GEO-ENVIRONMENTAL & GEOTECHNICAL ASSESSMENT (GROUND INVESTIGATION) REPORT

FOR

1A HIGHGATE ROAD
LONDON
NW5 1JY

JONAS

Specialists in the investigation & reclamation of brownfield sites

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EXECUTIVE SUMMARY

IDM Land commissioned Jomas Associates Ltd ('JAL') to undertake a Geo-environmental and Geotechnical ground investigation at the site 1A Highgate Road, London.

The principle objectives of the study were as follows:

- To determine the nature and where possible, the extent of contaminants potentially present at the site;
- To establish the presence of significant pollutant linkages, in accordance with the procedures set out within the Environment Agency (EA) report R&D CLR11 and relevant guidance within the National Planning Policy Framework (NPPF);
- To assess whether the site is safe and suitable for the purpose for which it is intended, or can be made so by remedial action; and,
- To obtain geotechnical parameters to inform preliminary foundation design.

It should be noted that the table below is an executive summary of the findings of this report and is for briefing purposes only. Reference should be made to the main report for detailed information and analysis.

Site History and Ground Investigation	
Desk Study Overview	A Desk Study report has been produced for the site by others (GeoSmart) and provided for information. A brief overview of the desk study findings is presented below. Reference should be made to the full report for detailed information. A review of historical OS maps provided within the report indicates the presence of buildings (unidentified, possibly commercial) within the site from at least 1871. At this time a portion of the site is also comprised of garden areas from adjacent residential properties. By 1915 the site is reported to be occupied by a single building which occupies the majority of the site (including the former garden areas). This building is identified over subsequent mapping editions as a Welding Works, Engineering Works, and a Works, although no further changes in mapping data are noted. The surrounding area is reported to have been utilised for a combination of residential and commercial land uses, with uses of note in the local area including a Chemical Warehouse and a Railway. The report notes the site to be directly underlain by solid deposits of the London Clay Formation, which is identified as unproductive. There are also no source protection zones or groundwater abstractions reported within 500m of the site. The report identifies no significant surface water features within 250m of the site, and considers controlled waters to represent only a minor receptor. The report considers the site to present an overall low risk, in view of the proposed development (at the time of writing) which states the site to be overlain by hardstanding. The report recommends a watching brief be undertaken during construction works.
Intrusive Investigation	The ground investigation was undertaken on 27 July, and consisted of the following: • 4 No. window sampling boreholes, drilled up to 4m below ground level (bgl), with associated in situ testing and sampling; • 3 No. monitoring wells to depths of up to 4m bgl to permit return monitoring; • 5 No. hand excavated trial pits, undertaken to depths of up to 1.2m bgl; • Laboratory analysis for chemical and geotechnical purposes,

Site History and Ground Investigation	
Ground Conditions	The results of the ground investigation revealed a ground profile comprising Made Ground over deposits of clay. Groundwater was not encountered during the intrusive works. During return monitoring, groundwater was reported at depths of between 3.29m to 3.89m bgl.
Environmental Considerations	Following generic risk assessments and statistical analysis, individual elevated concentrations of Arsenic and Lead were reported. The results of statistical analysis indicated the upper ninety fifth percentile value for arsenic to not exceed the respective criteria. Consequently, the concentrations of Arsenic are not considered to present a significant risk to human health. While the upper ninety fifth percentile value for Lead was noted to exceed the criteria, this was indicated to be representative of an isolated hotspot within the site, as opposed to the underlying soil conditions within the site. Formalised development proposals are currently unavailable. In view of the lack of significant controlled water receptors identified (with the site directly underlain by solid deposits of the London Clay), where the area of the hotspot (WS2 & 3) is to be overlain by building footprint or hardstanding, no formal remedial measures will be required, as the covering will act as a suitable barrier. Should the area fall within an area of proposed soft landscaping, the use of a capping layer will be required, comprising a minimum 600mm imported clean topsoil, laid over a geotextile membrane. Alternatively, the samples in question may be submitted for bioavailbility testing to provide an indication of the substances ability to impact human health. No other contaminants were reported above their respective criteria. No asbestos fibres were detected in the samples analysed in the laboratory. No significant controlled water receptors were identified from the desk study (undertaken by others). The results of soil gas monitoring undertaken to date indicate no formal gas protection measures to be required. As with any ground investigation, the presence of further hotspots between sampling points cannot be ruled out. Should any contamination be encountered, a suitably qualified environmental consultant should be informed immediately, so that adequate measures may be recommended.
Geotechnical Considerations	Foundations should not be formed in either the Made Ground or the Topsoil due to the unacceptable risk of total and differential settlement. It should be noted that the demolition and removal of existing structures, foundations and services may increase the depth of Made Ground on the site. It is likely that traditional shallow foundations would be appropriate to support the proposed structure. However, the location of previous, existing and proposed trees must be taken into consideration in the design of foundations. Using the geotechnical testing obtained (summarised in Table 9.1) and with reference to

Site History and Ground Investigation	
	NHBC Chapter 4.2 it can be seen that a minimum founding depth of 1. 5m will be required. Based on the findings of the investigation, it is considered that traditional strip footings, formed at a depth of 2m bgl within the underlying clay, could be designed with an allowable bearing pressure of 125kPa. This however does not take into account the distance to and species of any previous, existing and proposed trees, which must be considered. The above comments are indicative only based on limited ground investigation data. Foundations should be designed by a suitably qualified Engineer. Once structural loads have been fully determined a full design check in accordance with BS EN 1997 should be undertaken to confirm suitability of foundation choice. As Made Ground in excess of 600mm thickness has been reported, and to allow for potential volume change within the underlying clay, suspended floor slabs are recommended. The loadings from the suspended floor slab will need to be carried by the foundations, which will need to be designed to not only carry the structural loadings but the additional floor loadings Any groundwater encountered during construction works should be addressed by conventional pumping from a sump. Excavations during the intrusive works, although open for a relatively short period of time remained reasonably stable. However it is recommended that the stability of all excavations should be assessed during construction. Based on the results of chemical testing, the required concrete class for the site is DS-2 assuming an Aggressive Chemical Environment for Concrete classification of AC-1 in accordance with the procedures outlined in BRE Special Digest 1.

1 INTRODUCTION

1.1 Terms of Reference

1.1.1 IDM Land ("The Client") has commissioned Jomas Associates Ltd, to assess the risk of contamination posed by the ground conditions at a site referred to as 1A Highgate Road, London and to provide indicative recommendations for foundation design prior to the redevelopment of the site.

1.1.2 A Desk Study has been produced for the site (EnviroSmart, December 2015) and provided for information, followed by an intrusive investigation (detailed in this report).

1.1.3 The intrusive investigation was undertaken in accordance with Jomas proposal dated 11 July 2016.

1.2 Proposed Development

1.2.1 The proposed development comprises the conversion of the existing warehouses to a residential usage. The ground floor will be predominantly residential, with a small portion remaining in warehouse use. No car parking is proposed.

1.2.2 For the purposes of the contamination risk assessment, the proposed development is classified as 'Residential without plant uptake'.

1.2.3 For the purpose of geotechnical assessment, it is considered that the project could be classified as a Geotechnical Category (GC) 1 site in accordance with BS EN 1997. GC 1 projects are defined as involving:

- Small and simple structures.
- Requiring qualitative investigation and analysis.
- With negligible risk.
- Straightforward ground conditions.
- Routine design and construction methods.
- No excavation below the water table (unless comparable local experience indicates it will be straightforward).

1.3 Objectives

1.3.1 The objectives of Jomas' investigation were as follows:

- To present a description of the present site status, based upon the published geology, hydrogeology and hydrology of the site and surrounding area;;
- To provide an assessment of the environmental sensitivity at the site and the surrounding area, in relation to any suspected or known contamination which may significantly affect the site and the proposed development;
- To conduct an intrusive investigation, to determine the nature and extent of contaminants potentially present at the site;
- To establish the presence of significant pollutant linkages, in accordance with the procedures set out within Part IIA of the Environmental Protection Act 1990,

associated statutory guidance and current best practice including the EA report R&D CLR 11; and,

- To obtain geotechnical parameters to inform preliminary foundation design.

1.4 Scope of Works

1.4.1 The following tasks were undertaken to achieve the objectives listed above:

- Intrusive ground investigation to determine shallow ground conditions, and potential for contamination at the site;
- Undertaking of laboratory chemical and geotechnical testing upon samples obtained;
- The compilation of this report, which collects and discusses the above data, and presents an assessment of the site conditions, conclusions and recommendations.

1.5 Supplied Documentation

1.5.1 A number of reports previously prepared by third parties were supplied to Jomas Associates at the commencement of this investigation. Table 1.1 details the documents supplied:

Table 1.1: Supplied Reports

Title	Author	Reference	Date
EnviroSmart Report	Geosmart Information Ltd	64500R1	December 2015

1.6 Limitations

1.6.1 Jomas Associates Ltd has prepared this report for the sole use of IDM Land, in accordance with the generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon by any other party without the explicit written agreement of JAL. No other third party warranty, expressed or implied, is made as to the professional advice included in this report. This report must be used in its entirety.

1.6.2 The records search was limited to information available from public sources; this information is changing continually and frequently incomplete. Unless JAL has actual knowledge to the contrary, information obtained from public sources or provided to JAL by site personnel and other information sources, have been assumed to be correct. JAL does not assume any liability for the misinterpretation of information or for items not visible, accessible or present on the subject property at the time of this study.

1.6.3 Whilst every effort has been made to ensure the accuracy of the data supplied, and any analysis derived from it, there may be conditions at the site that have not been disclosed by the investigation, and could not therefore be taken into account. As with any site, there may be differences in soil conditions between exploratory hole positions. Furthermore, it should be noted that groundwater conditions may vary due to seasonal and other effects and may at times be significantly different from those

measured by the investigation. No liability can be accepted for any such variations in these conditions.

1.6.4 Any reports provided to JAL have been reviewed in good faith. JAL cannot be held liable for any errors or omissions in these reports, or for any incorrect interpretation contained within them.

1.6.5 This investigation and report has been carried out in accordance with the relevant standards and guidance in place at the time of the works. Future changes to these may require a re-assessment of the recommendations made within this report.

1.6.6 ***This report is not an engineering design and the figures and calculations contained in the report should be used by the Structural Engineer, taking note that variations may apply, depending on variations in design loading, in techniques used, and in site conditions. Our recommendations should therefore not supersede the Engineer's design.***

2 SITE SETTING

2.1 Site Information

2.1.1 The site location plan is appended to this report as Figure 1.

Table 2.1: Site Information

Name of Site	-
Address of Site	1A Highgate Road London N1 5AE
Approx. National Grid Ref.	528923, 185288
Site Area (Approx)	0.07ha
Site Ownership	Unknown
Site Occupation	Currently vacant
Local Authority	London Borough of Camden
Proposed Site Use	Conversion of the existing warehouses to a residential usage with the majority of the ground floor being residential, with a small portion remaining in warehouse use. No car parking is proposed.

2.2 Desk Study Overview

2.2.1 A Desk Study report has been produced for the site by others (GeoSmart) and provided for information. A brief overview of the desk study findings is presented below. Reference should be made to the full report for detailed information.

2.2.2 A review of historical OS maps provided within the report indicates the presence of buildings (unidentified, possibly commercial) within the site from at least 1871. At this time a portion of the site is also comprised of garden areas from adjacent residential properties. By 1915, the site is reported to be occupied by a single building which occupies the majority of the site (including the former garden areas). This building is identified over subsequent mapping editions as a Welding Works, Engineering Works, and a Works, although no further changes in mapping data are noted.

2.2.3 The surrounding area is reported to have been utilised for a combination of residential and commercial land uses, with uses of note in the local area including a Chemical Warehouse and a Railway.

2.2.4 The report notes the site to be directly underlain by solid deposits of the London Clay Formation, which is identified as unproductive. There are also no source protection zones or groundwater abstractions reported within 500m of the site.

2.2.5 The report identifies no significant surface water features within 250m of the site, and considers controlled waters to represent only a minor receptor.

2.2.6 The report considers the site to present an overall low risk, in view of the proposed development (at the time of writing) which states the site to be overlain by hardstanding. The report recommends a watching brief be undertaken during construction works.

2.2.7 The conceptual site model provided within the report identifies the following potential sources of contamination:

- Potential for inorganic and low volatility organic contaminants to be present within the subsurface soils
- Potential for volatile organic contaminants to be present within the subsurface soils
- Potential for asbestos containing materials within the subsurface soils
- Potential for dissolved phase contaminants to be present within the shallow groundwater
- Potential for elevated methane to be present within the subsurface soils
- Potential for elevated carbon dioxide to be present within the subsurface soils
- Potential for radon within the subsurface
- Railway line

3 GROUND INVESTIGATION

3.1 Rationale for Ground Investigation

3.1.1 The site investigation has been undertaken generally in accordance with Contaminated Land Report 11, BS10175, NHBC Standards Chapter 4.1, and other associated Statutory Guidance. If required, further targeted investigations and remedial option appraisal would be dependent on the findings of this site investigation.

3.1.2 The soil sampling rationale for the site investigation was developed with reference to EA guidance 'Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination' (Technical Report P5-066/TR).

3.1.3 The sampling proposal was designed in order to gather data representative of the site conditions.

3.2 Scope of Ground Investigation

3.2.1 The ground investigation was undertaken in part by Jomas, and in part by others. Jomas' element of the investigation was undertaken on 27th July 2016.

3.2.2 The work was undertaken in accordance with BS5930 'Code of Practice for Site Investigation' and BS10175 'Investigation of Potentially Contaminated Sites'. All works were completed without incident.

3.2.3 The investigation focused on collecting data on the following:

- Quality of Made Ground/ natural ground within the site boundaries;
- Presence of groundwater beneath the site (if any), perched or otherwise;
- Determination of the presence or absence of hazardous ground gases
- Obtaining geotechnical parameters to allow initial design to take place.

3.2.4 A summary of the fieldwork carried out at the site, with justifications for exploratory hole positions, are offered in Table 3.1 below.

Table 3.1: Scope of Intrusive Investigation

Investigation Type	Number of Exploratory Holes Achieved	Exploratory Hole Designation	Depth Achieved (m BGL)	Justification
Window Sample Boreholes	4	WS1 – 4	Up to 4mbgl	Obtain shallow samples for contamination testing. WS1-WS4 positioned for general site coverage. To allow in-situ geotechnical testing.
Monitoring Wells	3	WS1, WS3, WS4	Up to 4mbgl	Combined soil gas and groundwater monitoring wells. WS1 - response zone in Made Ground / Clay

Investigation Type	Number of Exploratory Holes Achieved	Exploratory Hole Designation	Depth Achieved (m BGL)	Justification
				WS3 - response zone in Made Ground / Clay WS4 - response zone in Clay.
Hand dug Trial Pits	≥5	HTP1 - 5	Up to 1.2mbgl	Expose foundations of existing structures. These were undertaken by a third party. With Jomas carrying out an inspection of the pits. At time of inspection 4No.inspection pits had been completed and a fifth was being started.

3.2.5 The exploratory holes were completed to allow soil samples to be taken in the areas of interest identified in Table 3.1 above. In all cases, all holes were logged in accordance with BS5930:2015.

3.2.6 Exploratory hole positions were measured in using tape and reel, as shown in the exploratory hole location plan presented in Appendix 1. The exploratory hole records are included in Appendix 2.

3.2.7 The boreholes were backfilled with the arisings (in the reverse order in which they were drilled) and the ground surface was reinstated so that no depression was left.

3.3 Sampling Rationale

3.3.1 Our soil sampling rationale for the site investigation was developed with reference to EA guidance 'Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination' (Technical Report P5-066/TR).

3.3.2 The exploratory holes were positioned by applying a combined non-targeted sampling strategy, as well as sample locations positioned with reference to sources identified from the desk study.

3.3.3 Soil samples were taken from across the site at various depths as shown in the exploratory hole logs.

3.3.4 JAL's engineers normally collect samples at appropriate depths based on field observations such as:

- appearance, colour and odour of the strata and other materials, and changes in these;
- the presence or otherwise of sub-surface features such as pipework, tanks, foundations and walls; and,
- areas of obvious damage, e.g. to the building fabric.

3.3.5 A number of the samples were taken from the top 0-1m to aid in the assessment of the pollutant linkages identified at the site. In addition, some deeper samples were taken to aid in the interpretation of fate and transport of any contamination identified.

3.3.6 Where groundwater samples are taken, all boreholes were purged of three well volumes prior to obtaining the sample for testing. This removes stagnant groundwater from the monitoring well.

3.3.7 Samples were stored in cool boxes (<4^{o}C) and preserved in accordance with laboratory guidance.

3.3.8 Disturbed samples were collected for geotechnical analysis.

3.3.9 Groundwater strikes noted during drilling, are recorded within the exploratory hole records in Appendix 2.

3.4 Sampling Limitations

3.4.1 All exploratory holes were completed as planned.

3.5 Laboratory Analysis

3.5.1 A programme of chemical laboratory testing, scheduled by JAL, was carried out on selected samples of Made Ground and natural strata.

Chemical Testing

3.5.2 Soil samples were submitted to The Environmental Laboratory Ltd, East Sussex (a UKAS and MCerts accredited laboratory), for analysis.

3.5.3 The samples were analysed for a wide range of contaminants as shown in Table 3.2 below:

Table 3.2: Chemical Tests Scheduled

	No. of tests	
Test Suite	**Made Ground / Topsoil**	**Natural**
Basic Suite 3	5	1
Total Organic Carbon	3	-
Water Soluble Sulphate	-	1
Concrete Suite	3	2
Asbestos Identification	6	

3.5.4 The determinands contained in the basic suite are as detailed in Table 3.3 below:

Table 3.3: Basic Suite of Determinands

DETERMINAND	LIMIT OF DETECTION (mg/kg)	UKAS ACCREDITATION	TECHNIQUE
Arsenic	1	Y (MCERTS)	ICPMS
Cadmium	0.5	Y (MCERTS)	ICPMS
Chromium	5	Y (MCERTS)	ICPMS
Chromium (Hexavalent)	0.02	N	Colorimetry
Lead	5	Y (MCERTS)	ICPMS
Mercury	0.5	Y (MCERTS)	ICPMS
Nickel	5	Y (MCERTS)	ICPMS
Selenium	1	PENDING	ICPMS
Copper	5	Y (MCERTS)	ICPMS
Zinc	45	Y (MCERTS)	ICPMS
Boron (Water Soluble)	0.5	N	ICPMS
pH Value	0.1 units	Y (MCERTS)	Electrometric
Sulphate (Water Soluble)	0.02g/l	Y (MCERTS)	Ion Chromatography
Total Cyanide	1	Y (MCERTS)	Colorimetry
Speciated/Total PAH	0.1/0.4	Y (MCERTS)	GCFID
Phenols	5	Y (MCERTS)	HPLC
Total Petroleum Hydrocarbons (banded)	1	N	Gas Chromatography

3.5.5 To support the derivation of appropriate tier 1 screening values, 3No. samples were also analysed for total organic carbon.

Laboratory test results are summarised in Section 6, with raw laboratory data included in Appendix 3.

Geotechnical Laboratory Testing

3.5.6 In addition to the contamination assessment, soil samples were submitted to the UKAS Accredited laboratory of PSL for the following assessment.

- 8No. Atterberg Limit determinations;
- 8No. Particle Size Distributions;

3.5.7 All testing was in accordance with BS 1377.

3.5.8 In addition, the pH and Sulphate results from the chemical suite were used for concrete classification purposes.

3.5.9 In-situ geotechnical testing included Standard Penetration Test (SPT) to determine a 'N' value

3.5.10 The results of the geotechnical laboratory testing are presented as Appendix 4 and discussed in Section 8 of this report. In-situ test results are included on the exploratory hole logs.

4 GROUND CONDITIONS

4.1 Soil

4.1.1 Ground conditions were logged in accordance with the requirements of BS5930:2015. Detailed exploratory hole logs are provided in Appendix 2. The ground conditions encountered are summarised in Table 4.1 below, based on the strata observed during the investigation.

Table 4.1: Ground Conditions Encountered

Stratum and Description	Encountered from (m bgl)	Base of strata (m bgl)	Thickness range (m)
Screed, brick paving, weak concrete, sandy gravel consisting of brick, flint and concrete. (MADE GROUND).	GL	1.2-1.3	1.2-1.3
Light orange-brown CLAY with flints present at some positions - band of flint in WS1. Mudstone patches in WS4. (LONDON CLAY)	1.0-1.3	1.8-2.5	0.6-1.5
Grey-brown veined blue CLAY. Some fine crystals and orange sandy lenses. (LONDON CLAY)	1.8-2.5	>4.0	>1.5->2.2

4.1.2 The BGS indicates that the site is directly underlain by solid deposits of the London Clay. The London Clay is defined by the BGS as comprising of:

> *"bioturbated or poorly laminated, blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay"*

4.1.3 Consequently the Clay deposits encountered below 1.2m bgl are considered to be London Clay. The colour difference considered to be due to weathering of the upper materials

4.2 Hydrogeology

4.2.1 Groundwater was not reported in any of the window sampler holes during the drilling.

4.2.2 Groundwater measurements obtained during return monitoring are shown within Table 4.2 below:

Table 4.2: Water Monitoring Records

Exploratory Hole ID	Depth Encountered (mbgl)	Stratum within which water was observed	Depth of Response Zone (m bgl)	Response Zone Strata
WS1	3.29 – 3.64	London Clay	1.00 - 3.96	Made Ground and London Clay
WS3	3.45 – 3.83	London Clay	1.00 - 3.92	Made Ground and London Clay
WS4	3.61 – 3.89	London Clay	1.00 - 3.94	London Clay

4.2.3 Given that no groundwater was observed during the drilling works, the observed groundwater levels are considered to potentially represent percolated rainwater that has infiltrated into the Made Ground and is then draining into the well which is then not draining through the London Clay. It is noted that the water is at the base of the wells, with the level gradually increasing with each monitoring visit, further evidencing that these results represent infiltration of rainwater as opposed to the natural groundwater level.

4.3 Physical and Olfactory Evidence of Contamination

4.3.1 Visual or olfactory evidence of contamination was not observed during the course of the investigation.

5 RISK ASSESSMENT – ANALYTICAL FRAMEWORK

5.1 Context and Objectives

5.1.1 This section seeks to evaluate the level of risk pertaining to human health and the environment which may result from both the existing use and proposed future use of the site. It makes use of the site investigation findings, as described in the previous sections, to evaluate further the potential pollutant linkages identified in the desk study. A combination of qualitative and quantitative techniques is used, as described below.

5.1.2 The purpose of generic quantitative risk assessment is to compare concentrations of contaminants found on site against screening level generic assessment criteria (GAC) to establish whether there are actual or potential unacceptable risks. It also determines whether further detailed assessment is required. The approaches detailed all broadly fit within a tiered assessment structure in line with the framework set out in the Department of Environment, Food and Rural Affairs (DEFRA), EA and Institute for Environment and Health Publication, Guidelines for Environmental Risk Assessment and Management.

5.1.3 It should be noted that the statistical tests carried out in this report in accordance with CL:AIRE and CIEH (2008) recommendations, are for guidance purposes only and the conclusions of this report should be approved by the local authority prior to any redevelopment works being undertaken.

5.2 Analytical Framework – Soils

5.2.1 There is no single methodology that covers all the various aspects of the assessment of potentially contaminated land and groundwater. Therefore, the analytical framework adopted for this investigation is made up of a number of procedures, which are outlined below. All of these are based on a Risk Assessment methodology centred on the identification and analysis of Source – Pathway – Receptor linkages.

5.2.2 The CLEA model provides a methodology for quantitative assessment of the long term risks posed to human health by exposure to contaminated soils. Toxicological data have been used to calculate Soil Guideline Values (SGV) for individual contaminants, based on the proposed site use; these represent minimal risk concentrations and may be used as screening values.

5.2.3 In the absence of any published SGVs for certain substances, or where the assumptions made in generating the SGVs do not apply to the site, JAL have obtained Tier 1 screening values for initial assessment of the soil, based on available current UK guidance including the LQM/CIEH S4ULs and DEFRA C4SL. Site-specific assessments are undertaken wherever possible and/or applicable. All assessments are carried out in accordance with the CLEA protocol.

5.2.4 CLEA requires a statistical treatment of the test results to take into account the normal variations in concentration of potential contaminants in the soil and allow comparisons to be made with published guidance.

5.2.5 The assessment criteria used for the screening of determinands within soils are identified within Table 5.1.

Table 5.1: Selected Assessment Criteria – Contaminants in Soils

Substance Group	Determinand(s)	Assessment Criteria Selected
Organic Substances		
Non-halogenated Hydrocarbons	Total Petroleum Hydrocarbons (TPHCWG banded)	LQM/CIEH
	Total Phenols	CLEA v1.06
Polycyclic Aromatic Hydrocarbons (PAH-16)	Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenzo(a,h)anthracene, Benzo(ghi)perylene	LQM/CIEH
Volatile Organic Compounds (VOCs/sVOCs).	Toluene, Ethylbenzene	LQM/CIEH
	Benzene, Xylenes	LQM/CIEH
Inorganic Substances		
Heavy Metals and Metalloids	Arsenic, Cadmium, Chromium, Lead, Mercury, Nickel, Selenium	LQM/CIEH/C4SL
	Copper, Zinc	LQM/CIEH
Cyanides	Free Cyanide	CLEA v1.06
Sulphates	Water Soluble Sulphate	BRE Special Digest 1:2005

5.3 BRE

5.3.1 The BRE Special Digest 1:2005, 'Concrete in Aggressive Ground' is used with soluble sulphate and pH results to assess the aggressive chemical environment of future underground concrete structures at the site.

5.4 Analytical Framework – Groundwater and Leachate

5.4.1 The requirement to protect groundwater from pollution is outlined in Groundwater protection: Principles and practice (GP3, EA, August 2013, v1.1).

5.4.2 Where undertaken, the groundwater quality analysis comprises a Level 1 assessment in accordance with the EA Remedial Targets Methodology Document (EA, 2006).

5.4.3 The criteria used by Jomas' in the Level 1 assessment of groundwater and leachate quality are shown in Table 5.2.

Table 5.2: Selected Assessment Criteria – Contaminants in Water

Substance Group	Determinand(s)	Assessment Criteria Selected
Metals	Arsenic, Copper, Cyanide, Mercury, Nickel, Lead, Zinc, Chromium	EQS/DWS
	Selenium	DWS
PAHs	Sum of Four – benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, indeno(1,2,3-c,d)pyrene	DWS
PAHs	Benzo(a)pyrene,	DWS
PAHs	Remainder	LEC
Total Petroleum Hydrocarbons	Aliphatic C5-C6, Aliphatic >C6-C8, Aliphatic >C8-C10. Aliphatic >C10-C12, Aliphatic >C12-C16, Aliphatic >C16-C21, Aromatic C5-C7, Aromatic >C7-C8, Aromatic >C8-C10, Aromatic >C10-C12, Aromatic >C12-C16, Aromatic >C16-C21, Aromatic> C21-C35	DWS/WHO
Benzene	Benzene	DWS
Toluene	Toluene	EQS
Ethylbenzene	Ethylbenzene	EQS
Xylene	Xylene	EQS
Oxygen Demand	Chemical Oxygen Demand and Biological Oxygen Demand	Urban Waste Water Treatment (England and Wales) Regulations

Environmental Quality Standards EQS

Environmental Quality Standards (EQS) have been released by the EA for dangerous substances, as identified by the EC Dangerous Substances Directive. EQS can vary for each substance, for the hardness of the water and can be different for fresh, estuarine or coastal waters.

Lowest Effect Concentration (LEC)

These criteria relate to the concentration of PAHs in groundwater. They are taken from the EA R&D Technical Report P45 – Polycyclic Aromatic Hydrocarbons (PAH): Priorities for Environmental Quality Standard Development (2001).

WHO Health

These screening criteria have been taken from the World Health Organisation Guidelines for Drinking Water Quality (1984). The health value is a guideline value representing the concentration of a contaminant that does not result in any significant risk to the receptor over a lifetime of exposure.

Further criteria have been obtained from 'Petroleum Products in Drinking-water' - Background document for development of WHO Guidelines for Drinking-water Quality (2005).

UK Drinking Water Standards (DWS)
These comprise screening criteria provided by the Drinking Water Inspectorate (DWI) in the Water Supply (Water Quality) Regulations 2006,

Urban Waste Water Treatment (England and Wales) Regulations - UWWT Regs
The Urban Waste Water Treatment (England and Wales) Regulations SI/1994/2841 as amended by SI/2003/1788 sets down minimum standards for the discharge of treated effluent from waste water treatment works to inland surface waters, groundwater, estuaries or coastal waters. Standards of (125mg/L) COD and (25mg/L) BOD have been set.

5.5 Site Specific Criteria

5.5.1 The criteria adopted in the selection of correct screening criteria from published reports as previously described, are provided within Tables 5.3.

Table 5.3: Site Specific Data

Input Details	Value
Land Use	Residential without plant uptake
Soil Type	Clay
pH	8
Soil Organic Matter	1%

5.5.2 A pH value of '8' has been used for the derivation of generic screening criteria as 8.38 was the mean pH value of samples analysed.

5.5.3 As the published reports only offer the option of selecting an SOM value of 1%, 2.5% or 6%, an SOM value of 1% has been used for the generation of generic assessment criteria, as 1.23% was the mean value obtained from laboratory analysis.

5.5.4 It is understood that the proposed development comprises the conversion of the existing warehouses to a residential usage. The ground floor will be predominantly residential, with a small portion remaining in warehouse use. No car parking is proposed. As a result the site has been assessed as 'Residential without Plant Uptake'.

6 GENERIC QUANTITATIVE RISK ASSESSMENT

6.1 Screening of Soil Chemical Analysis Results – Human Health Risk Assessment

6.1.1 To focus on the contaminants of potential concern (COPC), the results have been compared with the respective SGV/GAC. Those contaminants which exceed the SGV/GAC are considered to be the COPC. Those which do not exceed the respective SGV/GAC are not considered to be COPC and as such do not require further assessment in relation to the proposed development of the site.

6.1.2 Laboratory analysis for soils are summarised in Tables 6.1 to 6.3. Raw laboratory data is included in Appendix 7.

Table 6.1: Soil Laboratory Analysis Results – Metals, Metalloids, Phenol, Cyanide

Determinand	Unit	No. samples tested	Screening Criteria		Min	Max	No. Exceeding
Arsenic	mg/kg	6	40	S4UL	8.6	45.0	1 (WS2 @0.4m)
Cadmium	mg/kg	6	85	S4UL	<0.2	0.9	0
Chromium	mg/kg	6	910	S4UL	27	64	0
Lead	mg/kg	6	310	C4SL	13	1700	2 (WS2 @0.4m, WS3 @0.7m)
Mercury	mg/kg	6	56	S4UL	<0.3	3.0	0
Nickel	mg/kg	6	180	S4UL	24	54	0
Copper	mg/kg	6	7100	S4UL	34	180	0
Zinc	mg/kg	6	40000	S4UL	81	400	0
Total Cyanide [A]	mg/kg	6	33	CLEA v 1.06	<1	5	0
Selenium	mg/kg	6	430	S4UL	<1.0	1.2	0
Boron Water Soluble	mg/kg	6	11000	S4UL	1.8	8.5	0
Phenols	mg/kg	6	750	S4UL	<1	<1	0

Notes:

[A] Generic assessment criteria derived for free inorganic cyanide.

Table 6.2: Soil Laboratory Analysis Results – Polycyclic Aromatic Hydrocarbons (PAHs)

Determinand	Unit	No. Samples Tested	Screening Criteria		Min	Max	No. Exceeding
Naphthalene	mg/kg	6	S4UL	2.3	<0.05	0.27	0
Acenaphthylene	mg/kg	6	S4UL	2900	<0.10	<0.10	0
Acenaphthene	mg/kg	6	S4UL	3000	<0.10	<0.10	0
Fluorene	mg/kg	6	S4UL	2800	<0.10	<0.10	0
Phenanthrene	mg/kg	6	S4UL	1300	<0.10	0.85	0
Anthracene	mg/kg	6	S4UL	2300	<0.10	0.14	0
Fluoranthene	mg/kg	6	S4UL	1500	<0.10	1.7	0
Pyrene	mg/kg	6	S4UL	3700	<0.10	1.4	0
Benzo(a)anthracene	mg/kg	6	S4UL	11.0	<0.10	0.94	0
Chrysene	mg/kg	6	S4UL	30	<0.05	0.82	0
Benzo(b)fluoranthene	mg/kg	6	S4UL	3.9	<0.10	1.3	0
Benzo(k)fluoranthene	mg/kg	6	S4UL	110	<0.10	0.53	0
Benzo(a)pyrene	mg/kg	6	S4UL	3.2	<0.10	0.86	0
Indeno(123-cd)pyrene	mg/kg	6	S4UL	45	<0.10	0.44	0
Dibenzo(ah)anthracene	mg/kg	6	S4UL	0.31	<0.10	<0.10	0
Benzo(ghi)perylene	mg/kg	6	S4UL	360	<0.05	0.48	0
Total PAH	mg/kg	6	-		<1.60	9.7	-

Table 6.3: Soil Laboratory Analysis Results – Total Petroleum Hydrocarbons (TPH)

TPH Band	Unit	No. Samples Tested	Screening Criteria		Min	Max	No. Exceeding
C_8-C_{10}	mg/kg	6	S4UL	27	<0.1	<1	0
>C_{10}-C_{12}	mg/kg	6	S4UL	130	<2.0	<1	0
>C_{12}-C_{16}	mg/kg	6	S4UL	1100	<4.0	13	0
>C_{16}-C_{21}	mg/kg	6	S4UL	1900	<1.0	56	0
>C_{21}-C_{35}	mg/kg	6	S4UL	1900	<10	1100	0
Total TPH	mg/kg	6	-	-	<10	1156.5	-

Note: *The lower value of guidelines for Aromatic/Aliphatics has been selected

6.2 Statistical Analysis

6.2.1 Where samples tested exceeded the selected screening criteria, and the minimum numbers of samples were more than six, statistical analyses of the dataset are undertaken.

6.2.2 The CL:AIRE/CIEH Guidance 'Guidance on Comparing Soil Contamination Data with a Critical Concentration' (2008) describes the new approach to statistical analysis of datasets generated through the investigation of contaminated land. This includes differing statistical methodologies for the analysis of normally and non-normally distributed data. Different approaches to datasets being analysed under Part IIA and under the planning regime are also presented.

6.2.3 Chemical data from the laboratory testing has been assessed in accordance with the CL:AIRE/CIEH Guidance under a planning scenario. The purpose of the assessment is to determine if the land is suitable for the proposed development. Under the planning scenario, the key question is 'is there sufficient evidence that the true mean concentration of the contaminant within the data set (μ) is less than the critical concentration (Cc, in this instance the derived GAC). This is assessed by calculation of the upper confidence limit (UCL). The statistical test assesses the 95th percentile of contaminant populations across a site, and compares this value against the relevant GAC. Furthermore, the test determines statistically whether contaminants exceeding the soil guideline value could be regarded as outliers. Outliers are contaminant values which indicate a localised area of contamination or error in sampling, and may not be a member of the underlying population.

6.2.4 The statistical tests were run for:

- Arsenic
- Lead

6.2.5 The results of statistical tests are presented in Appendix 5. Table 6.4 below provides the summary of statistical tests.

Table: 6.4 Statistical Test Results

Determinand	95% UCL	Cc/GAC	GAC Exceeded
Arsenic	31.73	40	N
Lead	930.1	310	Y

6.2.6 The results of statistical tests indicate the upper ninety fifth percentile value for Arsenic to be below the respective assessment criteria. Consequently the concentrations of Arsenic identified during this investigation are not considered to pose a significant risk to human health.

6.2.7 The upper ninety fifth percentile value for Lead was noted to exceed the respective criteria. Further statistical analysis indicated the most significantly elevated concentration of Lead to represent an isolated hotspot.

6.3 Asbestos in Soil

6.3.1 6 No. samples of the made ground were screened in the laboratory for the presence of asbestos. These comprised samples taken from;

- WS1 – 0.8m
- WS2 – 0.4m
- WS2 – 0.7m
- WS3 – 0.4m
- WS3 – 1.0m
- WS4 – 0.6m

6.3.2 No asbestos fibres were detected.

6.4 Screening of Soil Chemical Analysis Results – Potential Risks to Plant Growth

6.4.1 Zinc, copper and nickel are phytotoxins and could therefore inhibit plant growth in soft landscaped areas. Concentrations measured in soil for these determinands have been compared with the pH dependent values given in BS3882:2007.

6.4.2 Adopting a pH value of greater than 7, as indicated by the results of the laboratory analysis, the following is noted;

Table 6.5: Soil Laboratory Analysis Results – Phytotoxic Determinands

Determinand	Threshold level (mg/kg)	Min (mgkg)	Max (mg/kg)	No. Exceeding
Zinc	300	81	400	1 (WS2 @0.4m)
Copper	200	34	180	0
Nickel	110	24	54	0

6.5 Screening for Water Pipes

6.5.1 The results of the analysis have been assessed for potential impact upon water supply pipes. Table 6.6 below summarises the findings of the assessment:

Table 6.6: Screening Guide for Water Pipes

Determinand	Threshold adopted for PE (mg/kg)	Min Value for site data	Max Value from site data
Total VOCs	0.5	-	-
BTEX	0.1	-	-
MTBE	0.1	-	-
EC5-EC10	1	<0.1	<0.1
EC10-EC16	10	<4	13
EC16-EC40	500	<10	1148
Naphthalene	5	<0.05	0.27
Phenols	2	<1	<1

6.5.2 The above results indicate that upgraded pipework may be required.

6.5.3 The water supply pipe requirements for this site should be discussed at an early stage with the relevant Utility provider.

6.6 Waste Disposal

6.6.1 The classification of materials for waste disposal purposes was outside the scope of this report. Should quantities of material require off-site disposal, Waste Acceptance Criteria testing will be required.

7 SOIL GAS RISK ASSESSMENT

7.1 Soil Gas Results

7.1.1 Three return monitoring visits were undertaken between the 10/08/16 and 22/08/16 to monitor wells installed within boreholes at the site for soil gas concentrations and groundwater levels.

7.1.2 The results of the monitoring undertaken are summarised in Table 7.1 below, with the monitoring records presented in Appendix 6.

Table 7.1: Summary of Gas Monitoring Data

Hole No.	CH_4 (%)	CO_2 (%)	O_2 (%)	H_2S (ppm)	Peak Flow Rate (l/hr)	Depth to water (mbgl)	Depth of installation (mbgl)
WS1	0.1	0.1 – 0.3	20.3 – 20.6	0	0.2 – 0.3	3.29 – 3.64	3.94
WS3	0.1	0.4 – 0.6	19.9 - 20.1	0	0.2	3.45 – 3.84	3.92
WS4	0.1	0.2 – 0.6	20.1 – 20.5	0	0.2 – 0.3	3.61 – 3.89	3.96

7.2 Screening of Results

7.2.1 As shown in Table 7.1, methane and carbon dioxide have been reported to maximum concentrations of 0.1% and 0.6% v/v respectively. A maximum flow rate of 0.3l/hr has been reported.

7.2.2 In the assessment of risks posed by hazardous ground gases and selection of appropriate mitigation measures, BS84985 (2015) identifies four types of development, termed Type A to Type D.

7.2.3 Type B buildings are defined as

> *" private or commercial property with central building management control of any alterations to the building or its uses but limited or no central building management control of the maintenance of the building, including the gas protection measures. Multiple occupancy. Small to medium size rooms with passive ventilation of rooms and other internal spaces throughout ground floor and basement areas. May be conventional building or civil engineering construction. Examples include managed apartments, multiple occupancy offices, some retail premises and parts of some public buildings (such as schools, hospitals, leisure centres) and parts of hotels."*

7.2.4 Type B has been adopted as the relevant category for the proposed development.

7.2.5 The soil gas assessment method is based on that proposed by Wilson & Card (1999), which was a development of a method proposed in CIRIA publication R149 (CIRIA, 1995). The method uses both gas concentrations and borehole flow rates to define a characteristic situation based on the limiting borehole gas volume flow for methane and carbon dioxide. In both these methods, the limiting borehole gas volume flow is renamed as the Gas Screening Value (GSV).

7.2.6 The Gas Screening Value (litres of gas per hour) is calculated by using the following equation

GSV = (Concentration/100) X Flow rate

Where concentration is measured in percent (%)
and flow rate is measured in litres per hour (l/hr)

7.2.7 The Characteristic Situation is then determined from Table 8.5 of CIRIA C665.

7.2.8 To accord with C665, worst case conditions are used in the calculation of GSVs for the site.

7.2.9 A worst case flow rate of 0.3l/hr (maximum reported) will be used in the calculation of GSVs for the site. The Characteristic Situation is then determined from Table 8.5 of CIRIA C665.

7.2.10 To accord with C665, worst case conditions are used in the calculation of GSVs for the site. These have been summarised below in Table 7.2

Table 7.2: Summary of Gas Monitoring Data

Gas	Concentration (v/v %)	Peak Flow Rate (l/hr)	GSV (l/hr)	Characteristic Situation (after CIRIA C665)
CO_2	0.6	0.3	**0.0018**	**1**
CH_4	0.1	0.3	**0.0003**	**1**

7.2.11 The methodology set out in BS 8485 (2015) has been used for determining the required gas protection measures.

7.2.12 The results of the monitoring undertaken to date would indicate Characteristic Situation 1 to be appropriate, where no formal gas protection measures are required.

8 SUMMARY OF RESULTS

8.1 Risk Assessment - Land Quality Impact Summary

8.1.1 Following the site investigation, the following is noted:

- It is understood that the proposed development will comprise the demolition of the existing buildings for the construction of a new mixed use development. The majority of the site is anticipated to be covered by a combination of building footprint and hardstanding.
- Following generic risk assessments and statistical analysis, individual elevated concentrations of Arsenic and Lead were reported.
- The results of statistical analysis indicated the upper ninety fifth percentile value for arsenic does not exceed the respective criteria. Consequently, the concentrations of Arsenic are not considered to present a significant risk to human health.
- While the upper ninety fifth percentile value for Lead was noted to exceed the criteria, this was indicated to be representative of an isolated hotspot within the site, as opposed to the underlying soil conditions within the site.
- Formalised development proposals are currently unavailable. In view of the lack of significant controlled water receptors identified (with the site directly underlain by solid deposits of the London Clay), where the area of the hotspot (WS2 & 3) is to be overlain by building footprint or hardstanding, no formal remedial measures are considered necessary, as the covering should act as a suitable barrier.
- Should the area fall within an area of proposed soft landscaping, the use of a capping layer will be required, comprising a minimum 600mm imported clean topsoil, laid over a geotextile membrane. Alternatively, the samples in question may be submitted for bioavailbility testing to provide an indication of the substances ability to impact human health when ingested.
- No other contaminants were reported above their respective criteria.
- No asbestos fibres were detected in the samples analysed in the laboratory.
- No significant controlled water receptors were identified from the desk study (undertaken by others).
- The results of soil gas monitoring undertaken to date indicate no formal gas protection measures to be required.
- As with any ground investigation, the presence of further hotspots between sampling points cannot be ruled out. Should any contamination be encountered, a suitably qualified environmental consultant should be informed immediately, so that adequate measures may be recommended.

8.1.2 The above conclusions are made subject to approval by the statutory regulatory bodies.

8.2 Review of Pollutant Linkages Following Site Investigation

8.2.1 The site CSM has been revised and updated from that suggested in the desk study in view of the ground investigation data, including soil laboratory analysis results. Table 8.1 highlights whether pollutant linkages identified in the original CSM are still relevant following the risk assessment, or whether pollutant linkages, not previously identified, exist.

Table 8.1: Plausible Pollutants Linkages Summary (Pre Remediation)

Potential Source (from desk study)	Pathway	Receptor	Relevant Pollutant Linkage?	Comment
• Potential for inorganic and low volatility organic contaminants to be present within the subsurface soils • Potential for volatile organic contaminants to be present within the subsurface soils • Potential for asbestos containing materials within the subsurface soils • Potential for dissolved phase contaminants to be present within the shallow groundwater • Potential for elevated methane to be present within the subsurface soils • Potential for elevated carbon dioxide to be present within the subsurface soils • Potential for radon within the subsurface • Railway line	• Ingestion and dermal contact with contaminated soil (P1) • Inhalation or contact with potentially contaminated dust and vapours (P2) • Permeation of water pipes and attack on concrete foundations by aggressive soil conditions (P6)	• Construction workers (R1) • Maintenance workers (R2) • Neighbouring site users (R3) • Future site users (R4) • Building foundations and on site buried services (water mains, electricity and sewer) (R5)	**Y**	see 9.1 above The findings of this report should be included in the construction health and safety file, with adequate measures put in place for the protection of construction and maintenance workers.
	• Accumulation and migration of soil gases (P5)		**X**	Results of gas monitoring undertaken to date indicate no formal gas protection measures to be required
	• Leaching through permeable soils, migration within the vadose zone (i.e., unsaturated soil above the water table) and/or lateral migration within surface water, as a result of cracked hardstanding or via service pipe/corridors and surface water runoff. (P3) Horizontal and vertical migration of contaminants within groundwater (P4)	• Neighbouring site users (R3) • Building foundations and on site buried services (water mains, electricity and sewer) (R5)	**X**	No significant controlled water receptors identified from previous desk study Contact should be made with relevant utility providers to confirm if upgraded materials are required.

9 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

9.1 Ground Investigation Summary

9.1.1 No detailed structural engineering design information, with respect to the type of construction and associated structural loadings, was provided at the time of preparing this report. Consequently, a detailed discussion of all the problems that may arise during the proposed redevelopment scheme is beyond the scope of this report.

9.1.2 Practical solutions to the difficulties encountered, both prior to, and during construction, are frequently decided by structural constraints or economic factors. For these reasons, this discussion is predominantly confined to remarks of a general nature, which are based on site conditions encountered during the intrusive investigations.

9.1.3 It is understood that the proposed development comprises the conversion of the existing warehouses to a residential usage. The ground floor will be predominantly residential, with a small portion remaining in warehouse use. No car parking is proposed.

9.2 Geotechnical Data Summary

9.2.1 The results of the ground investigation revealed a ground profile comprising a variable thickness of Made Ground (between 1.2 and 1.3m bgl depth), overlying a light orange brown becoming grey silty Clay (considered to represent the London Clay), encountered to the base of the boreholes (up to 4m bgl).

9.2.2 A summary of ground conditions obtained from the ground investigation and subsequent laboratory testing, is provided in Table 9.1 below.

Table 9.1: Summary of Ground Conditions And Subsequent Laboratory Testing

Strata	Depth Encountered (from-to)	SPT 'N' Value	Shear Strength (kPa)	Moisture content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (plasticity term)	NHBC Volume Change Classification
MADE GROUND	GL to 1.2 – 1.3	4	-	-	-	-	-	-
Light orange brown becoming grey brown with depth, sandy silty CLAY with some bands of flint (LONDON CLAY)	1.2 – 1.3 to >4.0	10 - 16	45 - 72	28 - 33	67 - 76	27 - 30	40 - 46	High

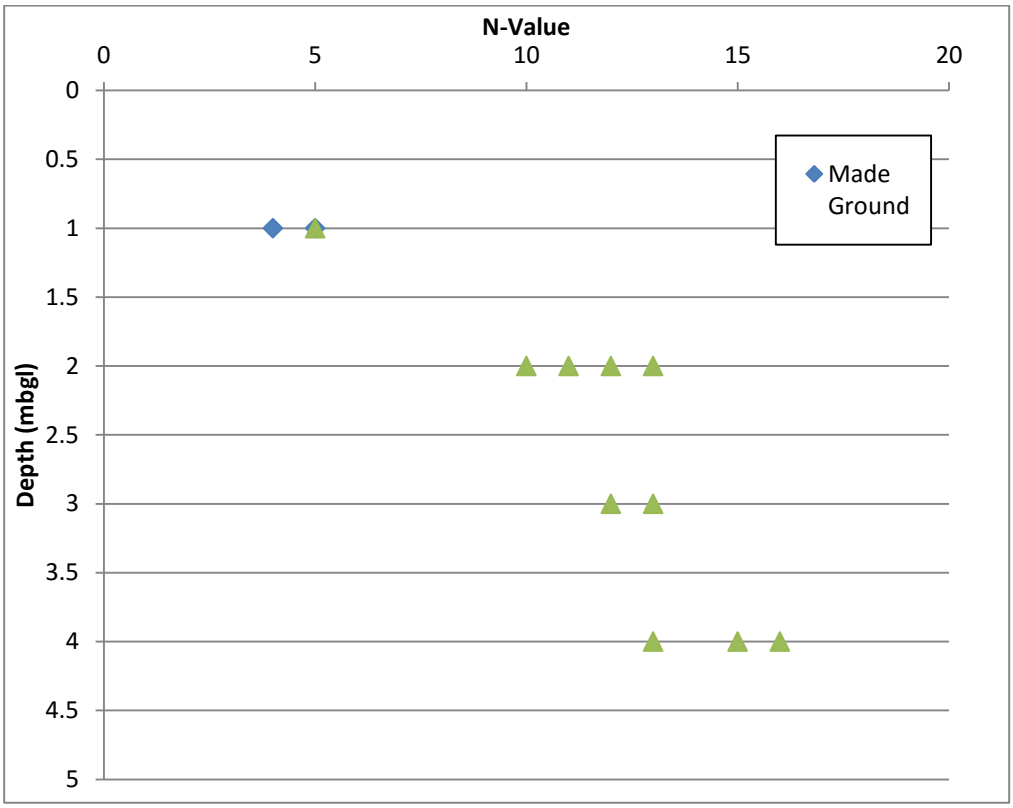
9.3 Geotechnical Data Summary

9.3.1 Standard Penetration Tests were undertaken at regular intervals throughout the window sampler holes and cable percussive borehole. The results of the SPTs are plotted against depth in Figure 9.1 below.

9.3.2 Due to the observational differences, the strata have been grouped into “Made Ground” and “London Clay”

9.3.3 N_{equi} results have been calculated for both stratum where SPT’s crossed strata.

Figure 9.1: SPT ‘N’ vs Depth



9.4 Undrained Shear Strength

9.4.1 As discussed above, the N values recorded in the clay varies with depth, this infers that the undrained shear strength of the clay is similarly variable. Figure 9.2 below shows the undrained shear strength inferred by the correlation suggested by Stroud (1974),

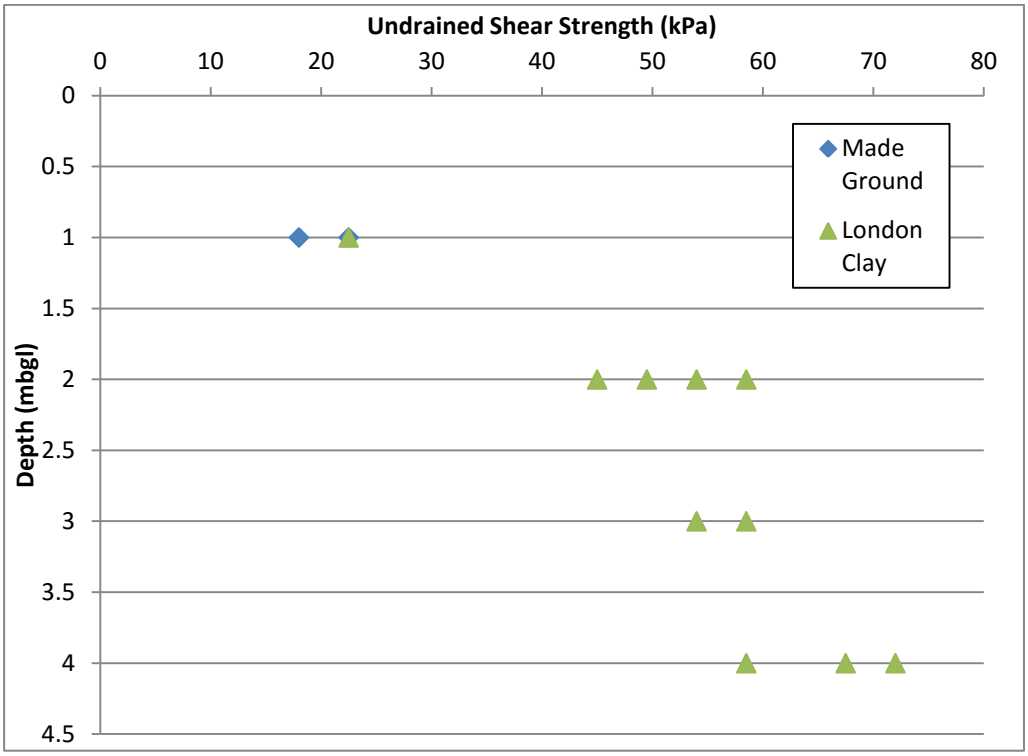
c_u = f1 x N can be applied,

in which
c_u= mass shear strength (kN)
f1 = constant (usually taken as 4.5 for London Clay Formation)

N = SPT Value achieved during boring operations

9.4.2 The graph below shows the shear strength profile of the London Clay Formation encountered at the site, based on the SPT to shear strength correlation described above, as well as the results of undrained triaxial tests on undisturbed samples taken from the boreholes.

Figure 9.2: Undrained Shear Strength (kPa) vs Depth



9.5 Building Near Trees

9.5.1 Reference to NHBC Chapter 4 indicates that the cohesive strata beneath the site are a high volume change potential as defined within Chapter 4.2 NHBC guidelines.

9.5.2 NHBC Chapter 4 guidance specifies a minimum 1.5m foundation depth due to the underlying clay being identified as high volume change.

9.5.3 The final depths of the foundations should be determined in accordance with NHBC guidance taking into account nearby trees..

9.6 Foundations

9.6.1 Foundations should not be formed in either the Made Ground or the Topsoil due to the unacceptable risk of total and differential settlement. It should be noted that the demolition and removal of existing structures, foundations and services may increase the depth of Made Ground on the site.

9.6.2 It is likely that traditional shallow foundations would be appropriate to support the proposed structure. However, the location of previous, existing and proposed trees must be taken into consideration in the design of foundations.

9.6.3 Using the geotechnical testing obtained (summarised in Table 9.1) and with reference to NHBC Chapter 4.2 it can be seen that a minimum founding depth of 1. 5m will be required.

9.6.4 Based on the findings of the investigation, it is considered that traditional strip footings, formed at a depth of 2m bgl within the underlying clay, could be designed with an allowable bearing pressure of 125kPa. This however does not take into account the distance to and species of any previous, existing and proposed trees, which must be considered.

9.6.5 The above comments are indicative only based on limited ground investigation data. Foundations should be designed by a suitably qualified Engineer. Once structural loads have been fully determined a full design check in accordance with BS EN 1997 should be undertaken to confirm suitability of foundation choice.

9.7 Concrete in the Ground

9.7.1 Sulphate attack on building foundations occurs where sulphate solutions react with the various products of hydration in Ordinary Portland Cement (OPC) or converted High-Alumina Cement (HAC). The reaction is expansive, and therefore disruptive, not only due to the formation of minute cracks, but also due to loss of cohesion in the matrix.

9.7.2 In accordance with BRE Special Digest 1, as there are less than 10 results in the data set the highest value has been taken.

9.7.3 Table 9.2 summarises the analysis of the aggressive nature of the ground for each of the strata encountered within the ground investigation.

Table 9.2: Concrete in the Ground Classes

Stratum	No. Samples	pH range	WS Sulphate (ave 20% / highest)	Design Sulphate Class	ACEC Class
Made Ground	9	7.4 – 9.7	1.4	DS2	AC1
London Clay	2	8.4	0.41	DS1	AC1

9.8 Ground Floor Slabs

9.8.1 As Made Ground in excess of 600mm thickness has been reported, and to allow for potential volume change within the underlying clay, suspended floor slabs are recommended.

9.8.2 The loadings from the suspended floor slab will need to be carried by the foundations, which will need to be designed to not only carry the structural loadings but the additional floor loadings.

9.9 Excavations

9.9.1 It is likely that some shallow excavations will be required at the site for services etc, in addition to larger excavations during the remediation and construction works. These are anticipated to remain stable for the short term only.

9.9.2 It is recommended that the stability of all excavations should be assessed during construction. The sides of any excavations into which personnel are required to enter, should be assessed and where necessary fully supported or battered back to a safe angle.

9.10 Groundwater Control

9.10.1 During the investigation groundwater was not reported.

9.10.2 During return monitoring groundwater was reported at depths of between 3.29m and 3.89m bgl, with the base of the monitoring well at between 3.92m and 3.96m bgl. The depth to groundwater was also noted to decrease slightly with each monitoring visit, suggesting slow rise in the groundwater level. As a result, and in view of the underlying ground (clay) it is considered that these results likely represent gradual infilling of the monitoring well by rainwater as opposed to the natural groundwater level.

9.10.3 Subject to seasonal variations, any groundwater / surface water or rainfall ingress encountered during site works could be readily dealt with by conventional pumping from a sump.

10 REFERENCES

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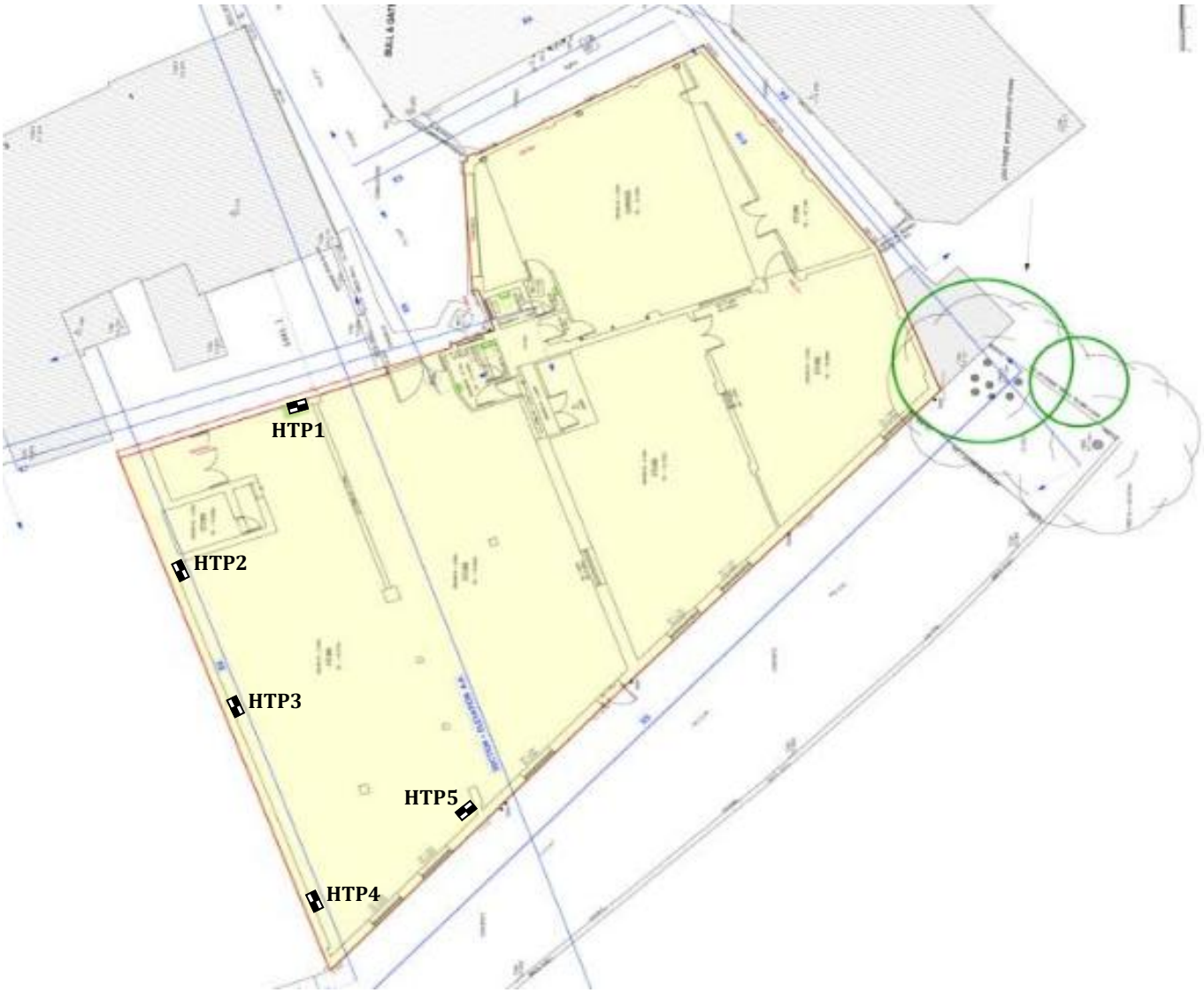
National Planning Policy Framework. Department for Communities and Local Government, March 2012

APPENDICES

APPENDIX 1 – FIGURES

Project Name	1a Highgate Road	**Client**	Barrett Mahony
Title	Proposed Exploratory Holes	**Project No.**	P9602J896



Project Name	1a Highgate Road	**Client**	Barrett Mahony
Title	Proposed Exploratory Holes	**Project No.**	P9602J896
Date	25/07/2016	**Prepared By**	TME

APPENDIX 2 – EXPLORATORY HOLE RECORDS

WINDOW/WINDOWLESS SAMPLING BOREHOLE RECORD

Exploratory Hole No:	WS1		
Site Address:	1A Highgate Road, London	Project No:	P9602J896
Client:	IDM HDF LLP	Ground Level:	
Logged By:	JE	Date Commenced:	27/07/2016
Checked By:	MW	Date Completed:	27/07/2016
Type and diameter of equipment:	Dando Terrier Rig	Sheet No:	1 Of 1

Water levels recorded during boring, m

Date:						
Hole depth:						
Casing depth:						
Level water on strike:						
Water Level after 20mins:						

Remarks

1:
2:
3:
4:

Sample or Tests										Strata				
Type	Depth (mbgl)	Result								Legend	Depth (mbgl)	Water Strikes (mbgl)	Strata Description	Installation
		75	75	75	75	75	75	N						
									0.00					
											0.10		MADE GROUND - Screed over brick paving blocks	
											0.30		MADE GROUND - CONCRETE	
J+P	0.50								0.50				MADE GROUND - Dark brown grey silty sandy gravel. Gravel is of brick, concrete and flint	
P	0.80										0.90			
S P	1.00	1	1	1	1	1	1	4	1.00				MADE GROUND - Dark yellow brown clay with occasional flint	
											1.20			
													Medium Strength light orange brown CLAY - Band of flint at 1.6m-1.7m	
									1.50					
											1.90			
S D	2.00	1	2	2	2	3	3	10	2.00				High strength grey brown veined blue CLAY	
									2.50					
S D	3.00	1	1	3	2	3	4	12	3.00					
									3.50					
S+D	4.00	2	2	3	3	4	5	15	4.00		4.00			
									4.50					
									5.00					

Sampling Code: U- Undisturbed B - Large Disturbed D - Small Disturbed W - Water (U*) Non recovery of Sample

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WINDOW/WINDOWLESS SAMPLING BOREHOLE RECORD

Exploratory Hole No:	WS2		
Site Address:	1A Highgate Road, London	Project No:	P9602J896
Client:	IDM HDF LLP	Ground Level:	
Logged By:	JE	Date Commenced:	27/07/2016
Checked By:	MW	Date Completed:	27/07/2016
Type and diameter of equipment:	Dando Terrier Rig	Sheet No:	1 Of 1

Water levels recorded during boring, m

Date:						
Hole depth:						
Casing depth:						
Level water on strike:						
Water Level after 20mins:						

Remarks

1:
2:
3:
4:

Sample or Tests										Strata				
Type	Depth (mbgl)	Result								Legend	Depth (mbgl)	Water Strikes (mbgl)	Strata Description	Installation
		75	75	75	75	75	75	N						
									0.00					
											0.10		MADE GROUND - Screed over brick cobble paving	
P	0.20												MADE GROUND - CONCRETE	
											0.37			
P	0.40												MADE GROUND - Dark brown black sandy silty gravelly clay. Gravel is of brick and flint	
									0.50		0.50			
													MADE GROUND - Brown patched grey dark orange silty clay with frequent brick and flint fragments	
P	0.70													
S	1.00	0	2	1	2	1	1	5	1.00					
D	1.20										1.20			
													Medium strength stiff light orange brown CLAY - occasional fine roots and flints	
									1.50					
											1.80			
													High strength grey brown veined blue grey CLAY - some fine crystals and sandy orange lenses	
S	2.00	2	2	3	3	3	4	13	2.00					
D														
									2.50					
S	3.00	2	3	3	3	3	3	12	3.00					
D														
									3.50					
											4.00			
S	4.00	1	1	3	3	5	5	16	4.00					
D														
									4.50					
									5.00					

Sampling Code: U- Undisturbed B - Large Disturbed D - Small Disturbed W - Water (U*) Non recovery of Sample

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WINDOW/WINDOWLESS SAMPLING BOREHOLE RECORD

		Exploratory Hole No:	WS3
Site Address:	1A Highgate Road, London	Project No:	P9602J896
Client:	IDM HDF LLP	Ground Level:	
Logged By:	JE	Date Commenced:	27/07/2016
Checked By:	MW	Date Completed:	27/07/2016
Type and diameter of equipment:	Dando Terrier Rig	Sheet No:	1 Of 1

Water levels recorded during boring, m						
Date:						
Hole depth:						
Casing depth:						
Level water on strike:						
Water Level after 20mins:						

Remarks

1:
2:
3:
4:

Sample or Tests										Strata				
Type	Depth (mbgl)	Result								Legend	Depth (mbgl)	Water Strikes (mbgl)	Strata Description	Installation
		75	75	75	75	75	75	N						
									0.00					
											0.08		MADE GROUND - SCREED	
													MADE GROUND - CONCRETE	
											0.30			
P	0.40												MADE GROUND - Dark brown grey clayey sandy gravel. Gravel is of brick and flint	
									0.50					
P	0.70													
S	1.00	1	1	1	1	1	1	4	1.00					
P														
											1.30			
													Medium strength light orange brown CLAY	
									1.50					
S	2.00	1	1	2	3	3	4	12	2.00					
D														
											2.20			
													High strength grey brown veined blue grey CLAY with occasional crystals	
D	2.50								2.50					
S	3.00	2	2	2	3	4	3	12	3.00					
D														
									3.50					
											4.00			
S	4.00	2	2	2	3	4	4	13	4.00					
D		2	2	2	3	4	4	13						
									4.50					
									5.00					

Sampling Code: U- Undisturbed B - Large Disturbed D - Small Disturbed W - Water (U*) Non recovery of Sample

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WINDOW/WINDOWLESS SAMPLING BOREHOLE RECORD

Exploratory Hole No:	WS4		
Site Address:	1A Highgate Road, London	Project No:	P9602J896
Client:	IDM HDF LLP	Ground Level:	
Logged By:	JE	Date Commenced:	27/07/2016
Checked By:	MW	Date Completed:	27/07/2016
Type and diameter of equipment:	Dando Terrier Rig	Sheet No:	1 Of 1

Water levels recorded during boring, m

Date:						
Hole depth:						
Casing depth:						
Level water on strike:						
Water Level after 20mins:						

Remarks

1:
2:
3:
4:

Sample or Tests										Strata				
Type	Depth (mbgl)	Result								Legend	Depth (mbgl)	Water Strikes (mbgl)	Strata Description	Installation
		75	75	75	75	75	75	N						
									0.00		0.12		MADE GROUND - Concrete slab over DPM	
											0.19		MADE GROUND / SUBBASE - Sandy gravel. Gravel is of flint	
											0.30		MADE GROUND - CONCRETE	
											0.52		MADE GROUND - CONCRETE	
									0.50					
P	0.60												MADE GROUND - Dark brown patched orange gravellly clay. Gravel is of flint	
S	1.00	1	0	1	1	1	2	5	1.00		1.00			
P													Medium strength orange brown mottled grey CLAY with occasional buff mudstone patches	
									1.50					
S	2.00	2	1	2	3	3	3	11	2.00					
D														
											2.50			
									2.50				Stiff grey brown veined blue grey CLAY	
S	3.00	2	2	3	3	3	4	13	3.00					
D														
									3.50					
											4.00			
S	4.00	2	2	2	4	3	4	13	4.00					
D														
									4.50					
									5.00					

Sampling Code: U- Undisturbed B - Large Disturbed D - Small Disturbed W - Water (U*) Non recovery of Sample

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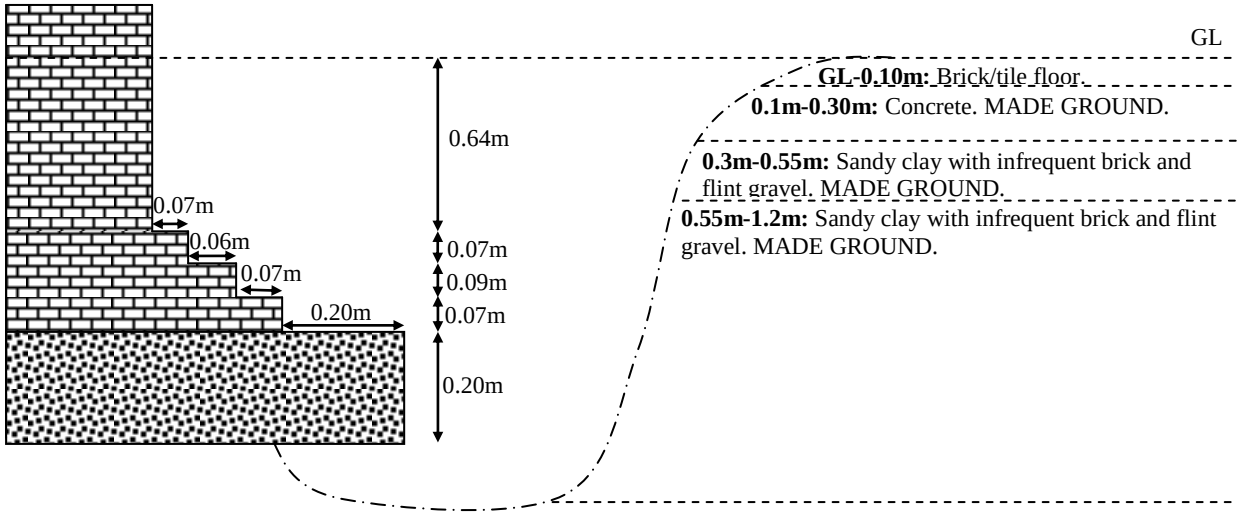
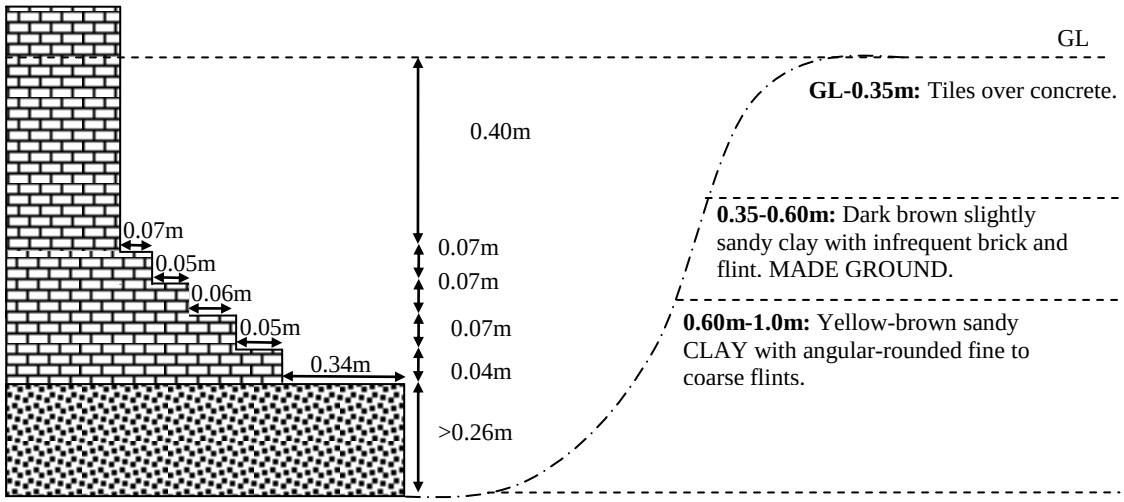
Project Name	Highgate Road	Client	Barrett Mahony
Title	Hand Trial Pit Sketches	Dwg No.	J896

HTP1
L: 1.00m
W: 0.70m
D: 1.10m

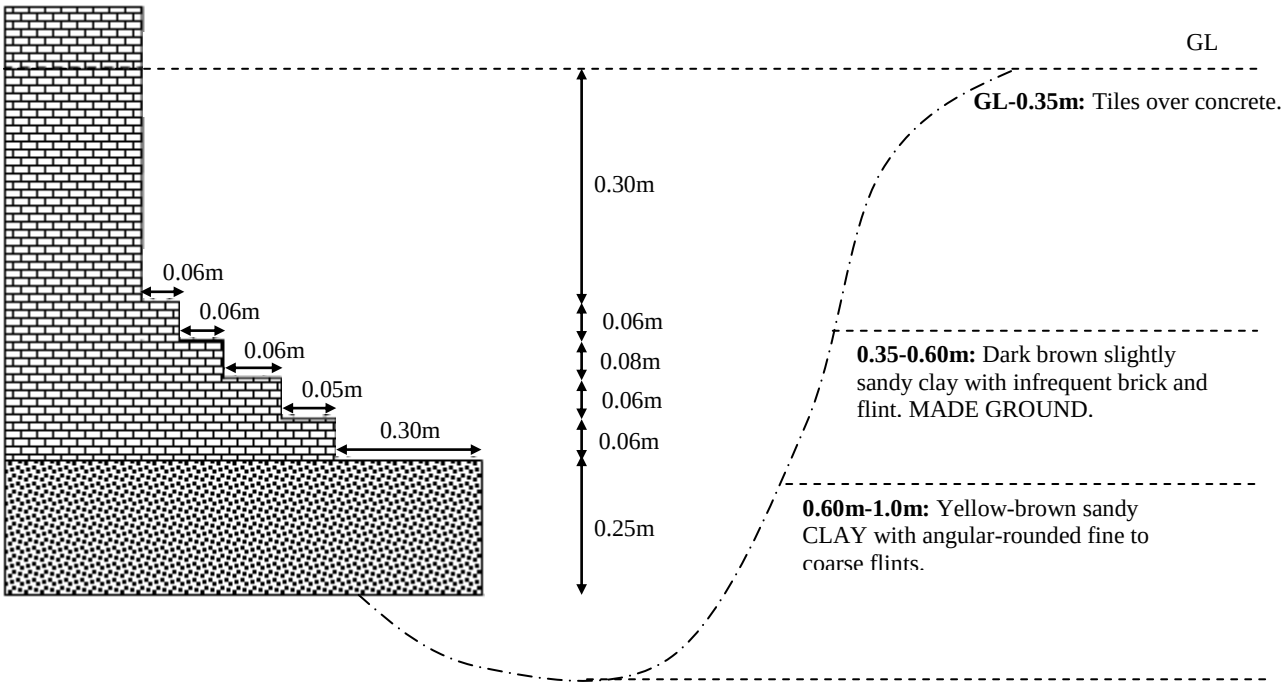


HTP2
L: 1.05m
W: 0.90m
D: 1.00m

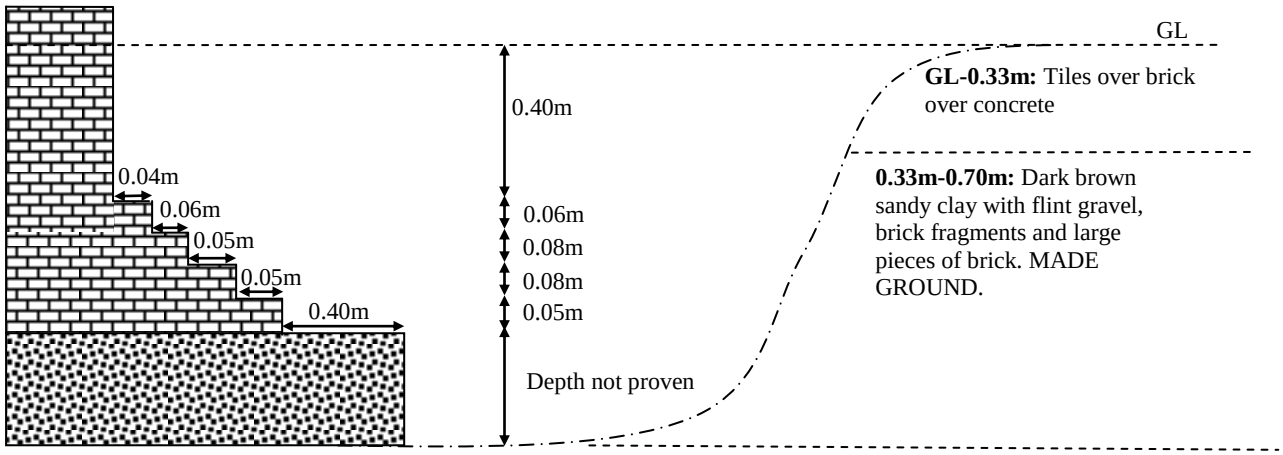


Project Name	Highgate Road	**Client**	Barrett Mahony
Title	Hand Trial Pit Sketches	**Dwg No.**	J896

HTP3



HTP4
L: 1.10m
W: 0.80m



HTP5 had been broken out but not excavated at time of visit.

APPENDIX 3 – CHEMICAL LABORATORY TEST RESULTS

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Stockley Park
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7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 16-24320

Project / Site name:	1A Highgate Road, London, NW5 1JY	**Samples received on:**	02/08/2016
Your job number:	J896	**Samples instructed on:**	02/08/2016
Your order number:	P9602J896.2	**Analysis completed by:**	09/08/2016
Report Issue Number:	1	**Report issued on:**	09/08/2016
Samples Analysed:	15 soil samples		

Signed:

Dr Irma Doyle
Senior Account Manager
For & on behalf of i2 Analytical Ltd.

Signed:

Emma Winter
Assistant Reporting Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Analytical Report Number: 16-24320

Project / Site name: 1A Highgate Road, London, NW5 1JY
Your Order No: P9602J896.2

Lab Sample Number				610729	610730	610731	610732	610733
Sample Reference				WS1	WS1	WS1	WS1	WS1
Sample Number				J	P	P	P	D
Depth (m)				0.50	0.50	0.80	1.00	3.00
Date Sampled				27/07/2016	27/07/2016	27/07/2016	27/07/2016	27/07/2016
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	-	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	6.7	8.3	-	16	18
Total mass of sample received	kg	0.001	NONE	0.47	0.72	-	0.60	0.68
Asbestos in Soil	Type	N/A	ISO 17025	-	-	Not-detected	-	-
General Inorganics								
pH	pH Units	N/A	MCERTS	9.7	9.3	-	8.0	8.4
Total Cyanide	mg/kg	1	MCERTS	< 1	-	-	-	-
Total Sulphate as SO_4	mg/kg	50	MCERTS	3500	-	-	350	790
Water Soluble Sulphate (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.54	1.4	-	0.073	0.18
Water Soluble Sulphate (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	543	-	-	-	-
Total Sulphur	mg/kg	50	NONE	-	-	-	140	360
Total Organic Carbon (TOC)	%	0.1	MCERTS	-	0.8	-	-	-
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	-	-	-	-
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Acenaphthylene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Acenaphthene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Fluorene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Phenanthrene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Anthracene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Fluoranthene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Pyrene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Benzo(a)anthracene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Chrysene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Benzo(b)fluoranthene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Benzo(k)fluoranthene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Benzo(a)pyrene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Dibenz(a,h)anthracene	mg/kg	0.1	MCERTS	< 0.10	-	-	-	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	-	-	-	-
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	1.6	MCERTS	< 1.60	-	-	-	-
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	8.6	-	-	-	-
Boron (water soluble)	mg/kg	0.2	MCERTS	2.7	-	-	-	-
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.9	-	-	-	-
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	-	-	-	-
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	27	-	-	-	-
Copper (aqua regia extractable)	mg/kg	1	MCERTS	37	-	-	-	-
Lead (aqua regia extractable)	mg/kg	1	MCERTS	84	-	-	-	-
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	0.5	-	-	-	-
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	24	-	-	-	-
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	-	-	-	-
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	86	-	-	-	-
Petroleum Hydrocarbons								
Petroleum Range Organics (C6 - C10)	mg/kg	0.1	NONE	< 0.1	-	-	-	-
TPH (C10 - C12)	mg/kg	2	NONE	< 2.0	-	-	-	-
TPH (C12 - C16)	mg/kg	4	NONE	8.5	-	-	-	-
TPH (C16 - C21)	mg/kg	1	NONE	48	-	-	-	-
TPH (C21 - C40)	mg/kg	10	NONE	1100	-	-	-	-

Analytical Report Number: 16-24320

Project / Site name: 1A Highgate Road, London, NW5 1JY
Your Order No: P9602J896.2

Lab Sample Number				610729	610730	610731	610732	610733
Sample Reference				WS1	WS1	WS1	WS1	WS1
Sample Number				J	P	P	P	D
Depth (m)				0.50	0.50	0.80	1.00	3.00
Date Sampled				27/07/2016	27/07/2016	27/07/2016	27/07/2016	27/07/2016
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					

Analytical Report Number: 16-24320

Project / Site name: 1A Highgate Road, London, NW5 1JY
Your Order No: P9602J896.2

Lab Sample Number				610734	610735	610736	610737	610738
Sample Reference				WS2	WS2	WS3	WS3	WS3
Sample Number				P	P	P	P	P
Depth (m)				0.40	0.70	0.40	0.70	1.00
Date Sampled				27/07/2016	27/07/2016	27/07/2016	27/07/2016	27/07/2016
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	19	12	17	21	21
Total mass of sample received	kg	0.001	NONE	0.29	0.50	0.86	0.75	0.65
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	-	Not-detected
General Inorganics								
pH	pH Units	N/A	MCERTS	7.8	8.0	-	8.1	-
Total Cyanide	mg/kg	1	MCERTS	5	-	-	< 1	-
Total Sulphate as SO_4	mg/kg	50	MCERTS	3200	700	-	740	-
Water Soluble Sulphate (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.61	0.12	-	0.088	-
Water Soluble Sulphate (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	606	-	-	88.0	-
Total Sulphur	mg/kg	50	NONE	-	350	-	-	-
Total Organic Carbon (TOC)	%	0.1	MCERTS	-	-	1.8	-	1.1
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	-	-	< 1.0	-
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	0.27	-	-	< 0.05	-
Acenaphthylene	mg/kg	0.1	MCERTS	< 0.10	-	-	< 0.10	-
Acenaphthene	mg/kg	0.1	MCERTS	< 0.10	-	-	< 0.10	-
Fluorene	mg/kg	0.1	MCERTS	< 0.10	-	-	< 0.10	-
Phenanthrene	mg/kg	0.1	MCERTS	0.85	-	-	< 0.10	-
Anthracene	mg/kg	0.1	MCERTS	0.14	-	-	< 0.10	-
Fluoranthene	mg/kg	0.1	MCERTS	1.7	-	-	< 0.10	-
Pyrene	mg/kg	0.1	MCERTS	1.4	-	-	< 0.10	-
Benzo(a)anthracene	mg/kg	0.1	MCERTS	0.94	-	-	< 0.10	-
Chrysene	mg/kg	0.05	MCERTS	0.82	-	-	< 0.05	-
Benzo(b)fluoranthene	mg/kg	0.1	MCERTS	1.3	-	-	< 0.10	-
Benzo(k)fluoranthene	mg/kg	0.1	MCERTS	0.53	-	-	< 0.10	-
Benzo(a)pyrene	mg/kg	0.1	MCERTS	0.86	-	-	< 0.10	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	MCERTS	0.44	-	-	< 0.10	-
Dibenz(a,h)anthracene	mg/kg	0.1	MCERTS	< 0.10	-	-	< 0.10	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.48	-	-	< 0.05	-
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	1.6	MCERTS	9.70	-	-	< 1.60	-
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	45	-	-	28	-
Boron (water soluble)	mg/kg	0.2	MCERTS	8.5	-	-	3.1	-
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	-	-	0.2	-
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	-	-	< 4.0	-
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	41	-	-	27	-
Copper (aqua regia extractable)	mg/kg	1	MCERTS	180	-	-	160	-
Lead (aqua regia extractable)	mg/kg	1	MCERTS	1700	-	-	400	-
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	3.0	-	-	1.8	-
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	39	-	-	29	-
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	-	-	< 1.0	-
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	400	-	-	160	-
Petroleum Hydrocarbons								
Petroleum Range Organics (C6 - C10)	mg/kg	0.1	NONE	< 0.1	-	-	< 0.1	-
TPH (C10 - C12)	mg/kg	2	NONE	< 2.0	-	-	< 2.0	-
TPH (C12 - C16)	mg/kg	4	NONE	13	-	-	< 4.0	-
TPH (C16 - C21)	mg/kg	1	NONE	56	-	-	< 1.0	-
TPH (C21 - C40)	mg/kg	10	NONE	610	-	-	< 10	-

Analytical Report Number: 16-24320

Project / Site name: 1A Highgate Road, London, NW5 1JY
Your Order No: P9602J896.2

Lab Sample Number				610734	610735	610736	610737	610738
Sample Reference				WS2	WS2	WS3	WS3	WS3
Sample Number				P	P	P	P	P
Depth (m)				0.40	0.70	0.40	0.70	1.00
Date Sampled				27/07/2016	27/07/2016	27/07/2016	27/07/2016	27/07/2016
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					

Analytical Report Number: 16-24320

Project / Site name: 1A Highgate Road, London, NW5 1JY
Your Order No: P9602J896.2

Lab Sample Number				610739	610740	610741	610742	610743
Sample Reference				WS3	WS3	WS4	WS4	WS4
Sample Number				D	D	P	P	D
Depth (m)				2.00	3.00	0.60	1.00	2.00
Date Sampled				27/07/2016	27/07/2016	27/07/2016	27/07/2016	27/07/2016
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	19	20	17	19	19
Total mass of sample received	kg	0.001	NONE	0.74	1.0	0.83	0.63	0.30
Asbestos in Soil	Type	N/A	ISO 17025	-	-	Not-detected	-	-
General Inorganics								
pH	pH Units	N/A	MCERTS	8.4	8.4	8.1	7.7	8.6
Total Cyanide	mg/kg	1	MCERTS	< 1	-	< 1	< 1	-
Total Sulphate as SO_4	mg/kg	50	MCERTS	600	1100	1300	770	750
Water Soluble Sulphate (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.16	0.41	0.31	0.23	0.11
Water Soluble Sulphate (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	159	-	306	229	-
Total Sulphur	mg/kg	50	NONE	-	370	-	-	250
Total Organic Carbon (TOC)	%	0.1	MCERTS	-	-	-	-	-
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	-	< 1.0	< 1.0	-
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	< 0.05	-
Acenaphthylene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Acenaphthene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Fluorene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Phenanthrene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Anthracene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Fluoranthene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Pyrene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Benzo(a)anthracene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Chrysene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	< 0.05	-
Benzo(b)fluoranthene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Benzo(k)fluoranthene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Benzo(a)pyrene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Dibenz(a,h)anthracene	mg/kg	0.1	MCERTS	< 0.10	-	< 0.10	< 0.10	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	-	< 0.05	< 0.05	-
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	1.6	MCERTS	< 1.60	-	< 1.60	< 1.60	-
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	12	-	14	15	-
Boron (water soluble)	mg/kg	0.2	MCERTS	1.8	-	3.9	2.6	-
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	-	< 0.2	< 0.2	-
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	-	< 4.0	< 4.0	-
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	64	-	37	50	-
Copper (aqua regia extractable)	mg/kg	1	MCERTS	35	-	150	34	-
Lead (aqua regia extractable)	mg/kg	1	MCERTS	13	-	94	48	-
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	-	0.7	0.4	-
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	45	-	54	25	-
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	1.2	-	< 1.0	< 1.0	-
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	84	-	91	81	-
Petroleum Hydrocarbons								
Petroleum Range Organics (C6 - C10)	mg/kg	0.1	NONE	< 0.1	-	< 0.1	< 0.1	-
TPH (C10 - C12)	mg/kg	2	NONE	< 2.0	-	< 2.0	< 2.0	-
TPH (C12 - C16)	mg/kg	4	NONE	< 4.0	-	< 4.0	< 4.0	-
TPH (C16 - C21)	mg/kg	1	NONE	< 1.0	-	< 1.0	< 1.0	-
TPH (C21 - C40)	mg/kg	10	NONE	< 10	-	< 10	< 10	-

Analytical Report Number: 16-24320

Project / Site name: 1A Highgate Road, London, NW5 1JY
Your Order No: P9602J896.2

Lab Sample Number				610739	610740	610741	610742	610743
Sample Reference				WS3	WS3	WS4	WS4	WS4
Sample Number				D	D	P	P	D
Depth (m)				2.00	3.00	0.60	1.00	2.00
Date Sampled				27/07/2016	27/07/2016	27/07/2016	27/07/2016	27/07/2016
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					

Analytical Report Number : 16-24320

Project / Site name: 1A Highgate Road, London, NW5 1JY

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
610729	WS1	J	0.50	Brown loam and sand with gravel and rubble.
610730	WS1	P	0.50	Brown loam and sand with gravel and rubble.
610731	WS1	P	0.80	-
610732	WS1	P	1.00	Brown clay and sand with gravel.
610733	WS1	D	3.00	Brown clay and sand.
610734	WS2	P	0.40	Brown clay and sand with gravel and rubble.
610735	WS2	P	0.70	Brown clay and sand with gravel.
610736	WS3	P	0.40	Brown clay and sand with gravel.
610737	WS3	P	0.70	Brown clay and sand with gravel and brick.
610738	WS3	P	1.00	Brown clay and sand with gravel and brick.
610739	WS3	D	2.00	Brown clay and sand.
610740	WS3	D	3.00	Brown clay and sand.
610741	WS4	P	0.60	Brown clay and sand with gravel.
610742	WS4	P	1.00	Brown clay and sand.
610743	WS4	D	2.00	Brown clay and sand.

Analytical Report Number : 16-24320

Project / Site name: 1A Highgate Road, London, NW5 1JY

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
PRO (Soil)	Determination of hydrocarbons C6-C10 by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	NONE
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Total organic carbon in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L023-PL	D	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, and MEWAM 2006 Methods for the Determination of Metals in Soil	L038-PL	D	NONE
TPH in (Soil)	Determination of TPH bands by HS-GC-MS/GC-FID	In-house method, TPH with carbon banding.	L076-PL	D	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
WS1	J	S	16-24320	610729	b	PRO (Soil)	L073B-PL	b
WS2	P	S	16-24320	610734	b	Monohydric phenols in soil	L080-PL	b
WS2	P	S	16-24320	610734	b	PRO (Soil)	L073B-PL	b
WS2	P	S	16-24320	610734	b	Speciated EPA-16 PAHs in soil	L064-PL	b
WS2	P	S	16-24320	610734	b	TPH in (Soil)	L076-PL	b
WS3	D	S	16-24320	610739	b	Monohydric phenols in soil	L080-PL	b
WS3	D	S	16-24320	610739	b	PRO (Soil)	L073B-PL	b
WS3	D	S	16-24320	610739	b	Speciated EPA-16 PAHs in soil	L064-PL	b
WS3	D	S	16-24320	610739	b	TPH in (Soil)	L076-PL	b
WS3	P	S	16-24320	610737	b	Monohydric phenols in soil	L080-PL	b
WS3	P	S	16-24320	610737	b	PRO (Soil)	L073B-PL	b
WS3	P	S	16-24320	610737	b	Speciated EPA-16 PAHs in soil	L064-PL	b
WS3	P	S	16-24320	610737	b	TPH in (Soil)	L076-PL	b
WS4	P	S	16-24320	610741	b	Monohydric phenols in soil	L080-PL	b
WS4	P	S	16-24320	610741	b	PRO (Soil)	L073B-PL	b
WS4	P	S	16-24320	610741	b	Speciated EPA-16 PAHs in soil	L064-PL	b
WS4	P	S	16-24320	610741	b	TPH in (Soil)	L076-PL	b
WS4	P	S	16-24320	610742	b	Monohydric phenols in soil	L080-PL	b
WS4	P	S	16-24320	610742	b	PRO (Soil)	L073B-PL	b
WS4	P	S	16-24320	610742	b	Speciated EPA-16 PAHs in soil	L064-PL	b
WS4	P	S	16-24320	610742	b	TPH in (Soil)	L076-PL	b

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

APPENDIX 4 – GEOTECHNICAL LABORATORY TEST RESULTS

TEST CERTIFICATE

Determination of Moisture Content

Tested in Accordance with BS 1377-2:1990: Clause 3.2

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

4041

Client:	Jomas Associates Ltd	Client Reference:	J896
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	16-24379
		Date Sampled:	27/07/2016
		Date Received:	02/08/2016
Contact:	Emma Hucker	Date Tested:	09/08/2016
Site Name:	1A Highgate Road, London, NW5 1JY	Sampled By:	Not Given
Site Address:	1A Highgate Road, London, NW5 1JY		

Test results

Laboratory Reference	Sample Reference	Location	Depth Top [m]	Depth Base [m]	Sample Type	Description	Moisture Content [%]
611064	D	WS1	2	Not Given	D	Yellowish brown CLAY with pocket of light brown clay	30
611065	D	WS1	3	Not Given	D	Yellowish brown CLAY with thin laminae of grey clay	29
611066	D	WS2	2	Not Given	D	Yellowish brown CLAY with thin laminae of clay and rootlets	31
611067	D	WS2	4	Not Given	D	Yellowish brown CLAY with thin laminae of light grey clay	31
611068	D	WS3	2.5	Not Given	D	Yellowish brown CLAY with thin laminae of grey clay	28
611069	D	WS3	4	Not Given	D	Yellowish brown CLAY with thin laminae of grey clay and gypsum crystals	31
611070	D	WS4	2	Not Given	D	Yellowish brown CLAY with thin laminae of light grey clay and light brown clay	30
611071	D	WS4	3	Not Given	D	Yellowish brown CLAY with thin laminae of light grey clay	33

Comments:

Approved:

Mirosława Pytlik
PL Head of Geotechnical section
Date Reported: 16/08/2016

Signed:

Terry Stafford
Geotechnical Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

Client:	Jomas Associates Ltd	Client Reference:	J896
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	16-24379
		Date Sampled:	27/07/2016
		Date Received:	02/08/2016
Contact:	Emma Hucker	Date Tested:	09/08/2016
Site Name:	1A Highgate Road, London, NW5 1JY	Sampled By:	Not Given
Site Address:	1A Highgate Road, London, NW5 1JY		

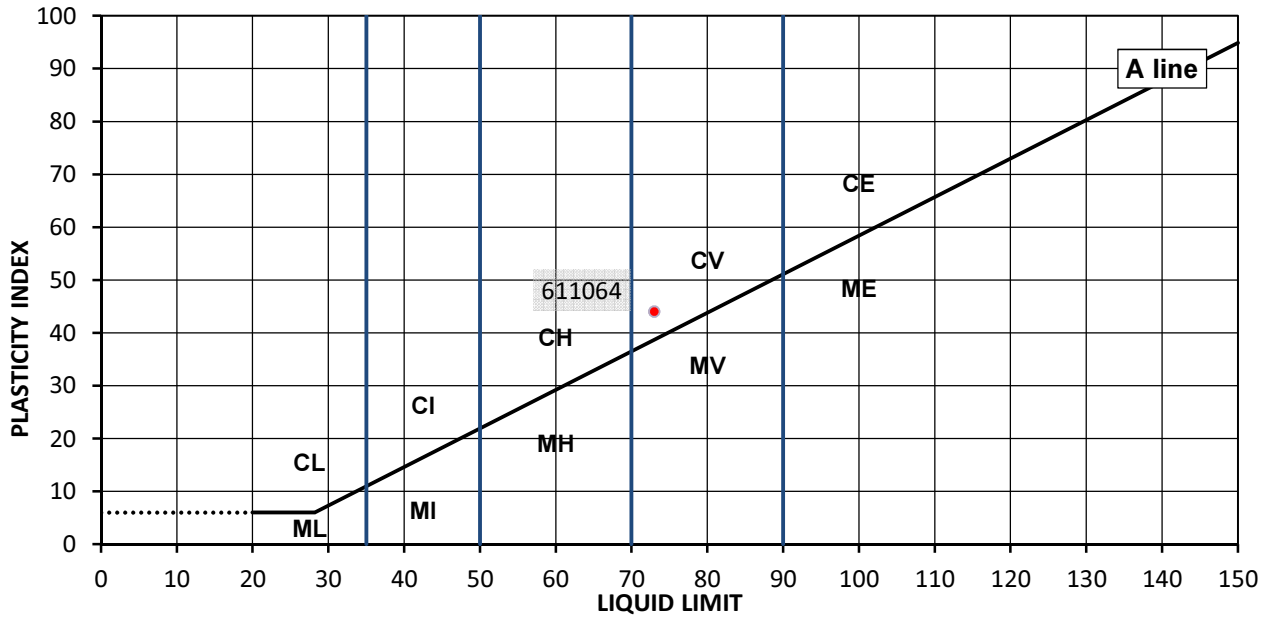
TEST RESULTS

Laboratory Reference: 611064
Sample Reference: D

Description: Yellowish brown CLAY with pocket of light brown clay
Location: WS1
Sample Preparation: Tested in natural condition

Sample Type: D
Depth Top [m]: 2
Depth Base [m]: Not Given

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
30	73	29	44	100



Legend, based on BS 5930:1999 +A2: 2010 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Comments:

Approved:

Mirosława Pytlik
PL Head of Geotechnical section
Date Reported: 16/08/2016

Signed:

Terry Stafford
Geotechnical Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

Client:	Jomas Associates Ltd	Client Reference:	J896
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	16-24379
		Date Sampled:	27/07/2016
		Date Received:	02/08/2016
Contact:	Emma Hucker	Date Tested:	09/08/2016
Site Name:	1A Highgate Road, London, NW5 1JY	Sampled By:	Not Given
Site Address:	1A Highgate Road, London, NW5 1JY		

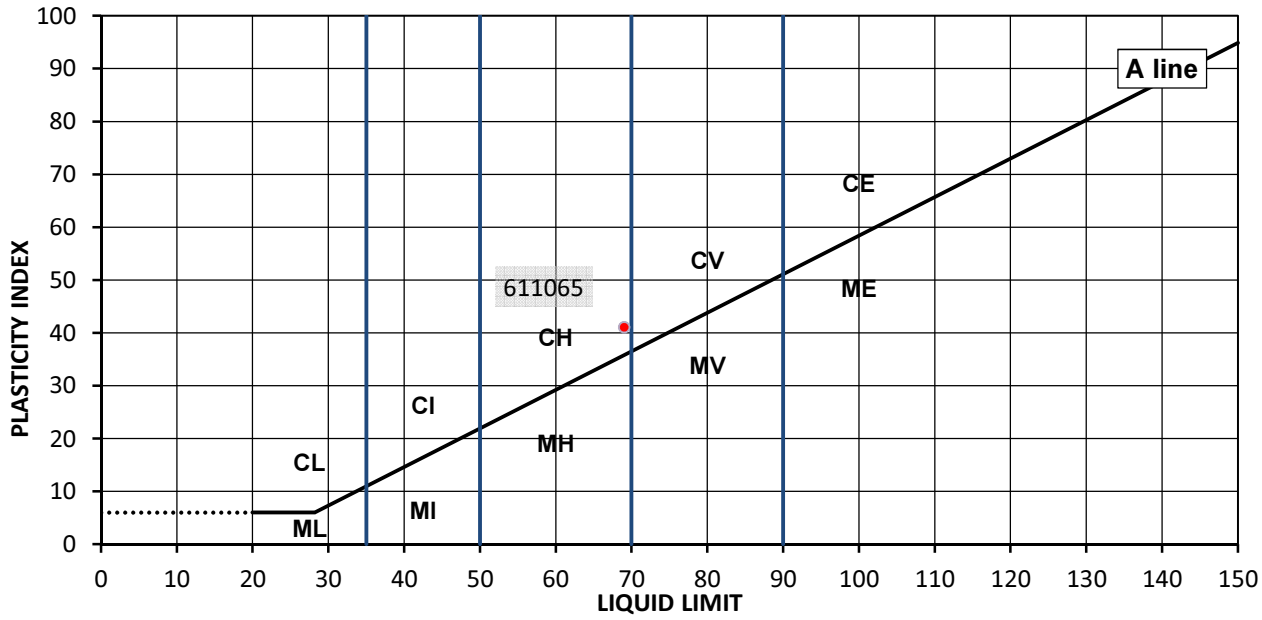
TEST RESULTS

Laboratory Reference: 611065
Sample Reference: D

Description: Yellowish brown CLAY with thin laminae of grey clay
Location: WS1
Sample Preparation: Tested in natural condition

Sample Type: D
Depth Top [m]: 3
Depth Base [m]: Not Given

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
29	69	28	41	100



Legend, based on BS 5930:1999 +A2: 2010 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Comments:

Approved:

Mirosława Pytlik
PL Head of Geotechnical section
Date Reported: 16/08/2016

Signed:

Terry Stafford
Geotechnical Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

4041

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

Client:	Jomas Associates Ltd	Client Reference:	J896
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	16-24379
		Date Sampled:	27/07/2016
		Date Received:	02/08/2016
Contact:	Emma Hucker	Date Tested:	09/08/2016
Site Name:	1A Highgate Road, London, NW5 1JY	Sampled By:	Not Given
Site Address:	1A Highgate Road, London, NW5 1JY		

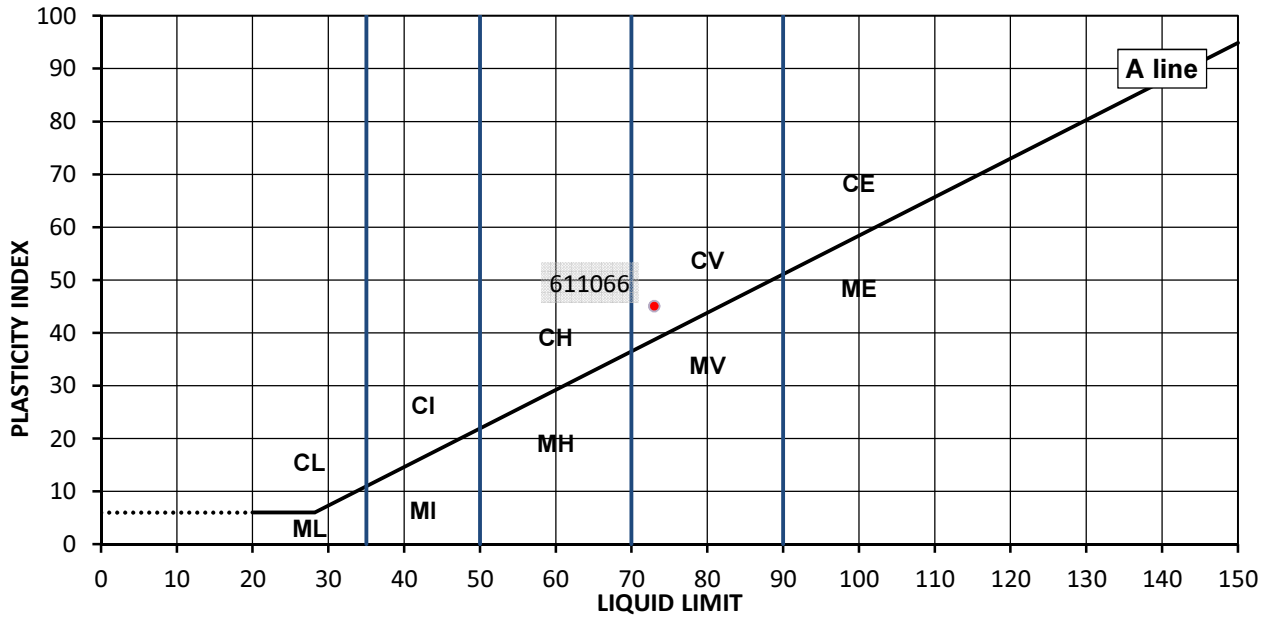
TEST RESULTS

Laboratory Reference: 611066
Sample Reference: D

Description: Yellowish brown CLAY with thin laminae of clay and rootlets
Location: WS2
Sample Preparation: Tested in natural condition

Sample Type: D
Depth Top [m]: 2
Depth Base [m]: Not Given

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
31	73	28	45	100



Legend, based on BS 5930:1999 +A2: 2010 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Comments:

Approved:

Mirosława Pytlik
PL Head of Geotechnical section
Date Reported: 16/08/2016

Signed:

Terry Stafford
Geotechnical Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

Client:	Jomas Associates Ltd	Client Reference:	J896
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	16-24379
		Date Sampled:	27/07/2016
		Date Received:	02/08/2016
Contact:	Emma Hucker	Date Tested:	09/08/2016
Site Name:	1A Highgate Road, London, NW5 1JY	Sampled By:	Not Given
Site Address:	1A Highgate Road, London, NW5 1JY		

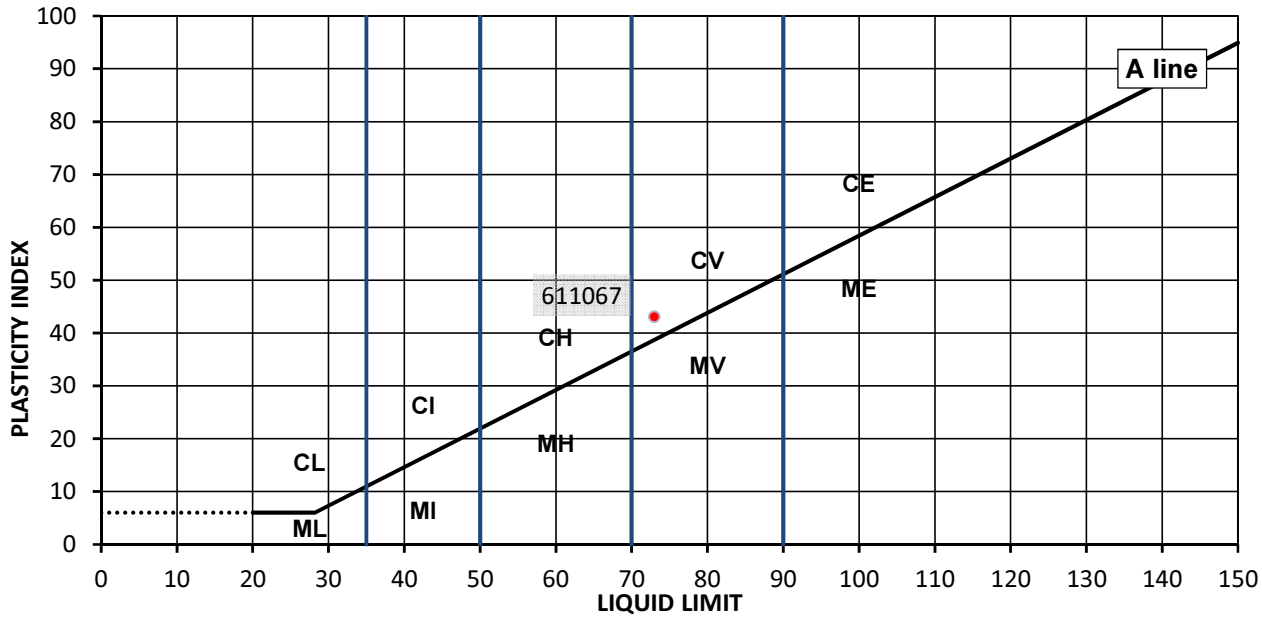
TEST RESULTS

Laboratory Reference: 611067
Sample Reference: D

Description: Yellowish brown CLAY with thin laminae of light grey clay
Location: WS2
Sample Preparation: Tested in natural condition

Sample Type: D
Depth Top [m]: 4
Depth Base [m]: Not Given

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
31	73	30	43	100



Legend, based on BS 5930:1999 +A2: 2010 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Comments:

Approved:

Mirosława Pytlik
PL Head of Geotechnical section
Date Reported: 16/08/2016

Signed:

Terry Stafford
Geotechnical Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

Client:	Jomas Associates Ltd	Client Reference:	J896
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	16-24379
		Date Sampled:	27/07/2016
		Date Received:	02/08/2016
Contact:	Emma Hucker	Date Tested:	09/08/2016
Site Name:	1A Highgate Road, London, NW5 1JY	Sampled By:	Not Given
Site Address:	1A Highgate Road, London, NW5 1JY		

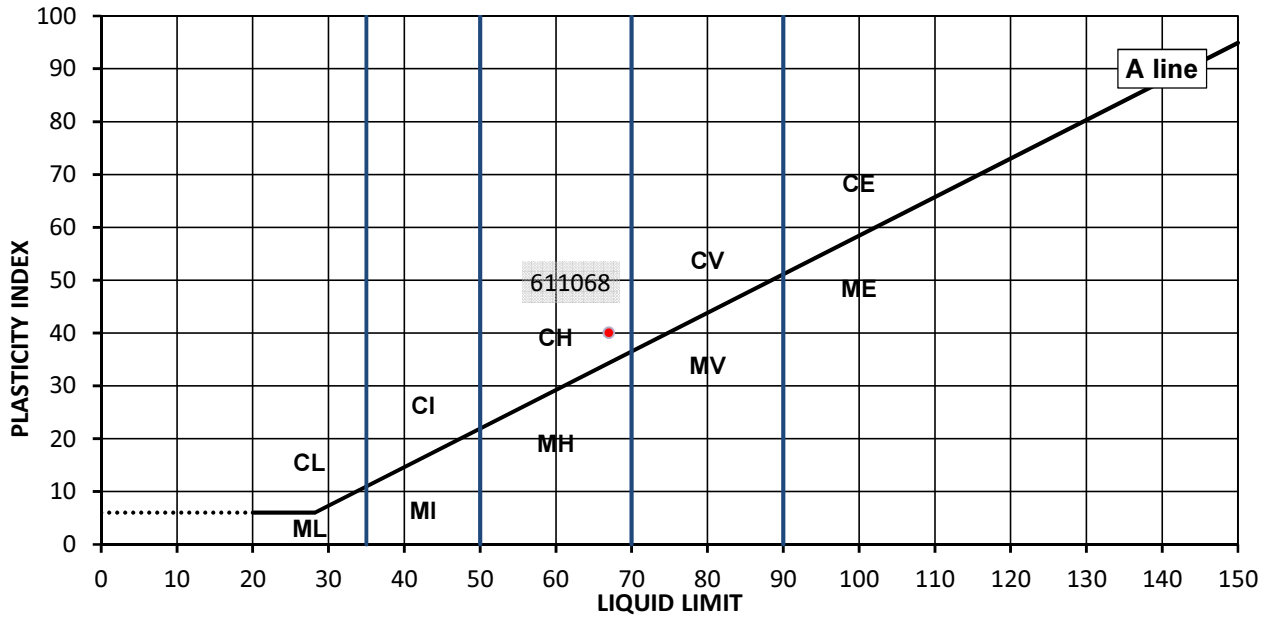
TEST RESULTS

Laboratory Reference: 611068
Sample Reference: D

Description: Yellowish brown CLAY with thin laminae of grey clay
Location: WS3
Sample Preparation: Tested in natural condition

Sample Type: D
Depth Top [m]: 2.5
Depth Base [m]: Not Given

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
28	67	27	40	100



Legend, based on BS 5930:1999 +A2: 2010 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Comments:

Approved:

Mirosława Pytlik
PL Head of Geotechnical section
Date Reported: 16/08/2016

Signed:

Terry Stafford
Geotechnical Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

Client:	Jomas Associates Ltd	Client Reference:	J896
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	16-24379
		Date Sampled:	27/07/2016
		Date Received:	02/08/2016
Contact:	Emma Hucker	Date Tested:	09/08/2016
Site Name:	1A Highgate Road, London, NW5 1JY	Sampled By:	Not Given
Site Address:	1A Highgate Road, London, NW5 1JY		

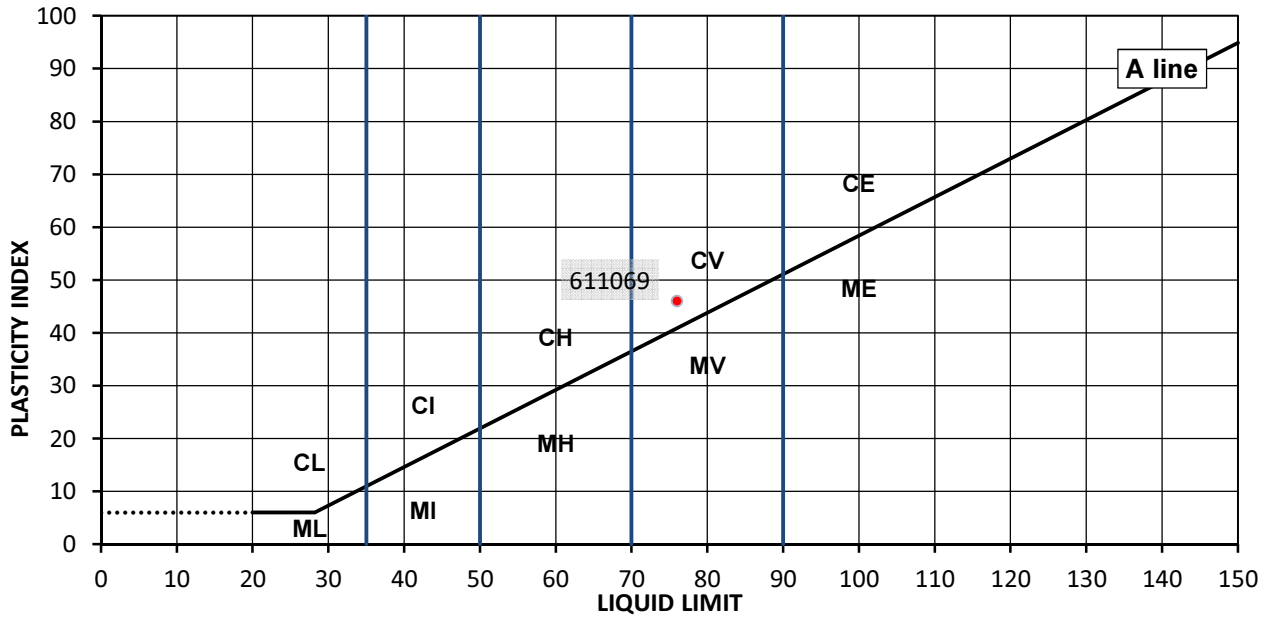
TEST RESULTS

Laboratory Reference: 611069
Sample Reference: D

Description: Yellowish brown CLAY with thin laminae of grey clay and gypsum crystals
Location: WS3
Sample Preparation: Tested in natural condition

Sample Type: D
Depth Top [m]: 4
Depth Base [m]: Not Given

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
31	76	30	46	100



Legend, based on BS 5930:1999 +A2: 2010 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Comments:

Approved:

Mirosława Pytlik
PL Head of Geotechnical section
Date Reported: 16/08/2016

Signed:

Terry Stafford
Geotechnical Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

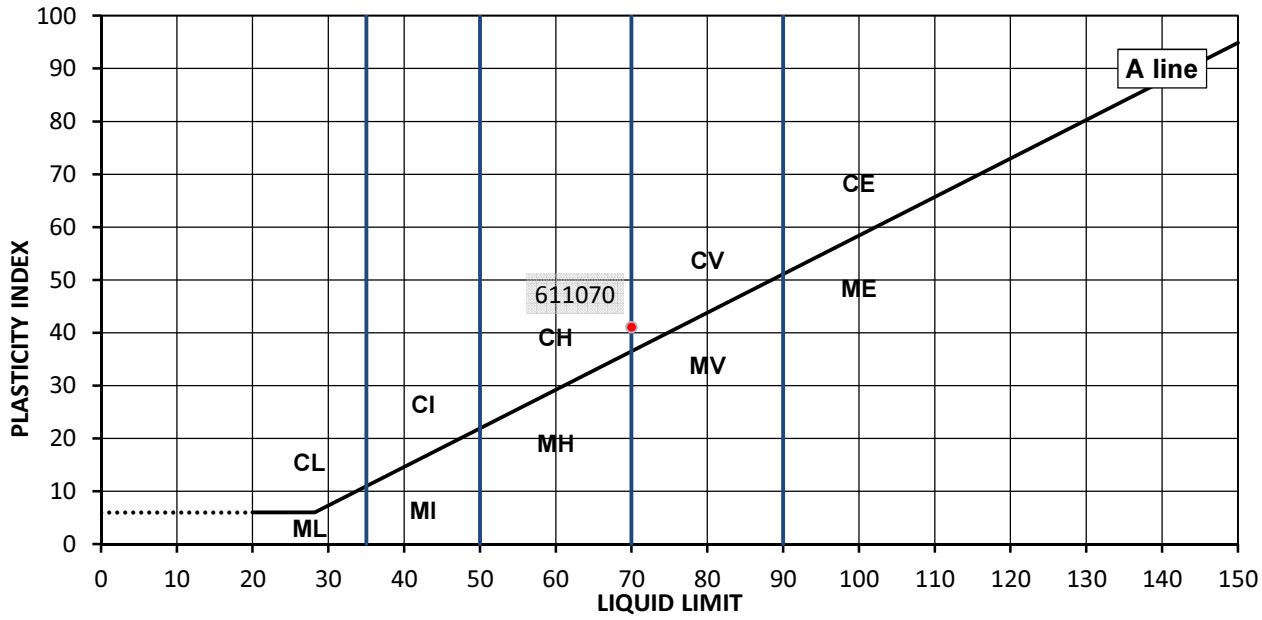
Client:	Jomas Associates Ltd	Client Reference:	J896
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	16-24379
		Date Sampled:	27/07/2016
		Date Received:	02/08/2016
Contact:	Emma Hucker	Date Tested:	09/08/2016
Site Name:	1A Highgate Road, London, NW5 1JY	Sampled By:	Not Given
Site Address:	1A Highgate Road, London, NW5 1JY		

TEST RESULTS

Laboratory Reference: 611070
Sample Reference: D

Description:	Yellowish brown CLAY with thin laminae of light grey clay and light brown clay	Sample Type:	D
Location:	WS4	Depth Top [m]:	2
Sample Preparation:	Tested in natural condition	Depth Base [m]:	Not Given

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
30	70	29	41	100



Legend, based on BS 5930:1999 +A2: 2010 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Comments:

Approved:

Mirosława Pytlik
PL Head of Geotechnical section
Date Reported: 16/08/2016

Signed:

Terry Stafford
Geotechnical Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

Client:	Jomas Associates Ltd	Client Reference:	J896
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	16-24379
		Date Sampled:	27/07/2016
		Date Received:	02/08/2016
Contact:	Emma Hucker	Date Tested:	09/08/2016
Site Name:	1A Highgate Road, London, NW5 1JY	Sampled By:	Not Given
Site Address:	1A Highgate Road, London, NW5 1JY		

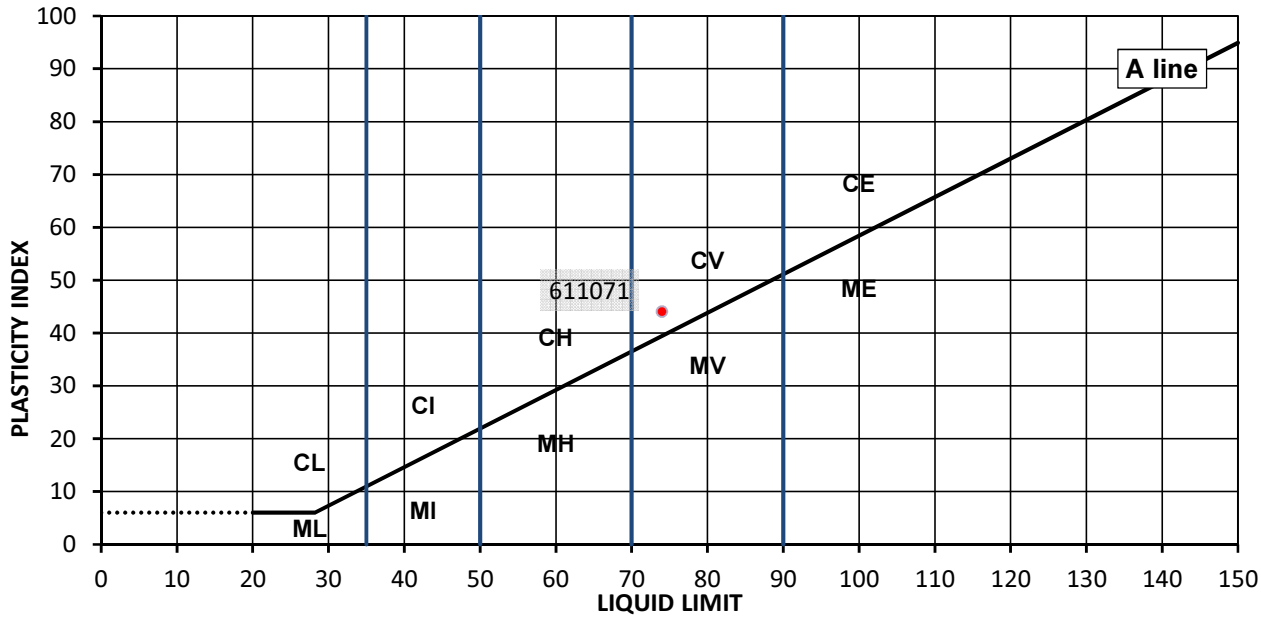
TEST RESULTS

Laboratory Reference: 611071
Sample Reference: D

Description: Yellowish brown CLAY with thin laminae of light grey clay
Location: WS4
Sample Preparation: Tested in natural condition

Sample Type: D
Depth Top [m]: 3
Depth Base [m]: Not Given

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
33	74	30	44	100



Legend, based on BS 5930:1999 +A2: 2010 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Comments:

Approved:

Mirosława Pytlik
PL Head of Geotechnical section
Date Reported: 16/08/2016

Signed:

Terry Stafford
Geotechnical Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Summary of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

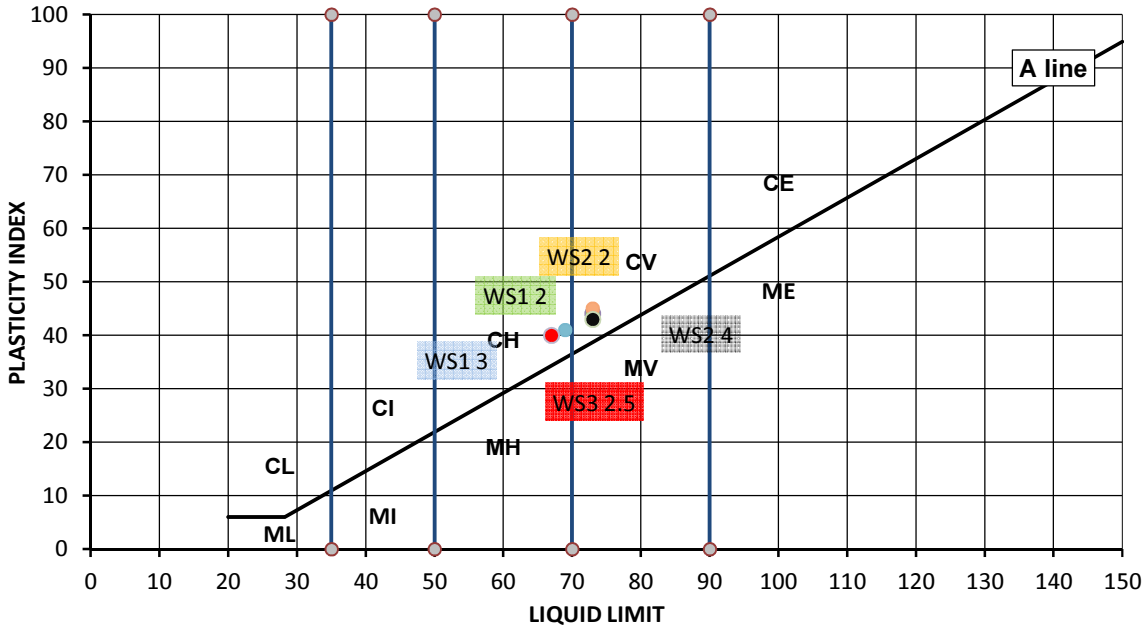
4041

Tested in Accordance with BS1377-2: 1990: Clauses 4.4 & 5: One Point Method

Client:	Jomas Associates Ltd	Client Reference:	J896
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	16-24379
		Date Sampled:	27/07/2016
		Date Received:	02/08/2016
Contact:	Emma Hucker	Date Tested:	09/08/2016
Site Name:	1A Highgate Road, London, NW5 1JY	Sampled By:	Not Given
Site Address:	1A Highgate Road, London, NW5 1JY		

TEST RESULTS

Location	Depth [m]	As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
WS1	2	30	73	29	44	100
WS1	3	29	69	28	41	100
WS2	2	31	73	28	45	100
WS2	4	31	73	30	43	100
WS3	2.5	28	67	27	40	100



Legend, based on BS 5930:1999 +A2: 2010 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Comments:

Approved: Mirosława Pytlik
PL Head of Geotechnical section

Signed: Terry Stafford
Geotechnical Manager

Date Reported: 16/08/2016

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Summary of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

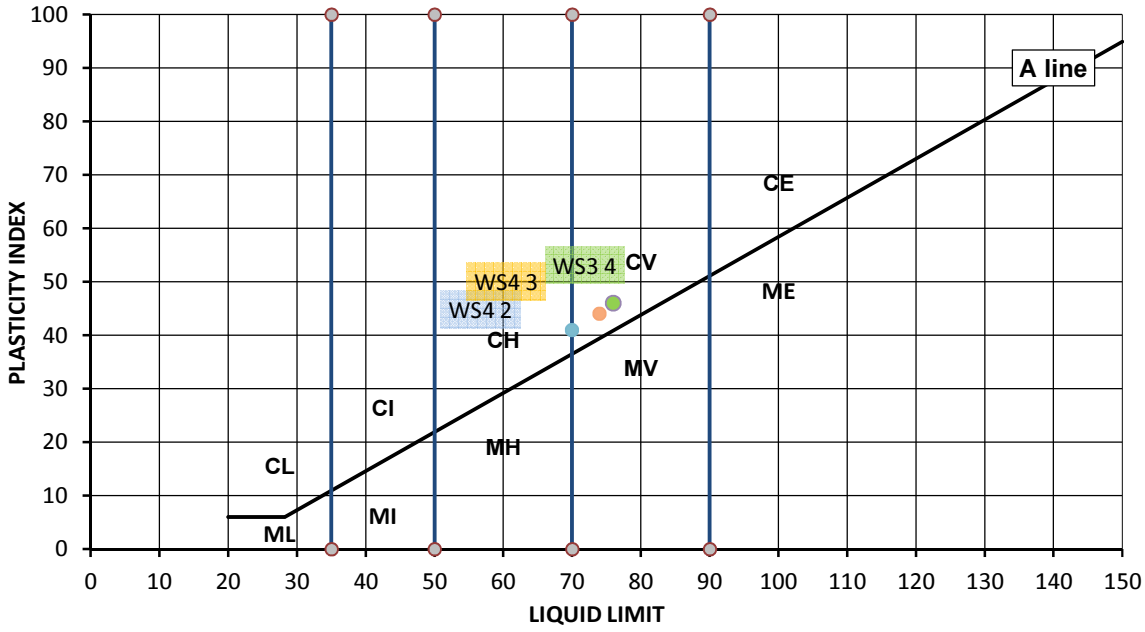
4041

Tested in Accordance with BS1377-2: 1990: Clauses 4.4 & 5: One Point Method

Client:	Jomas Associates Ltd	Client Reference:	J896
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	16-24379
		Date Sampled:	27/07/2016
		Date Received:	02/08/2016
Contact:	Emma Hucker	Date Tested:	09/08/2016
Site Name:	1A Highgate Road, London, NW5 1JY	Sampled By:	Not Given
Site Address:	1A Highgate Road, London, NW5 1JY		

TEST RESULTS

Location	Depth [m]	As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
WS3	4	31	76	30	46	100
WS4	2	30	70	29	41	100
WS4	3	33	74	30	44	100



Legend, based on BS 5930:1999 +A2: 2010 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Comments:

Approved: Mirosława Pytlik
PL Head of Geotechnical section

Signed: Terry Stafford
Geotechnical Manager

Date Reported: 16/08/2016

for and on behalf of i2 Analytical Ltd

APPENDIX 5 – STATISTICAL ANALYTICAL RESULTS

1					**Outlier Tests for Selected Uncensored Variables**							
2				**User Selected Options**								
3			Date/Time of Computation		19/08/2016 11:12:20							
4				From File	J896 results for stats.xls							
5				Full Precision	OFF							
6												
7												
8	**Dixon's Outlier Test for Arsenic**											
9												
10	Number of Observations = 6											
11	10% critical value: 0.482											
12	5% critical value: 0.56											
13	1% critical value: 0.698											
14												
15	**1. Observation Value 45 is a Potential Outlier (Upper Tail)?**											
16												
17	Test Statistic: 0.467											
18												
19	For 10% significance level, 45 is not an outlier.											
20	For 5% significance level, 45 is not an outlier.											
21	For 1% significance level, 45 is not an outlier.											
22												
23	**2. Observation Value 8.6 is a Potential Outlier (Lower Tail)?**											
24												
25	Test Statistic: 0.093											
26												
27	For 10% significance level, 8.6 is not an outlier.											
28	For 5% significance level, 8.6 is not an outlier.											
29	For 1% significance level, 8.6 is not an outlier.											
30												
31												
32	**Dixon's Outlier Test for Lead**											
33												
34	Number of Observations = 6											
35	10% critical value: 0.482											
36	5% critical value: 0.56											
37	1% critical value: 0.698											
38												
39	**1. Observation Value 1700 is a Potential Outlier (Upper Tail)**											
40												
41	Test Statistic: 0.771											
42												
43	For 10% significance level, 1700 is an outlier.											
44	For 5% significance level, 1700 is an outlier.											
45	For 1% significance level, 1700 is an outlier.											
46												
47	**2. Observation Value 13 is a Potential Outlier (Lower Tail)?**											
48												
49	Test Statistic: 0.021											
50												
51	For 10% significance level, 13 is not an outlier.											
52	For 5% significance level, 13 is not an outlier.											
53	For 1% significance level, 13 is not an outlier.											
54												

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	19/08/2016 11:06:07
From File	J896 results for stats.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	8.6	Mean	20.43
Maximum	45	Median	14.5
SD	13.73	Std. Error of Mean	5.606
Coefficient of Variation	0.672	Skewness	1.457

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0

Normal GOF Test

Shapiro Wilk Test Statistic	0.831	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.32	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.362	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	31.73	95% Adjusted-CLT UCL (Chen-1995)	33.22
		95% Modified-t UCL (Johnson-1978)	32.29

Gamma GOF Test

A-D Test Statistic	0.408	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.701	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.298	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.334	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.217	k star (bias corrected MLE)	1.72
Theta hat (MLE)	6.351	Theta star (bias corrected MLE)	11.88
nu hat (MLE)	38.61	nu star (bias corrected)	20.64
MLE Mean (bias corrected)	20.43	MLE Sd (bias corrected)	15.58
		Approximate Chi Square Value (0.05)	11.32
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	8.938

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	37.24	95% Adjusted Gamma UCL (use when n<50)	47.18

55												
56	**Lognormal GOF Test**											
57				Shapiro Wilk Test Statistic		0.933	**Shapiro Wilk Lognormal GOF Test**					
58				5% Shapiro Wilk Critical Value		0.788	Data appear Lognormal at 5% Significance Level					
59				Lilliefors Test Statistic		0.262	**Lilliefors Lognormal GOF Test**					
60				5% Lilliefors Critical Value		0.362	Data appear Lognormal at 5% Significance Level					
61	**Data appear Lognormal at 5% Significance Level**											
62												
63	**Lognormal Statistics**											
64				Minimum of Logged Data		2.152	Mean of logged Data					2.854
65				Maximum of Logged Data		3.807	SD of logged Data					0.605
66												
67	**Assuming Lognormal Distribution**											
68				95% H-UCL		45.8	90% Chebyshev (MVUE) UCL					35.06
69				95% Chebyshev (MVUE) UCL		41.81	97.5% Chebyshev (MVUE) UCL					51.18
70				99% Chebyshev (MVUE) UCL		69.58						
71												
72	**Nonparametric Distribution Free UCL Statistics**											
73	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
74												
75	**Nonparametric Distribution Free UCLs**											
76				95% CLT UCL		29.65	95% Jackknife UCL					31.73
77				95% Standard Bootstrap UCL		29.02	95% Bootstrap-t UCL					62.84
78				95% Hall's Bootstrap UCL		103.4	95% Percentile Bootstrap UCL					29.5
79				95% BCA Bootstrap UCL		31.5						
80				90% Chebyshev(Mean, Sd) UCL		37.25	95% Chebyshev(Mean, Sd) UCL					44.87
81				97.5% Chebyshev(Mean, Sd) UCL		55.44	99% Chebyshev(Mean, Sd) UCL					76.21
82												
83	**Suggested UCL to Use**											
84				95% Student's-t UCL		31.73						
85												
86	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
87	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
88	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
89	For additional insight the user may want to consult a statistician.											
90												
91												
92	**Lead**											
93												
94	**General Statistics**											
95				Total Number of Observations		6	Number of Distinct Observations					6
96							Number of Missing Observations					0
97				Minimum		13	Mean					389.8
98				Maximum		1700	Median					89
99				SD		656.7	Std. Error of Mean					268.1
100				Coefficient of Variation		1.685	Skewness					2.225
101												
102	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use**											
103	**guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.**											
104	**For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**											
105	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.0**											
106												
107	**Normal GOF Test**											
108				Shapiro Wilk Test Statistic		0.651	**Shapiro Wilk GOF Test**					

109	5% Shapiro Wilk Critical Value					0.788	Data Not Normal at 5% Significance Level					
110	Lilliefors Test Statistic					0.34	**Lilliefors GOF Test**					
111	5% Lilliefors Critical Value					0.362	Data appear Normal at 5% Significance Level					
112	**Data appear Approximate Normal at 5% Significance Level**											
113												
114	**Assuming Normal Distribution**											
115	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
116	95% Student's-t UCL					930.1	95% Adjusted-CLT UCL (Chen-1995)					1091
117							95% Modified-t UCL (Johnson-1978)					970.7
118												
119	**Gamma GOF Test**											
120	A-D Test Statistic					0.446	**Anderson-Darling Gamma GOF Test**					
121	5% A-D Critical Value					0.733	Detected data appear Gamma Distributed at 5% Significance Level					
122	K-S Test Statistic					0.309	**Kolmogrov-Smirnoff Gamma GOF Test**					
123	5% K-S Critical Value					0.348	Detected data appear Gamma Distributed at 5% Significance Level					
124	**Detected data appear Gamma Distributed at 5% Significance Level**											
125												
126	**Gamma Statistics**											
127	k hat (MLE)					0.541	k star (bias corrected MLE)					0.382
128	Theta hat (MLE)					720.1	Theta star (bias corrected MLE)					1021
129	nu hat (MLE)					6.496	nu star (bias corrected)					4.582
130	MLE Mean (bias corrected)					389.8	MLE Sd (bias corrected)					630.9
131							Approximate Chi Square Value (0.05)					0.964
132	Adjusted Level of Significance					0.0122	Adjusted Chi Square Value					0.499
133												
134	**Assuming Gamma Distribution**											
135	95% Approximate Gamma UCL (use when n>=50))					1853	95% Adjusted Gamma UCL (use when n<50)					3582
136												
137	**Lognormal GOF Test**											
138	Shapiro Wilk Test Statistic					0.968	**Shapiro Wilk Lognormal GOF Test**					
139	5% Shapiro Wilk Critical Value					0.788	Data appear Lognormal at 5% Significance Level					
140	Lilliefors Test Statistic					0.228	**Lilliefors Lognormal GOF Test**					
141	5% Lilliefors Critical Value					0.362	Data appear Lognormal at 5% Significance Level					
142	**Data appear Lognormal at 5% Significance Level**											
143												
144	**Lognormal Statistics**											
145	Minimum of Logged Data					2.565	Mean of logged Data					4.807
146	Maximum of Logged Data					7.438	SD of logged Data					1.699
147												
148	**Assuming Lognormal Distribution**											
149	95% H-UCL					78279	90% Chebyshev (MVUE) UCL					1016
150	95% Chebyshev (MVUE) UCL					1317	97.5% Chebyshev (MVUE) UCL					1736
151	99% Chebyshev (MVUE) UCL					2560						
152												
153	**Nonparametric Distribution Free UCL Statistics**											
154	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
155												
156	**Nonparametric Distribution Free UCLs**											
157	95% CLT UCL					830.8	95% Jackknife UCL					930.1
158	95% Standard Bootstrap UCL					785.9	95% Bootstrap-t UCL					6921
159	95% Hall's Bootstrap UCL					4328	95% Percentile Bootstrap UCL					875.8
160	95% BCA Bootstrap UCL					997.3						
161	90% Chebyshev(Mean, Sd) UCL					1194	95% Chebyshev(Mean, Sd) UCL					1559
162	97.5% Chebyshev(Mean, Sd) UCL					2064	99% Chebyshev(Mean, Sd) UCL					3058

	A	B	C	D	E	F	G	H	I	J	K	L
163												
164	**Suggested UCL to Use**											
165	95% Student's-t UCL					930.1						
166												
167	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
168	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
169	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
170	For additional insight the user may want to consult a statistician.											
171												

APPENDIX 6 – SOIL GAS MONITORING TEST RESULTS

GAS AND GROUNDWATER MONITORING BOREHOLE RECORD SHEET

Site: Highgate Road	**Operative(s):** SRC	**Date:** 10/08/16	**Time:** 12:30	**Round:** 1	**Page:**

MONITORING EQUIPMENT

Instrument Type	**Instrument Make**	**Serial No.**	**Date Last Calibrated**
Analox	GA5000		19/11/2015
PID	Phocheck tiger		26/08/2015
Dip Meter	GeoTech		

MONITORING CONDITIONS

Weather Conditions: Cloudy	**Ground Conditions:** Dry (Inside)	**Temperature**: °C
Barometric Pressure (mbar): 1016	**Barometric Pressure Trend (24hr):**	**Ambient Concentration:** 0.1%CH_4, 0.1%CO_2, 20.9%O_2

MONITORING RESULTS

Monitoring Point Location	Flow		Atmospheric Pressure (mbar)	Methane %	Methane % LEL	Carbon Dioxide %	Oxygen %	VOC (ppm)		Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	Depth to water (mbgl)	Depth to Base of well (mbgl)
	Peak	Average						Peak	Average				
WS1	-	+0.3	1018	0.1	-	0.2	20.8	-	-	0	0	3.64	3.94
WS3	-	+0.2	1016	0.1	-	0.5	20.1	-	-	0	0	3.83	3.92
WS4	-	+0.3	1016	0.1	-	0.6	20.1	-	-	0	0	3.89	3.96

GAS AND GROUNDWATER MONITORING BOREHOLE RECORD SHEET

Site: Highgate Road	**Operative(s):** SRC	**Date:** 17/08/16	**Time:** 14:00	**Round:** 2	**Page:**

MONITORING EQUIPMENT

Instrument Type	**Instrument Make**	**Serial No.**	**Date Last Calibrated**
Analox	GA5000		19/11/2015
PID	Phocheck tiger		26/08/2015
Dip Meter	GeoTech		

MONITORING CONDITIONS

Weather Conditions: Sunny	**Ground Conditions:** Dry (Inside)	**Temperature**: °C
Barometric Pressure (mbar): 1009	**Barometric Pressure Trend (24hr):**	**Ambient Concentration:** 0.1%CH_4, 0.1%CO_2, 20.7%O_2

MONITORING RESULTS

Monitoring Point Location	Flow		Atmospheric Pressure (mbar)	Methane %	Methane % LEL	Carbon Dioxide %	Oxygen %	VOC (ppm)		Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	Depth to water (mbgl)	Depth to Base of well (mbgl)
	Peak	Average						Peak	Average				
WS1	-	+0.2	1009	0.1	-	0.1	20.6	-	-	0	0	3.38	3.96
WS3	-	+0.2	1009	0.1	-	0.4	20.1	-	-	0	1	3.62	3.92
WS4	-	+0.2	1009	0.1	-	0.3	20.3	-	-	0	1	3.73	3.94

GAS AND GROUNDWATER MONITORING BOREHOLE RECORD SHEET

Site: Highgate Road	**Operative(s):** SRC	**Date:** 22/08/16	**Time:** 14:15	**Round:** 3	**Page:**

MONITORING EQUIPMENT

Instrument Type	**Instrument Make**	**Serial No.**	**Date Last Calibrated**
Analox	GA5000		19/11/2015
PID	Phocheck tiger		26/08/2015
Dip Meter	GeoTech		

MONITORING CONDITIONS

Weather Conditions: Sunny	**Ground Conditions:** Dry (Inside)	**Temperature**: 24 °C
Barometric Pressure (mbar): 1019	**Barometric Pressure Trend (24hr):** Rising	**Ambient Concentration:** 0.1%CH_4, 0.1%CO_2, 20.7%O_2

MONITORING RESULTS

Monitoring Point Location	Flow		Atmospheric Pressure (mbar)	Methane %	Methane % LEL	Carbon Dioxide %	Oxygen %	VOC (ppm)		Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	Depth to water (mbgl)	Depth to Base of well (mbgl)
	Peak	Average						Peak	Average				
WS1	-	+0.3	1020	0.1	-	0.3	20.3	-	-	0	0	3.29	3.96
WS3	-	+0.2	1020	0.1	-	0.6	19.9	-	-	0	1	3.45	3.92
WS4	-	+0.2	1019	0.1	-	0.2	20.5	-	-	0	0	3.61	3.94