GEO-ENVIRONMENTAL & GEOTECHNICAL ASSESSMENT (GROUND INVESTIGATION) REPORT

FOR

2 GASWORKS COTTAGE
STATION ROAD
BOREHAMWOOD
WD6 1DF

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EXECUTIVE SUMMARY

Belgravia Property Development London Ltd ('The Client') commissioned Jomas Associates Ltd to undertake a Geo-environmental and Geotechnical ground investigation on a site at 2 Gasworks Cottage, Station Road, Borehamwood, WD6 1DF.

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.
- 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	
Current Site Use	Vacant residential property
Proposed Site Use	It is understood that the proposed development is to comprise the demolition of the existing buildings and the construction of new residential flats with associated car parking and communal outside space. No private gardens or areas of soft landscaping are proposed.
Desk Study Overview	A desk study was previously undertaken for the site and issued separately (Jomas – January 2018). A brief overview of the report is presented below. A review of historical maps indicates that the site was undeveloped until the late 1950s, with the site appearing in its current configuration by the 1964 map edition. A third party reports for the adjacent gas works notes that parts of the gas works were subsequently used for as an automotive repair garage until 2015. Suspected former structures included an interceptor and an underground storage tank (UST). No evidence for which were found during investigations in 2016. The report notes that all buildings on the site, bar the Gasworks cottage, were demolished in March 2016. The British Geological Survey indicates that the site is directly underlain by solid deposits of the London Clay Formation. A trial pit record located 17m south-east indicates a layer of Made Ground, underlain by sandy clay. The solid deposits underlying the site are reported to be Unproductive Strata. A review of the EnviroInsight Report indicates that there are no source protection zones within 500m of the site. There are no groundwater, surface water or potable water abstractions reported within 1km of the site. A secondary river and culvert (believed to be the same feature) are reported on site. An Environment Agency Zone 2 and 3 floodplain are reported within 118m north of the site.

Site History and Ground Investigation	
Intrusive Investigation	The ground investigation was undertaken on 25th January 2018, and consisted of the following: • 5 No. window sampling boreholes, drilled up to 5.45m below ground level (bgl), with associated in situ testing and sampling; • Laboratory analysis for chemical and geotechnical purposes, • 4No. return visits to monitor ground gas concentrations and groundwater levels have been completed.
Ground Conditions	The results of the ground investigation revealed a ground profile comprising a variable thickness of Made Ground (up to 0.7m bgl depth) or Topsoil (to a maximum depth of 0.5m bgl), overlying an orange brown mottled blue/ grey low to medium strength Clay (considered to represent the London Clay), encountered to the base of the boreholes (up to 5.45m bgl). No groundwater was encountered during the site works. Subsequently monitored groundwater levels are considered to have been due to surface water ingress unable to egress.
Environmental Considerations	Following the generic risk assessment, elevated concentrations of dibenzo(ah)anthracene were detected in soils in excess of generic assessment criteria for the protection of human health in a residential without plant uptake end use scenario in one sample. No other metals or hydrocarbons were reported to exceed the assessment criteria. Dibenzo(ah)anthracene marginally exceeded the generic assessment criteria in a single sample of topsoil material from WS1 @ 0.25m. As a total of four samples of this materials has been subjected to laboratory analysis, it is not appropriate to undertake statistical analysis on this limited dataset. However, further sampling of the topsoil material soil would allow statistical analysis, which could demonstrate that this material is suitable for use within a residential without plant uptake land use scenario. The site proposal indicates that the entirety of the site will remain covered by a combination of the proposed building footprint and hard surfacing. Where this is the case, no formal remedial measures are considered necessary in terms of human health, as the building and hard surfacing are expected to provide a barrier to potential receptors. If any areas of soft landscaping are subsequently proposed, it would be necessary, in the absence of any additional testing, to replace the soils with approximately 450mm of imported clean topsoil, placed on a geotextile membrane. No asbestos fibres were detected in the samples analysed in the laboratory. Groundwater analysis has reported exceedances of the Drinking Water Standards (DWS) for cyanide and sulphates and 4No exceedances of the Environmental Quality Standards (EQS) screening criteria's for lead, nickel, zinc, and cyanide. It is noted that a secondary river and culvert (believed to be the same feature) are reported on site. Based on the observed water level within the culvert drain (0.2m bgl) and the shallowest encountered groundwater levels within the boreholes (1.20mbgl), there can be no flow from groundwater beneath the site into the culverted drain. In addition, the groundwater monitoring results indicate that the water encountered does not represent the true groundwater level of the London Clay Formation, as groundwater levels were shown to increase on each visit. Therefore, the water encountered here is likely to represent surface water ingress that could not then egress through the very low permeability clay. The water encountered could also be sourced from potential leaks from the culvert drain, which is likely to be in a poor condition due to its route flowing past off-site areas of the former gas works.

Site History and Ground Investigation	
	Although the groundwater analysis reports these contaminants to exceed the EQS, no significant source of metals was noted within the soils from the ground investigation on site. Therefore, a pollutant linkage to controlled waters is not considered to exist at the site. A ground gas risk assessment has concluded that the site can be characterised as Characteristic Situation 1. Consequently, no formal protection measures are 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	Based upon the information obtained to date, it is considered that conventional foundations are likely to be suitable. Allowable bearing capacities have been provided for a range of depths. As Made Ground in excess of 0.6m thick has been encountered at the site, and the underlying high volume change clay, it is recommended that suspended floor slabs be adopted. As previously discussed, some groundwater was encountered during the return monitoring visits. 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. Attention is also drawn to the provisions of the Health and Safety at Work Regulations, which state that the sides of any excavations greater than 1.2m depth, into which personnel are required to enter, should be fully supported or battered back to a safe angle. Based on the results of chemical testing, the required concrete class for the London Clay Formation is DS-2 assuming an Aggressive Chemical Environment for Concrete classification of AC-1s in accordance with the procedures outlined in BRE Special Digest 1.

1 INTRODUCTION

1.1 Terms of Reference

1.1.1 Belgravia Property Development London Ltd ("The Client") has commissioned Jomas Associates Ltd, to assess the risk of contamination posed by the ground conditions at a site referred to as 2 Gasworks Cottage, Borehamwood, WD6 1DF and to provide indicative recommendations for foundation design prior to the redevelopment of the site.

1.1.2 To this end a Desk Study has been produced for the site and issued separately (Jomas, January 2018), followed by an intrusive investigation (detailed in this report).

1.1.3 A full list of previous reports undertaken for the site by Jomas are detailed in Table 1.1:

Table 1.1: Previous Reports - Jomas

Title	Author	Reference	Date
Geo-environmental Desk Study / Preliminary Risk Assessment	Jomas	P1312J1279, Final V1.0	9th January 2018

1.1.4 The intrusive investigation was undertaken in accordance with Jomas proposal dated 15 January 2018.

1.2 Proposed Development

1.2.1 It is understood that the proposed development is to comprise the demolition of the existing buildings and the construction of new residential flats with associated car parking and communal outside space. No private gardens or areas of soft landscaping are 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) 2 site in accordance with BS EN 1997. GC 2 projects are defined as involving:

- Conventional structures.
- Quantitative investigation and analysis.
- Normal risk.
- No difficult soil and site conditions.
- No difficult loading conditions.
- Routine design and construction methods.

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 1.2: Supplied Reports

Title	Author	Reference	Date
Environmental Improvement Works, Former Gasworks, Station Road, Borehamwood, Hertfordshire	Komex	CB127/A	January 2004

1.6 Limitations

1.6.1 Jomas Associates Ltd has prepared this report for the sole use of Belgravia Property Development London Ltd, 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 Jomas Associates Limited. 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 Jomas Associates Limited has actual knowledge to the contrary, information obtained from public sources or provided to Jomas Associates Limited by site personnel and other information sources, have been assumed to be correct. Jomas Associates Limited

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 Jomas Associates Limited have been reviewed in good faith. Jomas Associates Limited 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 in Appendix 1.

Table 2.1: Site Information

Name of Site	2 Gasworks Cottage
Address of Site	Station Road, Borehamwood, WD6 1DF
Approx. National Grid Ref.	519258, 196123
Site Area (Approx)	0.04ha
Site Occupation	Disused residential
Local Authority	Hertsmere Borough Council
Proposed Site Use	Redevelopment for residential use

2.2 Desk Study Overview

2.2.1 A Desk Study report has been produced for the site and issued separately (Jomas – January 2018). 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 maps indicates that the site was undeveloped until the late 1950s, with the site appearing in its current configuration by the 1964 map edition.

2.2.3 The surrounding area was first recorded as agricultural land, with a railway running adjacent to the site as early as 1870. A large gas works was developed immediately north of the site in the late 1800s, along with several other industrial sites within close proximity of the study site, including brick and tile works 100m south-west of site.

2.2.4 A third party report for the adjacent gas works notes that southern areas of the gasworks site were subsequently used for as an automotive repair garage until 2015. The report notes that suspected former structures include an interceptor and an underground storage tank (UST), although no evidence of a tank structure or base was found during investigations in 2016. The report also notes that all buildings at the gas works (with the exception of the Gasworks cottage were demolished as part of the gasholder dismantling works, completed in March 2016.

2.2.5 Information provided by the British Geological Survey indicates that the site is directly underlain by solid deposits of the London Clay Formation.

2.2.6 There are no superficial or artificial deposits within the site area.

2.2.7 The solid deposits underlying the site are reported to be Unproductive Strata.

2.2.8 A review of the EnviroInsight report indicates that there are no source protection zones located within 500m of the site.

2.2.9 There are no groundwater, surface water or potable water abstractions reported within 1km of the site.

2.2.10 A secondary river and culvert (believed to be the same feature) are reported on site, a secondary river is reported 30m south-west.

2.2.11 The conceptual site model provided within the report identifies the following potential sources, pathways and receptors. The report indicates the following potential sources of contamination:

- Potential for Made Ground associated with previous development operations – on site (S1)
- Potential contamination associated with neighbouring gas works and garage site use – off site (S2)
- Potential asbestos containing materials within existing buildings – on site (S3)
- Potentially off -site infilled land – brick and tile works 100m SW, infilled gas holders north of site (S4)

2.2.12 The conceptual site model identifies the following potential pathways:

- Ingestion and dermal contact with contaminated soil (P1)
- Inhalation or contact with potentially contaminated dust and vapours (P2)
- 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)
- Accumulation and Migration of Soil Gases (P5)
- Permeation of water pipes and attack on concrete foundations by aggressive soil conditions (P6)

2.2.13 The conceptual site model identifies the following potential receptors:

- 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)
- Controlled Waters (Culvert/Secondary River) (R6)

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, BS: 10175, 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 for both a contamination and geotechnical assessment.

3.2 Scope of Ground Investigation

3.2.1 The ground investigation was undertaken on 25th January 2018.

3.2.2 The work was undertaken in accordance with BS: 5930 (2015) '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 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	5	WS1 – 5	Up to 5.45m bgl	Obtain shallow samples for laboratory contamination and geotechnical testing. To allow in-situ geotechnical testing.
Monitoring Wells	3	WS1, WS3 and WS5	Up to 4mbgl	Combined soil gas and groundwater monitoring wells. WS1 - response zone in clay WS3 - response zone in clay and clayey gravel WS5 - response zone in clay

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 BS: 5930 (2015).

3.2.6 Exploratory hole positions were located approximately with reference to known features on site as shown in the exploratory hole location plan presented in Appendix 1. The exploratory hole records are included in Appendix 2.

3.2.7 Where monitoring well installations were not installed, the exploratory holes 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 In-situ geotechnical testing

3.3.1 In-situ geotechnical testing included Standard Penetration Tests. The determined 'N' values have been used to determine the relative density of granular materials and have been used with standard correlations to infer various other derived geotechnical parameters including the undrained shear strength of the cohesive strata. The results of the individual tests are on the appropriate exploratory hole logs in Appendix 2.

3.4 Sampling Rationale

3.4.1 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).

3.4.2 The exploratory holes were positioned by applying a combined non-targeted sampling strategy.

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

3.4.4 Jomas Associates Limited'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.

3.4.5 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.

3.4.6 Soil samples were taken from across the site at various depths as shown in the exploratory hole logs (copies of which are provided in Appendix 2). The methodology used and type of samples taken were chosen to allow the Sampling category to be A or B according to EN ISO 22475-1. This in turn allows suitable geotechnical testing to be carried out.

3.4.7 During return groundwater monitoring visits, where groundwater samples are taken, all the sampling was undertaken using the low flow methodology. This removes stagnant

groundwater from the monitoring well, whilst attempting to ensure that sediment is not removed with the sample. The low flow sample was taken once various readings of the water being removed from the well had stabilised. The low flow sampling records are included in Appendix 7.

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

3.4.9 Samples were stored in cool boxes (<4°C) and preserved in accordance with laboratory guidance.

3.5 Sampling Limitations

3.5.1 All of the boreholes were drilled in their original proposed locations.

3.6 Laboratory Analysis

3.6.1 A programme of laboratory testing, scheduled by Jomas Associates Limited, was carried out on selected samples of Made Ground and natural strata.

Chemical Testing

3.6.2 Soil samples were submitted to i2 Analytical (a UKAS and MCerts accredited laboratory), for analysis.

3.6.3 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**
Jomas Suite 5	3	6
TPHCWG (inc BTEX)	3	6
Asbestos Screen & ID	4	1
Total Organic Carbon	1	3

3.6.4 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	0.2	Y (MCERTS)	ICPMS
Chromium	1	Y (MCERTS)	ICPMS
Chromium (Hexavalent)	4	Y (MCERTS)	Colorimetry
Lead	1	Y (MCERTS)	ICPMS
Mercury	0.3	Y (MCERTS)	ICPMS
Nickel	1	Y (MCERTS)	ICPMS
Selenium	1	Y (MCERTS)	ICPMS
Copper	1	Y (MCERTS)	ICPMS
Zinc	1	Y (MCERTS)	ICPMS
Boron (Water Soluble)	0.2	Y (MCERTS)	ICPMS
pH Value	0.1 units	Y (MCERTS)	Electrometric
Sulphate (Water Soluble)	0.0125g/l	Y (MCERTS)	Ion Chromatography
Total Cyanide	1	Y (MCERTS)	Colorimetry
Speciated/Total PAH	0.05/0.80	Y (MCERTS)	GCFID
Phenols	1	Y (MCERTS)	HPLC
Total Petroleum Hydrocarbons (banded)	-	N Y (MCERTS)	Gas Chromatography

3.6.5 To support the selection of appropriate tier 1 screening values, 4No. samples were also analysed for total organic carbon.

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

Geotechnical Laboratory Testing

3.6.7 In addition to the contamination assessment, soil samples were submitted to the UKAS Accredited laboratory of i2 Analytical Ltd. for a series of analysis.

3.6.8 This testing was specifically designed to:

- to classify the samples; and
- to obtain parameters (either directly or sufficient to allow relevant correlations to be used) relevant to the technical objectives of the investigation.

3.6.9 The following laboratory geotechnical testing (as summarised in Table 5.4) was carried out:

Table 5.4 Laboratory Geotechnical Analysis

BS 1377 (1990) Test Number	Test Description	Number of tests
Part 2		
3.2	Moisture Content Determination	8
4.3 and 5.3	Liquid and Plastic Limit Determination (Atterberg Limits)	8

3.6.10 The water soluble sulphate and pH results obtained as part of the chemical analysis was used in combination with BRE Special Digest 1 to allow buried concrete to be designed.

3.6.11 The results of the geotechnical laboratory testing are presented as Appendix 8 and discussed in Section 10 of this report.

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)	Proven Base of Strata (m bgl)	Thickness range (m)
Topsoil	0	0.3 – 0.5	0.3 – 0.5
Made Ground consisting of either topsoil or reinforced concrete overlying brown sandy very gravelly clay. Gravel consists of fine to coarse brick and concrete fragments. (MADE GROUND)	0.0	0.5 – 0.7	0.5 – 0.7
Orange to brown mottled blue to grey slightly sandy CLAY containing rootlets. Sand is fine to medium.	0.3 – 0.5	>4.0 – >5.0	>3.7 – >4.5
Sandy clayey GRAVEL. (WS3 only)	1.4	1.6	0.2

4.1.2 Given the likely ground strata profile identified in the Desk Study and the BGS descriptions of the materials given in Section 3 of the Desk Study, it is considered that the encountered strata represent made ground overlying solid deposits of the London Clay Formation.

4.2 Hydrogeology

4.2.1 Groundwater was not encountered in any of the exploratory holes.

4.2.2 Four return visits have been made to monitor the standing groundwater levels. These are summarised in Table 6.2 below:

Table 6.2: Groundwater Monitoring Records

Exploratory Hole ID	Depth Encountered (m bgl)	Depth to Base of Well (m bgl)	Stratum
WS1	2.55 - >3.98 (Dry)	3.98	London Clay Formation
WS3	2.10 – 3.80	3.93	London Clay Formation
WS5	1.20 – 3.47	4.0	London Clay Formation

4.2.3 It should be noted that the results of the monitoring showed a significant range of water levels. Therefore, the results are considered not to represent groundwater levels but rather the ingress of surface water that has percolated into the well.

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, Jomas Associates Limited 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)	S4UL
	Total Phenols	S4UL
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	S4UL
Volatile Organic Compounds (VOCs/sVOCs).	Toluene, Ethylbenzene, Benzene, Xylenes	S4UL
Inorganic Substances		
Heavy Metals and Metalloids	Arsenic, Cadmium, Chromium, Lead, Mercury, Nickel, Selenium, Copper, Zinc	S4UL
	Copper, Zinc, Nickel	BS: 3882 (2015).
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

Substance Group	Determinand(s)	Assessment Criteria Selected
	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 Organic Matter	1%

5.5.2 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 1.55% was the mean value obtained from laboratory analysis.

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	9	40	S4UL	11	32	0
Cadmium	mg/kg	9	85	S4UL	<0.2	<0.2	0
Chromium	mg/kg	9	910	S4UL	29	58	0
Lead	mg/kg	9	310	C4SL	12	42	0
Mercury	mg/kg	9	1.2	S4UL	<0.3	<0.3	0
Nickel	mg/kg	9	180	S4UL	18	72	0
Copper	mg/kg	9	7100	S4UL	15	24	0
Zinc	mg/kg	9	40000	S4UL	55	120	0
Total Cyanide [A]	mg/kg	9	33	CLEA v 1.06	<1	4	0
Selenium	mg/kg	9	430	S4UL	<1.0	1.4	0
Boron Water Soluble	mg/kg	9	11000	S4UL	0.8	5.4	0
Phenols	mg/kg	9	440	S4UL	<1.0	<1.0	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	9	S4UL	2.3	<0.05	<0.3	0
Acenaphthylene	mg/kg	9	S4UL	2900	<0.05	<0.05	0
Acenaphthene	mg/kg	9	S4UL	3000	<0.05	0.38	0
Fluorene	mg/kg	9	S4UL	2800	<0.05	0.33	0
Phenanthrene	mg/kg	9	S4UL	1300	<0.05	2.7	0
Anthracene	mg/kg	9	S4UL	2300	<0.05	0.65	0
Fluoranthene	mg/kg	9	S4UL	1500	<0.05	3.2	0

Determinand	Unit	No. Samples Tested	Screening Criteria		Min	Max	No. Exceeding
Pyrene	mg/kg	9	S4UL	3700	<0.05	2.5	0
Benzo(a)anthracene	mg/kg	9	S4UL	11.0	<0.05	1.5	0
Chrysene	mg/kg	9	S4UL	30	<0.05	1.7	0
Benzo(b)fluoranthene	mg/kg	9	S4UL	3.9	<0.05	2.3	0
Benzo(k)fluoranthene	mg/kg	9	S4UL	110	<0.05	0.94	0
Benzo(a)pyrene	mg/kg	9	S4UL	3.2	<0.05	2.1	0
Indeno(123-cd)pyrene	mg/kg	9	S4UL	45	<0.05	1.2	0
Dibenzo(ah)anthracene	mg/kg	9	S4UL	0.31	<0.05	0.32	1No, WS1 at 0.25m
Benzo(ghi)perylene	mg/kg	9	S4UL	360	<0.05	1.3	0
Total PAH	mg/kg	9	-	-	<0.80	20.9	-

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

TPH Band	Unit	No. Samples Tested	Screening Criteria		Min	Max	No. Exceeding
$>C_5$-C_6 Aliphatic	mg/kg	9	S4UL	42	<0.01	<0.01	0
$>C_6$-C_8 Aliphatic	mg/kg	9	S4UL	100	<0.01	<0.01	0
$>C_8$-C_{10} Aliphatic	mg/kg	9	S4UL	27	<0.01	<0.01	0
$>C_{10}$-C_{12} Aliphatic	mg/kg	9	S4UL	130	<1.0	<1.0	0
$>C_{12}$-C_{16} Aliphatic	mg/kg	9	S4UL	1100	<2.0	<2.0	0
$>C_{16}$-C_{35} Aliphatic	mg/kg	9	S4UL	65000	<8.0	<8.0	0
$>C_5$-C_7 Aromatic	mg/kg	9	S4UL	370	<0.01	<0.01	0
$>C_7$-C_8 Aromatic	mg/kg	9	S4UL	860	<0.01	<0.01	0
$>C_8$-C_{10} Aromatic	mg/kg	9	S4UL	47	<1.0	<1.0	0
$>C_{10}$-C_{12} Aromatic	mg/kg	9	S4UL	250	<1.0	2.4	0
$>C_{12}$-C_{16} Aromatic	mg/kg	9	S4UL	1800	<2.0	6.3	0
$>C_{16}$-C_{21} Aromatic	mg/kg	9	S4UL	1900	<10	26	0
$>C_{21}$-C_{35} Aromatic	mg/kg	9	S4UL	1900	<10	62	0
Total TPH (Ali/Aro)	mg/kg	9	S4UL	1900	20	98	0

6.2 Volatile Organic Compounds

6.2.1 In addition to the suites outlined previously, 9No samples were tested for the presence of volatile organic compounds including BTEX compounds (benzene, toluene, ethylbenzene, xylene). No VOCs were reported above the laboratory detection limit within any tested sample.

6.3 Statistical Analysis

6.3.1 Dibenzo(ah)anthracene marginally exceeded the generic assessment criteria in a single sample of topsoil material from WS1 @ 0.25m. As a total of four samples of this materials has been subjected to laboratory analysis, it is not appropriate to undertake statistical analysis on this limited dataset.

6.3.2 However, further sampling of the topsoil material soil would allow statistical analysis, which could demonstrate that this material is suitable for use within a residential without plant uptake land use scenario.

6.4 Asbestos in Soil

6.4.1 5No samples of the Made Ground were screened in the laboratory for the presence of asbestos. The results of the analysis is summarised below in Table 6.5 below

Table 6.5: Asbestos Analysis – Summary

Sample	Screening result.	Quantification result (%)	Comments
WS1– 0.25m bgl	None Detected	N/A	-
WS2 – 0.25m bgl	None Detected	N/A	-
WS3 – 0.50m bgl	None Detected	N/A	-
WS4 – 0.75m bgl	None Detected	N/A	-
WS5 – 0.50m bgl	None Detected	N/A	-

6.5 Screening of Groundwater Chemical Analysis Results

6.5.1 Samples of groundwater obtained from the borehole installations installed within exploratory locations WS1, WS3 and WS5 were submitted for chemical analysis.

6.5.2 The samples were obtained by means of low flow methodology.

6.5.3 The results of the laboratory testing are summarised in Tables 6.6 to 6.8 below, with the raw chemical testing data presented in Appendix 3.

Table 6.6: Groundwater Laboratory Analysis Results

Determinand	Unit	No. samples tested	Screening Criteria		Min	Max	No of Exceedances
Arsenic	µg/l	3	10	DWS	3.5	4.1	0
	µg/l	3	50	EQS	3.5	4.1	0
Cadmium	µg/l	3	85	DWS	< 0.08	< 0.08	0
Chromium	µg/l	3	910	DWS	< 0.4	10	0
Lead	µg/l	3	310	DWS	2.8	9.3	0
	µg/l	3	1.2*	EQS	2.8	9.3	3No – WS1, WS3, WS5
Nickel	µg/l	3	180	DWS	5.8	6.6	0
	µg/l	3	4*	EQS	5.8	6.6	3No – WS1, WS3, WS5

Table 6.6: Groundwater Laboratory Analysis Results

Determinand	Unit	No. samples tested	Screening Criteria		Min	Max	No of Exceedances
Copper	µg/l	3	12 2000	EQS DWS	6.2	12	0
Zinc	µg/l	3	5000	DWS	38	1300	0
	µg/l	3	12.9**	EQS	38	1300	3No – WS1, WS3, WS5
Mercury	µg/l	3	1	DWS	<0.5	<0.5	0
Selenium	µg/l	3	10	DWS	< 4.0	< 4.0	0
Boron	µg/l	3	1000	DWS	400	520	0
	µg/l	3	2000	EQS	400	520	0
Cyanide (Total)	µg/l	3	50	DWS	<1.0	100	1No – WS5
	µg/l	3	1	EQS	<1.0	100	2No – WS3, WS5
Phenols (Total)	µg/l	3	7.7	EQS	<10	<10	0
Sulphate	mg/l	3	250	DWS	3930	5540	3No – WS1, WS3, WS5
pH Value	Units	3	6-9	EQS	7.2	7.4	0

* bioavailable concentration

**bioavailable concentration + ambient background concentration dissolved for Thames Groundwater (2 µg/L)

6.5.4 It should be noted that the laboratory detection limit for Phenol is higher than the EQS. However, it is assumed that only detected levels have failed the relevant criteria.

Table 6.7: Groundwater Analysis Results – Polycyclic Aromatic Hydrocarbons (PAHs)

Determinand	Unit	No. samples tested	Screening Criteria		Min.	Max.	No. of Exceedances
Naphthalene	µg/l	3	2.4	EQS	< 0.01	< 0.01	0
Acenaphthylene	µg/l	3	-	-	< 0.01	<0.01	0
Acenaphthene	µg/l	3	-	-	< 0.01	<0.01	0
Fluorene	µg/l	3	-	-	< 0.01	<0.01	0
Phenanthrene	µg/l	3	-	-	< 0.01	<0.01	0
Anthracene	µg/l	3	0.1	EQS	< 0.01	<0.01	0
Fluoranthene	µg/l	3	0.0063	EQS	< 0.01	< 0.01	0*
Pyrene	µg/l	3	-	-	< 0.01	< 0.01	0
Benzo(a)anthracene	µg/l	3	-	-	< 0.01	< 0.01	0
Chrysene	µg/l	3	-	-	< 0.01	< 0.01	0
Sum of four Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(ghi)perylene	µg/l	3	0.1	DWS	< 0.04	< 0.04	0

Determinand	Unit	No. samples tested	Screening Criteria		Min.	Max.	No. of Exceedances
Indeno(123-cd)pyrene							
Benzo(a)pyrene	µg/l	3	0.01	DWS	< 0.01	< 0.01	0
	µg/l	3	0.00017	EQS	< 0.01	< 0.01	0*
Dibenzo(ah)anthracene	µg/l	3	-	-	< 0.01	< 0.01	0

***** Laboratory method detection limit exceeds the EQS.

Table 6.8: Groundwater Analysis Results (Round 2) – TPHCWG – Controlled Waters

Determinand	Unit	No. Samples tested	Screening Criteria		Min.	Max.	No. of Exceedances
Benzene	µg/l	3	10	EQS	<1	<1	0
	µg/l	3	1	DWS	<1	<1	0
Toluene	µg/l	3	700	DWS	<1	<1	0
	µg/l	3	74	EQS	<1	<1	0
Ethyl benzene	µg/l	3	300	DWS	<1	<1	0
Xylenes	µg/l	3	500	DWS	<1	<1	0
MTBE	µg/l	3	15	DWS	<1	<1	0
>C5-C6 Aliphatic	µg/l	3	15000	WHO	<1.0	<1.0	0
>C6-C8 Aliphatic	µg/l	3	15000	WHO	<1.0	<1.0	0
>C8-C10 Aliphatic	µg/l	3	300	WHO	<1.0	<1.0	0
>C10-C12 Aliphatic	µg/l	3	300	WHO	<10.0	<10.0	0
>C12-C16 Aliphatic	µg/l	3	300	WHO	<10.0	<10.0	0
>C16-C21 Aliphatic	µg/l	3	-	-	<10.0	<10.0	-
>C21-C35 Aliphatic	µg/l	3	90	WHO	<10.0	<10.0	0
>C5-C7 Aromatic	µg/l	3	10	WHO	<1.0	<1.0	0
>C7-C8 Aromatic	µg/l	3	700	WHO	<1.0	<1.0	0
>C8-C10 Aromatic	µg/l	3	300	WHO	<1.0	<1.0	0
>C10-C12 Aromatic	µg/l	3	90	WHO	<10.0	<10.0	0
>C12-C16 Aromatic	µg/l	3	90	WHO	<10.0	<10.0	0
>C16-C21 Aromatic	µg/l	3	90	WHO	<10.0	<10.0	0
>C21-C35 Aromatic	µg/l	3	90	WHO	<10.0	<10.0	0

6.5.5 In addition to the suite outlined above, the three water samples were also analysed for a suite of volatile organic compounds. None of the compounds analysed for were reported above the laboratory method detection limit.

6.5.6 Similarly for the BTEX (Benzene, Toluene, Ethylbenzene and Xylene) compounds, none of the results were reported above the laboratory method of detection.

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

6.6.1 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 BS: 3882 (2015).

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

Table 6.9: Soil Laboratory Analysis Results – Phytotoxic Determinands

Determinand	Threshold level (mg/kg)	Min (mg/kg)	Max (mg/kg)	No. Exceeding
Zinc	300	55	120	0
Copper	200	15	24	0
Nickel	110	18	72	0

6.7 Screening for Water Pipes

6.7.1 The results of the analysis have been assessed for potential impact upon water supply pipes. Table 6.10 below summarises the findings of the assessment:

Table 6.10: Screening Guide for Water Pipes

Determinand	Threshold adopted for PE (mg/kg)	Min Value for site data (mg/kg)	Max Value from site data (mg/kg)
Total VOCs	0.5	<0.056*	<0.056*
BTEX	0.1	<0.005*	<0.005*
MTBE	0.1	<0.001*	<0.001*
EC5-EC10	1	<0.006*	<0.006*
EC10-EC16	10	<6	11.7
EC16-EC40	500	<36.0	104
Naphthalene	5	0.7	0.7
Phenols	2	<9*	<9*

*Laboratory detection limit

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

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

6.8 Waste Disposal

6.8.1 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 Four return monitoring visits have been undertaken to monitor wells installed within boreholes at the site for soil gas concentrations and groundwater levels.

7.1.2 Four return monitoring visits have been undertaken from 29 January 2018 to 22 February 2018, to monitor wells installed within boreholes at the site for soil gas concentrations and groundwater levels.

7.1.3 During these visits atmospheric pressure ranged between 993mb and 1015mb. During these visits pressure trends observed were static, falling and rising.

7.1.4 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)	VOCs	Peak Flow Rate (l/hr)	Depth to water (mbgl)	Depth of installation (mbgl)
WS1	0.0 - 0.2	1.3 – 1.8	20.4 – 21.0	0	1 - 4	0.1 – 0.3	2.55 - >3.98	3.98
WS3	0.0 – 0.2	1.6 – 3.5	14.4 – 18.2	0	1 - 5	0.1 – 0.2	2.10 – 3.80	3.93
WS5	0.0 – 0.2	1.1 – 1.6	17.9 – 20.5	0	1 - 4	0.1 – 0.2	1.20 – 3.47	4.00

7.2 Screening of Results

7.2.1 As shown in Table 7.1, methane has been reported to a maximum concentration of 0.2%v/v date. Carbon dioxide has been reported to a maximum concentration of 3.5%v/v. Screening of the monitoring well headspaces with a photo-ionisation detector (PID) has detected maximum Volatile organic compound (VOC) concentration to a maximum level of 5.0ppm. Hydrogen sulphide was not detected during the monitoring and carbon monoxide was recorded to a maximum concentration of 3ppm. 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, BS8485 (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	3.5	0.3	**0.0105**	**1**
CH_4	0.2	0.3	**0.006**	**1**

7.2.11 The methodology set out in BS: 8485 (2015) has been used for determining the required gas protection measures. For a Type A development on a CS1 sites the gas no formal gas protection measures are required.

7.2.12 BS: 8576 (2013) has been used to derived threshold levels for Carbon Monoxide and Volatile Organic Compounds.

7.2.13 Given the recorded levels it is not considered that additional protection measures need to be incorporated to protect end users from the recorded Carbon Monoxide concentrations.

7.2.14 PID screening of the monitoring well headspace has revealed maximum concentrations of VOCs of 5ppm. The VOC concentrations reported in both the soil and groundwater laboratory results were below the detection limit of the analysis. Furthermore, no visual/olfactory evidence of potential VOC contamination was reported on site during the ground investigation. Therefore, it is considered that the PID screening of monitoring well confirms the assessment that risks to human health receptors via vapour inhalation pathways are low.

8 SUMMARY OF RESULTS

8.1 Land Quality Impact Summary

8.1.1 Following the ground investigation, the following is noted:

- Following the generic risk assessment, elevated concentrations of dibenzo(ah)anthracene were detected in soils in excess of generic assessment criteria for the protection of human health in a residential without plant uptake end use scenario in one sample. No other metals or hydrocarbons were reported to exceed the assessment criteria.

- Dibenzo(ah)anthracene marginally exceeded the generic assessment criteria in a single sample of topsoil material from WS1 @ 0.25m. As a total of four samples of this materials has been subjected to laboratory analysis, it is not appropriate to undertake statistical analysis on this limited dataset. However, further sampling of the topsoil material soil would allow statistical analysis, which could demonstrate that this material is suitable for use within a residential without plant uptake land use scenario.

- The site proposal indicates that the entirety of the site will remain covered by a combination of the proposed building footprint and hard surfacing. Where this is the case, no formal remedial measures are considered necessary in terms of human health, as the building and hard surfacing are expected to provide a barrier to potential receptors. If any areas of soft landscaping are subsequently proposed, it would be necessary, in the absence of any additional testing, to replace the soils with approximately 450mm of imported clean topsoil, placed on a geotextile membrane.

- No asbestos fibres were detected in the samples analysed in the laboratory.

- Groundwater analysis has reported exceedances of the Drinking Water Standards (DWS) for cyanide and sulphates and 4No exceedances of the Environmental Quality Standards (EQS) screening criteria's for lead, nickel, zinc, and cyanide.

- It is noted that a secondary river and culvert (believed to be the same feature) are reported on site. Based on the observed water level within the culvert drain (0.2m bgl) and the shallowest encountered groundwater levels within the boreholes (1.20mbgl), there can be no flow from groundwater beneath the site into the culverted drain.

- In addition, the groundwater monitoring results indicate that the water encountered does not represent the true groundwater level of the London Clay Formation, as groundwater levels were shown to increase on each visit. Therefore, the water encountered here is likely to represent surface water ingress that could not then egress through the very low permeability clay. The water encountered could also be sourced from potential leaks from the culvert

drain, which is likely to be in a poor condition due to its route flowing past off-site areas of the former gas works.

- Although the groundwater analysis reports these contaminants to exceed the EQS, no significant source of metals was noted within the soils from the ground investigation on site.

- Therefore, a pollutant linkage to controlled waters is not considered to exist at the site.

- A ground gas risk assessment has concluded that the site can be characterised as Characteristic Situation 1. Consequently, no formal protection measures are 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 Made Ground associated with previous development operations – on site (S1) • Potential contamination associated with neighbouring gas works and garage site use – off site (S2) • Potential asbestos containing materials within existing buildings – on site (S3) • Potentially off -site infilled land – brick and tile works 100m SW, infilled gas holders north of site (S4)	• 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**	For outline remedial requirements, please see section 8.1 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)		**N**	No formal gas protection measures are 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) • Controlled Waters (Culvert/Secondary River) (R6)	**Y**	Contact should be made with relevant utility providers to confirm if upgraded materials are required. A pollutant linkage to controlled waters is not considered to exist.

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 of the demolition of the existing buildings and the construction of new residential flats with associated car parking and communal outside space. No private gardens or extensive areas of soft landscaping anticipated.

9.2 Geotechnical Classification

9.2.1 At the Desk Study stage this development was deemed to be a GC2 development in accordance with BS: 1997.

9.2.2 The findings of the investigation undertaken and discussed previously does not change this assessment.

9.3 Data Summary

9.3.1 The results of the ground investigation revealed a ground profile comprising a variable thickness of Made Ground (up to 0.7m bgl depth) or Topsoil (to a maximum depth of 0.5m bgl), overlying an orange brown mottled blue/ grey low to medium strength Clay (considered to represent the London Clay), encountered to the base of the boreholes (up to 5.45m bgl).

9.3.2 A summary of ground conditions obtained from the ground investigation and the derived geotechnical parameters, is provided in Table 9.1 below.

Table 9.1: Ground Conditions and Derived Geotechnical Parameters

Strata	Depth Encountered (from - to) (m bgl)	SPT 'N' Value	Inferred Shear Strength (kPa)	Inferred coefficient of compressibility (m^2/MN)	Moisture content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (corrected plasticity) (%)	NHBC Volume Change Classification
Topsoil or Made Ground consisting of either reworked / disturbed topsoil or reinforced concrete overlying brown sandy very gravelly clay. Gravel consists of fine to coarse brick and concrete fragments. (MADE GROUND)	GL to 0.3-0.7	-	-	-	-	-	-	-	-
Orange to brown mottled blue to grey slightly sandy CLAY containing rootlets. Sand is fine to medium.	0.3 - 0.5 to >4.0 – >5.0	8 - 17	36 - 77	0.131 – 0.278	25 - 38	68 - 76	25 - 31	43 – 47 (38.6 – 47)	Medium - High
Sandy clayey GRAVEL. (WS3 only)	1.4 to 1.6	-	-	-	-	-	-	-	-

9.4 Undrained Shear Strength

9.4.1 Standard Penetration Tests were undertaken at regular intervals throughout the window sampler holes within the London Clay Formation. The resultant 'N' values have been used with the correlation suggested by Stroud (1974), to infer the undrained shear strength of the London Clay Formation. Figure 9.2 below shows the undrained shear strength inferred by

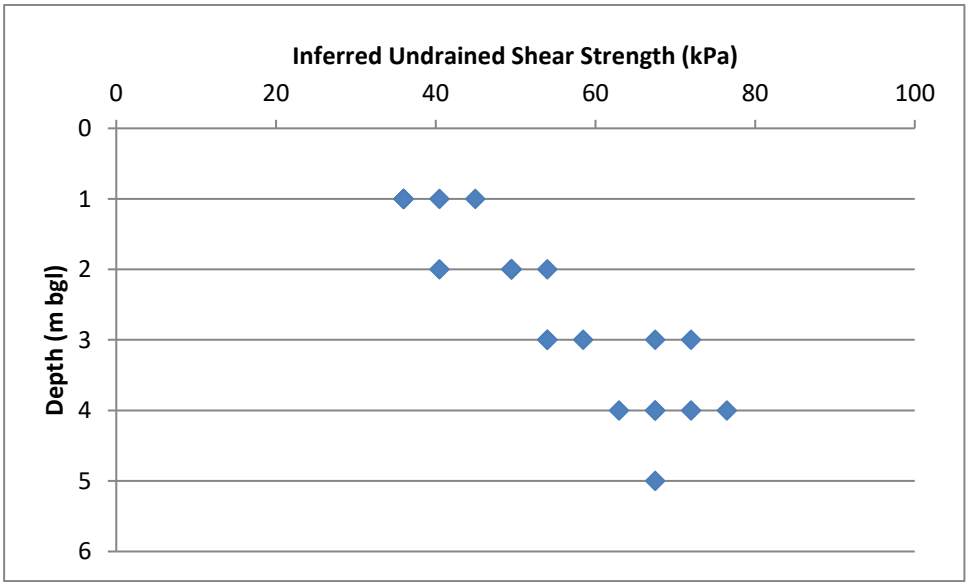
$c_u = f_1 \times N$ can be applied,

in which
c_u= mass shear strength (kN)
f_1 = constant
N= SPT Value achieved during boring operations

9.4.2 In the above equation f_1 is dependent on the plasticity of the material that the SPT is being carried out in. As the plasticity indices were shown to be greater than 27% a value for f_1 of 4.5 has been adopted after Tomlinson (2001)

9.4.3 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.

Figure 9.2: Undrained Shear Strength v Depth



9.5 Coefficient of Compressibility

9.5.1 Stroud and Butler (1974) developed a relationship between the coefficient of compressibility (m_v) and SPT 'N' value.

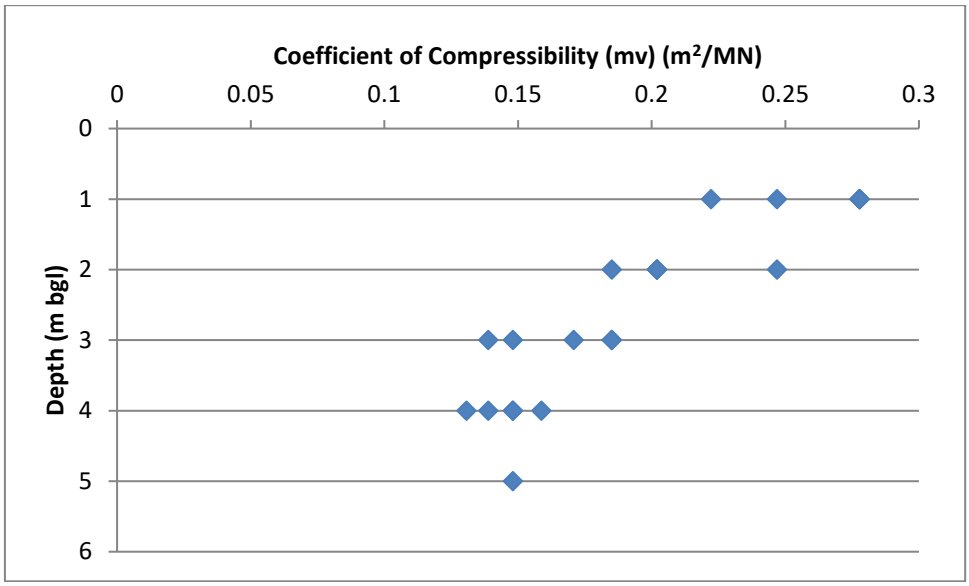
$m_v = 1/ (f_2 \times N)$ can be applied,

in which

m_v = coefficient of compressibilty (m^2/MN)
f_2 = constant dependant on the plasticity index
N = SPT Value achieved during boring operations

9.5.2 Using the plasticity indices obtained (See Table 9.1) and the graphs provided in Tomlinson (2001) a value of f_2 of 0.45 has been taken and used with the SPT 'N' values to infer coefficient of compressibility (m_v), these have been plotted against depth below in Table 9.2.

Table 9.3: of Coefficient of Volume Compressibility (m_v) v Depth



9.5.3 As would be expected the results reduce with depth as the clay increases in strength and the over burden increases, reducing the potential for compressibility.

9.5.4 The results from of the London Clay Formation are generally of "medium compressibility", this is slightly higher than would be expected within London Clay Formation. This is considered to be due to the lack of overburden pressure and weathering of the clays that have allowed the overconsolidated clays to relax and so compress slightly.

9.6 Building Near Trees

9.6.1 The underlying soil conditions have been shown to be of medium to high volume change potential.

9.6.2 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. This would allow for restricted new planting.

9.6.3 Presence of existing and proposed trees may increase this minimum depth. It is recommended that a tree survey that should include: location, species and height of all trees on and near to the proposed development is recommended.

9.6.4 Guidance is also given in relation to other aspects of construction where the shrink / swell potential of the soils may be needed to take into consideration. This guidance is summarised in the appropriate sections below.

9.7 Foundations

9.7.1 Foundations should not be formed in either the Made Ground or the Topsoil due to the unacceptable risk of total and differential settlement.

9.7.2 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.

9.7.3 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.

9.7.4 Based on the findings of this investigation, it is considered that traditional strip footings of 1m breadth formed at a range of depths have been determined and are summarised below:

Table 9.2: Determined Allowable Bearing Capacitys (kPa)

Depth of Foundation (m)	Allowable Bearing Capacity (kPa)
1.5	80
2.0	95
2.5	110

9.7.5 The above should be used in association with the distance to and species of any previous, existing and proposed trees, to determine required depth.

9.7.6 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.

9.8 Concrete in the Ground

9.8.1 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.

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

9.8.3 Table 9.3 summarises the analysis of the aggressive nature of the ground for each of the strata encountered within the ground investigation.

Table 9.3: Concrete in the Ground Classes

Stratum	No. Samples	pH range	Highest WS Sulphate (mg/l)	Design Sulphate Class	ACEC Class
Topsoil / Made Ground	3	7.4 – 8.7	305	DS-1	AC-1s
London Clay Formation	6	7.5 – 7.8	571	DS-2	AC-1s

9.9 Ground Floor Slabs

9.9.1 Due to the encountered depth of Made Ground (in excess of 600mm) and the presence of cohesive ground with a high volume change potential, in accordance with NHBC Chapter 4.2 a suspended floor slab will be required. The depth of clear void beneath the suspended floor slab will be dependant on the floor type used.

9.9.2 Under suspended in-situ concrete ground floor a minimum void of 150mm is required. Whilst under suspended precast concrete and timber floors a minimum of 300mm is required.

9.9.3 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.

9.10 Excavations

9.10.1 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.

9.10.2 The stability of all excavations should be assessed during construction. Attention is also drawn to the provisions of the Health and Safety at Work Regulations, which state that the sides of any excavations greater than 1.2m depth, into which personnel are required to enter, should be fully supported or battered back to a safe angle.

9.11 Groundwater Control

9.11.1 During the investigation groundwater was not encountered in any of the windowless sampler boreholes.

9.11.2 During return monitoring groundwater was reported at depths of between 1.20m and >3.98m bgl (dry). Such variance suggests that water was entering the well from the surface but was unable to drain away, as opposed to the natural groundwater table.

9.11.3 Subject to seasonal variations, any groundwater encountered during site works could be readily dealt with by conventional pumping from a sump used to collate waters.

9.11.4 Surface water or rainfall ingress could be similiarly dealt with.

10 REFERENCES

BRE Report BR211: Radon: Protective measures for new dwellings, 2007

BRE Special Digest 1: Concrete in Aggressive Ground, 2005

British Standards Institution (2007) BS 3882:2007 *Specification for topsoil and requirements for use.* Milton Keynes: BSI

British Standards Institution (2011) BS 10175:2011 *Code of practice for the investigation of potentially contaminated sites*. Milton Keynes: BSI

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Environment Agency (2004) *Model procedures for the management of land contamination*. CLR11. Bristol: Environment Agency

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CIRIA C665 (2007) *Assessing risks posed by hazardous ground gases to buildings London,* CIRIA

British Standards Institution (2015) BS 8485:2015 Incorporating corrigendum No.1 *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings* Milton Keynes: BSI

British Standards Institution (2013) BS 8576:2013 *Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOC's),* Milton Keynes: BSI

APPENDICES

APPENDIX 1 – FIGURES

JOMAS ASSOCIATES LTD
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Project Name	Gasworks Cottage	**Client**	Belgravia Property Development London LTD
Project No.	P1312J1279	**Date**	22/12/2017
Title	Proposed Exploratory Holes	**Prepared By**	TE

Small shed on site

Key:
Hardstanding walkway

Photo location and number (x)
● Trees

APPENDIX 2 – EXPLORATORY HOLE RECORDS

WINDOW/WINDOWLESS SAMPLING BOREHOLE RECORD

Exploratory Hole No:	WS1		
Site Address:	Gasworks Cottage, Station Road, Borehamwood	Project No:	P1312J1279
Client:	Belgravia Property Development London LTD	Ground Level:	
Logged By:	RS	Date Commenced:	25/01/2018
Checked By:	PSw	Date Completed:	25/01/2018
Type and diameter of equipment:	Dando Terrier	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: No water reported

2: * Field description

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				TOPSOIL	
PJV	0.25										0.30			
PJV	0.50								0.50				Orange brown mottled blue grey low to medium strength slightly sandy becoming sandy CLAY. Sand is fine to medium. (LONDON CLAY FORMATION)	
PJV	1.00								1.00					
SPT		0	0	1	2	3	3	9						
D														
									1.50					
SPT	2.00	1	1	2	2	3	4	11	2.00					
D														
									2.50					
D	3.00								3.00					
SPT		2	2	3	4	4	5	16						
									3.50					
D	4.00								4.00					
SPT		1	2	3	3	4	5	15						
											4.45			
									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:	Gasworks Cottage, Station Road, Borehamwood	Project No:	P1312J1279
Client:	Belgravia Property Development London LTD	Ground Level:	
Logged By:	RS	Date Commenced:	25/01/2018
Checked By:	PSw	Date Completed:	25/01/2018
Type and diameter of equipment:	Dando Terrier	Sheet No:	1 Of 2

Water levels recorded during boring, m

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

Remarks

1: Between 0.5m and 1.5m some rootlets were noted
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					
PJV	0.25												TOPSOIL	
PJV	0.50								0.50		0.50			
													Orange brown mottled blue grey low to medium strength sandy CLAY. Sand is fine to medium. (LONDON CLAY FORMATION)	
PJV	1.00								1.00					
D														
SPT		0	1	1	2	3	2	8						
									1.50					
D	2.00								2.00					
SPT		1	2	2	3	3	3	11						
									2.50					
D	3.00								3.00					
SPT		1	2	2	3	3	4	12						
									3.50					
D	4.00								4.00					
SPT		1	3	3	3	4	4	14						
									4.50					
D	5.00								5.00					
SPT		2	2	3	4	4	4	15						

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:	Gasworks Cottage, Station Road, Borehamwood	Project No:	P1312J1279
Client:	Belgravia Property Development London LTD	Ground Level:	
Logged By:	RS	Date Commenced:	25/01/2018
Checked By:	PSw	Date Completed:	25/01/2018
Type and diameter of equipment:	Dando Terrier	Sheet No:	2 Of 2

Water levels recorded during boring, m

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

Remarks

1: Between 0.5m and 1.5m some rootlets were noted
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						
D	5.00								5.00					
SPT		2	2	3	4	4	4	15					Orange brown mottled blue grey low to medium strength sandy CLAY. Sand is fine to medium. (LONDON CLAY FORMATION)	
											5.45			
									5.50					
									6.00					
									6.50					
									7.00					
									7.50					
									8.00					
									8.50					
									9.00					
									9.50					
									10.00					

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:	Gasworks Cottage, Station Road, Borehamwood	Project No:	P1312J1279
Client:	Belgravia Property Development London LTD	Ground Level:	
Logged By:	RS	Date Commenced:	25/01/2018
Checked By:	PSw	Date Completed:	25/01/2018
Type and diameter of equipment:	Dando Terrier	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: No water reported
2: * Field description
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				Topsoil (MADE GROUND)	
PJV	0.25													
PJV	0.50								0.50		0.50		Soft consistency* brown sandy very gravelly clay. Gravel consists of fine to coarse brick and concrete. (MADE GROUND)	
											0.70		Orange brown mottled blue grey low strength sandy CLAY. Sand is fine to medium. (LONDON CLAY FORMATION)	
PJV	1.00								1.00					
D														
SPT		0	1	2	1	2	3	8			1.40			
									1.50				Sandy clayey GRAVEL. Sand is fine to medium. Gravel consists of fine to medium angular to subrounded flint.	
											1.60		Orange brown mottled blue grey medium strength brown sandy CLAY. Sand is fine to medium. (LONDON CLAY FORMATION)	
D	2.00								2.00					
SPT		1	2	2	4	3	3	12						
									2.50					
D	3.00								3.00					
SPT		1	2	2	3	3	4	12						
									3.50					
D	4.00								4.00					
SPT		1	3	3	3	5	5	16			4.45			
									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:	Gasworks Cottage, Station Road, Borehamwood	Project No:	P1312J1279
Client:	Belgravia Property Development London LTD	Ground Level:	
Logged By:	RS	Date Commenced:	25/01/2018
Checked By:	PSw	Date Completed:	25/01/2018
Type and diameter of equipment:	Dando Terrier	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: No water reported
2: * Field description
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		Reinforced concrete. (MADE GROUND)	
										0.30		Medium dense* sandy gravel. Sand is coarse. (MADE GROUND)	
										0.50			
										0.70			
PJV	0.75											Orange brown medium strength becoming high strength sandy mottled blue grey CLAY. Sand is fine to medium. (LONDON CLAY FORMATION)	
PJV	1.00									1.00			
D													
SPT		0	1	2	1	2	3	8					
										1.50			
D	2.00									2.00			
SPT		1	1	2	3	3	3	11					
										2.50			
D	3.00									3.00			
SPT		2	3	3	3	4	5	15					
										3.50			
D	4.00									4.00			
SPT		2	3	3	4	5	5	17					
										4.45			
										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:	WS5		
Site Address:	Gasworks Cottage, Station Road, Borehamwood	Project No:	P1312J1279
Client:	Belgravia Property Development London LTD	Ground Level:	
Logged By:	RS	Date Commenced:	25/01/2018
Checked By:	PSw	Date Completed:	25/01/2018
Type and diameter of equipment:	Dando Terrier	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: No water reported
2: * Field description
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						
PJV	0.25								0.00				TOPSOIL	
PJV	0.50								0.50		0.50		Orange brown mottled blue grey medium strength sandy CLAY. Sand is fine to medium. (LONDON CLAY FORMATION)	
PJV D SPT	1.00	0	2	2	2	3	3	10	1.00					
									1.50					
D SPT	2.00	1	2	1	2	3	3	9	2.00					
									2.50					
D SPT	3.00	2	2	2	3	4	4	13	3.00					
									3.50					
D SPT	4.00	1	3	3	3	4	5	15	4.00		4.45			
									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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APPENDIX 3 – CHEMICAL LABORATORY TEST RESULTS

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Croxley Green
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Herts,
WD18 8YS

t: 01923 225404
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e: reception@i2analytical.com

Analytical Report Number : 18-74926

Project / Site name:	Gasworks Cottage, Station Road, Borehamwood	**Samples received on:**	01/02/2018
Your job number:	JJ1279	**Samples instructed on:**	01/02/2018
Your order number:	P1312JJ1279.3	**Analysis completed by:**	08/02/2018
Report Issue Number:	1	**Report issued on:**	08/02/2018
Samples Analysed:	12 soil samples		

Signed:

Jordan Hill
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: 18-74926

Project / Site name: Gasworks Cottage, Station Road, Borehamwood
Your Order No: P1312JJ1279.3

Lab Sample Number				901243	901244	901245	901246	901247
Sample Reference				WS1	WS1	WS2	WS2	WS2
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.25	1.00	0.25	0.50	1.00
Date Sampled				25/01/2018	25/01/2018	25/01/2018	25/01/2018	01/02/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	1700
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	17	21	-	22	22
Total mass of sample received	kg	0.001	NONE	0.87	0.34	-	0.89	1.5
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-	Not-detected	-	-
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.4	7.8	-	7.7	7.7
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	-	< 1	< 1
Total Sulphate as SO_4	mg/kg	50	MCERTS	710	520	-	800	570
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.018	0.14	-	0.16	0.15
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	17.6	142	-	156	153
Total Organic Carbon (TOC)	%	0.1	MCERTS	-	-	-	1.6	-
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	0.30	< 0.05	-	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	0.38	< 0.05	-	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	0.33	< 0.05	-	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	2.7	< 0.05	-	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	0.65	< 0.05	-	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	3.2	< 0.05	-	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	2.5	< 0.05	-	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	1.5	< 0.05	-	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	1.3	< 0.05	-	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	2.1	< 0.05	-	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.94	< 0.05	-	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	2.1	< 0.05	-	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	1.2	< 0.05	-	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.32	< 0.05	-	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	1.3	< 0.05	-	< 0.05	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	20.9	< 0.80	-	< 0.80	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	17	12	-	32	21
Boron (water soluble)	mg/kg	0.2	MCERTS	1.7	0.8	-	3.1	2.6
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	-	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	-	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	33	55	-	50	53
Copper (aqua regia extractable)	mg/kg	1	MCERTS	21	23	-	23	24
Lead (aqua regia extractable)	mg/kg	1	MCERTS	25	13	-	42	28
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	20	47	-	29	33
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	-	1.1	1.3
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	67	63	-	90	120

Analytical Report Number: 18-74926

Project / Site name: Gasworks Cottage, Station Road, Borehamwood
Your Order No: P1312JJ1279.3

Lab Sample Number				901243	901244	901245	901246	901247
Sample Reference				WS1	WS1	WS2	WS2	WS2
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.25	1.00	0.25	0.50	1.00
Date Sampled				25/01/2018	25/01/2018	25/01/2018	25/01/2018	01/02/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	1700
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	-	< 2.0	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	-	< 8.0	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	< 8.0	-	< 8.0	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	-	< 10	< 10
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	-	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	2.4	< 1.0	-	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	6.3	< 2.0	-	< 2.0	< 2.0
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	21	< 10	-	< 10	< 10
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	32	< 10	-	< 10	< 10
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	62	< 10	-	< 10	< 10

Analytical Report Number: 18-74926

Project / Site name: Gasworks Cottage, Station Road, Borehamwood
Your Order No: P1312JJ1279.3

Lab Sample Number				901243	901244	901245	901246	901247
Sample Reference				WS1	WS1	WS2	WS2	WS2
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.25	1.00	0.25	0.50	1.00
Date Sampled				25/01/2018	25/01/2018	25/01/2018	25/01/2018	01/02/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	1700
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
Chloroethane	µg/kg	1	NONE	< 1.0	< 1.0	-	< 1.0	< 1.0
Bromomethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
Vinyl Chloride	µg/kg	1	NONE	< 1.0	< 1.0	-	< 1.0	< 1.0
Trichlorofluoromethane	µg/kg	1	NONE	< 1.0	< 1.0	-	< 1.0	< 1.0
1,1-Dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	-	< 1.0	< 1.0
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,1-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
2,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Trichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,1,1-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,2-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,1-Dichloropropene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Trans-1,2-dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	-	< 1.0	< 1.0
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Tetrachloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Trichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Dibromomethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Bromodichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,1,2-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,3-Dichloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
Dibromochloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
Tetrachloroethene	µg/kg	1	NONE	< 1.0	< 1.0	-	< 1.0	< 1.0
1,2-Dibromoethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
Chlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
p & m-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Styrene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Tribromomethane	µg/kg	1	NONE	< 1.0	< 1.0	-	< 1.0	< 1.0
o-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Isopropylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Bromobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
n-Propylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
2-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
4-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
tert-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
sec-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
p-Isopropyltoluene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
1,2-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,4-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
Hexachlorobutadiene	µg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	-	< 1.0	< 1.0

Analytical Report Number: 18-74926

Project / Site name: Gasworks Cottage, Station Road, Borehamwood
Your Order No: P1312JJ1279.3

Lab Sample Number				901248	901249	901250	901251	901252
Sample Reference				WS3	WS4	WS4	WS5	WS5
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	0.75	1.00	0.25	1.00
Date Sampled				25/01/2018	25/01/2018	25/01/2018	25/01/2018	25/01/2018
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	25	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	20	22	16	16	21
Total mass of sample received	kg	0.001	NONE	0.89	0.82	1.4	0.82	0.85
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	-	-	-
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.7	7.8	7.6	7.9	7.5
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	4
Total Sulphate as SO_4	mg/kg	50	MCERTS	1400	500	840	600	1400
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.30	0.16	0.41	0.028	0.57
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	305	155	413	27.7	571
Total Organic Carbon (TOC)	%	0.1	MCERTS	-	-	0.3	-	-
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	0.95	< 0.05	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	0.35	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	2.7	< 0.05	< 0.05	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	2.4	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	1.5	< 0.05	< 0.05	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	1.7	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	2.3	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.85	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	1.9	< 0.05	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	1.1	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.29	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	1.1	< 0.05	< 0.05	< 0.05	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	17.1	< 0.80	< 0.80	< 0.80	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	11	24	32	16	18
Boron (water soluble)	mg/kg	0.2	MCERTS	5.4	1.9	0.9	4.0	0.8
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	32	52	50	29	58
Copper (aqua regia extractable)	mg/kg	1	MCERTS	20	15	23	16	22
Lead (aqua regia extractable)	mg/kg	1	MCERTS	22	15	15	21	12
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	23	34	55	18	72
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	1.0	1.4	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	55	72	75	61	72

Analytical Report Number: 18-74926

Project / Site name: Gasworks Cottage, Station Road, Borehamwood
Your Order No: P1312JJ1279.3

Lab Sample Number				901248	901249	901250	901251	901252
Sample Reference				WS3	WS4	WS4	WS5	WS5
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	0.75	1.00	0.25	1.00
Date Sampled				25/01/2018	25/01/2018	25/01/2018	25/01/2018	25/01/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	26	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	62	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	88	< 10	< 10	< 10	< 10

Analytical Report Number: 18-74926

Project / Site name: Gasworks Cottage, Station Road, Borehamwood
Your Order No: P1312JJ1279.3

Lab Sample Number				901248	901249	901250	901251	901252
Sample Reference				WS3	WS4	WS4	WS5	WS5
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	0.75	1.00	0.25	1.00
Date Sampled				25/01/2018	25/01/2018	25/01/2018	25/01/2018	25/01/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloroethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vinyl Chloride	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichlorofluoromethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloropropene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,2-dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromomethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromodichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromochloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromoethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Styrene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tribromomethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Isopropylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
n-Propylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
4-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
tert-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
sec-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p-Isopropyltoluene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,4-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Hexachlorobutadiene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

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Project / Site name: Gasworks Cottage, Station Road, Borehamwood
Your Order No: P1312JJ1279.3

Lab Sample Number				901253	901254			
Sample Reference				WS5	WS3			
Sample Number				None Supplied	None Supplied			
Depth (m)				0.50	0.25			
Date Sampled				25/01/2018	25/01/2018			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1			
Moisture Content	%	N/A	NONE	23	12			
Total mass of sample received	kg	0.001	NONE	0.84	0.75			
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	-			
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	-	-			
Total Cyanide	mg/kg	1	MCERTS	-	-			
Total Sulphate as SO_4	mg/kg	50	MCERTS	-	-			
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	-	-			
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	-	-			
Total Organic Carbon (TOC)	%	0.1	MCERTS	0.9	3.4			
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	-	-			
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	-	-			
Acenaphthylene	mg/kg	0.05	MCERTS	-	-			
Acenaphthene	mg/kg	0.05	MCERTS	-	-			
Fluorene	mg/kg	0.05	MCERTS	-	-			
Phenanthrene	mg/kg	0.05	MCERTS	-	-			
Anthracene	mg/kg	0.05	MCERTS	-	-			
Fluoranthene	mg/kg	0.05	MCERTS	-	-			
Pyrene	mg/kg	0.05	MCERTS	-	-			
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	-			
Chrysene	mg/kg	0.05	MCERTS	-	-			
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	-	-			
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	-	-			
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	-			
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	-			
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	-			
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	-			
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	-	-			
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	-	-			
Boron (water soluble)	mg/kg	0.2	MCERTS	-	-			
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	-	-			
Chromium (hexavalent)	mg/kg	4	MCERTS	-	-			
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	-	-			
Copper (aqua regia extractable)	mg/kg	1	MCERTS	-	-			
Lead (aqua regia extractable)	mg/kg	1	MCERTS	-	-			
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	-	-			
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	-	-			
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	-	-			
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	-	-			

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Lab Sample Number				901253	901254			
Sample Reference				WS5	WS3			
Sample Number				None Supplied	None Supplied			
Depth (m)				0.50	0.25			
Date Sampled				25/01/2018	25/01/2018			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	-	-			
Toluene	µg/kg	1	MCERTS	-	-			
Ethylbenzene	µg/kg	1	MCERTS	-	-			
p & m-xylene	µg/kg	1	MCERTS	-	-			
o-xylene	µg/kg	1	MCERTS	-	-			
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-			
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-			
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-			
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-			
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-			
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-			
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-			
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-			
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-			
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-			
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-			
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-			
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-			
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-			
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-			
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-			
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-			

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Lab Sample Number				901253	901254			
Sample Reference				WS5	WS3			
Sample Number				None Supplied	None Supplied			
Depth (m)				0.50	0.25			
Date Sampled				25/01/2018	25/01/2018			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	-	-			
Chloroethane	µg/kg	1	NONE	-	-			
Bromomethane	µg/kg	1	ISO 17025	-	-			
Vinyl Chloride	µg/kg	1	NONE	-	-			
Trichlorofluoromethane	µg/kg	1	NONE	-	-			
1,1-Dichloroethene	µg/kg	1	NONE	-	-			
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	-	-			
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	-	-			
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-			
1,1-Dichloroethane	µg/kg	1	MCERTS	-	-			
2,2-Dichloropropane	µg/kg	1	MCERTS	-	-			
Trichloromethane	µg/kg	1	MCERTS	-	-			
1,1,1-Trichloroethane	µg/kg	1	MCERTS	-	-			
1,2-Dichloroethane	µg/kg	1	MCERTS	-	-			
1,1-Dichloropropene	µg/kg	1	MCERTS	-	-			
Trans-1,2-dichloroethene	µg/kg	1	NONE	-	-			
Benzene	µg/kg	1	MCERTS	-	-			
Tetrachloromethane	µg/kg	1	MCERTS	-	-			
1,2-Dichloropropane	µg/kg	1	MCERTS	-	-			
Trichloroethene	µg/kg	1	MCERTS	-	-			
Dibromomethane	µg/kg	1	MCERTS	-	-			
Bromodichloromethane	µg/kg	1	MCERTS	-	-			
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	-	-			
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	-	-			
Toluene	µg/kg	1	MCERTS	-	-			
1,1,2-Trichloroethane	µg/kg	1	MCERTS	-	-			
1,3-Dichloropropane	µg/kg	1	ISO 17025	-	-			
Dibromochloromethane	µg/kg	1	ISO 17025	-	-			
Tetrachloroethene	µg/kg	1	NONE	-	-			
1,2-Dibromoethane	µg/kg	1	ISO 17025	-	-			
Chlorobenzene	µg/kg	1	MCERTS	-	-			
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	-	-			
Ethylbenzene	µg/kg	1	MCERTS	-	-			
p & m-Xylene	µg/kg	1	MCERTS	-	-			
Styrene	µg/kg	1	MCERTS	-	-			
Tribromomethane	µg/kg	1	NONE	-	-			
o-Xylene	µg/kg	1	MCERTS	-	-			
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	-	-			
Isopropylbenzene	µg/kg	1	MCERTS	-	-			
Bromobenzene	µg/kg	1	MCERTS	-	-			
n-Propylbenzene	µg/kg	1	ISO 17025	-	-			
2-Chlorotoluene	µg/kg	1	MCERTS	-	-			
4-Chlorotoluene	µg/kg	1	MCERTS	-	-			
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	-	-			
tert-Butylbenzene	µg/kg	1	MCERTS	-	-			
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	-	-			
sec-Butylbenzene	µg/kg	1	MCERTS	-	-			
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	-	-			
p-Isopropyltoluene	µg/kg	1	ISO 17025	-	-			
1,2-Dichlorobenzene	µg/kg	1	MCERTS	-	-			
1,4-Dichlorobenzene	µg/kg	1	MCERTS	-	-			
Butylbenzene	µg/kg	1	MCERTS	-	-			
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	-	-			
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	-	-			
Hexachlorobutadiene	µg/kg	1	MCERTS	-	-			
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	-	-			

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Project / Site name: Gasworks Cottage, Station Road, Borehamwood

* 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 *
901243	WS1	None Supplied	0.25	Brown loam and sand with vegetation and gravel.
901244	WS1	None Supplied	1.00	Brown clay with vegetation and gravel
901245	WS2	None Supplied	0.25	-
901246	WS2	None Supplied	0.50	Brown clay and sand with vegetation and gravel
901247	WS2	None Supplied	1.00	Brown clay and sand with vegetation and gravel
901248	WS3	None Supplied	0.50	Brown loam and sand with vegetation and stones.
901249	WS4	None Supplied	0.75	Light brown clay with gravel.
901250	WS4	None Supplied	1.00	Light brown clay with gravel and vegetation.
901251	WS5	None Supplied	0.25	Brown loam and sand with vegetation and gravel.
901252	WS5	None Supplied	1.00	Brown clay and sand.
901253	WS5	None Supplied	0.50	Brown clay and sand with vegetation.
901254	WS3	None Supplied	0.25	Brown sandy loam with vegetation and gravel

Analytical Report Number : 18-74926

Project / Site name: Gasworks Cottage, Station Road, Borehamwood

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

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
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	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 2, 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
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 (16hr extraction)	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 (Automated) 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""	L009-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
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method	L088/76-PL	W	MCERTS
Volatile organic compounds in soil	Determination of volatile organic compounds in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS

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.

Emma Hucker
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e: Jomas Group

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7 Woodshots Meadow,
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Analytical Report Number : 18-75955

Project / Site name:	Gasworks Cottage, Station Road, Borehamwood	**Samples received on:**	08/02/2018
Your job number:	JJ1279	**Samples instructed on:**	14/02/2018
Your order number:	P1312JJ1279.5	**Analysis completed by:**	20/02/2018
Report Issue Number:	1	**Report issued on:**	20/02/2018
Samples Analysed:	3 water samples		

Signed:

Jordan Hill
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

Excel copies of reports are only valid when accompanied by this PDF certificate.

Analytical Report Number: 18-75955

Project / Site name: Gasworks Cottage, Station Road, Borehamwood

Your Order No: P1312JJ1279.5

Lab Sample Number				907408	907409	907410		
Sample Reference				WS1	WS3	WS5		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				3.38	3.06	2.45		
Date Sampled				07/02/2018	07/02/2018	07/02/2018		
Time Taken				None Supplied	None Supplied	None Supplied		
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
General Inorganics								
pH	pH Units	N/A	ISO 17025	7.3	7.4	7.2		
Electrical Conductivity at 20 °C	µS/cm	10	ISO 17025	8300	6500	8000		
Total Cyanide (Low Level 1 µg/l)	µg/l	1	ISO 17025	< 1.0	7.5	100		
Sulphate as SO_4	µg/l	45	ISO 17025	5540000	3930000	5050000		
Ammonium as NH_4	µg/l	15	ISO 17025	240	640	3000		
Hardness - Total	mgCaCO3/l	1	ISO 17025	6330	4430	5460		
Total Phenols								
Total Phenols (monohydric)	µg/l	10	ISO 17025	< 10	< 10	< 10		
Speciated PAHs								
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Fluorene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01		
Total PAH								
Total EPA-16 PAHs	µg/l	0.16	ISO 17025	< 0.16	< 0.16	< 0.16		

Analytical Report Number: 18-75955

Project / Site name: Gasworks Cottage, Station Road, Borehamwood

Your Order No: P1312JJ1279.5

Lab Sample Number				907408	907409	907410		
Sample Reference				WS1	WS3	WS5		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				3.38	3.06	2.45		
Date Sampled				07/02/2018	07/02/2018	07/02/2018		
Time Taken				None Supplied	None Supplied	None Supplied		
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (dissolved)	µg/l	1	ISO 17025	3.5	4.1	3.9		
Boron (dissolved)	µg/l	10	ISO 17025	520	400	460		
Cadmium (dissolved)	µg/l	0.08	ISO 17025	< 0.08	< 0.08	< 0.08		
Calcium (dissolved)	mg/l	0.012	ISO 17025	560	530	530		
Chromium (dissolved)	µg/l	0.4	ISO 17025	1.0	< 0.4	0.6		
Copper (dissolved)	µg/l	0.7	ISO 17025	12	6.2	6.9		
Lead (dissolved)	µg/l	1	ISO 17025	9.3	4.6	2.8		
Magnesium (dissolved)	mg/l	0.005	ISO 17025	1200	750	1000		
Mercury (dissolved)	µg/l	0.5	ISO 17025	< 0.5	< 0.5	< 0.5		
Nickel (dissolved)	µg/l	0.3	ISO 17025	6.6	5.8	6.1		
Selenium (dissolved)	µg/l	4	ISO 17025	< 4.0	< 4.0	< 4.0		
Zinc (dissolved)	µg/l	0.4	ISO 17025	38	1300	38		
Monoaromatics								
Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
p & m-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
o-xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >C5 - C6	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
TPH-CWG - Aliphatic >C6 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
TPH-CWG - Aliphatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
TPH-CWG - Aliphatic >C10 - C12	µg/l	10	NONE	< 10	< 10	< 10		
TPH-CWG - Aliphatic >C12 - C16	µg/l	10	NONE	< 10	< 10	< 10		
TPH-CWG - Aliphatic >C16 - C21	µg/l	10	NONE	< 10	< 10	< 10		
TPH-CWG - Aliphatic >C21 - C35	µg/l	10	NONE	< 10	< 10	< 10		
TPH-CWG - Aliphatic (C5 - C35)	µg/l	10	NONE	< 10	< 10	< 10		
TPH-CWG - Aromatic >C5 - C7	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
TPH-CWG - Aromatic >C7 - C8	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
TPH-CWG - Aromatic >C8 - C10	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
TPH-CWG - Aromatic >C10 - C12	µg/l	10	NONE	< 10	< 10	< 10		
TPH-CWG - Aromatic >C12 - C16	µg/l	10	NONE	< 10	< 10	< 10		
TPH-CWG - Aromatic >C16 - C21	µg/l	10	NONE	< 10	< 10	< 10		
TPH-CWG - Aromatic >C21 - C35	µg/l	10	NONE	< 10	< 10	< 10		
TPH-CWG - Aromatic (C5 - C35)	µg/l	10	NONE	< 10	< 10	< 10		

Analytical Report Number: 18-75955

Project / Site name: Gasworks Cottage, Station Road, Borehamwood

Your Order No: P1312JJ1279.5

Lab Sample Number				907408	907409	907410		
Sample Reference				WS1	WS3	WS5		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				3.38	3.06	2.45		
Date Sampled				07/02/2018	07/02/2018	07/02/2018		
Time Taken				None Supplied	None Supplied	None Supplied		
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Chloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Bromomethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Vinyl Chloride	µg/l	1	NONE	< 1.0	< 1.0	< 1.0		
Trichlorofluoromethane	µg/l	1	NONE	< 1.0	< 1.0	< 1.0		
1,1-Dichloroethene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,1,2-Trichloro-1,2,2-trifluoroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Cis-1,2-dichloroethene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
MTBE (Methyl Tertiary Butyl Ether)	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,1-Dichloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
2,2-Dichloropropane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Trichloromethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,1,1-Trichloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,2-Dichloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,1-Dichloropropene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Trans-1,2-dichloroethene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Benzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Tetrachloromethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,2-Dichloropropane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Trichloroethene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Dibromomethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Bromodichloromethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Cis-1,3-dichloropropene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Trans-1,3-dichloropropene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Toluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,1,2-Trichloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,3-Dichloropropane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Dibromochloromethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Tetrachloroethene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,2-Dibromoethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Chlorobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,1,1,2-Tetrachloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Ethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
p & m-Xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Styrene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Tribromomethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
o-Xylene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,1,2,2-Tetrachloroethane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Isopropylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Bromobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
n-Propylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
2-Chlorotoluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
4-Chlorotoluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,3,5-Trimethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
tert-Butylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,2,4-Trimethylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
sec-Butylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,3-Dichlorobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
p-Isopropyltoluene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,2-Dichlorobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,4-Dichlorobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Butylbenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,2-Dibromo-3-chloropropane	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,2,4-Trichlorobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
Hexachlorobutadiene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		
1,2,3-Trichlorobenzene	µg/l	1	ISO 17025	< 1.0	< 1.0	< 1.0		

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number : 18-75955

Project / Site name: Gasworks Cottage, Station Road, Borehamwood

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

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Ammonium as NH4 in water	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method. Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	ISO 17025
Boron in water	Determination of boron in water by acidification followed by ICP-OES. Accredited matrices: SW PW GW	In-house method based on MEWAM	L039-PL	W	ISO 17025
BTEX and MTBE in water (Monoaromatics)	Determination of BTEX and MTBE in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA8260	L073B-PL	W	ISO 17025
Electrical conductivity at 20oC of water	Determination of electrical conductivity in water by electrometric measurement. Accredited Matrices SW, GW, PW	In-house method	L031-PL	W	ISO 17025
Low level total cyanide in water	Determination of total cyanide by distillation followed by colorimetry. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
Metals in water by ICP-MS (dissolved)	Determination of metals in water by acidification followed by ICP-MS. Accredited Matrices: SW, GW, PW except B=SW,GW, Hg=SW,PW, Al=SW,PW.	In-house method based on USEPA Method 6020 & 200.8 "for the determination of trace elements in water by ICP-MS.	L012-PL	W	ISO 17025
Metals in water by ICP-OES (dissolved)	Determination of metals in water by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW, PrW.(Al, Cu,Fe,Zn).	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Monohydric phenols in water	Determination of phenols in water by continuous flow analyser. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	ISO 17025
pH at 20oC in water (automated)	Determination of pH in water by electrometric measurement. Accredited matrices: SW PW GW	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	W	ISO 17025
Speciated EPA-16 PAHs in water	Determination of PAH compounds in water by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards. Accredited matrices: SW PW GW	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
Sulphate in water	Determination of sulphate in water by acidification followed by ICP-OES. Accredited matrices: SW PW GW, PrW.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Total Hardness of water	Determination of hardness in waters by calculation from calcium and magnesium. Accredited Matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L045-PL	W	ISO 17025
TPHCWG (Waters)	Determination of dichloromethane extractable hydrocarbons in water by GC-MS, speciation by interpretation.	In-house method	L070-PL	W	NONE
Volatile organic compounds in water	Determination of volatile organic compounds in water by headspace GC-MS. Accredited matrices: SW PW GW	In-house method based on USEPA8260	L073B-PL	W	ISO 17025

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.

APPENDIX 4 – GEOTECHNICAL LABORATORY TEST RESULTS

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

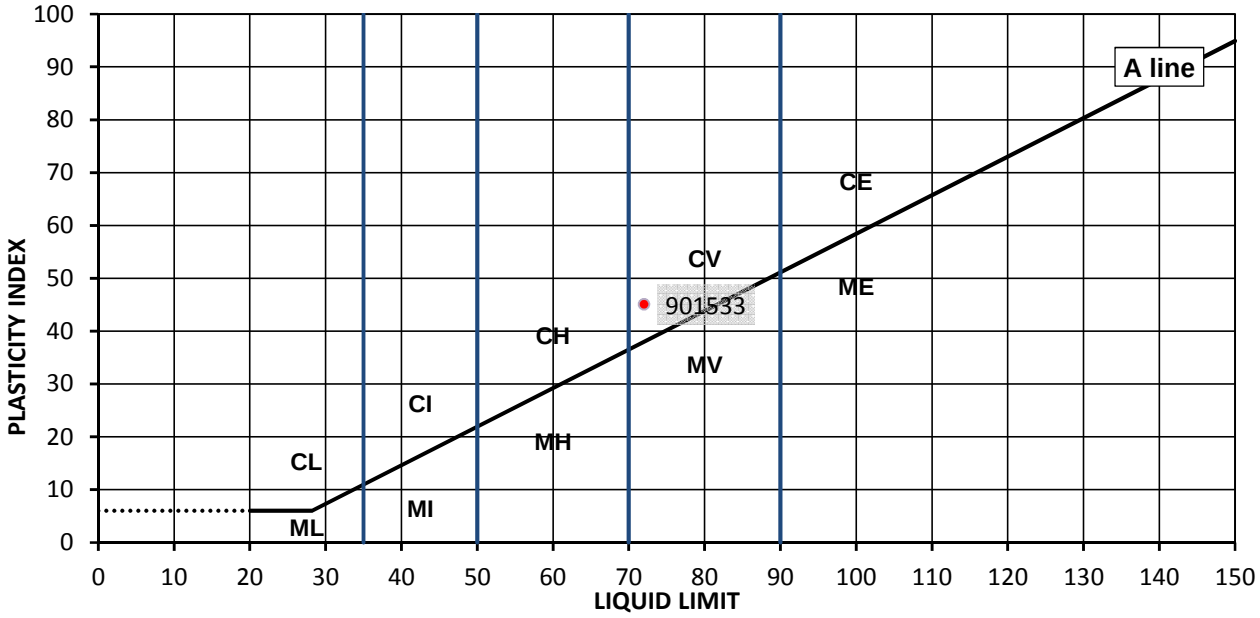
Client:	Jomas Associates Ltd	Client Reference:	JJ1279
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	18-74955
		Date Sampled:	Not Given
		Date Received:	29/01/2018
Contact:	Emma Hucker	Date Tested:	12/02/2018
Site Name:	Gasworks Cottage, Station Road, Borehamwood	Sampled By:	Not Given
Site Address:	Gasworks Cottage, Station Road, Borehamwood		

TEST RESULTS

Laboratory Reference: 901533
Sample Reference: Not Given

Description:	Dark brown CLAY	Sample Type:	D
Location:	WS1	Depth Top [m]:	1.00
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
35	72	27	45	100



Legend, based on BS 5930:2015 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)	

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager Geotechnical Section
Date Reported: 19/02/2018

Signed:

Darren Berrill
Geotechnical General 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

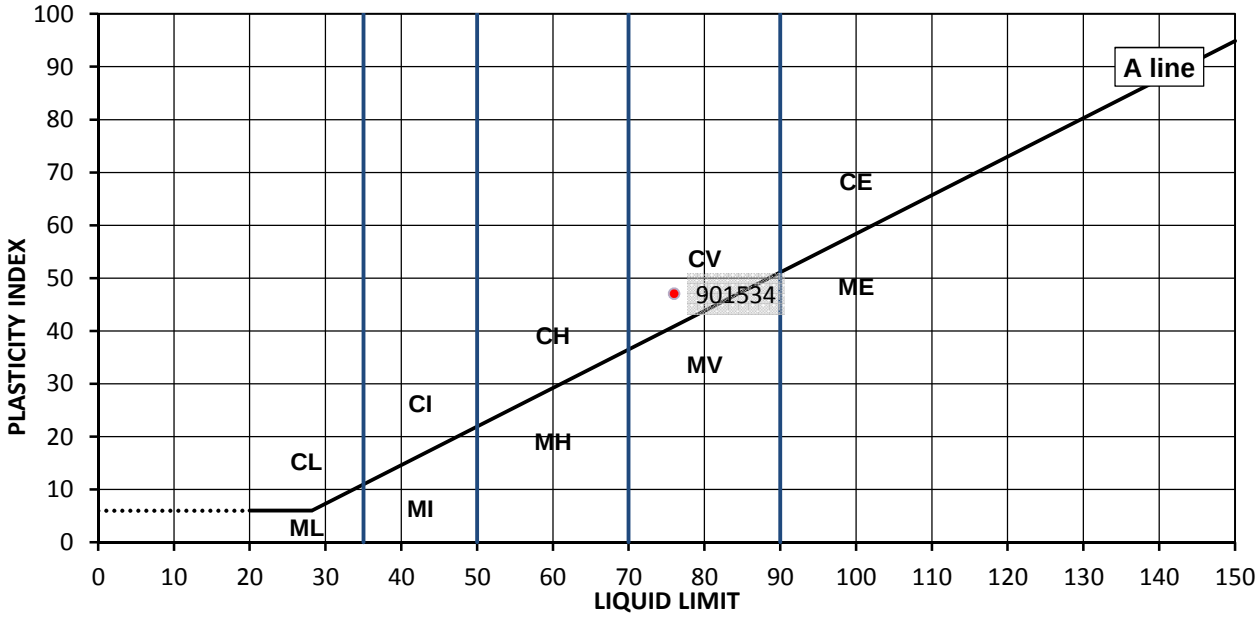
Client:	Jomas Associates Ltd	Client Reference:	JJ1279
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	18-74955
		Date Sampled:	Not Given
		Date Received:	29/01/2018
Contact:	Emma Hucker	Date Tested:	12/02/2018
Site Name:	Gasworks Cottage, Station Road, Borehamwood	Sampled By:	Not Given
Site Address:	Gasworks Cottage, Station Road, Borehamwood		

TEST RESULTS

Laboratory Reference: 901534
Sample Reference: Not Given

Description:	Brown CLAY	Sample Type:	B
Location:	WS2	Depth Top [m]:	2.00
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
38	76	29	47	100



Legend, based on BS 5930:2015 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)	

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager Geotechnical Section
Date Reported: 19/02/2018

Signed:

Darren Berrill
Geotechnical General 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

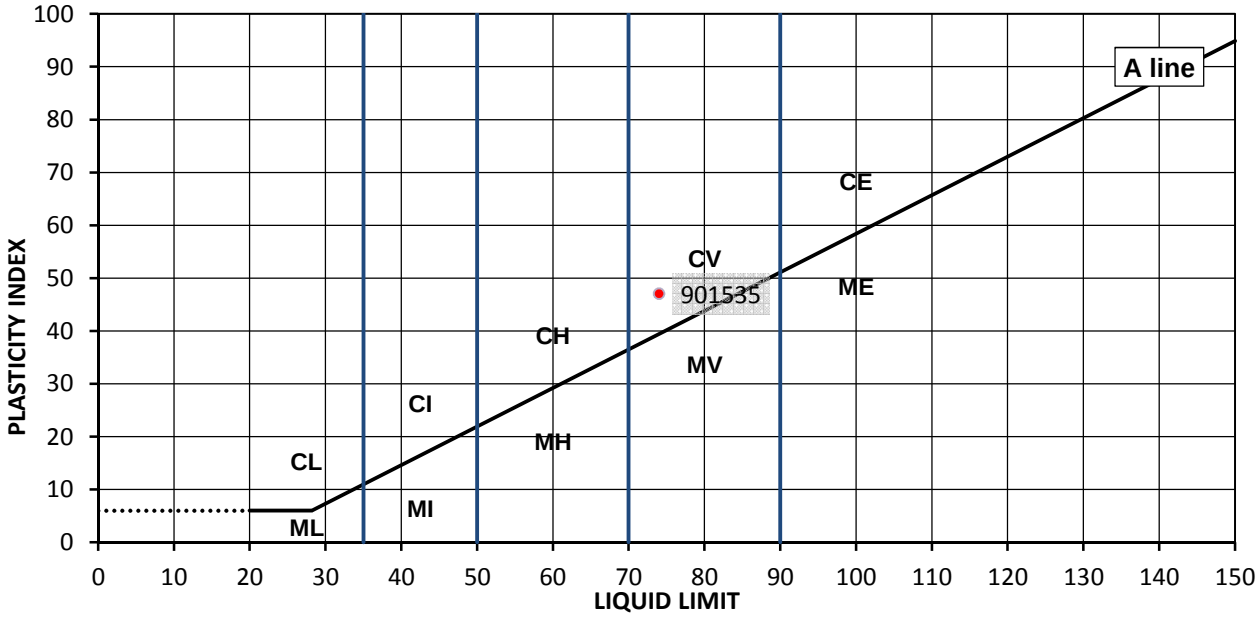
Client:	Jomas Associates Ltd	Client Reference:	JJ1279
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	18-74955
		Date Sampled:	Not Given
		Date Received:	29/01/2018
Contact:	Emma Hucker	Date Tested:	12/02/2018
Site Name:	Gasworks Cottage, Station Road, Borehamwood	Sampled By:	Not Given
Site Address:	Gasworks Cottage, Station Road, Borehamwood		

TEST RESULTS

Laboratory Reference: 901535
Sample Reference: Not Given

Description:	Brown CLAY	Sample Type:	B
Location:	WS2	Depth Top [m]:	3.00
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
32	74	27	47	100



Legend, based on BS 5930:2015 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)	

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager Geotechnical Section
Date Reported: 19/02/2018

Signed:

Darren Berrill
Geotechnical General 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

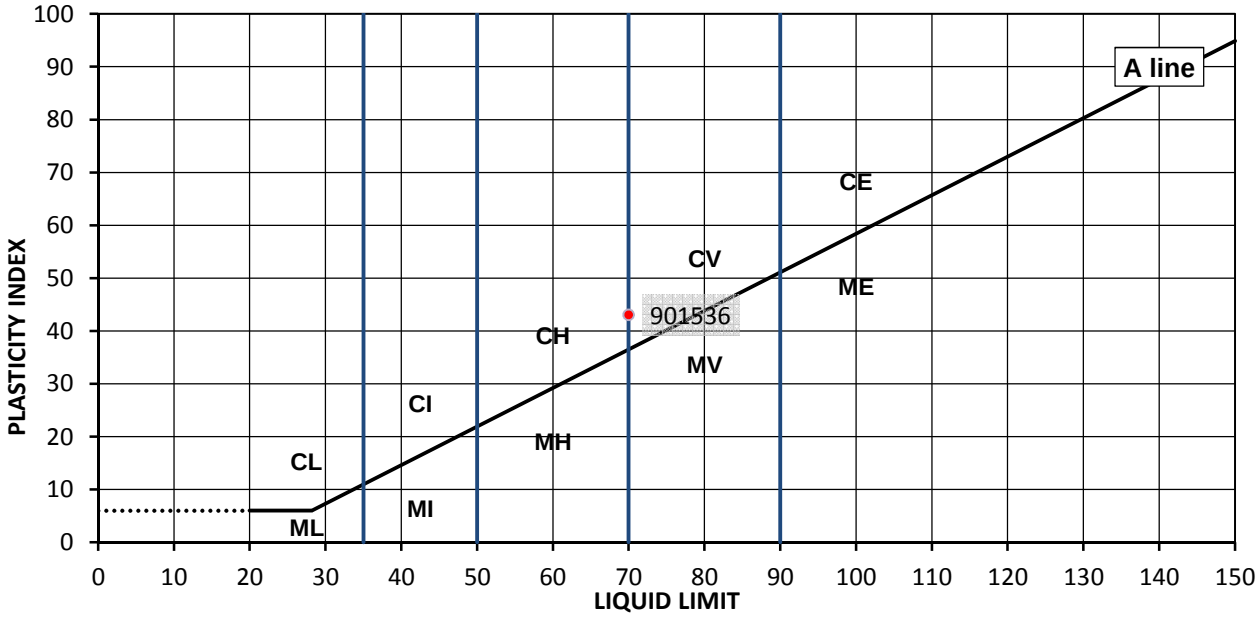
Client:	Jomas Associates Ltd	Client Reference:	JJ1279
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	18-74955
		Date Sampled:	Not Given
		Date Received:	29/01/2018
Contact:	Emma Hucker	Date Tested:	12/02/2018
Site Name:	Gasworks Cottage, Station Road, Borehamwood	Sampled By:	Not Given
Site Address:	Gasworks Cottage, Station Road, Borehamwood		

TEST RESULTS

Laboratory Reference: 901536
Sample Reference: Not Given

Description:	Brown CLAY with little pockets of gravel	Sample Type:	B
Location:	WS3	Depth Top [m]:	2.00
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
29	70	27	43	100



Legend, based on BS 5930:2015 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)	

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager Geotechnical Section
Date Reported: 19/02/2018

Signed:

Darren Berrill
Geotechnical General 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

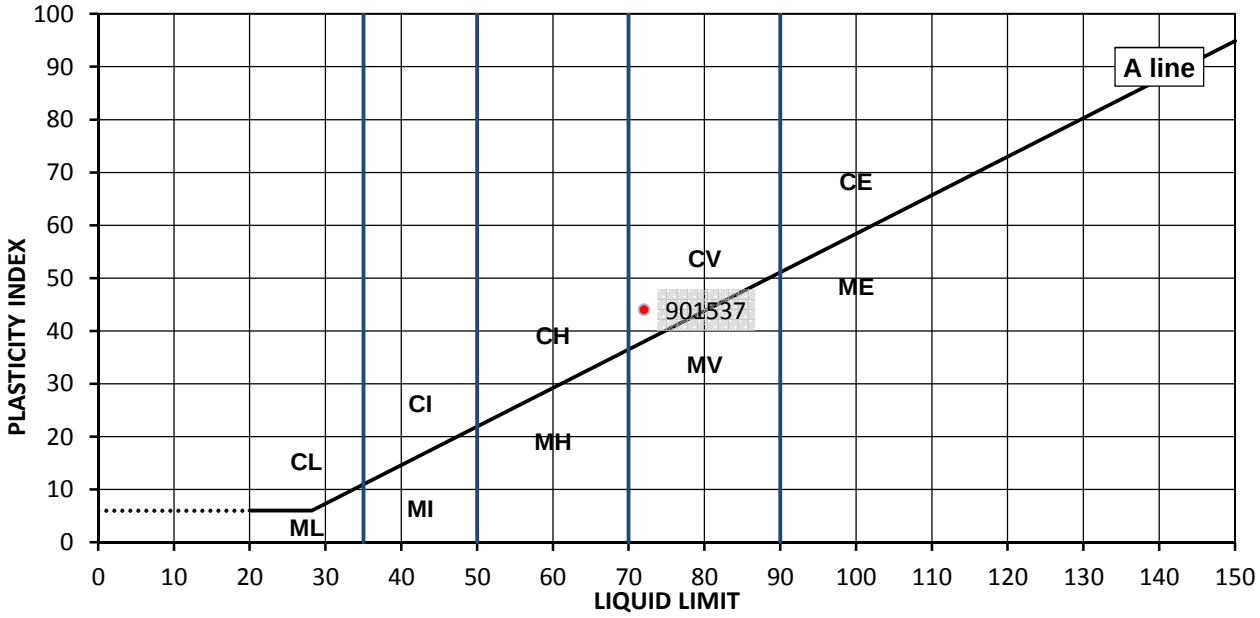
Client:	Jomas Associates Ltd	Client Reference:	JJ1279
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	18-74955
		Date Sampled:	Not Given
		Date Received:	29/01/2018
Contact:	Emma Hucker	Date Tested:	12/02/2018
Site Name:	Gasworks Cottage, Station Road, Borehamwood	Sampled By:	Not Given
Site Address:	Gasworks Cottage, Station Road, Borehamwood		

TEST RESULTS

Laboratory Reference: 901537
Sample Reference: Not Given

Description:	Brown CLAY	Sample Type:	B
Location:	WS3	Depth Top [m]:	3.00
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	72	28	44	100



Legend, based on BS 5930:2015 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)	

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager Geotechnical Section
Date Reported: 19/02/2018

Signed:

Darren Berrill
Geotechnical General 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

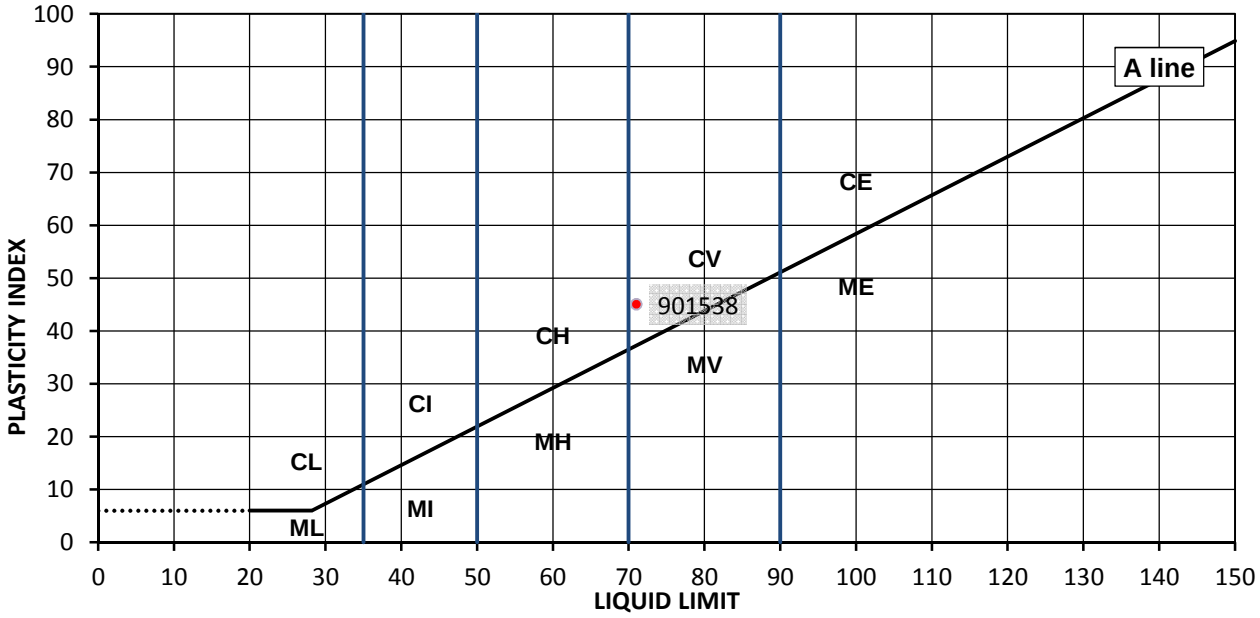
Client:	Jomas Associates Ltd	Client Reference:	JJ1279
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	18-74955
		Date Sampled:	Not Given
		Date Received:	29/01/2018
Contact:	Emma Hucker	Date Tested:	12/02/2018
Site Name:	Gasworks Cottage, Station Road, Borehamwood	Sampled By:	Not Given
Site Address:	Gasworks Cottage, Station Road, Borehamwood		

TEST RESULTS

Laboratory Reference: 901538
Sample Reference: Not Given

Description:	Brown CLAY	Sample Type:	B
Location:	WS4	Depth Top [m]:	1.00
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
31	71	26	45	100



Legend, based on BS 5930:2015 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)	

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager Geotechnical Section
Date Reported: 19/02/2018

Signed:

Darren Berrill
Geotechnical General 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

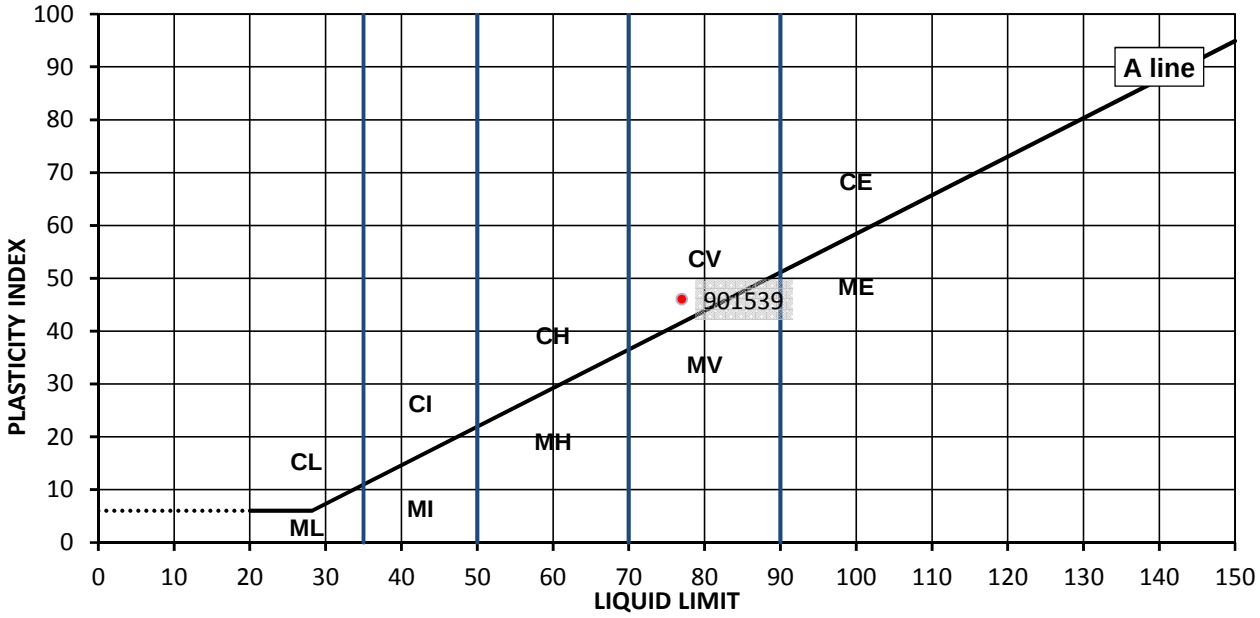
Client:	Jomas Associates Ltd	Client Reference:	JJ1279
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	18-74955
		Date Sampled:	Not Given
		Date Received:	29/01/2018
Contact:	Emma Hucker	Date Tested:	12/02/2018
Site Name:	Gasworks Cottage, Station Road, Borehamwood	Sampled By:	Not Given
Site Address:	Gasworks Cottage, Station Road, Borehamwood		

TEST RESULTS

Laboratory Reference: 901539
Sample Reference: Not Given

Description:	Yellowish brown slightly gravelly CLAY	Sample Type:	B
Location:	WS4	Depth Top [m]:	3.00
Sample Preparation:	Tested after washing to remove >425um	Depth Base [m]:	Not Given

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
36	77	31	46	84



Legend, based on BS 5930:2015 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)	

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager Geotechnical Section
Date Reported: 19/02/2018

Signed:

Darren Berrill
Geotechnical General 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

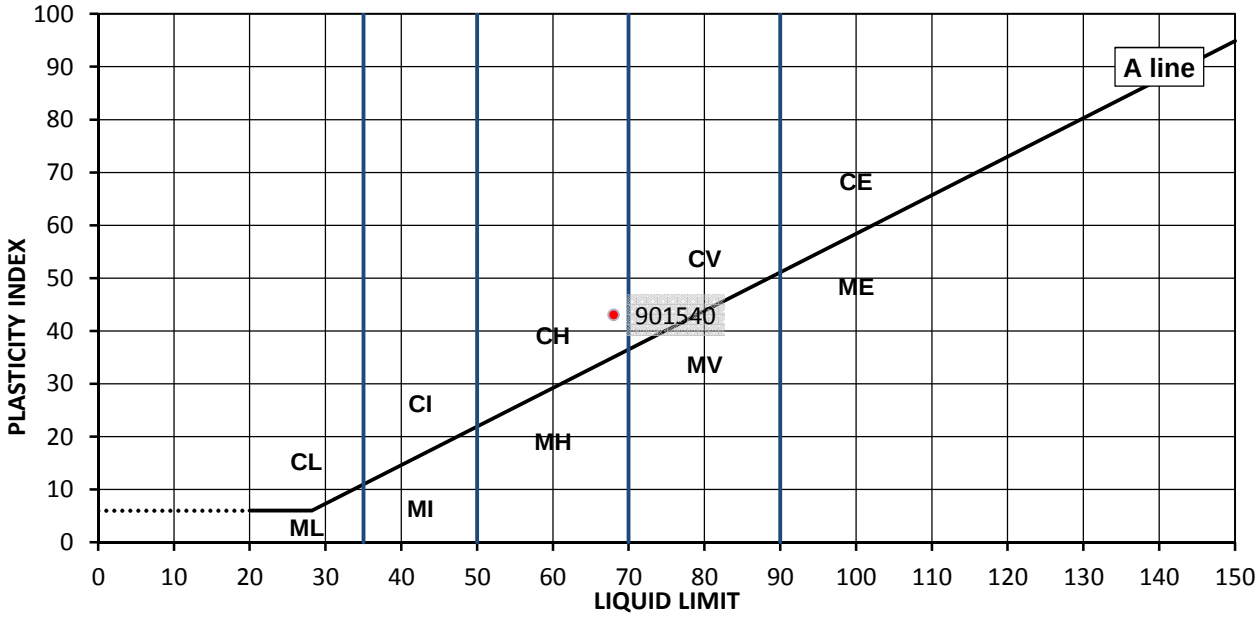
Client:	Jomas Associates Ltd	Client Reference:	JJ1279
Client Address:	Lakeside House 1 Furzeground Way Stockley Park UB11 1BD	Job Number:	18-74955
		Date Sampled:	Not Given
		Date Received:	29/01/2018
Contact:	Emma Hucker	Date Tested:	12/02/2018
Site Name:	Gasworks Cottage, Station Road, Borehamwood	Sampled By:	Not Given
Site Address:	Gasworks Cottage, Station Road, Borehamwood		

TEST RESULTS

Laboratory Reference: 901540
Sample Reference: Not Given

Description:	Brown CLAY	Sample Type:	B
Location:	WS5	Depth Top [m]:	4.00
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
25	68	25	43	100



Legend, based on BS 5930:2015 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)	

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager Geotechnical Section
Date Reported: 19/02/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

TEST CERTIFICATE

Summary of Classification Test Results

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

Client: Jomas Associates Ltd
Client Address: Lakeside House
1 Furzeground Way
Stockley Park
UB11 1BD
Contact: Emma Hucker
Site Name: Gasworks Cottage, Station Road, Borehamwood
Site Address: Gasworks Cottage, Station Road, Borehamwood

Client Reference: JJ1279
Job Number: 18-74955
Date Sampled: Not Given
Date Received: 29/01/2018
Date Tested: 12/02/2018
Sampled By: Not Given

Test results

Laboratory Reference	Hole No.	Sample				Soil Description	Density		M/C	Atterberg				PD
		Reference	Top depth [m]	Base depth [m]	Type		bulk Mg/m^3	dry Mg/m^3	%	% Passing 425um %	LL %	PL %	PI %	Mg/m^3
901533	WS1	Not Given	1.00	Not Given	D	Dark brown CLAY			35	100	72	27	45	
901534	WS2	Not Given	2.00	Not Given	B	Brown CLAY			38	100	76	29	47	
901535	WS2	Not Given	3.00	Not Given	B	Brown CLAY			32	100	74	27	47	
901536	WS3	Not Given	2.00	Not Given	B	Brown CLAY with little pockets of gravel			29	100	70	27	43	
901537	WS3	Not Given	3.00	Not Given	B	Brown CLAY			30	100	72	28	44	
901538	WS4	Not Given	1.00	Not Given	B	Brown CLAY			31	100	71	26	45	
901539	WS4	Not Given	3.00	Not Given	B	Yellowish brown slightly gravelly CLAY			36	84	77	31	46	
901540	WS5	Not Given	4.00	Not Given	B	Brown CLAY			25	100	68	25	43	

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Date Reported: 19/02/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

APPENDIX 5 – SOIL GAS MONITORING TEST RESULTS

GAS AND GROUNDWATER MONITORING BOREHOLE RECORD SHEET

Site: Gasworks Cottage	**Operative(s):** AM	**Date:** 29/01/2018	**Time:** 11:08	**Round: 1**	**Page:** 1

MONITORING EQUIPMENT

Instrument Type	**Instrument Make**	**Serial No.**	**Date Last Calibrated**
Analox	GA5000		10/01/2018
PID	Phocheck tiger		20/05/2016
Dip Meter	GeoTech		

MONITORING CONDITIONS

Weather Conditions: Overcast	**Ground Conditions: Dry**	**Temperature**: 8°C
Barometric Pressure (mbar): 1015	**Barometric Pressure Trend (24hr): Rising**	**Ambient Concentration:** **0.1**%CH_4, 0.2%CO_2, 21.7%O_2

MONITORING RESULTS

Monitoring Point Location	**Flow**		**Atmospheric Pressure (mbar)**	**CH_4 %**	**CH_4 % LEL**	**CO_2 %**	**O_2 %**	**VOC (ppm)**		**H_{2S} (ppm)**	**CO (ppm)**	**Depth to product (mbgl)**	**Depth to water (mbgl)**	**Depth to Base of well (mbgl)**
	Peak	**Steady**						**Peak**	**Steady**					
WS1	-0.3	-0.3	1015	0.2	/	1.3	20.9	4	4	0	1	/	Dry	3.98
WS3	+0.2	+0.2	1015	0.2	/	1.6	20.6	5	5	0	3	/	3.80	3.93
WS5	+0.1	+0.1	1015	0.2	/	1.1	20.6	4	4	0	0	/	3.47	4.00

GAS AND GROUNDWATER MONITORING BOREHOLE RECORD SHEET

Site: Gasworks Cottage	**Operative(s):** AM	**Date:** 07/02/2018	**Time:** 11:20	**Round: 2**	**Page:** 1

MONITORING EQUIPMENT

Instrument Type	**Instrument Make**	**Serial No.**	**Date Last Calibrated**
Analox	GA5000		10/01/2018
PID	Phocheck tiger		20/05/2016
Dip Meter	GeoTech		

MONITORING CONDITIONS

Weather Conditions: Sunny	**Ground Conditions: Dry**	**Temperature**: 2°C
Barometric Pressure (mbar): 1010	**Barometric Pressure Trend (24hr): Rising**	**Ambient Concentration:** **0.2**%CH_4, 0.3%CO_2, 21.9%O_2

MONITORING RESULTS

Monitoring Point Location	**Flow**		**Atmospheric Pressure (mbar)**	**CH_4 %**	**CH_4 % LEL**	**CO_2 %**	**O_2 %**	**VOC (ppm)**		**H_{2S} (ppm)**	**CO (ppm)**	**Depth to product (mbgl)**	**Depth to water (mbgl)**	**Depth to Base of well (mbgl)**
	Peak	**Steady**						**Peak**	**Steady**					
WS1	+0.1	+0.1	1010	0.2	/	1.8	21.0	1	1	0	0	/	3.38	3.98
WS3	+0.1	+0.1	1010	0.2	/	2.3	20.7	1	1	0	0	/	3.06	3.93
WS5	+0.2	+0.2	1010	0.2	/	1.6	20.5	1	1	0	0	/	2.45	4.00

GAS AND GROUNDWATER MONITORING BOREHOLE RECORD SHEET

Site: Gasworks Cottage	**Operative(s):** AJH	**Date:** 14/02/2018	**Time:** 11:20	**Round: 3**	**Page:** 1

MONITORING EQUIPMENT

Instrument Type	**Instrument Make**	**Serial No.**	**Date Last Calibrated**
Analox	GA5000		10/01/2018
PID	Phocheck tiger		20/05/2016
Dip Meter	GeoTech		

MONITORING CONDITIONS

Weather Conditions: Overcast	**Ground Conditions: Dry - Damp**	**Temperature**: 7°C
Barometric Pressure (mbar): 993	**Barometric Pressure Trend (24hr): Rising**	**Ambient Concentration:** **0.2**%CH_4, 0.3%CO_2, 21.4%O_2

MONITORING RESULTS

Monitoring Point Location	Flow		Atmospheric Pressure (mbar)	CH_4 %	CH_4 % LEL	CO_2 %	O_2 %	VOC (ppm)		H_{2S} (ppm)	CO (ppm)	Depth to product (mbgl)	Depth to water (mbgl)	Depth to Base of well (mbgl)
	Peak	Steady						Peak	Steady					
WS1	+0.2	+0.2	994	0.2	/	1.7	20.4	0	0	0	0	/	3.06	3.98
WS3	+0.2	+0.2	993	0.2	/	3.0	19.2	0	0	0	0	/	2.72	3.93
WS5	0.0	0.0	994	0.2	/	1.4	19.6	0	0	0	0	/	1.80	4.00

GAS AND GROUNDWATER MONITORING BOREHOLE RECORD SHEET

Site: Gasworks Cottage	**Operative(s):** AMM	**Date:** 22/02/2018	**Time:** 12:40	**Round: 4**	**Page:** 1

MONITORING EQUIPMENT

Instrument Type	**Instrument Make**	**Serial No.**	**Date Last Calibrated**
Analox	GA5000		10/01/2018
PID	Phocheck tiger		20/05/2016
Dip Meter	GeoTech		

MONITORING CONDITIONS

Weather Conditions: Overcast	**Ground Conditions: Dry**	**Temperature**: 4°C
Barometric Pressure (mbar): 1013	**Barometric Pressure Trend (24hr):** Falling	**Ambient Concentration:** **0.1**%CH_4, 0.2%CO_2, 21.3%O_2

MONITORING RESULTS

Monitoring Point Location	**Flow**		**Atmospheric Pressure (mbar)**	**CH_4 %**	**CH_4 % LEL**	**CO_2 %**	**O_2 %**	**VOC (ppm)**		**H_{2S} (ppm)**	**CO (ppm)**	**Depth to product (mbgl)**	**Depth to water (mbgl)**	**Depth to Base of well (mbgl)**
	Peak	**Steady**						**Peak**	**Steady**					
WS1	+0.1	+0.1	1014	0.0	-	1.4	20.6	1	1	0	0	-	2.55	3.98
WS3	+0.1	+0.1	1013	0.0	-	3.5	18.2	1	1	0	0	-	2.10	3.93
WS5	+0.2	+0.2	1014	0.0	-	1.3	20.0	1	1	0	0	-	1.20	4.00

APPENDIX 6 – GROUNDWATER LOW FLOW SAMPLING RECORDS

LOW FLOW GROUNDWATER MONITORING BOREHOLE RECORD SHEET

Site: Gasworks Cottage	**Operative(s):** AM	**Date:** 06/02/2018	**Time:** 11:30	**Round: 1**	**Page:** 1 of 1

MONITORING EQUIPMENT

Instrument Type	Instrument Make	Serial No.	Date Last Calibrated
SmarTROLL MP	In-Situ		
Dip Meter	In-Situ		

MONITORING CONDITIONS

Weather Conditions: Sunny	**Ground Conditions: Dry**	**Temperature**: 3**°C**

Hole ID	Temperature (°C)	Specific Conductivity (µS/cm)	pH	(ORP) Oxidation-Reduction Potential (mV)	(RDO) Rugged Dissolved Oxygen Concentration (mg/L)	Water Level	Hole Depth	Comments
WS1	9.42	8987.1	6.82	228.4	3.30	3.38	3.97	Test ran for 6 minutes, clear turbidity, no odour, sample taken from 3.90m.
WS3	9.23	696.2	6.79	228.7	5.46	3.06	3.95	Test ran for 15 minutes, clear turbidity, no odour, sample taken from 3.90m.
WS5	11.01	8500.9	6.80	225.4	0.53	2.45	4.00	Test ran for 30 minutes, clear turbidity, no odour, sample taken from 4.00m.