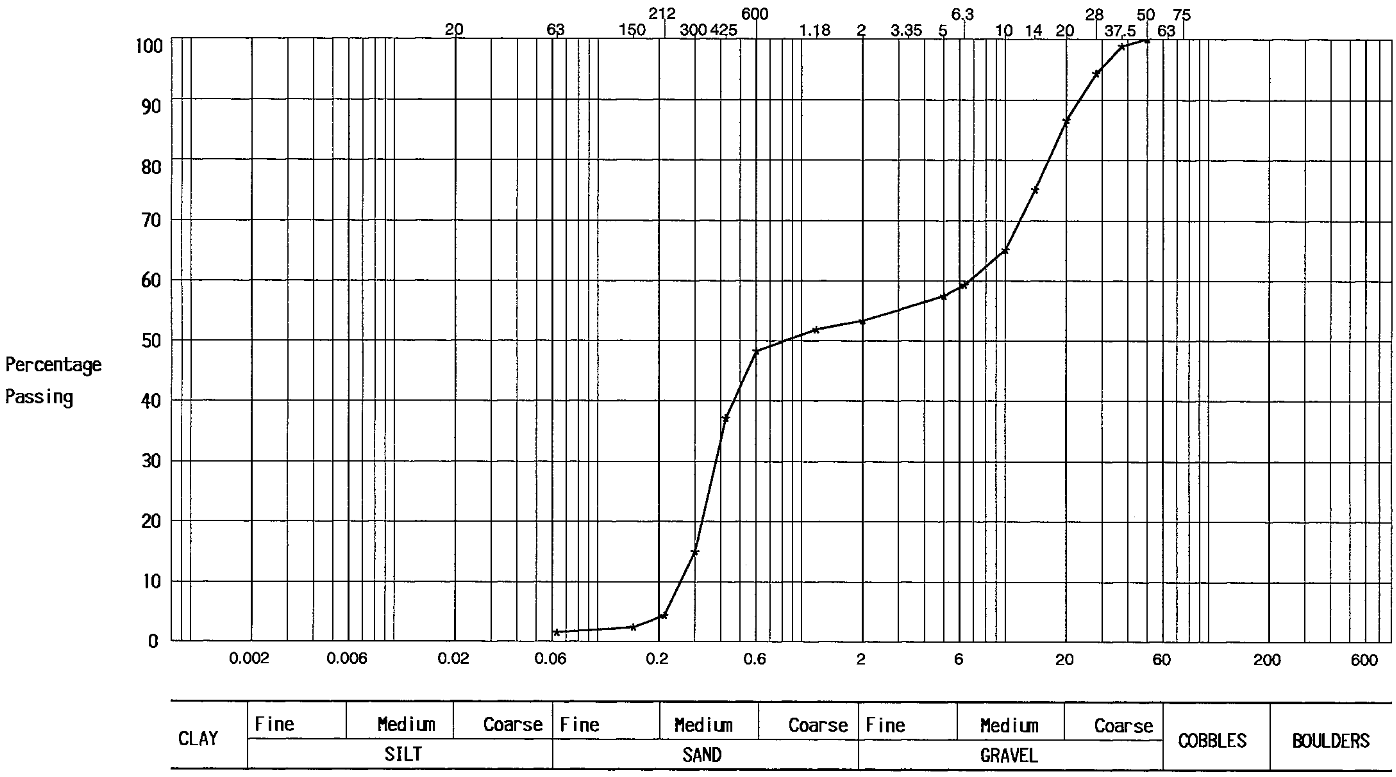
DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole/ Pit No.	Depth m.	Sample	Description	Remarks
BH1	1.00 -1.20	B1.0	Pale orangish brown slightly silty SAND and black, brown and white angular and subangular flint GRAVEL	

Method of Test: Wet Sieve

Method of pre-treatment:

	Size (microns)						Size (mm)											
Sieve Size	63	150	212	300	425	600	1.18	2	5	6.3	10	14	20	28	37.5	50	75
Percentage by Mass passing Sieve	1	2	4	15	37	48	52	53	58	59	65	75	87	94	99	100	-



METHOD OF PREPARATION: BS 1377:PART 1:1990:7.3 & 7.4.5

METHOD OF TEST : BS 1377:PART 2:1990:9.2

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS :

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

DATE OF ISSUE : As page 1 **PAGE** 10 of 15

Contract Torrington Square, London

Serial No. S31358

UKAS TESTING 0998

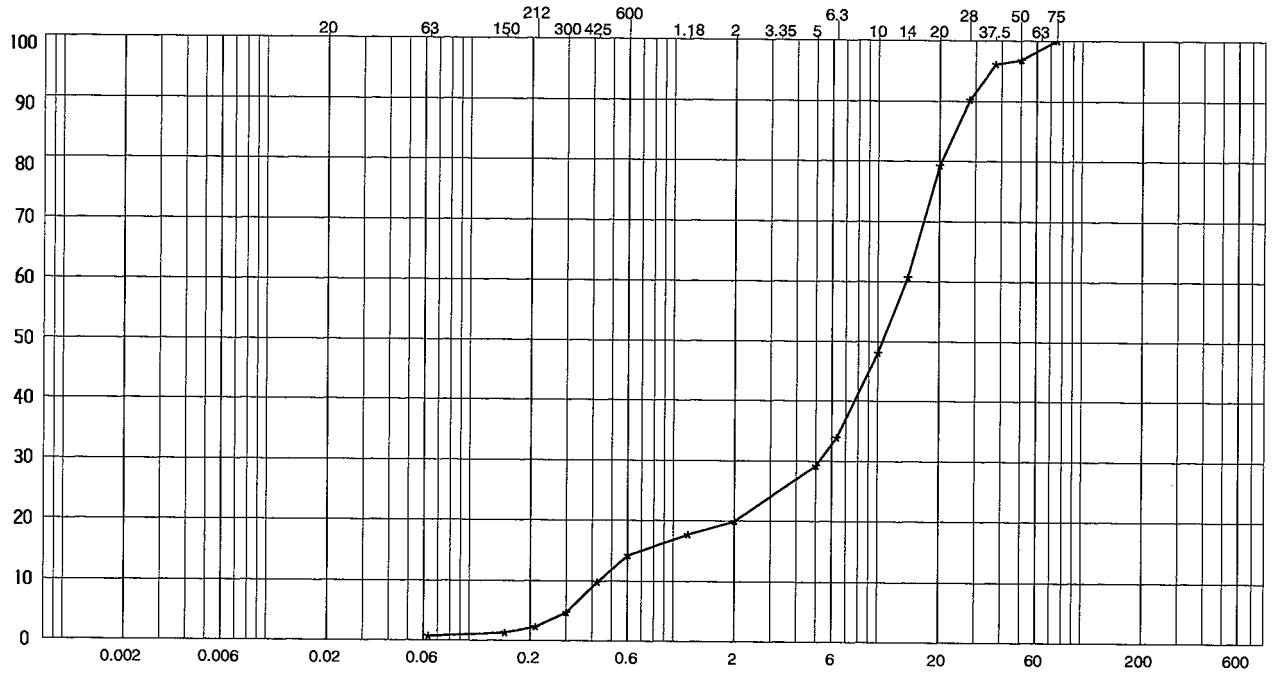
DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole/ Pit No.	Depth m.	Sample	Description	Remarks
BH1	2.00 -2.45	B2.0	Black, brown and white slightly silty sandy subangular and subrounded flint GRAVEL. Sand is black, brown and white subangular and subrounded	

Method of Test: Wet Sieve

Method of pre-treatment:

Size (microns)													Size (mm)												
Sieve Size	63	150	212	300	425	600	1.18	2	5	6.3	10	14	20	28	37.5	50	75								
Percentage by Mass passing Sieve	1	1	2	5	10	14	18	20	29	34	48	61	79	90	96	97	100								



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES	BOULDERS
	SILT			SAND			GRAVEL				

METHOD OF PREPARATION: BS 1377:PART 1:1990:7.3 & 7.4.5

METHOD OF TEST : BS 1377:PART 2:1990:9.2

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS :

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

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Contract Torrington Square, London

Serial No. S31358

UKAS TESTING 0998

DETERMINATION OF DENSITY, MOISTURE CONTENT AND UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole/ Pit No.	Depth m.	Sample	Moisture Content (%)	Bulk Density (Mg/m^3)	Dry Density (Mg/m^3)	Lateral Pressure (kPa)	Deviator Stress (kPa)	Shear Stress (kPa)	MOHRS CIRCLE ANALYSIS Cu (kPa)	MOHRS CIRCLE ANALYSIS Ø (degrees)	Description
BH1	4.20	U4.2	32	1.93	1.46	84	147	73			Firm (Medium strength) slightly fissured dark greyish brown CLAY
BH1	9.50	U9.5	22	2.06	1.69	188	304	152			Very stiff (Very high strength) slightly fissured dark greyish brown CLAY with occasional fine sand/silt pockets
BH1	12.50	U12.5	20	2.05	1.71	239	356	178			Very stiff (Very high strength) slightly fissured dark greyish brown CLAY with locally slightly sandy silty clay with occasional dark grey and dark greyish brown mottling

METHOD OF PREPARATION : BS 1377:PART 1:1990:7.4.2 & 8 PART 2:1990:7.2 PART 7:1990:8.3

METHOD OF TEST : BS 1377:PART 2:1990:3 Determination of Moisture Content 1990:7 Determination of Density
:PART 7:1990:8 Undrained Shear Strength 1990:9 Multi-stage test
Note Multi-stage test used when specimen has granular content / behaviour and length of specimen precludes the taking of 3 x 100mm dia by 200mm long specimens.

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS :

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

TEST REPORT.

ISSUED BY : SOIL PROPERTY TESTING LTD.

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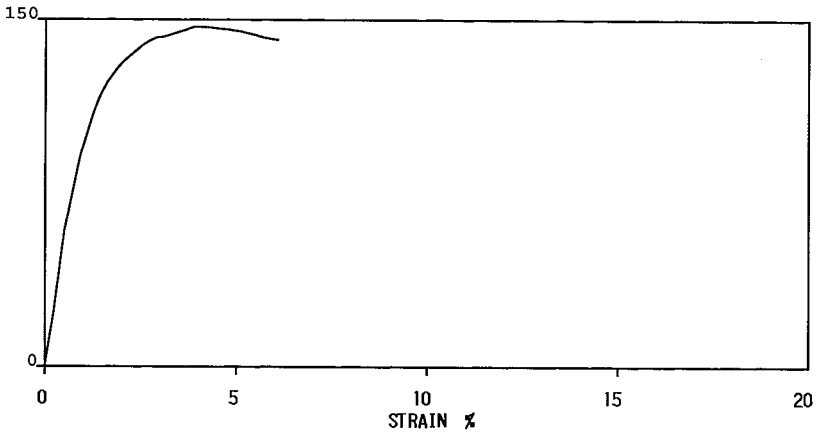
UKAS TESTING 0998

DETERMINATION OF UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole/ Pit No.	Depth m.	Sample	Description	Remarks
BH1	4.20	U4.2	Firm (Medium strength) slightly fissured dark greyish brown CLAY	

Initial Specimen	Height mm	Diameter mm	Weight g	Moisture Content %	Wet Density Mg/m^3	Dry Density Mg/m^3
Depth of Top of Specimen (m) 4.44	150.1	100.4	2295	32	1.93	1.46

TEST INFORMATION — Rate of Strain 0.9 % per Min — Rubber Membrane Thickness 0.3 mm



Specimen at Failure	Measured Cell Pressure $\sigma 3$ (kPa)	Strain at Failure (%)	Stress Corrections (kPa)		Corrected Max. Deviator Stress $\sigma 1 - \sigma 3$ (kPa)	Shear Stress Cu $\frac{1}{2}(\sigma 1 - \sigma 3)_f$ (kPa)	Mohrs Circle Analysis	
			Rubber Membrane	Piston Friction			Cu (kPa)	PHI °
	84	4.1	0.3	/	147	73		

METHOD OF PREPARATION: BS 1377:PART 1:1990:

METHOD OF TEST : BS 1377:PART 7:1990:8 Definitive Method. 1990:9 Multi-stage loading

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : Tested in Vertical Orientation.
UKAS Calibration - loads from 0.2 to 10kN.

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

TEST REPORT.

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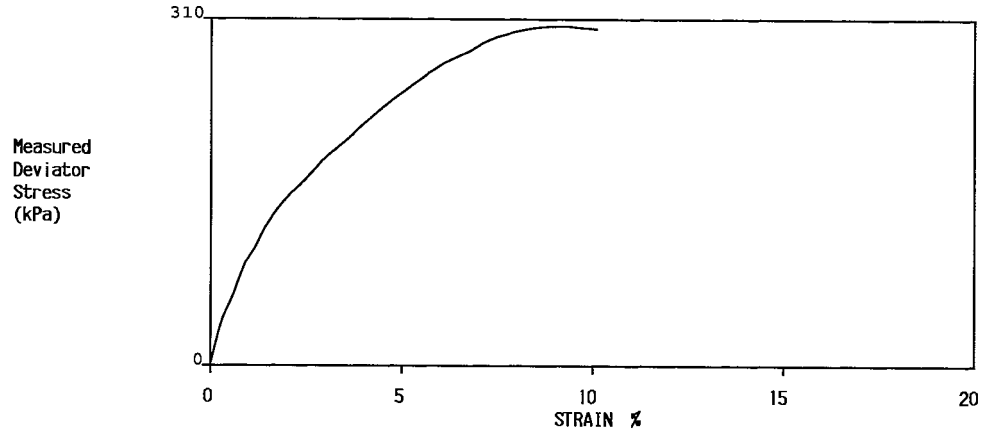
DETERMINATION OF UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole/ Pit No.	Depth m.	Sample	Description	Remarks
BH1	9.50	U9.5	Very stiff (Very high strength) slightly fissured dark greyish brown CLAY with occasional fine sand/silt pockets	

Initial Specimen	Height mm	Diameter mm	Weight g	Moisture Content %	Wet Density Mg/m^3	Dry Density Mg/m^3
Depth of Top of Specimen (m) 9.57	150.1	102.1	2536	22	2.06	1.69

TEST INFORMATION — Rate of Strain 0.9 % per Min — Rubber Membrane Thickness 0.3 mm



Specimen at Failure	Measured Cell Pressure $\sigma 3$ (kPa)	Strain at Failure (%)	Stress Corrections (kPa)		Corrected Max. Deviator Stress $\sigma 1 - \sigma 3$ (kPa)	Shear Stress Cu $\frac{1}{2}(\sigma 1 - \sigma 3)_f$ (kPa)	Mohrs Circle Analysis	
			Rubber Membrane	Piston Friction			Cu (kPa)	PHI °
	188	9.1	0.6	/	304	152		

METHOD OF PREPARATION: BS 1377:PART 1:1990:

METHOD OF TEST : BS 1377:PART 7:1990:8 Definitive Method. 1990:9 Multi-stage loading

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : Tested in Vertical Orientation.
UKAS Calibration - loads from 0.2 to 10kN.

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

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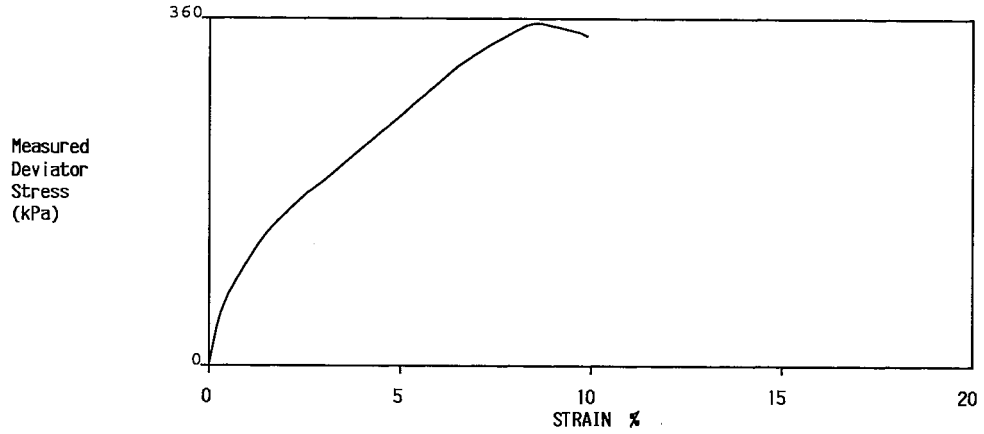
DETERMINATION OF UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole/ Pit No.	Depth m.	Sample	Description	Remarks
BH1	12.50	U12.5	Very stiff (Very high strength) slightly fissured dark greyish brown CLAY with locally slightly sandy silty clay with occasional dark grey and dark greyish brown mottling	

Initial Specimen	Height mm	Diameter mm	Weight g	Moisture Content %	Wet Density Mg/m^3	Dry Density Mg/m^3
Depth of Top of Specimen (m) 12.56	199.4	102.5	3364	20	2.05	1.71

TEST INFORMATION — Rate of Strain 0.9 % per Min — Rubber Membrane Thickness 0.3 mm



Specimen at Failure	Measured Cell Pressure $\sigma 3$ (kPa)	Strain at Failure (%)	Stress Corrections (kPa)		Corrected Max. Deviator Stress $\sigma 1 - \sigma 3$ (kPa)	Shear Stress Cu $\frac{1}{2}(\sigma 1 - \sigma 3)_f$ (kPa)	Mohrs Circle Analysis	
			Rubber Membrane	Piston Friction			Cu (kPa)	PHI °
	239	8.3	0.6	/	356	178		

METHOD OF PREPARATION: BS 1377:PART 1:1990:

METHOD OF TEST : BS 1377:PART 7:1990:8 Definitive Method. 1990:9 Multi-stage loading

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS : Tested in Vertical Orientation.
UKAS Calibration - loads from 0.2 to 10kN.

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.

TEST REPORT.

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Serial No. S31358

UKAS TESTING 0998

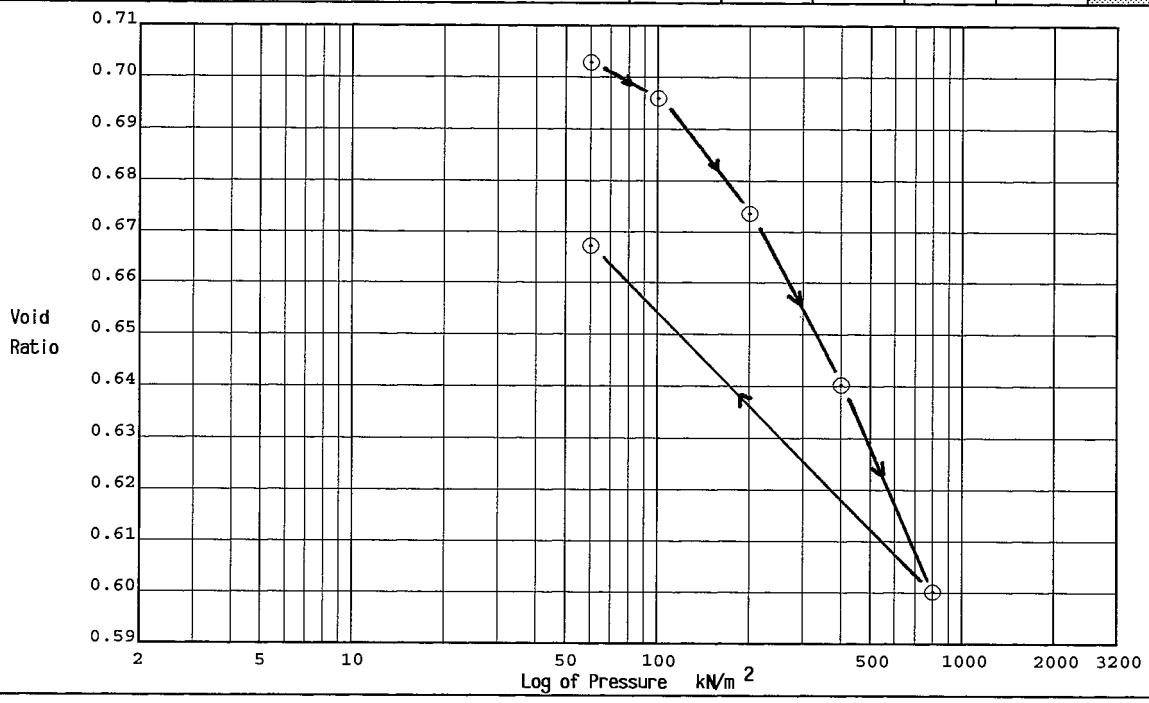
DETERMINATION OF THE ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

Borehole/ Pit No.	Depth m.	Sample	Specimen Depth/Location m. H/V	Moisture Content %	Description	Remarks
BH01	6.50	U6.5	6.54 Horizontal	26	Firm dark grey CLAY with occasional fine sand/silt pockets	

INITIAL CONDITIONS

Height	18.80 mm	Particle Density	2.71 Assumed
Diameter	75.02 mm	Void Ratio	0.708
Wet Weight	166.28 g	Degree of Saturation	100 %
Moisture Content	26 %	Swelling Pressure	60 kN/m^2
Bulk Density	2.00 Mg/m^3	Dry Density	1.59 Mg/m^3

Increment No.	Load kN/m^2	Change in Height (mm)	Void Ratio	Cv (m^2/yr)	Mv (m^2/MN)	Temp °C	Corrected Cv
1	60	0.047	0.703		0.04	23	
2	100	0.123	0.696	0.89	0.10	22	0.86
3	200	0.369	0.674	0.66	0.13	21	0.65
4	400	0.737	0.641	0.58	0.10	20	0.58
5	800	1.178	0.601	0.63	0.06	20	0.63
6	60	0.440	0.668		0.06	20	



METHOD OF PREPARATION: BS 1377:PART 5:1990:3.3 & 3.4 METHOD OF TIME FITTING USED : Square Root

METHOD OF TEST : BS 1377:PART 5:1990:3.5

TYPE OF SAMPLE KEY : U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter

COMMENTS :

REMARKS TO INCLUDE : Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110 deg C.