



Report
Title:

Geo-Environmental Site Investigation

Project
Name:

Bartons Road, Havant



Report
Reference:

BRD3818-OR2-C

Date:

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BRD Environmental Ltd

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REPORT CONTROL SHEET

REPORT TITLE	GEO-ENVIRONMENTAL SITE INVESTIGATION
PROJECT	BARTONS ROAD, HAVANT
CLIENT	REDROW HOMES & MR PHILLIP DYMOKE WHITE

REPORT REFERENCE	ISSUE DETAIL	DATE	PREPARED BY	CHECKED BY
BRD3818-OR2-A	First Issue - Draft. Monitoring on going.	25/11/2020	I Hibberd & A Leon	B Devonshire
BRD3818-OR2-B	Second Issue - Following minor amendments. Remains draft - Monitoring on going.	30/11/2020	I Hibberd	B Devonshire
BRD3818-OR2-C	Third Issue - Following completion of gas monitoring	19/03/2021	I Hibberd	B Devonshire

BRD Environmental Limited

Geotechnical and Environmental Services

- Ground Investigation
- Japanese Knotweed Removal
- Soil, Water and Gas Testing
- Contamination Assessment
- Geotechnical Advice
- Remediation Solutions

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Geo-Environmental Site Investigation
Bartons Road, Havant
BRD3818-OR2-C Havant SI

REPORT LAYOUT

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

SUMMARY REPORT

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

TECHNICAL REPORT

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

1. INTRODUCTION TO TECHNICAL REPORT	1
1.1. CONTRACT DETAILS	1
1.2. SCOPE OF WORKS	1
1.3. REPORT LIMITATIONS	2
2. SITE CHARACTERISTICS	4
2.1. SITE SETTING	4
2.2. SITE DESCRIPTION	4
2.3. PREVIOUS INVESTIGATIONS	5
3. GROUND INVESTIGATION	7
3.1. INVESTIGATION DESIGN	7
3.2. BRD FIELDWORK	8
3.3. LABORATORY TESTING	9
4. GROUND CONDITIONS	11
4.1. OVERVIEW	11
4.2. TOPSOIL AND MADE GROUND TOPSOIL	11
4.3. SUPERFICIAL DEPOSITS	11
4.4. BEDROCK	12
4.5. GEOTECHNICAL COMMENTS	12
4.6. CONTAMINATION OBSERVATIONS	12



4.7.	GROUNDWATER BEHAVIOUR	12
4.8.	GROUNDWATER MONITORING	13
5.	GEOTECHNICAL PROPERTIES	14
5.1.	COARSE SOIL PARAMETERS	14
5.2.	FINE SOIL PARAMETERS	15
5.3.	SULPHATE AND pH	16
6.	GEOTECHNICAL ASSESSMENT	17
6.1.	INTRODUCTION	17
6.2.	EXCAVATIONS	17
6.3.	SLOPE STABILITY	18
6.4.	SUB-SURFACE CONCRETE	18
6.5.	SOAKAWAYS	18
6.6.	PAVEMENT CONSTRUCTION	19
6.7.	PRELIMINARY FOUNDATION RECOMMENDATIONS	20
6.8.	RECOMMENDATIONS FOR FURTHER GEOTECHNICAL WORK	23
7.	RISK ESTIMATION - SOILS	24
7.1.	HUMAN HEALTH	24
7.2.	WATER ENVIRONMENT	26
7.3.	BUILDING MATERIALS	26
8.	RISK ESTIMATION - GAS	27
8.1.	RESULTS SUMMARY	27
8.2.	GAS REGIME CHARACTERISATION	29
8.3.	GAS PROTECTION MEASURES	30
9.	RISK EVALUATION	31
9.1.	REVISED CONCEPTUAL MODEL	31
9.2.	UPDATED CONTAMINATION RISK ASSESSMENT	31
9.3.	RISK MANAGEMENT	32
9.4.	WASTE SOIL DISPOSAL	33
10.	HEALTH AND SAFETY FILE INFORMATION	34
10.1.	INTRODUCTION	34
10.2.	HAZARDS	34
10.3.	HAZARDOUS MATERIALS	34
10.4.	UTILITY SERVICES	34

REFERENCES

SUPPORTING INFORMATION

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

APPENDICES

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

APPENDIX 1 SITE PLANS & PHOTOGRAPHS

Site Location Plan	Ref.BRD3818-OP2-A
Revised Conceptual Site Model	Ref. BRD3818-OP6-B
Proposed Development Layout	'Site Layout' DRAFT - Camp Fields, Barton Road, Southleigh' thrive architects, Drawing No. SL.01 Rev. P2, dated 03.12.20
Exploratory Hole Location Plan	Ref. BRD3818-OD1-A
Tree Influence & foundation Assessment	Ref. BRD3818-OD2-B

APPENDIX 2 EXPLORATORY HOLE & MONITORING RECORDS

Logs of trial pits.	Ref. TP101 - TP110
Logs of hand dug pits.	Ref. HD01 and HD02
Photographic records of trial pits.	Ref. BRD3818-OP5-A
Logs of boreholes.	Ref. WS101 - WS105
Rising head permeability test.	1 x A4 pages
BRE365 soakage test records (borehole).	1 x A4 pages
Gas monitoring records.	6 x A4 pages
Groundwater monitoring records.	1 x A4 pages



APPENDIX 3 LABORATORY TEST RESULTS

DETS reports 20-12742, 20-13040 & 20-13390, 26 x A4 pages
20-13468

SPT reports 37723_1 & 37723_2 17 x A4 pages

APPENDIX 4 EXTRACTS FROM PREVIOUS INVESTIGATION

Exploratory Point Plan	1 x A4 pages
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Exploratory Hole Logs WS1, WS2 & TP2 to TP4

SUMMARY REPORT - GENERAL INFORMATION

SUBJECT	COMMENTS
CURRENT SITE CONDITION	The site currently comprises a large agricultural field with a tarmac access road in the south east corner which leads to an off site Crematorium to the north of the site.
PROPOSED DEVELOPMENT	It is proposed that the site will be developed with 72No. residential houses with associated private gardens, parking and road access.
HISTORICAL SUMMARY	The site has remained in agricultural use since initially recorded in Ordnance Survey mapping. During the 20 th Century the surrounding area has been developed with residential housing, a Crematorium and a hospital. A small infilled gravel pit is located approximately 20m to the south east of the site.
PUBLISHED GEOLOGY	The site is shown to be underlain by superficial deposits in the east of the site comprising Head Deposits. The shallowest bedrock unit is shown to be the London Clay Formation, which is present near surface in the west of the site.
ACTUAL GROUND CONDITIONS	The ground conditions were as anticipated from the published geological map and as encountered within the previous investigations with clayey granular Head Deposits being proven to depths of 5.35m bgl in the eastern area of the site and in the west, the Head Deposits thinned with the underlying London Clay Formation being encountered near surface or even absent as proven in the south west corner.
HYDROGEOLOGY	The eastern half of the site is situated upon superficial deposits designated a Secondary A Aquifer. The underlying bedrock geology is designated Unproductive Strata. The site is located within a groundwater Source Protection Zone 1 (Inner Protection Zone) - subsurface activity only.
HYDROLOGY	The closest water feature to the site is a stream approximately 177m west of the site. The site is not in an area indicated to be at risk of flooding.
PREVIOUS GROUND REPORTS	A flood risk assessment incorporating a ground investigation to determine the potential drainage strategy has been completed at the site and is referenced as follows: • 'Flood Risk Assessment and Surface Water Drainage Strategy - Land west of the Havant Crematorium, Bartons Road, Havant', Charles & Associated Consulting Engineers, ref.17-055, dated December 2018. BRD has also undertaken geo-environmental desk study research and this has been reported separately.

SUMMARY REPORT - GEOTECHNICAL

SUBJECT	COMMENTS
EXCAVATIONS	It should be possible to forward excavations employing normal equipment. Specific groundwater control unlikely to be required at this site. Limited groundwater control in the form of pumping from sumps is likely to be required. It is unlikely that requirements of the Party Wall Act will apply to the development.
SLOPE STABILITY	It is considered that slope stability is unlikely to be a concern at this site.
SUB-SURFACE CONCRETE	Design Sulphate Class of DS-1 and Aggressive Chemical Environment for Concrete class of AC-1 applies, but subject to further testing.
SOAKAWAYS	Shallow soakaways or other forms of infiltration devices could be employed in the eastern part of the site subject to further investigation.
PAVEMENT DESIGN	<u>Head Deposits</u>: A preliminary design California Bearing Ratio (CBR) of 10% has been recommended. <u>London Clay Formation</u>: A preliminary design California Bearing Ratio (CBR) of 2% has been recommended.
FOUNDATIONS	
LIKELY FOUNDATION TYPE	The site has been divided into two different zones for foundation design purposes. <u>Western Zone A</u>: Shallow strip/trench fill footings to bear upon Head Deposits/London Clay. Deep foundations, such as pile, for plots located within the influence of zones of trees. Reinforced where straddling changes in strata of soil type. <u>Eastern Zone B</u>: Shallow strip/trench fill footings to bear upon Head Deposits.
VOLUME CHANGE POTENTIAL	<u>Head Deposits</u>: Non shrinkable soils. <u>London Clay Formation</u>: High i.e. significant swelling or shrinking with moisture content changes.
ESTIMATED FOUNDATION DEPTHS	<u>Western Zone A</u>: The minimum footing depth required is 1.00 m, but 1.50 m where required to allow for restricted new tree planting. Deepened foundations are required for Plots 30 to 32 (inclusive) If required pile lengths to be determined by specialist piling contractor. <u>Eastern Zone B</u>: The minimum footing depth required is 0.75m.
HEAVE PROTECTION	Will be required for those plots located in close proximity to the boundary trees in the western part of the site.

SUMMARY REPORT - CONTAMINATION ISSUES

SUBJECT	COMMENTS
SOIL RISKS TO HUMAN HEALTH	No unacceptable contamination in respect of human health have been identified by this investigation.
LANDFILL GAS	The completed gas monitoring has shown that landfill gas protection measures are not required.
RADON GAS	Radon gas protection measures are not required.
RISKS TO THE WATER ENVIRONMENT	No unacceptable contamination risks to water resources have been identified by this investigation.
RISKS TO BUILDING MATERIALS AND SERVICES	No unacceptable contamination risks to building materials and services have been identified by this investigation. It should be noted that the water pipe specification should always be confirmed with the local water supply company as they may insist on such protective pipes regardless of the level of contamination or remediation.
REMEDIATION	No remedial works are considered necessary to facilitate the development at this stage.
WASTE SOIL DISPOSAL	The topsoil is suitable for residential garden use in terms contamination and therefore the topsoil at the site should be stripped and the surplus reused on other developments, however, due to its high gravel content any surplus topsoil may have a reduced commercial value for re-use on other sites unless screened to reduce the gravel content to an acceptable level. It is considered that the natural soils disposed of from the site would be classified as 'non-hazardous waste' and would be characterised for disposal to landfill as 'inert waste'. However, the chemical results should be forwarded to the proposed landfill site and the waste classification confirmed prior to disposing of any surplus soils.

SUMMARY REPORT - KEY RECOMMENDATIONS

GEOTECHNICAL RECOMMENDATIONS

Should piled foundations be required and in order to confirm deeper ground conditions further ground investigation comprising deep cable percussive boreholes is recommended. It is suggested that 1No. borehole is drilled to a depth of 20m. Monitoring wells should be included in the boreholes and at least one post work monitoring visit should be undertaken to record groundwater levels. Insitu Standard Penetration Tests should be conducted during forwarding of the boreholes and collected soil samples submitted for appropriate geotechnical laboratory testing.

If infiltration devices are actively considered in the eastern area of the site, then in order to confirm the viability of soakaways and to collect design data, trial pit soakage tests in accordance with BRE Digest 365 are recommended. In order to undertake the three fillings of water necessary, it is recommended that the test pits are gravel filled with an observation standpipe to prevent collapsing sides and for overnight safety. Water should be supplied tanker so the test pits are filled rapidly and a sufficient volume of water is employed within the test.

There is some uncertainty in respect of ground conditions at the boundary between the deeper Head Deposits and the London Clay. It is recommended that further investigation is undertaken at some plots to determine depths of the superficial Head Deposits in order to better delineate the geological divide and confirm foundation depths.

The topsoil was observed to be very gravelly particularly in the eastern half of the site. Accordingly, allowance will need to be made for appropriate screening of the topsoil to generate a suitable topsoil for re-use. Such screening will need to be undertaken during a period when the topsoil can be stripped and processed in a dry condition.

CONTAMINATION RECOMMENDATIONS

Should the soils from the soil pile in the south east corner of the site be reused within the development, further sampling of these soils is recommended to confirm they are suitable for use in the proposed residential development setting.

1. INTRODUCTION TO TECHNICAL REPORT

1.1. CONTRACT DETAILS

CLIENT	Redrow Homes Limited & Mr Phillip Dymoke White
SITE	Land situated north of Bartons Road in the town of Havant.
CLIENT'S ADVISORS	BRD Environmental Limited (BRD) has been commissioned directly by the Client.
REPORT CONTEXT	It is understood that the Client intends to purchase the site and develop it for residential housing.
REPORT TYPE	Geo-environmental site investigation (i.e. combined geotechnical ground investigation and Phase 2 contamination assessment).
REPORT OBJECTIVES	The site has been the subject of a desk study referenced as follows: • 'Phase 1 Environmental Desk Study - Bartons Road, Havant', BRD Environmental Ltd, report ref. BRD3818-OR1-A, dated November 2020. The purpose of the report is to present the findings of a Geo-Environmental site investigation and to present both geotechnical and contamination assessments of the ground conditions revealed.

1.2. SCOPE OF WORKS

The agreed scope of works was:

- Mobilisation to site and production of health and safety documentation.
- One day of windowless sampling using a percussive drilling rig to provide approximately 5No. boreholes to a nominal depth of 3m-5m, ground conditions permitting. Undertake Standard Penetration Tests (SPT) at 1m intervals. Installation of a 3m-4m depth groundwater monitoring well (nominal 50mm diameter) into each borehole. Installations will be finished with a flush fitting metal stopcock cover.
- One day of trial pitting using a mechanical excavator to provide approximately 8-9No. trial pits to a nominal depth of 3m, ground conditions permitting.
- All exploratory points will be logged and sampled in general accordance with BS5930:2015 by supervising Geo-Environmental Consultant. In-situ geotechnical testing of fine soils using a Hand Shear Vane and/or Pocket Penetrometer.
- Determination of the accurate location and level of exploratory points by topographical GPS survey unit.
- Geo-Environmental Technician to undertake a total of 6No. combined gas, vapour and groundwater monitoring visits. For gas, the determination of oxygen, carbon dioxide, methane, hydrogen sulphide and carbon monoxide concentrations, together with atmospheric pressure and flow rates, using portable equipment. For vapours, determination of the concentration of volatile organic compounds by photo ionisation detector. For groundwater, the determination of groundwater levels.

- On the first monitoring visit water samples will be collected for geotechnical analysis and some falling head permeability tests or simple soakage tests (as appropriate the ground conditions) will also be undertaken to confirm the likely lack of soil permeability or infiltration rates.
- Chemical testing of soil samples to confirm the soils are uncontaminated, to determine waste classification for muckaway and to meet the requirements for new water supply pipe specification. Budget based on the following testing schedule:
 - o 8No. Metals Suite - As, Cd, Cr, CrVI, Hg, Pb, Se, Cu, Ni and Zn.
 - o 8No. Inorganics Suite - water soluble sulphate, pH, organic matter.
 - o 8No. Speciated Polycyclic Aromatic Hydrocarbons (PAH).
 - o 2No. Banded aliphatic/aromatic Total Petroleum Hydrocarbons (TPH).
 - o 2No. Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and Methyl Tertiary Butyl Ether (MTBE) compounds.
 - o 3No. Organochlorine pesticides.
 - o 2No. Semi-Volatile Organic Compounds (SVOC) suite.
- Chemical testing of 1No. soil sample for Waste Acceptance Criteria (WAC) to assist in establishing the waste classification of the soil for disposal purposes.
- Geotechnical testing as appropriate to the nature of the ground conditions encountered, but the budget is based on the following testing schedule:
 - o 8No. Moisture content
 - o 8No. Plasticity indices.
 - o 2No. Particle size distribution by wet sieve and follow on hydrometer.
 - o 8No. pH and water soluble sulphate analysis - soil.
 - o 8No. Total sulphate and sulphur analysis - soil.
 - o 3No. pH and sulphate analysis - water.
- Provision of a combined factual and interpretative investigation report. Factual findings to include all exploratory point records, monitoring and test results. Interpretative reporting to include a summary of information from desk study research, a Generic Quantitative Contamination Risk Assessment (GQRA), waste classification and a Geotechnical Assessment providing comments on pavement design, concrete classification, soakaway feasibility, foundation design recommendations.

1.3. REPORT LIMITATIONS

Any site boundary lines depicted on plans included within this report are approximate only and do not imply legal ownership of land. Any observations of tree species, asbestos containing materials within structures or invasive weeds, does not constitute a formal survey of such features. The identification of such features is therefore tentative only. In the case of Japanese Knotweed, BRD can undertake separate surveys for this plant undertaken by a Property Care Association qualified surveyor.

The report does not consider whether sensitive ecology or archaeology is present as these require consideration by professionals specialising in these matters. It should be recognised that the collection of desk study information may not be exhaustive and that other information pertinent to the site may be available.

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

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

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

2. SITE CHARACTERISTICS

2.1. SITE SETTING

SITE ADDRESS AND POST CODE	Camp Field, Bartons Road, Havant, PO9 5NA.
NATIONAL GRID REFERENCE	473320E, 108050N.

2.2. SITE DESCRIPTION

SUBJECT	COMMENTS
CURRENT SITE DESCRIPTION	The site is currently part of a large agricultural field covered by vegetation with large Oak tree located centrally. The site is irregular in shape covers an area of approximately 3 hectares and generally slopes downwards towards the south west corner. In the south east corner of the site is a tarmac access road, which passes through this corner of the site to the Crematorium, located off site to the north. The tarmac road is surrounded by new planting, soft landscaping and a high stock proof fence on both sides. A temporary road junction leads from this tarmac road to the gated entrance to the main part of the site. Further to the south east on the opposite side of the tarmac road, is small corner of the site segregated from the main site. This area currently contains part of a soil pile, which extends further off site to the east. A further small bund is present along the extent of the southern boundary, separating the site from the adjacent Bartons Road.
SURROUNDING LAND USE	The site is set in a mixed rural and residential area with an adjoining field a Crematorium and woodland is present to the north of the site In the south east corner of the site is part of a large soil pile and the remainder of the eastern boundary is bordered by the Crematorium access road and surrounding landscaping. Beyond this is a woodland and further to the east Spire Portsmouth Hospital. Bartons Road with several residential properties are present to the south and a recently constructed housing estate is located to the west of the site. To the north west is further woodland.
PROPOSED DEVELOPMENT	It is proposed that the site will be developed as 72No. residential houses with associated private gardens, parking and road access.
HISTORICAL SUMMARY	The site has remained in agricultural use since initially recorded in mapping. During the 20th Century the surrounding area has been developed with residential housing, a Crematorium and a hospital. A small infilled gravel pit is located approximately 20m to the south east of the site, was no longer shown on the map editions from 1970 onwards. The road in the south east corner of the site, was constructed with the Crematorium in 2014.

SUBJECT	COMMENTS
PUBLISHED GEOLOGY	The site is shown to be underlain by superficial deposits in the east of the site comprising Head Deposits. The shallowest bedrock unit is shown to be the London Clay Formation, which is present near surface in the west of the site.
RADON	Radon protection measures are not required.
HYDROGEOLOGY	The eastern half of the site is situated upon superficial deposits designated a Secondary A Aquifer. The underlying bedrock geology is designated Unproductive Strata. The site is located within a groundwater Source Protection Zone 1c (Inner Protection Zone) - subsurface activity only.
HYDROLOGY	The closest water feature to the site is a stream approximately 177m west of the site. The site is not in an area indicated to be at risk of flooding.

2.3. PREVIOUS INVESTIGATIONS

An intrusive ground investigation was conducted by Charles & Associated Consulting Engineers in 2018 to assess the infiltration potential of the underlying soils. The works undertaken comprised 5No. trial pits undertaken in March 2018 and 5No. Windowless Sampling boreholes undertaken in May 2018. However, only boreholes WS01 to WS03 (inclusive) and trial pits TP2 to TP5 (inclusive) were undertaken on site or in close proximity to the site boundary.

2.3.1. Ground conditions

Beneath a nominal layer of topsoil, Head Deposits were identified across the site rather than just in the east as geological mapping indicates. Head Deposits were recorded comprising sandy, gravelly clay to clayey gravel. In the east, these deposits were found to extend beyond 3.0m bgl but were then found to thin towards the west being encountered to depths ranging between 0.6m and 1.5m bgl.

Underlying the Head Deposits, the London Clay was encountered and typically recorded as 'Brown, orange, grey mottled Clay'.

Groundwater was only encountered in TP01 at a depth of 2.20m bgl.

2.3.2. Soakage testing

Infiltration rates were recorded between 2.81×10^{-5} m/s and 3.16×10^{-4} m/s in the soakage tests conducted within each of the trial pits. As a result of the recorded infiltration rates, soakaways were not recommended as the primary method of surface water management and would be utilised for proposed pervious paving and a highways infiltration trench only. It is proposed that the remainder of the surface water will be managed by a mixture of surface water attenuation measures and controlled discharges into the watercourse located to the west of the site.

It should be noted that at the time of the BRD walkover, the watercourse was a dry ditch.

2.3.3. Phase 1 Desk Study

The site has also been the subject of a desk study undertaken BRD and is referenced as follows:

- 'Phase 1 Environmental Desk Study - Bartons Road, Havant', BRD Environmental Ltd, report ref. BRD3818-OR1-A, dated November 2020.

2.3.3.1. *Preliminary Contamination Assessment*

Given the site has remained as an agricultural field / grazing throughout its mapped history, it is considered unlikely that there is any onsite sources of contamination. The off-site former gravel pit in close proximity to the south east boundary and the potential for similar workings to the west, however, do offer a potential risk for the migration of landfill gasses albeit low.

2.3.3.2. *Preliminary Geotechnical Assessment*

On the basis of the anticipated ground conditions and the findings from the previous site investigation, conventional shallow foundations should be feasible for the majority of the site, but deepened trench fill footings or even piling may be required in areas within the influence of trees in accordance NHBC Standards Chapter 4.2.

2.3.3.3. *Recommendations*

Based on the findings of the desk study an intrusive ground investigation incorporating both a Phase 2 contamination assessment and a geotechnical assessment was proposed.

3. GROUND INVESTIGATION

3.1. INVESTIGATION DESIGN

METHODOLOGY	A combination of trial pits and shallow windowless sample boreholes were chosen for the investigation. Trial pits were selected as they expose more soils which enables a more reliable record of the ground conditions encountered and the window samples were selected as monitoring installations and in-situ density tests were required in the coarse soils.	
DATES OF SITE WORKS	The main field works were undertaken on 26th and 28th October 2020. To date, monitoring visits have been undertaken on 30th October, 10th and 16th November. A further 3No. monitoring visits are proposed over the winter period to monitor winter groundwater levels.	
CONSTRAINTS TO EXPLORATORY HOLE LAYOUT	Investigation of the soil pile in the south east corner of the site was limited to hand dug excavation only due to access restrictions. No investigation beneath the existing Crematorium road in the south east corner of the site could be completed as this remains the only access to this facility.	
EXPLORATORY HOLE SPACING	Approximately 35m grid.	
LAYOUT RATIONALE	SOURCE / FEATURE	EXPLORATORY HOLE
CONTAMINATION SOURCES TARGETED	Migration of gasses from off site sources	WS101 - WS105 (inclusive)
	Soil piles / bund	HD01, HD02
	Concrete fragments at surface	TP105
GROUND FEATURES TARGETED	Variable ground conditions	All exploratory points
	Winter monitoring levels	WS101 - WS105 (inclusive)
CONTAMINATION SAMPLING PLAN	Based on the proposed end use, the sampling and analysis plan is more positively biased towards near surface samples as these represent the soils most likely to be available to future site users. The analysis is more biased towards the Made Ground samples as this stratum represents the soils most likely to be contaminated.	
ANALYSIS PLAN	Given the site's history as agricultural fields, BRD has scheduled a suite of typically occurring contaminants that tend to be associated with such sites. Groundwater sampling was also undertaken on selected borehole but for geotechnical purposes only.	

3.2. BRD FIELDWORK

HAND DUG INSPECTION PITS	
REFERENCES	HD01 to HD02.
DEPTH RANGE	0.2m bgl.
BACKFILL	The inspection pits were backfilled with arisings upon completion.

TRIAL PITS	
REFERENCES	TP101 to TP110.
DEPTH RANGE	From 0.60m to 3.2m.
EXCAVATOR	JCB 3CX style wheeled backactor.
BACKFILL	All the trial pits were backfilled with arisings upon completion and compacted with rams of the excavator bucket.

WINDOWLESS SAMPLING BOREHOLES	
REFERENCES	WS101 to WS105.
DEPTH RANGE	From 4.45m to 5.45m.
RIG TYPE	Premier Drilling Rig.
INSTALLATION / BACKFILL	All boreholes had monitoring wells installed. These comprised 50mm nominal diameter standpipes fitted with a gas tap finished with a flush metal cover. The slotted response length of the well is shown on the individual logs. Bentonite seals are also indicated on the logs. The filter medium used was pea gravel.

MONITORING	
TYPE	Ground gases and groundwater monitoring.
DATES	30 th October, 10 th and 16 th November 2020. 5 th January, 4 th February and 15 th March 2021.
GROUNDWATER SAMPLING METHOD	Samples were retrieved using a sampling bailer dedicated to each well.

3.3. LABORATORY TESTING

GEOTECHNICAL TESTING	
The soil samples for geotechnical testing were forwarded to the laboratory of Soil Property Testing Ltd with pH and sulphate analysis undertaken at the laboratory of DETS Ltd. The geotechnical testing suite is detailed below. The UKAS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
TEST	NUMBER OF SAMPLES TESTED
Moisture content	8
Liquid and plastic limits	8
Particle size distribution by wet sieve	2
Particle size distribution by wet sieve and hydrometer	1
pH and Water soluble Sulphate	8
Total Sulphur and Sulphate	8

SOIL CHEMICAL TESTING	
The soil samples for contamination and/or chemical geotechnical testing were forwarded to the laboratory of DETS Ltd and the testing suite is detailed below. The UKAS or MCERTS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
SOIL TESTS	NUMBER OF SAMPLES TESTED
Arsenic, Cadmium, Chromium, Chromium VI, Copper, Lead, Mercury, Nickel, Selenium, Zinc	10
Speciated Polycyclic Aromatic Hydrocarbons (PAH)	10
Total Petroleum Hydrocarbons (TPH) with full carbon banding and aliphatic/aromatic split	2
Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) plus Methyl Tert Butyl Ether (MTBE)	2
Organic Matter	10
Semi-Volatile Organic Compounds (SVOCs)	2
Organochlorine pesticides	3
Waste Acceptance Criteria (WAC) testing	1

GROUNDWATER CHEMICAL TESTING	
The water samples for chemical geotechnical testing were forwarded to the laboratory of DETS Ltd and the testing suite is detailed below. The UKAS or MCERTS accreditation of the individual test methods is shown on the laboratory test report included in the Appendices.	
WATER TESTS	NUMBER OF SAMPLES TESTED
pH	3
Sulphate	3

4. GROUND CONDITIONS

4.1. OVERVIEW

The ground conditions were as anticipated from the published geological map and as encountered within the previous investigation. Clayey granular Head Deposits were proven to depths of 5.35m bgl in the eastern area of the site and in the west, the Head Deposits thinned with the underlying London Clay Formation being encountered near surface or even absent as proven in the south west corner.

Groundwater was encountered in a number of exploratory holes towards the eastern area of the site within the Head Deposits and at depths ranging from 2.0m to 3.2m bgl.

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

4.2. TOPSOIL AND MADE GROUND TOPSOIL

4.2.1. Made Ground Topsoil

During the main investigation works, Made Ground was only encountered in TP105 and at depths ranging from GL to 0.3m bgl. This trial pit was excavated as a lump of concrete were observed on the surface and beneath the concrete a Made Ground topsoil was encountered, although no evidence of any potential contamination was observed.

Hand dug pits HD01 and HD02 were undertaken in the soil mound in the south east corner and soil bund on the southern boundary. In both locations, the soils were observed to consist of a Made Ground topsoil containing brick and flint.

It is considered likely that the soil pile in the south east corner was generated as part of the works to develop the nearby Crematorium in 2014.

4.2.2. Topsoil

Topsoil was encountered in all of the exploratory holes undertaken within the main field area and to depths ranging from 0.2m to 0.3m bgl. The Topsoil was typically described as 'TOPSOIL: Soft, brown, sandy, very gravelly silt. Gravel is fine to coarse, subangular to subrounded flint'.

The topsoil was observed to be very gravelly particularly in the eastern half of the site, which may limit the volume of useable good quality topsoil when forming new residential gardens unless the material is screened to remove the excess gravel content.

4.3. SUPERFICIAL DEPOSITS

4.3.1. Head Deposits

Head Deposits were encountered in all of the main exploratory holes and at depths ranging from 0.2m to 5.35m bgl, the exception being WS104 in the south west corner of the site, where these superficial deposits were absent.

In the eastern half the site the Head Deposits were proven to a maximum depth of 5.35m bgl in WS101 and then thinned towards the west, where in WS105 they were only encountered to depths of 1.0m bgl.

The Head Deposits generally consisted of 'Medium dense, orange brown and light brown, clayey to very clayey, slightly sandy GRAVEL and COBBLES of subangular to subrounded flint with occasional clay pockets'. Frequent lenses of clay were also encountered. Sand, silt and clay lenses were also encountered at depth in exploratory holes WS101, WS102, TP106, TP107 and

TP108 and it is considered this is likely the interface between the Head Deposits and the underlying London Clay Formation.

4.4. BEDROCK

4.4.1. London Clay Formation

The London Clay was encountered at depths ranging from 0.3m bgl in WS104 and 1.0m bgl in WS105 in the western half of the site and 5.35m bgl in WS101 in the east. In WS103 located centrally it was encountered at 2.3m bgl.

The London Clay was typically described as ‘Stiff, brown mottled grey, slightly fissured CLAY with occasional polished surfaces, relict rootlets and occasional calcareous aggregations’. The clay became dark brown / grey and increasingly fissured with depth.

4.5. GEOTECHNICAL COMMENTS

The London Clay was observed to be desiccated in WS105 and TP101 in the north west corner of the site in the vicinity of the boundary trees. The desiccation extended to 2.5m bgl in WS105 and the soil in TP101 were observed to be very stiff / hard and friable to depths greater than 3.0m bgl.

Some slight spalling of the trial pits was observed in the deeper Head Deposits in trial pit TP106 to TP109, with the gravelly soil in TP110 collapsing from 0.3m to 1.0m bgl.

Across the eastern half of the site the surface was generally compact and dry considering the time of year. However, in the west, just past the central Oak Tree, the surface soils became increasingly wet with some standing water observed. This reflects the thinner cover of Head deposits in the western part of the site.

4.6. CONTAMINATION OBSERVATIONS

No visual or olfactory evidence of contamination was noted during the forwarding of exploratory holes.

4.7. GROUNDWATER BEHAVIOUR

During the progressing of exploratory holes, the following general observations of groundwater behaviour were made.

Groundwater was encountered in a number of exploratory holes towards the eastern area of the site within the Head Deposits and at depths ranging from 2.0m to 3.2m bgl. In the boreholes where groundwater was encountered at depth it resulted in collapse resulting in re-drilling to ensure the installation of the monitoring pipe.

In the trial pits, groundwater was encountered at depths of 2.0m bgl or greater and was observed to be a slight seepage. The trial pits remained stable on encountering the groundwater.

4.8. GROUNDWATER MONITORING

DATE	RESTING GROUNDWATER RANGE	COMMENTS
30/10/2020	From 1.07m to 2.79m bgl.	The shallowest water was recorded in WS103 and the deepest in WS101.
10/11/2020	From 2.50m to 3.77m bgl.	The shallowest water was recorded in WS102 and the deepest in WS104. Groundwater levels were lower following the groundwater monitoring undertaken during the first monitoring visit. This indicates slow recharge.
16/11/2020	From 1.81m to 3.68m bgl.	The shallowest water was recorded in WS102 and the deepest in WS104. Slight increase in groundwater levels as the boreholes slowly recharge.
05/01/2021	From 1.09m to 3.09m bgl	The shallowest water was recorded in WS105 and the deepest in WS104.
04/02/2021	From 0.28m to 2.83m bgl	The shallowest water was recorded in WS105 and the deepest in WS104. Significant rise in groundwater levels following periods of heavy rainfall in January. It is probable that towards the western end of the site where clay soil predominates, the water level recorded represents the slow accumulation of water within the well rather than true groundwater level.
15/03/2021	From 0.26m to 2.96m bgl	The shallowest water was recorded in WS105 and the deepest in WS101. Groundwater levels have remained seasonally high from the increase recorded in February. The water level recorded in WS105 is suggesting saturation of the near surface thin Head Deposits has occurred and the well has filled up with water from the surface water infiltration.

5. GEOTECHNICAL PROPERTIES

5.1. COARSE SOIL PARAMETERS

5.1.1. Variable Head Permeability

A rising head permeability test was undertaken in borehole WS101 after bailing the standing groundwater recorded in the borehole at 2.78m bgl. The records of the variable head permeability tests are presented in the Appendices that includes the calculation of the permeability. The results are presented in the table below:

BOREHOLE	PERMEABILITY	STRATUM TESTED
WS101	1.36×10^{-5} m/s	Light brown with some orange, silty SAND.

5.1.2. Standard Penetration Tests

Standard Penetration tests (SPTs) were undertaken in all the boreholes.

Tests undertaken in the coarse gravelly and sandy soils of the Head Deposits recorded N-values ranging between 17 and 44 in the gravelly soils which are indicative of medium dense to dense relative density. The lowest values were recorded in borehole WS102 at 3.0m depth in the presence of the groundwater level.

Likewise, due to the presence of the groundwater level, sand deposits recorded in borehole WS101 between 4.0m and 5.0 depth recorded N-values between 4 and 6 which are indicative of loose soils.

It seems clear that the presence of the groundwater has reduced the relative density of the granular soils recorded on site.

5.1.3. Particle Size Distribution (PSD)

The grading curves of the two samples of Head Deposits subject to PSD determination revealed the soil to be slightly sandy, silty, clay Gravel. A gravel content between 73% and 74% has been recorded. The sand content ranges between 8% and 14% and the fines content range between 12% and 19%.

One sample of Topsoil was subject to PSD determination and revealed the soil to be a slightly sandy, clayey, gravelly silt. A gravel and sand content of 49% and 12%, respectively, has been recorded. A fines content of 39% has been recorded with a 4% in clay content and 35% in silty content.

The Topsoil has a high gravel content. In comparison to BS3882:2015 'Specification for Topsoil' the limit for 2mm gravel of 30% maximum and 20mm gravel of 10% has been exceeded by results of 49% and 19% for the sample tested. This will result in a reduced volume of re-useable suitable topsoil and any surplus topsoil may also have a reduced value for re-use on other sites. Accordingly, allowance will need to be made for appropriate screening of the topsoil to generate a suitable topsoil. Such screening will need to be undertaken during a period when the topsoil can be stripped and processed in a dry condition.

5.2. FINE SOIL PARAMETERS

5.2.1. Index Property Testing

SOIL TYPE	Head Deposits.
PLASTICITY INDEX (PI)	Oversize particles present.
MODIFIED PI	2% - 8% (Three samples: Non shrinkable soil type). 12% (One sample: Low volume change potential).
NHBC CLASS	Non shrinkable soil type.

SOIL TYPE	London Clay Formation.
PLASTICITY INDEX (PI)	46% - 49%
MODIFIED PI	Not applicable - no oversize particles.
NHBC CLASS	High volume change potential.

5.2.2. Undrained Shear Strength

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

5.2.2.1. *Hand Shear Vane*

SOIL TYPE	London Clay Formation.
CORRECTION FACTOR μ	$\mu=1.0$
JUSTIFICATION	Professional judgement.
DISCUSSION OF CORRECTED RESULTS	The recorded undrained shear strength was in the range of 60kPa and 104kPa, averaging 90kPa, which is indicative of high strength soil type.

5.2.2.2. *Hand Penetrometer*

SOIL TYPE	London Clay Formation.
DISCUSSION OF CORRECTED RESULTS	The recorded undrained shear strength was in the range of 74kPa and 123kPa which is indicative of medium to high strength soil type.

5.2.2.3. Standard Penetration Test Correlations

A total of 11No. Standard Penetration Tests were undertaken in the clay-rich soils recorded on site.

Tests undertaken in the clay-rich soils of the London Clay Formation have recorded N-values between 7 and 15 which is indicative of firm to stiff soils.

A single test undertaken in the sporadic clayey beds recorded as part of the Head Deposits recorded an N-value of 7 which is indicative of firm soils.

For fissured, over consolidated fine-grained soils, such as the London Clay, SPT N-values can be converted using industry standard correlations, such as Stroud's method, to equivalent undrained shear strengths of a 100mm-diameter triaxial compression test. This conversion uses values for Stroud's conversion factor, f_1 , selected on the basis of plasticity index recorded in the samples tested in the London Clay. An energy ratio value for the windowless sample rig of $E_r=0.86$ has been applied based on the annual calibration certificate provided by the sub-contractor.

Equivalent undrained shear strengths for the London Clay of between 45kPa and 71kPa have been recorded at 1.0m bgl depth, these values are indicative of medium strength.

Between 2.0m and 4.0m bgl, equivalent undrained shear strengths of between 77kPa and 97kPa have been recorded, which are indicative of high strength.

Below at 5.0m an equivalent undrained shear strength value of 71Pa have been recorded, which is indicative of medium strength soils.

5.3. SULPHATE AND pH

	ALL ON-SITE SOILS			
	Sulphate		pH	
Characteristic Value	239 mg/l		7.1 units	
Justification	Highest groundwater result.		Mean of lowest 20% results.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	18	<10 - 121 mg/l	18	6.7 - 8.2 units
Groundwater	3	39 - 239 mg/l	3	7.2 - 8.1 units
Total Potential Sulphate	8	Not applicable as pyrite unlikely in the samples tested.		

6. GEOTECHNICAL ASSESSMENT

6.1. INTRODUCTION

The following advice and recommendations are based on the construction of about 72No. low rise two to three storey residential properties across the entire site. The proposed development layout plan is included in Appendix 1. From assessment of the nature of the ground conditions and the type of proposed structures, it is considered that the situation falls within EC7 Geotechnical Category 1.

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

6.2. EXCAVATIONS

STABILITY	Most of the site has a cover of Head Deposits generally recorded as gravelly soils which are absent mainly along the eastern part of the site. It is considered that shallow excavations (1m or less) should remain stable in the short term (a few hours at most). However, the Head were noted to be prone to spalling and some wall collapse at some areas across the site. This behaviour is likely to be worse in this winter time when groundwater levels are shallower. On the basis of the above, any excavation requiring man entry should be battered back to a safe angle, supported by an appropriate proprietary trench support system or be adequately shored. Shoring to any excavation requiring man entry must be designed by a suitably qualified and experienced engineer. Any support system will require regular inspection as detailed in published guidelines to ensure the excavation support is adequate and appropriate for the ground conditions present. Arisings and movement of construction plant should be kept away from open excavations as the loadings from mounded soils and vibrations from plant movement could induce spalling and collapse of excavation walls. Deeper excavations or any excavations open for longer periods within these granular units would be expected to undergo more pronounced collapse, which would be exacerbated when encountering groundwater inflows, as was apparent in some of the trial pits which collapsed rapidly. Excavations below the water table at this site are likely to result in excavation difficulties due to 'running sands' and appropriate groundwater control will therefore be required to increase stability.
EQUIPMENT	It should be possible to progress excavations with conventional equipment.
GROUNDWATER CONTROL	Specific groundwater control is unlikely to be required at this site. Limited pumping from sumps or bailing out may be required to deal with slight seepages or surface water ingress during periods of inclement weather.
PARTY WALL ISSUES	As there are no nearby third party structures, the Party Wall Act is unlikely to apply to the development.

6.3. SLOPE STABILITY

The site is relatively flat and no significant changes in level as part of the development are anticipated. It is therefore considered that slope stability is unlikely to be a significant concern at this site.

6.4. SUB-SURFACE CONCRETE

MADE GROUND / TOPSOIL / HEAD DEPOSITS / LONDON CLAY	
SITE / SOIL CATEGORY	Natural ground.
DESIGN SULPHATE CLASS	DS-1
GROUNDWATER REGIME	Mobile.
AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) CLASS	AC-1
COMMENTS	The London Clay is considered a natural soil highly likely to contain sulphates. Further testing in these soils should be required to offer a more reliable classification.

6.5. SOAKAWAYS

6.5.1. Soil Infiltration Rate

A modified borehole style soakage test was undertaken in borehole WS102. The records of a soakage tests are presented in the Appendices that includes the calculation of the soil infiltration rate. A summary of results are presented in the table below:

BOREHOLE	SOIL INFILTRATION RATE		STRATUM TESTED
WS102	Test 1	6.24×10^{-6} m/s Result extrapolated and so guide only.	Orange brown, slightly sandy, clayey GRAVEL. Gravel of fine to coarse, subangular to subrounded flint.

Whilst repeat tests required by BRE365 were not undertaken due to budgetary constraints, the nature of the ground conditions is such that repeat tests would be expected to have given infiltration rates at similar orders of magnitude.

6.5.2. Soakaway Design Advice

An extrapolated infiltration rate of the order of 10^{-6} m/s was recorded in the sandy clayey gravelly soils encountered on borehole WS102 which is indicative of poor infiltration media. However, this is an extrapolated result and should be used as a guide only.

The proposed drainage strategy for the site is based on the use of permeable pavements together with an attenuation pond located along the western site boundary prior to discharge off site.

Based on the findings of this additional ground investigation, it is BRD opinion that the disposal of collected surface water to shallow infiltration devices such as permeable pavements, swales and

shallow soakaways will be feasible at the eastern part of the site due to the granular nature and therefore anticipated good permeability of the underlying Head deposits soils. Infiltration devices will not be suitable in the western part of the site where these deposits are only thin.

Standing groundwater level in the most eastern part of the site have been recorded between 1.61m and 2.96m bgl. Soakaway design will need to consider the variation of the groundwater table as during periods of elevated groundwater the ability of the soils underlying the site to receive additional water may be limited. In addition, the Environment Agency will object to the use of infiltration devices that lead to the direct input to groundwater and seek that in excess of a 1m thick unsaturated zone is present between the base of the infiltration device and the seasonal high maximum groundwater level. Therefore, an extended period of groundwater level monitoring is recommended to evaluate the impact on soakaway design, if considered.

If infiltration devices are actively considered in the eastern area of the site, then in order to confirm the viability of soakaways and to collect design data, trial pit soakage tests in accordance with BRE Digest 365 are recommended. In order to undertake the three fillings of water necessary, it is recommended that the test pits are gravel filled with an observation standpipe to prevent collapsing sides and for overnight safety. Water should be supplied tanker so the test pits are filled rapidly and a sufficient volume of water is employed within the test.

6.6. PAVEMENT CONSTRUCTION

Head Deposits have been typically recorded as sandy, clayey gravel, then from consideration of the observed ground conditions, it is recommended that a preliminary design California Bearing Ratio (CBR) of 10% is assumed where these soils are present at formation.

From consideration of the observed ground conditions and the plasticity of the London Clay Formation, it is recommended that a preliminary design California Bearing Ratio (CBR) of 2% is assumed. The cohesive deposits will be prone to rapid degradation during wet weather working and this should be avoided where possible.

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

6.7. PRELIMINARY FOUNDATION RECOMMENDATIONS

6.7.1. Introduction

Ground conditions across the site have been recorded comprising deep clayey gravelly soils along the east and centre part of the site thinning towards the west where also have been found absent (borehole WS04 located in the south western corner). Then, clay-rich soils of the London Clay have been recorded along the western part of the site both below the Head or the Topsoil.

Based on the variability of the recorded soils and the proposed layout provided in Appendix 1, the site has been segregated into two different Zones (Zone A and Zone B) for foundation advice. A Tree Influence and Foundation Assessment Plan is provided in Appendix 1 that illustrates the following two areas:

- **Zone A:** This area mainly extends along the western part of the site. The foundation stratum recorded in this zone comprises both the Head Deposits and the London Clay Formation. The first one has been recorded as non-shrinkable soils when recorded as gravel whereas the latter has been recorded with a High volume change in accordance with NHBC. Due to the Head Deposits thinning towards the west, further investigation is required on Plots 29 to 52 (inclusive) to provide an accurate foundation solution. However, until this is completed, the foundation solution for Zone A should be assumed.
- **Zone B:** This area occupies approximately the central and eastern part of the site. Generally, competent clayey gravelly soils of the Head Deposits have been recorded across this area with proved depths between 2.30m and 5.35m and recorded as non-shrinkable soil type.

It is considered that shallow spread foundations may be adopted for the proposed residential properties if founded within the underlying natural soils recorded at each zone, but different design considerations will apply for each zone. Within the zones of influence of the trees in Zone A, deepened trench fill foundations will generally be required.

With reference to the Tree Influence and Foundation Assessment Plan the influence of the high water demand trees has confirmed that Plots 30, 31 and 32 will require foundation depths in excess of 2.0m and the garages to Plots 31 and 32 Area will require foundation depths in excess of 2.5m in accordance with NHBC Standards 4.2.

The influence of these trees and required foundation depths may dictate that piled foundations may need to be considered if trench fill foundations are too deep to be economic or practical to construct. Additionally, desiccated soils over 3.0m depth have been recorded along the north western corner of the site adjacent to woodland, piling design should be also considered for any structures affected by desiccation.

Due to the Head Deposits thinning towards the west, the thickness of these deposits is particularly relevant for foundation depths purposes. There is some uncertainty in respect of ground conditions at the boundary between the deeper Head Deposits and the London Clay. Accordingly, further investigation is recommended in order to confirm the foundation advice. Until such further investigation is completed the same foundation solution as for Plots in Zone A should be assumed, and this will particularly apply to plots 49 to 52 (inclusive).

For a limited number of plots, mostly located along the western part of the site, reinforced footings are likely to be required where both gravelly Head Deposits and London Clay soils are present at foundation depth.

6.7.2. Floor Slabs

Subject to the removal of any made ground, soft spots or topsoil and replacement with suitable compacted granular fill, most of the site is suitable for the adoption of ground bearing floor slabs onto the granular Head Deposits.

In consideration of the near surface clay soils recorded mostly along the western part of the site, fully suspended floor slabs designed and constructed in accordance with NHBC Standards are recommended at this development.

With reference to Section 2.2, the floor construction will not have to incorporate radon gas protection measures.

6.7.3. Traditional Footings

6.7.3.1. *Zone A*

The area is suitable for the adoption of shallow strip/trench fill footings. Foundations should be taken through Made Ground/Topsoil to bear upon the London Clay and/or Head Deposits.

At shallow depths the London Clay Formation will have a more limited bearing capacity in contrast with the competent Head Deposits. Then, a bearing pressure value of 100kN/m² is considered appropriate for foundations up to 1m wide bearing upon the London Clay Formation or clayey gravelly soils of the Head Deposits. Immediate and long term settlement should be within tolerable limits and take place over several years.

Where both type of soils are found at formation level, gravelly Head Deposits and London Clay Formation, it is recommended that nominal steel mesh reinforcement is included within the footing to reduce the effects of differential settlement across the varying strata and distribute stresses more evenly.

The Head Deposits and the London Clay have been proved with different volume change potential. However, the Head Deposits have been recorded with limited thickness along this area and then in accordance with the NHBC Standards for foundations design the volume change potential of the London Clay Formation should be used.

Therefore, the London Clay Formation has been shown to have a high volume change potential when assessed against NHBC standards and therefore the minimum foundation depth required is 1.00m, but 1.50m where required to allow for restricted new tree planting. Under the NHBC Standards, foundation depths have to be increased if they are within the influence zone of felled trees, existing trees or proposed tree planting.

Several mature trees including ash, hawthorn and oak are located along the south western corner of the site as reflected on the provided tree survey report. Based on the proposed layout most of those trees will be retained.

With reference to the Tree Influence and Foundation Assessment Plan the following Plots will require depended foundations in accordance with NHBC requirements:

- Plots 30 to 32 (inclusive) - Foundation depths in excess of 2.0m are required.
- The garage block to Plots 31 and 32 - Foundation depths in excess of 2.5m are required in accordance with NHBC Standards 4.2 and so engineer design would be required if these are to be considered acceptable.

A piled foundation may therefore be preferred for these plots.

6.7.3.2. Zone B

This zone comprises most of the site and extends from the east to approximately the centre and of the site.

This part of the site is suitable for the adoption of shallow strip/trench fill footings. Foundations should be taken through Made Ground/Topsoil to bear upon the Head Deposits recorded as clayey gravel. A minimum foundation depth of 0.75m will apply.

A presumed bearing value of 125kN/m² is considered appropriate for foundations up to 1m wide bearing upon the clayey gravel of the Head Deposits. Immediate and long term settlement should be within tolerable limits and take place largely during the construction period.

6.7.3.3. Boundary Head Deposits / London Clay Formation

As mentioned above, the Head Deposits thin towards the west of the site and then is underlain by the London Clay Formation.

For those plots located where a reduced thickness of the Head Deposits have been recorded and/or are close to the boundary trees or proposed trees then foundations depths should consider the plasticity of the underlying London Clay.

With the existing ground information, there are a few plots including Plots 49-52 (inclusive) as well as the transition between Zone A and B where additional investigation is recommended in order to confirm the thickness of the granular Head Deposits in order to produce a more accurate foundation depth/design. The further ground investigation will increase the density of the exploratory holes and allow the better delineation of the deeper Head Deposits.

6.7.3.4. General Comments

It should be noted that where trees are in groups the resulting competition for resources can lead to deeper root systems than allowed for in the NHBC Standards. In any event, foundations should be taken below any roots encountered in foundation trench excavation. Where the required foundation depth varies around a structure, this can be accommodated by forming steps in the foundation as per NHBC Standards.

Where foundation depths exceed 1.50m in clay soils and are within the zone of influence of existing or felled trees or where foundations cut through tree roots, a compressible void former will be required against the internal faces of new foundations in order to accommodate potential long term soil heave. Such precautions against heave should be designed and constructed in accordance with NHBC Standards.

The excavator must be set up with care and operated correctly to ensure trench walls are vertical and base horizontal as any slight inclination will result in eccentric loading on such deep trench fill footings.

A number of trees are located along the site boundaries and the eastern part of the site. It will be necessary to remove all unwanted trees, stumps and root structures prior to commencing with the development. Any resultant void should be backfilled accordingly with respect to the preferred foundation design.

During construction, any soft spots found at foundation formation level should be excavated and replaced with lean mix concrete. Foundation excavations should be kept dry and left open for the minimum amount of time possible. Where foundations cannot be completed immediately, a blinding layer of concrete should be placed.

6.7.4. Piling

Dependent on the position of proposed plots relative to the zones of influence of the existing trees and hedgerow, specific plots may result in uneconomically deep trench fill foundations. Consequently, consideration may need to be given to adopting piled foundations for those plots located in close proximity of the tree boundaries, hedges or retained trees.

If piling is required, then in order to confirm deeper ground conditions for pile design further ground investigation comprising a deep cable percussive borehole is recommended. In-situ Standard Penetration Tests should be conducted during forwarding of the boreholes and collected soil samples submitted for appropriate geotechnical laboratory testing.

6.8. RECOMMENDATIONS FOR FURTHER GEOTECHNICAL WORK

In order to confirm deeper ground conditions for pile design further ground investigation comprising deep cable percussive boreholes is recommended. It is suggested that 1No. borehole are drilled to depths of 20m. Monitoring wells should be included in the boreholes and at least one post work monitoring visit should be undertaken to record groundwater levels. Insitu Standard Penetration Tests should be conducted during forwarding of the boreholes and collected soil samples submitted for appropriate geotechnical laboratory testing.

If infiltration devices are actively considered in the eastern area of the site, then in order to confirm the viability of soakaways and to collect design data, trial pit soakage tests in accordance with BRE Digest 365 are recommended. In order to undertake the three fillings of water necessary, it is recommended that the test pits are gravel filled with an observation standpipe to prevent collapsing sides and for overnight safety. Water should be supplied tanker so the test pits are filled rapidly and a sufficient volume of water is employed within the test.

There is some uncertainty in respect of ground conditions at the boundary between the deeper Head Deposits and the London Clay. It is recommended that further investigation is undertaken at some plots to determine depths of the superficial Head Deposits in order to better delineate the geological divide and confirm foundation depths.

7. RISK ESTIMATION - SOILS

7.1. HUMAN HEALTH

The Generic Assessment Criteria (GAC) employed below are for residential land use as this is appropriate to the proposed form of development.

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
Arsenic	mg/kg	10	18	37	0
Cadmium	mg/kg	10	0.3	22	0
Chromium (total)	mg/kg	10	35	910	0
Chromium (hexavalent)	mg/kg	10	<2	21	0
Copper	mg/kg	10	18	2,400	0
Lead	mg/kg	10	50	200	0
Mercury	mg/kg	10	<1	11	0
Nickel	mg/kg	10	24	180	0
Selenium	mg/kg	10	<3	250	0
Zinc	mg/kg	10	116	3,700	0
pH	Units	18	6.7 - 8.2	<5-10>	0
Naphthalene	mg/kg	10	<0.1	2.3	0
Acenaphthylene	mg/kg	10	<0.1	170	0
Acenaphthene	mg/kg	10	<0.1	210	0
Fluorene	mg/kg	10	<0.1	170	0
Phenanthrene	mg/kg	10	0.13	95	0
Anthracene	mg/kg	10	<0.1	2,400	0
Fluoranthene	mg/kg	10	0.31	280	0
Pyrene	mg/kg	10	0.28	620	0
Benzo(a)anthracene	mg/kg	10	0.15	7.2	0
Chrysene	mg/kg	10	0.17	15	0
Benzo(b)fluoranthene	mg/kg	10	0.21	2.6	0
Benzo(k)fluoranthene	mg/kg	10	<0.1	77	0
Benzo(a)pyrene	mg/kg	10	0.15	2.2	0
Indeno(1,2,3-cd)pyrene	mg/kg	10	<0.1	27	0
Dibenzo(a,h)anthracene	mg/kg	10	<0.1	0.24	0
Benzo(ghi)perylene	mg/kg	10	<0.1	320	0
TPH Aliphatic C5-C6	mg/kg	2	<0.01	42	0
TPH Aliphatic C6-C8	mg/kg	2	<0.05	100	0
TPH Aliphatic C8-C10	mg/kg	2	<2	27	0
TPH Aliphatic C10-C12	mg/kg	2	<2	130	0
TPH Aliphatic C12-C16	mg/kg	2	<3	1,100	0
TPH Aliphatic C16-C35	mg/kg	2	<10	65,000	0
TPH Aliphatic C35-C44	mg/kg	2	<10	65,000	0

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
TPH Aromatic C5-C7	mg/kg	2	<0.01	70	0
TPH Aromatic C7-C8	mg/kg	2	<0.05	130	0
TPH Aromatic C8-C10	mg/kg	2	<2	34	0
TPH Aromatic C10-C12	mg/kg	2	<2	74	0
TPH Aromatic C12-C16	mg/kg	2	<2	140	0
TPH Aromatic C16-C21	mg/kg	2	<3	260	0
TPH Aromatic C21-C35	mg/kg	2	<10	1,100	0
TPH Aromatic C35-C44	mg/kg	2	<10	1,100	0
Benzene	mg/kg	2	<2	0.87	0
Toluene	mg/kg	2	<5	130	0
Ethylbenzene	mg/kg	2	<2	47	0
Xylene (total of all types)	mg/kg	2	<2	56	0
Methyl Tert Butyl Ether (MTBE)	mg/kg	2	<5	49	0
Semi-Volatile Organic Compounds (SVOCs)	mg/kg	2	LOD	LOD*	0
Orgnaochlorine Pesticides	mg/kg	3	<0.02	LOD*	0
Notes: *Limit of detection: Given the large amount of compounds in this group, coupled with the lack of GAC for certain compounds, any concentrations above the limit of detection will be highlighted in the first instance.					

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

7.2. WATER ENVIRONMENT

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

The contaminant concentrations recorded in the soils at the site are not considered to be at such levels that they would present any significant risk to the underlying water environment.

7.3. BUILDING MATERIALS

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
pH	units	18	6.7 - 8.2	<5.5	0
Sulphate (w/s)	mg/l	18	121	500	0
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	mg/kg	2	LOD*	2	0
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	mg/kg	2	LOD*	10	0
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	mg/kg	2	LOD*	500	0
Sum of BTEX + MTBE above detection limits	mg/kg	2	LOD*	0.1	0
Phenols	mg/kg	2	LOD*	2	0
Cresols and chlorinated phenols	mg/kg	2	LOD*	2	0
Naphthalene	mg/kg	10	<0.1	0.5	0
Benzo(a)pyrene	mg/kg	10	0.15	0.5	0
Notes: *Limit of detection: Given the large amount of compounds in this group, coupled with the lack of GAC for certain compounds, any concentrations above the limit of detection will be highlighted in the first instance.					

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

8. RISK ESTIMATION - GAS

8.1. RESULTS SUMMARY

PARAMETER	MINIMUM	MAXIMUM	COMMENTS
Methane	0.0%	0.1%	No significant concentrations recorded.
Carbon Dioxide	0.0%	2.3 %	No significant concentrations recorded.
Oxygen	5.2%	20.2%	The oxygen levels were typically depleted as carbon dioxide and carbon monoxide concentrations increased during the first three monitoring visits. During the next three visits WS103 recorded consistently low oxygen concentrations with no other elevated gasses recorded in the borehole.
Hydrogen Sulphide	0ppm	1ppm	No significant concentrations recorded.
Carbon Monoxide	0ppm	13ppm	During the first round of monitoring an unusual carbon monoxide value of (>>>>) was recorded in WS103. The manufacturer was contacted and confirmed that the reading indicates that the concentration within this borehole was >500ppm. Given that only natural soils were recorded in this borehole and that a concentration of >500ppm would indicate a very significant source of carbon monoxide, it is considered that this reading should be considered as a combination of gas monitor error and / or high concentrations resulting from the initial drilling disturbance. During the remaining visits a maximum concentration of 13ppm was recorded which is more typical of the ground conditions encountered. Therefore the recorded concentration during the initial visit are not considered to be of concern.
Atmospheric pressure	1004mB	1022mB	All monitoring visits were undertaken during periods of rising pressure.

PARAMETER	MINIMUM	MAXIMUM	COMMENTS
Groundwater levels	0.26m	3.77m	During the first round of three visits, the shallowest groundwater level of 1.07m bgl was recorded in WS103 during the first monitoring visit. Following groundwater monitoring, the groundwater levels were slow to recharge with the shallowest groundwater of 1.81m bgl being recorded in WS102. During the next three visits the shallowest groundwater was recorded in WS105 with the last two visits recording very shallow levels of 0.28m and 0.26m bgl. This is considered to represent the filling up of the well from surface infiltration rather than true groundwater.
Flow rate	<0.0 l/hr	2.7l/hr	High flow rates have been consistently recorded in boreholes WS103 and WS105. The remaining boreholes recorded a maximum flow rate of 0.2l/hr. In both WS103 and WS105, high initial flow rates were recorded which then subsided with time during repeated monitoring. Both WS103 and WS105 encountered granular permeable Head Deposits overlying impermeable London Clay along with changing groundwater levels. It is considered that this variable permeability and changing water level is causing these high flow rates by creating a piston effect within the installation. The reduction in flow rates with time has been repeatedly proven during the monitoring visits and therefore it is considered that there is sufficient evidence to prove that the high flow rate is not indicative of a significant source of gas as also indicated by the by the limited gas concentrations recorded. Elsewhere, negative flows are indicative of 'draw down' in the boreholes. These can be a factor of the effect of drilling on the immediate ground conditions, the creation of a partial vacuum as a result of monitoring, groundwater behaviour or due to certain geologic conditions. In terms of the contamination risk assessment, this does not present a cause for concern as the net effect is to reduce the emission of gas at surface.

SENSITIVITY OF DEVELOPMENT	High (Residential with gardens)	
	IDEALISED	ACTUAL
MONITORING PERIOD	6 months	2 months
TOTAL NUMBER OF VISITS	9	6
NUMBER OF VISITS DURING FALLING PRESSURE TRENDS	At least two visits	1
COMMENT	Given the low concentrations of gas recorded, it is considered that the 6No. visits completed along with one visit during a period of falling pressure is sufficient to complete the gas risk assessment. This also meets the minimum NHBC requirement.	

8.2. GAS REGIME CHARACTERISATION

8.2.1. Gas Source

GAS SOURCE	GENERATION POTENTIAL	COMMENTS
Off site former gravel pit infilled with unknown material by the map editions from 1970.	Low	Whilst the nature of the fill is unknown, given that it was backfilled by the 1970s and the small size of the pit, the gas generation potential from this source is considered to be low.

8.2.2. Building Type

The proposed properties do not all form traditional small low rise housing and therefore do not comply with the NHBC traffic light model.

	CHARACTERISTIC GAS CONCENTRATION (fraction)	CHARACTERISTIC GAS FLOW RATE (l/hr)	GAS SCREENING VALUE (l/hr)
Methane	0.1	2.7	0.0027
Carbon Dioxide	2.3	2.7	0.0621
Methodology	NHBC Traffic Lights - Low rise housing with gardens.		
Gas Regime	A conservative flow rate of 2.7 l/hr has been used as flow rates of less than 1.0 l/hr have typically been recorded. Based on the calculated GSV and typical gas concentrations recorded, the site has been characterised as NHBC Green. It should be noted that even if the maximum flow rate of 20.2l/hr (that was discounted as unrepresentative) was used to demonstrate the worst case scenario, the site would still be characterised as NHBC Green.		

8.3. GAS PROTECTION MEASURES

8.3.1. Radon Gas

The site is not situated within an area where radon gas protection measures are required in new buildings.

8.3.2. Volatile Organic Compounds

The site is not affected by Volatile Organic Compounds (VOC) contamination.

8.3.3. Methane and Carbon Dioxide

Negligible gas regime identified and gas protection measures are not considered necessary.

9. RISK EVALUATION

9.1. REVISED CONCEPTUAL MODEL

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

ADDITIONAL POLLUTANT LINKAGES	During the ground investigation, no additional sources of contamination were identified.
INVALID POLLUTANT LINKAGES	Following the completion of the gas monitoring, no elevated concentrations of landfill gasses have been recorded at the site.
LIMITATIONS AND UNCERTAINTIES	Due to access restrictions, only limited investigation of the soil pile in the south west corner of the site could be undertaken. However, it is considered likely that the soil pile is associated with the recent construction of the crematorium and so is unlikely to be contaminated. No investigation was undertaken beneath the existing road in the south east corner of the site. However, within the area of the proposed residential redevelopment all of the potential contamination sources have been targeted by the exploratory holes and therefore it is considered that a sufficient number of exploratory points have been completed for contamination assessment purposes.

9.2. UPDATED CONTAMINATION RISK ASSESSMENT

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

SOURCES AND CONTAMINANTS	PATHWAYS (REFERENCE FROM MODEL)	RECEPTORS	POTENTIAL RISK
Infilled gravel pit to the south east of the site. Possible old infilled workings to the west of the site. - Landfill gasses	Inhalation of migrated gases and vapours [1]	Reduced human health effects given likely limited source of contamination [Mild]	Negligible risk

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

RISK TO HUMAN HEALTH

No unacceptable contamination risks to human health.

RISK TO WATER ENVIRONMENT

No unacceptable contamination risks to the water environment have been identified by this investigation.

RISK TO BUILDING MATERIALS AND SERVICES

No unacceptable contamination risks to building materials and services have been identified by this investigation.

It should be noted that the water pipe specification should always be confirmed with the local water supply company as they may insist on such protective pipes regardless of the level of contamination or remediation.

9.3. RISK MANAGEMENT

9.3.1. Introduction

The investigation has not identified any contamination in the underlying soils and the completed gas monitoring has not identified any elevated concentrations of landfill gasses from the identified potential off site source. As a result, no unacceptable risks to future residents, the water environment or building materials and services have been identified.

It is recommended that this report is submitted to the planning department of the Local Authority, the organisation undertaking the Building Control function, warranty providers to confirm that the investigation completed to date is satisfactory.

9.3.2. Further Contamination Assessment

In order to provide further confidence in the risk assessment and to address the limitations and uncertainties identified within the existing conceptual model it is recommended that the following additional investigation elements are completed for contamination assessment purposes:

- Should the soils from the soil pile in the south east corner of the site be reused within the development, further sampling of these soils is recommended to confirm they are suitable for use in the proposed residential development setting.

9.3.3. Outline Remediation Strategy

Due to the absence of contamination risks identified by the investigation undertaken to date, no remediation is considered necessary at this stage.

9.4. WASTE SOIL DISPOSAL

Topsoil should be viewed as a resource rather than a waste. As the topsoil is suitable for residential garden use in terms of contamination, the topsoil at the site should be stripped and the surplus reused on other developments. It should be noted that topsoil, even if uncontaminated, is unlikely to constitute 'inert waste' due to its high organic matter content. In addition, due to the high gravel content recorded any surplus topsoil may also have a reduced commercial value for re-use on other sites unless it is screened first.

It is considered that the natural soils disposed of from the site would be classified as 'non-hazardous waste' and would be characterised for disposal to landfill as 'inert waste'. However, the chemical results should be forwarded to the proposed landfill site and the waste classification confirmed prior to disposing of any surplus soils. Waste Acceptance Criteria (WAC) testing of the soils will also be required where the soil is to be disposed of at a landfill permitted to accept inert waste. Such WAC testing has been completed and the results are in the Appendices which confirm the soil tested complies with the inert waste limits. The waste code from the European Waste Catalogue (EWC) 2002 for the soils would be 17 05 04 'Soil and Stones, not containing dangerous substances'.

10. HEALTH AND SAFETY FILE INFORMATION

10.1. INTRODUCTION

The aim of the following sections is to present pertinent Health and Safety information that has arisen from the current investigation/survey works discussed in this report. The aim is to identify health and safety controls that may be necessary during any subsequent maintenance, refurbishment, demolition or construction works. The information is not exhaustive and stems only from the aspects identified within the scope of the works undertaken by BRD.

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

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

The works undertaken by BRD are detailed in the previous sections of this report.

10.2. HAZARDS

During the course of the BRD works the following noteworthy safety hazards have been identified:

10.2.1. Contamination

Although no contamination has been identified, as with any construction site, if any anomalous material is encountered during the redevelopment then expert environmental advice should be sought.

10.2.2. Other Issues

During the BRD works the following safety hazards were identified:

- Localised standing water and soft ground is present in the western area of the site.

10.3. HAZARDOUS MATERIALS

BRD did not construct anything with hazardous materials.

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

10.4. UTILITY SERVICES

The utility services plans held by the Client should be referred to. Of particular note is a live foul sewer which cross the north west and north eastern corners of the site. Raised manhole chambers are easily visible to indicate its location.

REPORT SPECIFIC REFERENCES

- 'Phase 1 Environmental Desk Study - Bartons Road, Havant', BRD Environmental Ltd, report ref. BRD3818-OR1-A, dated November 2020
- British Geological Survey sheet 316 'Fareham' Solid and Drift Edition (1:50,000), published 1998.
- 'Flood Risk Assessment and Surface Water Drainage Strategy - Land west of the Havant Crematorium, Bartons Road, Havant', Charles & Associated Consulting Engineers, ref.17-055, dated December 2018.



SUPPORTING INFORMATION

GROUND INVESTIGATION

Exploratory holes are logged by an experienced Geo-Environmental Consultant in general accordance with 'Code of practice for site investigations' BS5930:2015, British Standards Institution, 2015. Soil samples for chemical and geotechnical analysis are taken from the exploratory holes at intervals dictated by the nature of the soils and the objectives of the investigation.

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

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

Hand Dug Inspection Pits

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

Trial Pits

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

Windowless Sampling Boreholes

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

Hand Held Window Sampling

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

Cable Percussive Boreholes

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



Rotary Boreholes

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

Dynamic Probing

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

Static Cone Penetration Tests

Cone Penetration Tests (CPT) consist of pushing a conical 60° cone into the ground at a constant rate and recording the force required to do this. Sensors in the cone record other information and this data can be correlated to a number of different geotechnical parameters.

Dynamic Penetrometer

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

Gas Monitoring

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

Vapour Monitoring

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

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

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

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

Groundwater Level Monitoring

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

Geotechnical Sampling

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

SAMPLE TYPE	SYMBOL USED ON LOGS	DESCRIPTION
<i>Disturbed</i>	<i>D</i>	<i>Small disturbed soil samples of about 1 to 2 kg are collected in plastic bags.</i>
<i>Bulk</i>	<i>B</i>	<i>Large disturbed bulk samples up to about 20 to 30 kg are collected in plastic bags</i>
<i>Undisturbed</i>	<i>U</i>	<i>'Undisturbed' samples generally collected in plastic or metal tubes within cable percussive boreholes of 100mm diameter for samples of fine soils of firm to stiff consistency. Can also be representative of samples taken by cutting plastic sample liners from windowless sampling drilling methods. It is recognised that such samples do not generally meet Eurocode sample quality requirements for the tests commonly employed. However, given the wealth of experience with these sampling methods this continues to be common in United Kingdom practice particularly for less sensitive developments where more expensive sampling techniques are not economically justifiable.</i>
<i>Undisturbed</i>	<i>UT</i>	<i>A thin walled steel sampler developed by Archway Engineering called a UT100 in an attempt to gain better quality samples of soft to firm fine soils when using cable percussive drilling methods.</i>

Contamination Sampling

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

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

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

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

GEOTECHNICAL ASSESSMENT

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

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

GEOTECHNICAL PARAMETERS

Soakage Tests

Soakage tests comprise the filling of a test pit with water and recording the time taken for the water to drain away. The tests are undertaken in general accordance with 'Digest DG 365: Soakaway design' BRE, Revised 2016. The test pits are usually gravel filled for safety with a slotted vertical pipe through which water observations are made. Water is generally supplied by a tanker to allow fast filling of the pits with water. Compliant tests are filled and allowed to drain near empty three times.

Standard Penetration Tests

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

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

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

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

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

Sulphate

In order to compare the laboratory soil test results with 'Concrete in aggressive ground. BRE Special Digest 1: 2005' (BRE, 2005) laboratory results are converted to SO_4 mg/l. Laboratory results expressed as SO_3 g/l and are multiplied by a factor of 1200 to express the results as SO_4 mg/l.

Index Property Tests

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

Hand Shear Vane

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

Pocket Penetrometers

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

<i>Instrument Reading (uncompressive strength in kg/cm²)</i>	<i>Indicative Undrained Shear Strength (kN/m²)</i>	<i>Indicative Consistency</i>	<i>Indicative strength</i>
1.0	25 - 33	Soft	Low
1.5	38 - 50	Soft to firm	Low to medium
2.0	50 - 67	Firm	Medium
2.5	63 - 83	Firm to stiff	Medium to high
3.5	88 - 116	Stiff	High
4.5	113 - 150	Stiff to very stiff	High to very high

CONTAMINATION ASSESSMENT METHODOLOGY

UK Policy

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

The three main drivers for contamination assessment and remediation are:

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

Pollutant Linkages

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

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

- *The deliberate application of chemicals e.g. the spraying of herbicide/pesticide.*
- *Migration of pollutants from adjacent land.*
- *Naturally occurring processes e.g. elevated concentrations of particular heavy metals associated with specific geological strata.*

Conceptual Site Model

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

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

Technical Guidance

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

- 'Investigation of Potentially Contaminated Sites - Code of Practice - BS 10175:2011+A2:2017', The British Standards Institution 2017.
- 'Model Procedures for the management of Land Contamination - CLR Document No. 11', Environment Agency, 2004.
- 'Guidance for the safe development of housing on land affected by contamination - R&D66: 2008', NHBC/Environment Agency, 2008.

Risk Assessment Methodology

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

PHASE	DESCRIPTION	RISK ASSESSMENT STAGE
PHASE 1	Generally limited to desk based research and a site walkover survey to develop an initial conceptual site model and identify what risks, if any, are likely to be presented by the site.	Hazard Identification and Assessment A preliminary stage of risk assessment concerned with identifying and characterising the hazards that may be associated with a particular site and identifying potential pollutant linkages.
PHASE 2	This phase is concerned with establishing whether contamination is present, usually through intrusive ground investigation, and then evaluating the degree and magnitude of the associated risks.	Risk Estimation A stage concerned with estimating the likelihood that receptors will suffer adverse effects if they come into contact with, or are otherwise affected by, a hazardous substance or agent under defined conditions. Risk Evaluation A stage of risk assessment concerned with evaluating the acceptability of estimated risks, taking into account the nature and scale of the risk estimates, any uncertainties associated with the assessment and the broad costs and benefits of taking action to mitigate risks.
PHASE 3	The appraisal and selection of remediation techniques, their implementation and verification.	Risk Management The process whereby decisions are made to accept a known or assessed risk and/or the implementation of action to reduce the consequences or probabilities of occurrence.

Risk Classification

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

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

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

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

These risk classifications are defined as follows:

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

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

RISK ESTIMATION - SOILS

Introduction to Soil Human Health Generic Assessment Criteria (GAC)

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

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

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

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

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

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

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

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

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

Human Health - Soil Generic Assessment Criteria

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

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
Arsenic	37	40	640	C4SL
Cadmium	22	150	410	
Chromium (total) ^s	910	910	8,600	S4UL
Chromium VI	21	21	49	C4SL
Lead	200	310	2,330	
Mercury*	11	15	320	S4UL
Selenium	250	430	12,000	
Nickel	180	180	980	
Copper	2400	7,100	68,000	
Zinc	3,700	40,000	730,000	
pH	<5 - 10> units			Professional judgement
Naphthalene	2.3	2.3	190	S4UL
Acenaphthylene	170	2,900	83,000	
Acenaphthene	210	3,000	84,000	
Fluorene	170	2,800	63,000	
Phenanthrene	95	1,300	22,000	
Anthracene	2,400	31,000	520,000	
Fluoranthene	280	1,500	23,000	
Pyrene	620	3,700	54,000	
Benzo(a)anthracene	7.2	11	170	
Chrysene	15	30	350	
Benzo(b)fluoranthene	2.6	3.9	44	
Benzo(k)fluoranthene	77	110	1,200	
Benzo(a)pyrene	2.2	3.2	35	
Indeno(1,2,3-cd)pyrene	27	45	500	
Dibenzo(a,h)anthracene	0.24	0.31	3.5	S4UL
Benzo(ghi)perylene	320	360	3,900	
TPH Aliphatic C5-C6	42	42	3,200	
TPH Aliphatic C6-C8	100	100	7,800	
TPH Aliphatic C8-C10	27	27	2,000	
TPH Aliphatic C10-C12	130	130	9,700	
TPH Aliphatic C12-C16	1,100	1,100	59,000	
TPH Aliphatic C16-C35	65,000	65,000	1,600,000	
TPH Aliphatic C35-C44	65,000	65,000	1,600,000	

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
TPH Aromatic C5-C7	70	370	26,000	
TPH Aromatic C7-C8	130	860	56,000	
TPH Aromatic C8-C10	34	47	3,500	
TPH Aromatic C10-C12	74	250	16,000	
TPH Aromatic C12-C16	140	1,800	36,000	
TPH Aromatic C16-C21	260	1,900	28,000	
TPH Aromatic C21-C35	1,100	1,900	28,000	
TPH Aromatic C35-C44	1,100	1,900	28,000	
Benzene	0.87	3.3	98	C4SL
Toluene	130	880	56,000	S4UL
Ethylbenzene	47	83	5,700	EIC/AGS/CL:AIRE GAC
Xylene^	56	79	5,900	
MTBE	49	73	7,900	

Notes:

* The S4UL for methyl mercury has been adopted as the worst case mercury compound as generally there is no desk study evidence to suggest the potential for elemental mercury on the majority of sites.

^ The lowest S4UL of either p-xylene, o-xylene or m-xylene has been adopted for each land use as a conservative measure.

§ S4UL for Chromium III adopted, as in the absence of Chromium VI it is likely that all of the chromium will be in this form as these are the two most common and stable forms of chromium in the soil environment.

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

Water Environment - Soil Generic Assessment Criteria

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

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

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

- In common with some other consultants, the professional judgement and experience of BRD suggests that this value is a reasonable concentration above which concern for water resources is valid. The rationale is based on the fact that lower concentrations of fuel based contaminants are more likely to naturally degrade than migrate any great distance.
- BRD is aware of regional Environment Agency groundwater and contaminated land teams historically employing 500 mg/kg as a screening value for considering whether or not TPH could represent a risk to water resources.
- The value mirrors the mineral oil Waste Acceptance Criteria limits for what is considered 'inert waste'.



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

Building Materials and Services – Soil Generic Assessment Criteria

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

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

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

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

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

RISK ESTIMATION - GROUNDWATER

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

The reference source for the target concentrations is generally the EA's Environmental Quality Standards (EQS) (accessed July 2018: <http://evidence.environment-agency.gov.uk/ChemicalStandards/report.aspx?cid=17>), the Water Supply (Water Quality) Regulations 2016 and the DW1/DW2 criteria from the Surface Water (Abstraction for drinking water)(classification) Regulations 1996. The target concentrations are outlined in the table below. The 'Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies'. CL:AIRE, 2017 has also been used as reference source for the values.

ANALYSIS	GENERIC ASSESSMENT CRITERIA (GAC)	SOURCE
Arsenic	50 µg/l	DW1 & EQS
Cadmium	5 µg/l	EQS
Chromium (total)	50 µg/l	DW2 & EQS
Copper	50 µg/l	DW1
Nickel	20 µg/l	EQS
Lead	50 µg/l	DW1
Mercury	1 µg/l	WSR
Selenium	10 µg/l	WSR
Zinc	5 mg/l	DW2
Cyanide	50 µg/l	WSR
pH	6 to 9 units	EQS
Benzene	10 µg/l	EQS
Toluene	74 µg/l	EQS
Ethylbenzene	300 µg/l	WHO guideline
Xylene	30 µg/l	EQS
Methyl tert-butyl ether (MTBE)	15 µg/l	Taste and odour threshold.
Naphthalene	2 µg/l	EQS
Benzo(a)pyrene	0.0017 µg/l	EQS - Less than Limit of Detection (LOD)
Total PAH	0.2 µg/l	DW1
TPH Aliphatic C5-C6	15,000 µg/l	World Health Organization (WHO) guide values for TPHCWG fractions in drinking water
TPH Aliphatic C6-C8	15,000 µg/l	
TPH Aliphatic C8-C10	300 µg/l	
TPH Aliphatic C10-C12	300 µg/l	
TPH Aliphatic C12-C16	300 µg/l	
TPH Aromatic C5-C7	10 µg/l	
TPH Aromatic C7-C8	700 µg/l	
TPH Aromatic C8-C10	300 µg/l	
TPH Aromatic C10-C12	90 µg/l	
TPH Aromatic C12-C16	90 µg/l	
TPH Aromatic C16-C21	90 µg/l	
TPH Aromatic C21-C35	90 µg/l	

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

RISK ESTIMATION - GROUND GAS

Introduction

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

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

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

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

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

Radon is a naturally occurring colourless and odourless gas that is radioactive. It is formed by the radioactive decay of radium which in turn is derived from the radioactive decay of uranium, both of which are minerals that can be found in many soil types. Whilst it is recognised that the air inside every building contains radon, some buildings built in certain defined areas of the country might have unacceptably high concentrations and require special precautions to be taken. The maps contained within BRE211:2015 'Radon: guidance on protective measures for new buildings' identify areas where no radon protection measures are necessary or where higher concentrations are present that either basic or full radon protection measures are required to be fitted to all new buildings, extensions or refurbishments.

Basis of Gas Assessment

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

- *The source of the gas.*
- *The generation potential of the gas.*
- *The location of the source and the geological setting.*
- *Boreholes flow rate and estimated surface emission rate.*
- *The nature of the proposed development.*
- *Confidence in the knowledge of the gas regime.*

The gas assessment is made with reference to 'C665 - Assessing risks posed by hazardous ground gases to buildings', Construction Industry Research and Information Association (CIRIA), 2007 and 'BS8485:2015 - Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings' BSI 2015.

Gas Screening Value

The methods within CIRIA C665 and BS8485 both use the gas concentrations together with the borehole flow rates to define a characteristic situation for a site based on the limiting borehole gas volume flow for Methane and Carbon Dioxide. This limiting borehole gas volume flow is called the Gas Screening Value (GSV) and is expressed below:

$$\text{Gas Screening Value (l /hr)} = \text{borehole flow rate (l/hr)} \times \text{gas concentration (fraction)}$$

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

Characteristic Gas Situation

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

Characteristic situation	Hazard potential	Gas Screening Value (CH ₄ or CO ₂ l/hr)	Additional factors
CS1	Very low risk	<0.07	Typically Methane ≤1% and/or Carbon Dioxide ≤5%. Otherwise consider an increase to characteristic situation 2.
CS2	Low risk	0.07 to <0.7	Borehole air flow rate not to exceed 70 l/hr. Otherwise consider an increase to characteristic situation 3.
CS3	Moderate risk	0.7 to <3.5	-
CS4	Moderate to high risk	3.5 to <15	-
CS5	High risk	15 to <70	-
CS6	Very high risk	>70	-

Low rise housing with gardens – NHBC 'Traffic Lights'

The NHBC model for low rise housing development considered a typical residential house with a ground floor area of 64m², suspended floor and ventilated sub-floor void of height 150mm. Where the proposed development of a site is consistent with this model, the NHBC traffic light situation of the site is determined from evaluation of the Gas Screening Value against the criteria in the following table.

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

APPENDIX 1

Site Location Plan



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Not to scale.

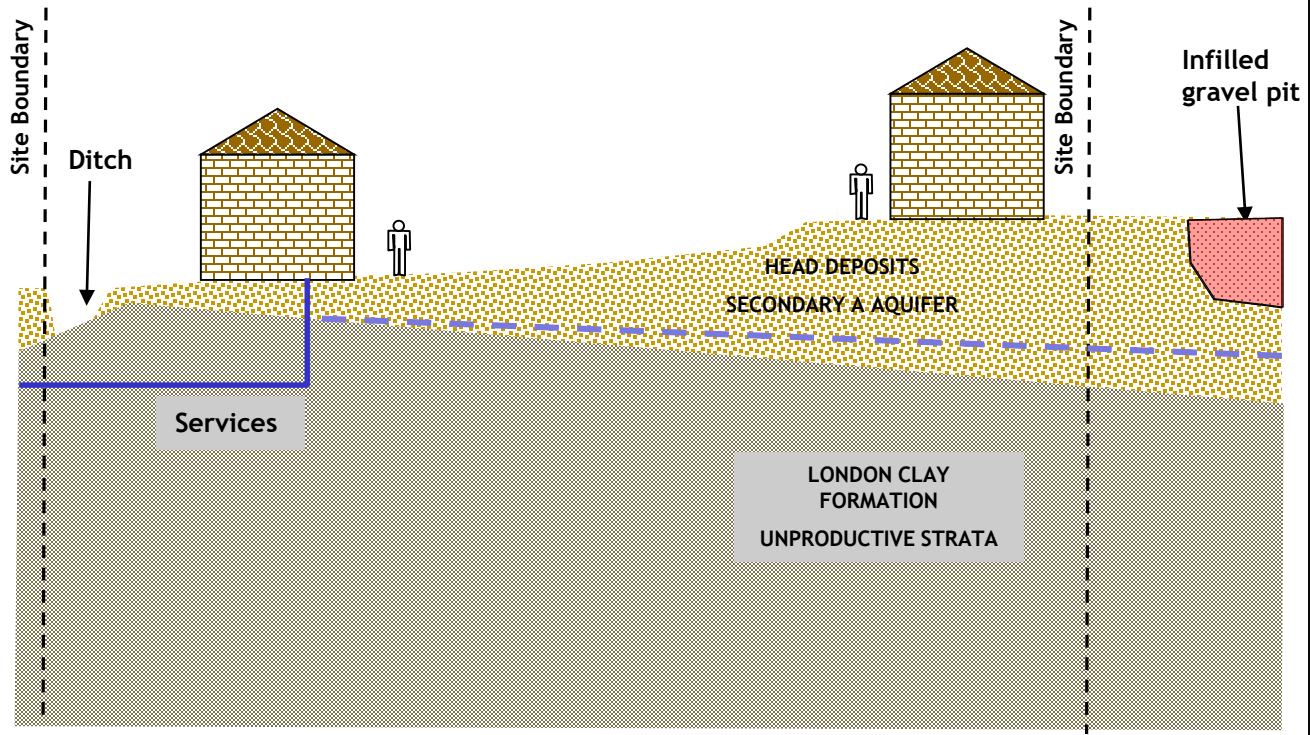
Project Title: Bartons Road, Havant
Client: Redrow Homes & Mr Phillip Dymoke White
BRD Reference: BRD3818-OP2-A
Date Issued: October 2020


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Revised Conceptual Model

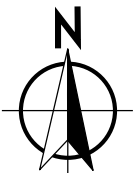
Proposed Development

No Pollutant Linkages identified

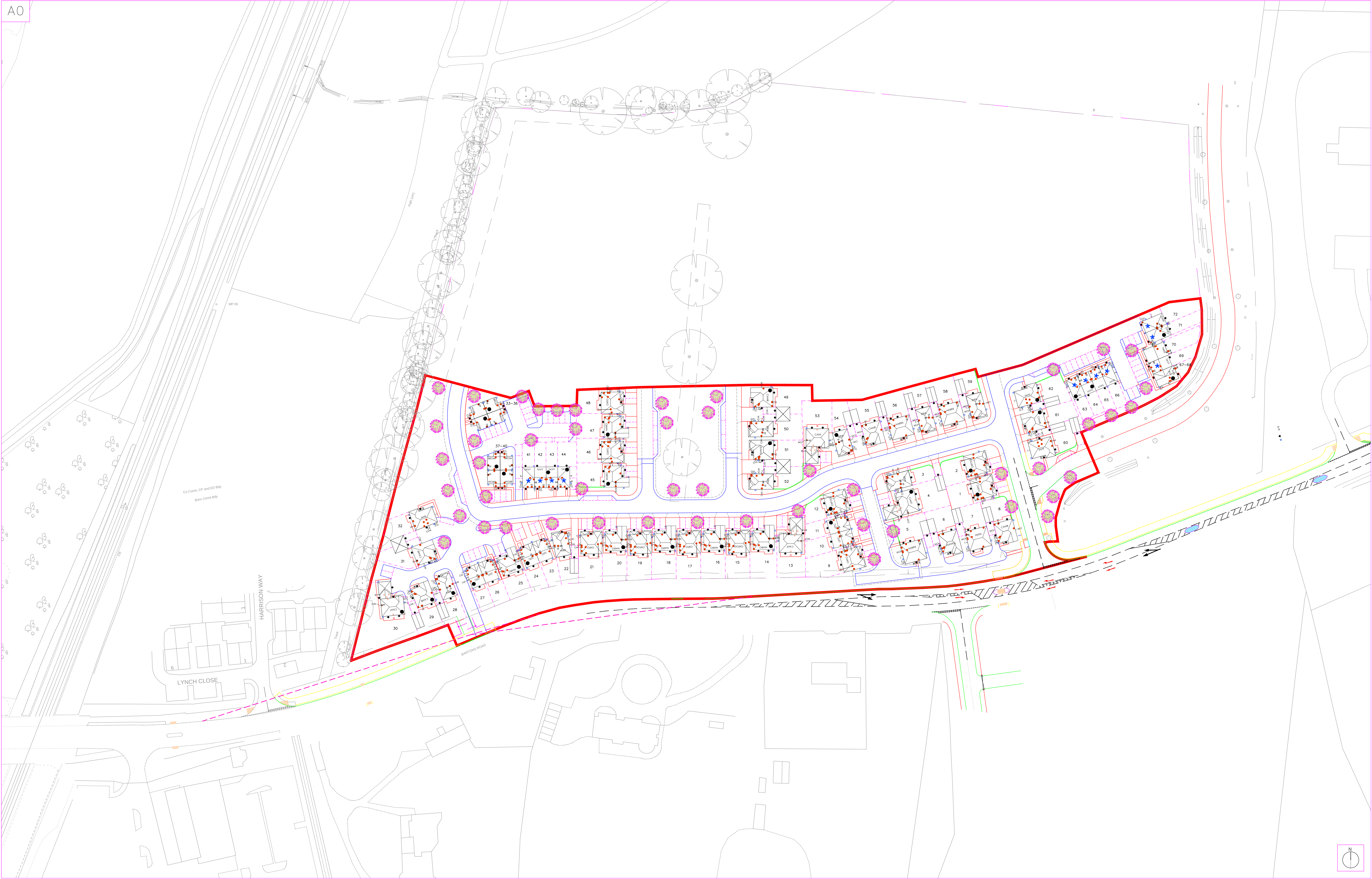


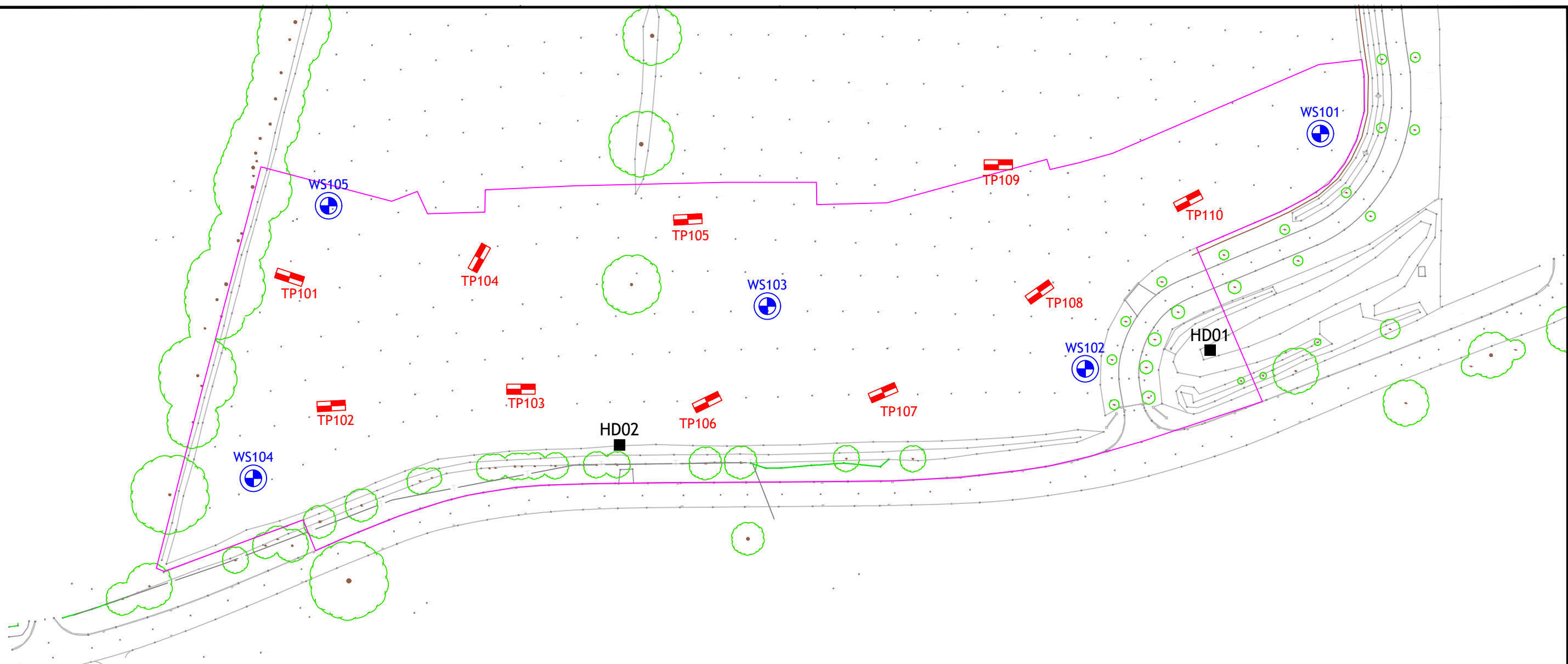
Proposed Development

No contamination risks identified



Project Title: Bartons Road, Havant
 Client: Redrow Homes & MR Phillip Dymoke White
 BRD Reference: BRD3818-OP6-B
 Date Issued: March 2021





Key:

-  BRD Trial pit locations
-  BRD Windowless sample borehole locations with monitoring well installations
-  BRD Hand dug pit locations
-  Site Boundary

Notes

Drawing reproduced from Cube Survey
Drawing title: Topographical Survey
Drawing No: CUB-IS-RSC-001; Dated 02/09/2020
Sheets No: Sheet 1 - Sheet 10

All BRD exploratory points were located from a topographical survey, except HD01 and HD02 which are approximate locations only.

All site boundaries are approximate only.

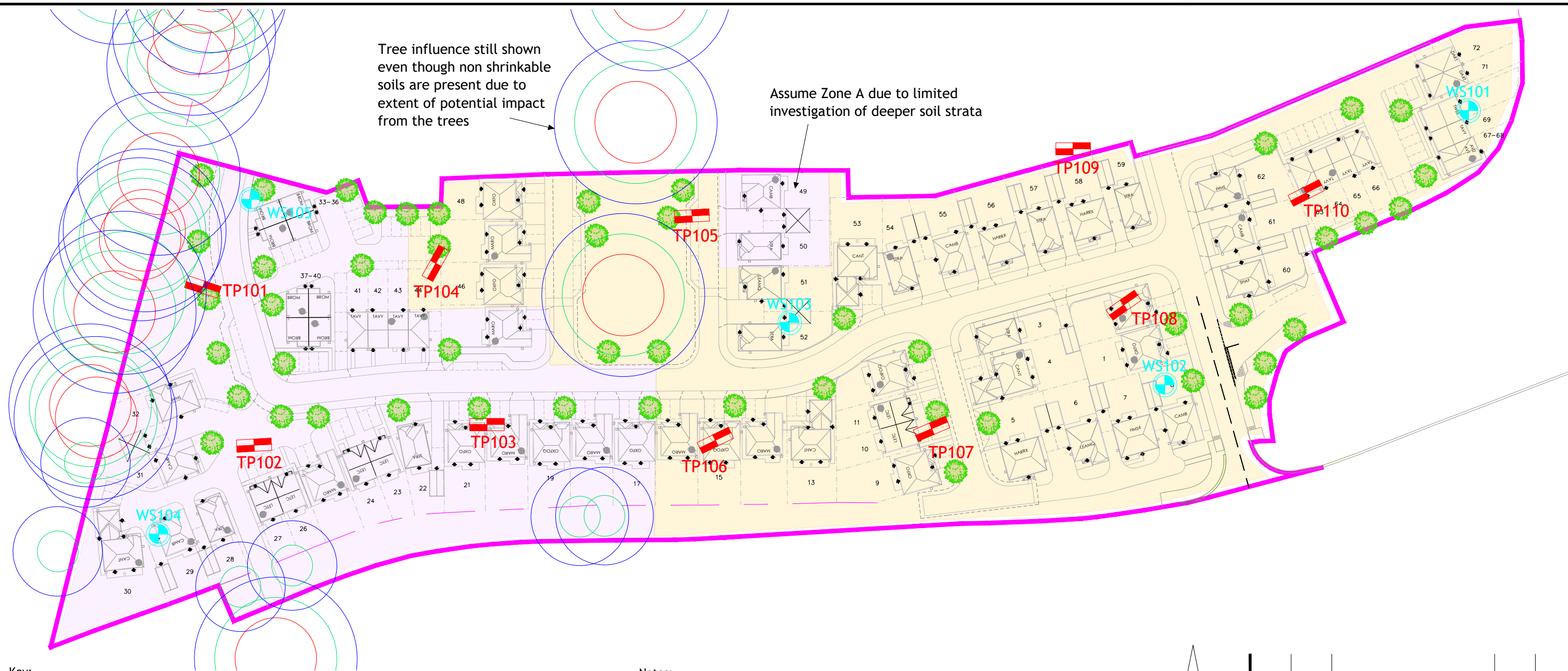


Revision	Date	Description	Drawn	Approved
Drawing title				
EXPLORATORY POINT PLANS				
Project title				
BARTONS ROAD, HAVANT				
Client				
REDROW HOMES & MR PHILLIP DYMOKE WHITE				
Scale	1:1000	Original drg. size/colour	A3 / C	Date
				17/11/2020
Drawn	DB	Checked	IH	Approved
				BD
Drawing Number				Rev
BRD3818-OD1				A



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Key:

- BRD Trial pit locations
- BRD Windowless sample borehole locations with monitoring installations
- Site Boundary

Foundation Depths:

- Zone A - Shallow strip / trench fill footings onto Head Deposits / London Clay. Footing depths at 1.0m minimum to 1.5m where required to allow for restricted new tree planting. Deep trench fill footings or piled foundations due to existing tree influence (see details below).
- Zone B - Shallow strip / trench fill footings onto Head Deposits. Footing depths at minimum 0.75m. No tree influence due to granular soils.

All footings reinforced where straddling changes in strata or soil type.

Tree Influence:

- Area where foundation depths in excess of 2.5m are required in accordance with NHBC Standards 4.2.
- Area where foundation depths in excess of 2.0m are required in accordance with NHBC Standards 4.2.
- Area where foundation depths in excess of 1.5m are required in accordance with NHBC Standards 4.2.

Notes:

Drawing reproduced from thrive architects
Drawing title: Site Layout
Drawing No: SL.01; Dated 3.12.20
Drawing is Draft - Work in Progress

Tree information reproduced from rps
Drawing title: Tree Constraints Plan
Drawing No: JSL3850; Dated December 2020

All BRD exploratory points were located from a topographical survey.

All site boundaries are approximate only.

Drawing should only be used in conjunction with the BRD site investigation report ref: BRD3818-OR1-C.

Further ground investigation is still recommended to determine ground conditions where soils transition from granular Head Deposits to the London Clay Formation.

Foundation depths are illustrative only and do not constitute detailed design.

Influence from proposed trees is not shown.

Intermediate required foundation depths not shown for clarity. Where the required foundation depth varies with a structure, this can be accommodated by forming steps in the foundation as per NHBC standards.



Revision	Date	Description	Drawn	Approved
B	19.3.21	Minor changes following report update	IH	BD
A	22.12.20	First issue	DB	BD

Drawing title				
TREE INFLUENCE & FOUNDATION ASSESSMENT PLAN				
Project title				
BARTONS ROAD, HAVANT				
Client				
REDROW HOMES				
Scale	1:1000	Original drg. size/colour	A3 / C	Date
				19.03.21
Drawn	IH / DB	Checked	JB	Approved
				BD
Drawing Number				Rev
BRD3818-OD2				B



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APPENDIX 2

TRIAL PIT RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Completed: 28/10/2020 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP101			
				Sheet 1 of 1			
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend	
Depth	Type & No	Value					
0.10	J1		TOPSOIL: Soft, brown, slightly clayey, sandy, very gravelly silt. Gravel is fine to coarse, subangular to subrounded flint.		TS		
			Medium dense, grey brown, slightly clayey GRAVEL of fine to coarse, subangular to subrounded flint.	0.30 ()		HEAD DEPOSITS	
			Firm to stiff, light brown with some orange and grey, very gravelly CLAY. Gravel is fine to coarse with occasional cobbles, subangular to subrounded flint and occasional chalk.	0.50 ()			
0.80	D1		0.80 m: Difficult to shear vane due to gravel content.	1.00 ()	LONDON CLAY FORMATION		
1.20	D2		Very stiff to hard, blocky, desiccated, brown with some grey and orange CLAY with occasional rootlets and calcareous aggregations.				
1.40	J2		1.20 m: Too hard to shear vane.				
2.00	J3			2.00 ()			
2.20	D3		2.20 m: Becoming very stiff to hard, heavily fissured and friable. Too hard to shear vane.	3.00 ()			
				4.00 ()			
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:			
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.00m bgl.				
			All dimensions in metres Log Scale 1:25 Telephone: 01295 272244 Email: info@brduk.com				

TRIAL PIT RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Completed: 28/10/2020 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP102		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		TOPSOIL: Soft, brown, slightly clayey, sandy, very gravelly silt. Gravel is fine to coarse, subangular to subrounded flint.	0.20 ()	TS	
			Medium dense, grey brown, slightly clayey GRAVEL of fine to coarse, subangular to subrounded flint.	0.40 ()		
0.80	B1		Medium dense, orange brown, very clayey GRAVEL and COBBLES of subangular to subrounded flint and occasional chalk with occasional pockets of firm, orange and grey, very gravelly clay. 0.40 - 1.20 m: Slight spalling of sides.	1 ()		
1.30	J2	92/98/104 kPa	Stiff, brown mottled grey, slightly fissured CLAY with occasional polished surfaces, relict rootlets and occasional calcareous aggregations.	1.20 ()	HEAD DEPOSITS	
1.40	D1					
1.50	SV					
2.60	SV	92/98/100 kPa	2.20 m: Becoming brown with dark grey and heavily fissured, friable in places.	2 ()	LONDON CLAY FORMATION	
2.60	D2					
				3 ()		
				4 ()		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.00m bgl. Density based on visual inspection only.			
				All dimensions in metres Log Scale 1:25		
				Telephone: 01295 272244 Email: info@brduk.com		

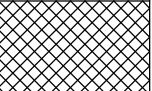
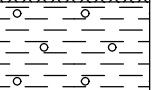
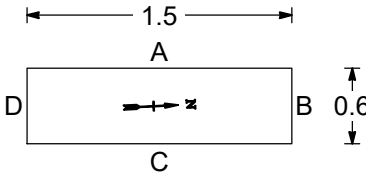
TRIAL PIT RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Completed: 28/10/2020 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP103			
				Sheet 1 of 1			
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend	
Depth	Type & No	Value					
0.10	J1		TOPSOIL: Soft, brown, slightly clayey, sandy, very gravelly silt. Gravel is fine to coarse, subangular to subrounded flint.	0.20 ()	TS		
			Firm, light brown with orange, gravelly CLAY. Gravel is fine to coarse, subangular to subrounded flint.	0.40 ()	HEAD DEPOSITS		
0.50	J2		Medium dense, orange brown with some grey, clayey GRAVEL and COBBLES of subangular to subrounded flint and occasional chalk with occasional pockets of fine, orange brown to grey CLAY.				
0.70	D1						
			1.20 m: Becoming sandy.	1.30 ()	LONDON CLAY FORMATION		
1.40	SV	60/62/64 kPa	Firm, brown mottled grey CLAY with occasional polished surfaces, slight fissuring and calcareous aggregations with occasional orange, sandy partings.				
1.60	D2		1.60 m: Becoming stiff to very stiff.				
1.80	SV	100/92/90 kPa					
2.00	J3			2			
			2.50 m: Becoming dark grey brown, heavily fissured with relict rootlets and some silty partings.				
2.70	SV D3	100/102/102 kPa		3			
				3.10 ()			
				4			
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.10m bgl. Density based on visual inspection only.				
All dimensions in metres Log Scale 1:25					 Telephone: 01295 272244 Email: info@brduk.com		

TRIAL PIT RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Completed: 28/10/2020 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP104		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		TOPSOIL: Soft, brown, slightly clayey, sandy, very gravelly silt. Gravel is fine to coarse, subangular to subrounded flint.	0.20 ()	TS	
0.30	D1		Medium dense, light brown, clayey GRAVEL and COBBLES of fine to coarse, subangular to subrounded flint.			
0.40	J2		0.20 - 0.80 Surface water seepage causing spalling of pit sides.			
1.50	B1		Medium dense, orange brown and grey, clayey GRAVEL and COBBLES of subangular to subrounded flint with occasional clayey pockets. 1.00 - 2.30 m: Becoming hard to dig.	0.80 ()	HEAD DEPOSITS	
			Very stiff, brown mottled grey CLAY with some polished surfaces and relict rootlets.	2.30 ()	LCF	
				2.50 ()		
				3		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level:	
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 2.50m bgl. Density based on visual inspection only.			
All dimensions in metres Log Scale 1:25						
Telephone: 01295 272244 Email: info@brduk.com						

TRIAL PIT RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Completed: 28/10/2020 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP105		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1		MADE GROUND: Soft, brown, gravelly clayey silt topsoil. Gravel is fine to cobbles, subangular to subrounded flint with some concrete boulders.	0.30 ()	MG	
			Firm, yellow brown, slightly gravelly CLAY. Gravel is fine to coarse, subangular to subrounded flint.	0.60 ()	HEAD	
				1		
				2		
				3		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level:	
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 0.60m bgl in natural soils.			
					All dimensions in metres Log Scale 1:25	
					 Telephone: 01295 272244 Email: info@brduk.com	

TRIAL PIT RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Completed: 28/10/2020 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP106		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1		TOPSOIL: Soft, brown, slightly clayey, sandy, very gravelly silt. Gravel is fine to coarse, subangular to subrounded flint.		TS	
			Medium dense, light grey, slightly clayey, silty GRAVEL of fine to coarse, subangular to subrounded flint.	0.30 ()		
0.60	J2		Medium dense, orange light brown, slightly sandy, slightly clayey GRAVEL and COBBLES of subangular to subrounded flint.	0.50 ()		
1.00	B1		0.50 - 2.60 m: Slight spalling of pit sides.	1 ()		
			Medium dense, orange brown with some grey, sandy clayey GRAVEL and COBBLES, subangular to subrounded flint.	1.40 ()		
1.80	D1			2 ()	HEAD DEPOSITS	
				2.60 ()		
2.70	D2		Medium dense, light brown with some orange and light grey, slightly gravelly, clayey, silty SAND. Gravel is fine to medium, subangular to subrounded flint with some clay lenses.	3 ()		
2.80	J4			3.20 ()		
				4 ()		
Pit Stability: Slight spalling of sides Groundwater: Slight seepage at 2.00m					Surface Elevation Level:	
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.20m bgl. Density based on visual inspection only.			
All dimensions in metres Log Scale 1:25						
Telephone: 01295 272244 Email: info@brduk.com						

TRIAL PIT RECORD

Client: Redrow Homes and Mr Phillip Dymoke White			Trial Pit No.																										
Project Title: Bartons Road, Havant			TP107																										
Project No: BRD3818																													
Logged By: I Hibberd			Sheet 1 of 1																										
Date Completed: 28/10/2020																													
Method Used: 180° Backhoe excavator (JCB 3CX type)																													
Samples & Tests			Description of Strata			Depth / (Level)			Geology			Legend																	
Depth Type & No Value																													
0.10			J1			TOPSOIL: Soft, brown, slightly clayey, sandy, very gravelly silt. Gravel is fine to coarse, subangular to subrounded flint.			0.30 ()			TS																	
0.50			J2															Medium dense, light brown, slightly clayey GRAVEL. Gravel is fine to coarse and cobbles, subangular to subrounded flint.											
1.20			D1			Medium dense, orange brown with some grey, slightly sandy, clayey GRAVEL and COBBLES, subangular to subrounded flint with occasional clay pockets. 1.00 - 3.00 m: Slight spalling of pit sides.			1 1.00 ()			HEAD DEPOSITS																	
2.00			D2															2.40 m: Becoming sandy and slightly clayey.											
2.60			D3						2																				
									3 3.00 ()																				
									4																				
Pit Stability: Slight spalling of sides Groundwater: Slight seepage at 2.70m										Surface Elevation Level:																			
Plan of Trial Pit: 										General Remarks: Trial pit terminated at 3.00m bgl. Density based on visual inspection only.										All dimensions in metres Log Scale 1:25 Telephone: 01295 272244 Email: info@brduk.com									

TRIAL PIT RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Completed: 28/10/2020 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP108		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1		TOPSOIL: Soft, brown, sandy, very gravelly silt. Gravel is fine to coarse, subangular to subrounded flint.	0.30 ()	TS	
1.30	B1		Loose to medium dense, light brown, slightly clayey, slightly sandy GRAVEL and COBBLES, subangular to subrounded flint.	1.10 ()	HEAD DEPOSITS	
			Medium dense, orange brown and light brown, clayey, slightly sandy GRAVEL and COBBLES, subangular to subrounded flint with occasional clay pockets.	2.70 ()		
			1.80 - 2.80 m: Increase cobble content with depth.	3.00 ()		
			Firm to stiff, light grey mottled orange, slightly sandy, slightly gravelly, silty CLAY. Gravel is fine to medium, subangular to subrounded.			
				4		
Pit Stability: Slight spalling of sides Groundwater: Slight seepage at 2.90m					Surface Elevation Level:	
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.00m bgl. Density based on visual inspection only.			
All dimensions in metres Log Scale 1:25					 Telephone: 01295 272244 Email: info@brduk.com	

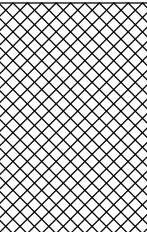
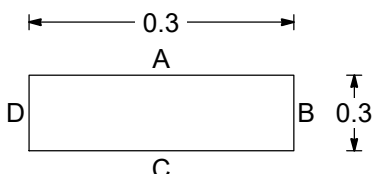
TRIAL PIT RECORD

Client: Redrow Homes and Mr Phillip Dymoke White			Trial Pit No.				
Project Title: Bartons Road, Havant			TP109				
Project No: BRD3818							
Logged By: I Hibberd			Sheet 1 of 1				
Date Completed: 28/10/2020							
Method Used: 180° Backhoe excavator (JCB 3CX type)							
Samples & Tests			Description of Strata		Depth / (Level)	Geology	Legend
Depth	Type & No	Value					
0.10	J1		TOPSOIL: Soft, brown, sandy, very gravelly silt. Gravel is fine to coarse, subangular to subrounded flint.		0.30 ()	TS	
0.60	J2		Medium dense, light brown, slightly sandy, slightly silty GRAVEL and COBBLES, subangular to subrounded flint. 0.30 - 1.70 m: Slight spalling of sides.				
0.80	B1						
1.40	D1		Medium dense, orange brown with some grey, clayey to very clayey GRAVEL and COBBLES of subangular to subrounded flint with clay pockets.				
1.80	J3		Stiff, orange and light grey, slightly gravelly, silty, sandy CLAY. Gravel is fie to coarse, subangular to subrounded flint.				
2.30	J4		Loose to medium dense, orange brown, slightly silty, sandy GRAVEL and COBBLES of subangular to subrounded flint. Soils are wet. 2.20 - 3.00 m: Slight spalling with some collapse.				
					3.00 ()		
					4		
Pit Stability: See General Remarks Groundwater: Slight seepage at 2.40m						Surface Elevation Level:	
Plan of Trial Pit:			General Remarks: Trial pit terminated at 3.00m bgl. Spalling with some collapse. Density based on visual inspection only.			All dimensions in metres Log Scale 1:25	
						Telephone: 01295 272244 Email: info@brduk.com	

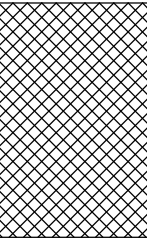
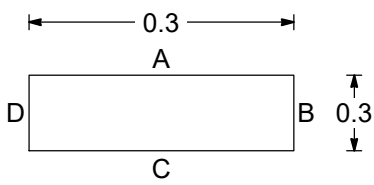
TRIAL PIT RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Completed: 28/10/2020 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP110			
				Sheet 1 of 1			
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend	
Depth	Type & No	Value					
1.00	J2		TOPSOIL: Soft, brown, sandy, very gravelly silt. Gravel is fine to coarse, subangular to subrounded flint.	0.30 ()	TS		
			Loose, brown, slightly clayey, slightly sandy GRAVEL and COBBLES, subangular to subrounded flint. 0.30 - 1.00 m: Collapse of FACE C.				
1.90	D1		1.00 m: Becoming medium dense.	1.80 ()	HEAD DEPOSITS		
			Stiff, orange brown, very gravelly CLAY. Gravel is fine to coarse, subangular to subrounded flint.				2.40 ()
			Medium dense, orange brown, clayey, slightly sandy GRAVEL and COBBLES of subangular to subrounded flint.				
				3.20 ()			
				4			
Pit Stability: Pit sides collapsed Groundwater: Not encountered					Surface Elevation Level:		
Plan of Trial Pit: 			General Remarks: Trial pit terminated at 3.20m bgl. Density based on visual inspection only.				
					All dimensions in metres Log Scale 1:25		
					Telephone: 01295 272244 Email: info@brduk.com		

INSPECTION PIT RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: D Brown Date Completed: 10/11/2020 Method Used: Hand Dug			Pit No. HD01			
			Sheet 1 of 1			
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1		MADE GROUND: Grass over: Soft, brown, sandy, very gravelly clayey topsoil with rootlets. Gravel of fine to coarse, angular to subangular flint, brick, occasional concrete and tile fragments.	0.30 ()	MG	
Pit Stability: Generally stable throughout Groundwater: Not encountered			Surface Elevation Level:			
Plan of Inspection Pit: 			General Remarks: Hand dug pits undertaken in soil mound running along eastern boundary.			
			All dimensions in metres Log Scale 1:10			
						
			Telephone: 01295 272244 Email: info@brduk.com			

INSPECTION PIT RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: D Brown Date Completed: 10/11/2020 Method Used: Hand Dug			Pit No. HD02			
			Sheet 1 of 1			
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		MADE GROUND: Grass over: Soft, brown, sandy, very gravelly clayey topsoil with rootlets. Gravel of fine to coarse, angular to subangular flint, brick, occasional concrete and tile fragments.	0.30 ()	MG	
Pit Stability: Generally stable throughout Groundwater: Not encountered			Surface Elevation Level:			
Plan of Inspection Pit: 			General Remarks: Hand dug pits undertaken in soil mound running along southern boundary.			
			All dimensions in metres Log Scale 1:10			
						
			Telephone: 01295 272244 Email: info@brduk.com			

Trial Pit Photographs

TP101



Project Title: Bartons Road, Havant
Client: Redrow Homes and Mr Phillip Dymoke White
BRD Reference: BRD3818-OP5-A
Date Issued: November 2020



01295 272244
info@brduk.com

Trial Pit Photographs

TP102



Project Title: Bartons Road, Havant
Client: Redrow Homes and Mr Phillip Dymoke White
BRD Reference: BRD3818-OP5-A
Date Issued: November 2020



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Trial Pit Photographs

TP103



Project Title: Bartons Road, Havant
Client: Redrow Homes and Mr Phillip Dymoke White
BRD Reference: BRD3818-OP5-A
Date Issued: November 2020



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info@brduk.com

Trial Pit Photographs

TP104



Project Title: Bartons Road, Havant
Client: Redrow Homes and Mr Phillip Dymoke White
BRD Reference: BRD3818-OP5-A
Date Issued: November 2020



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Trial Pit Photographs

TP105



Project Title: Bartons Road, Havant
Client: Redrow Homes and Mr Phillip Dymoke White
BRD Reference: BRD3818-OP5-A
Date Issued: November 2020



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Trial Pit Photographs

TP106



Project Title: Bartons Road, Havant
Client: Redrow Homes and Mr Phillip Dymoke White
BRD Reference: BRD3818-OP5-A
Date Issued: November 2020



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info@brduk.com

Trial Pit Photographs

TP107



Project Title: Bartons Road, Havant
Client: Redrow Homes and Mr Phillip Dymoke White
BRD Reference: BRD3818-OP5-A
Date Issued: November 2020



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info@brduk.com

Trial Pit Photographs

TP108



Project Title: Bartons Road, Havant
Client: Redrow Homes and Mr Phillip Dymoke White
BRD Reference: BRD3818-OP5-A
Date Issued: November 2020



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info@brduk.com

Trial Pit Photographs

TP109



Project Title: Bartons Road, Havant
Client: Redrow Homes and Mr Phillip Dymoke White
BRD Reference: BRD3818-OP5-A
Date Issued: November 2020



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info@brduk.com

Trial Pit Photographs

TP110



Project Title: Bartons Road, Havant
Client: Redrow Homes and Mr Phillip Dymoke White
BRD Reference: BRD3818-OP5-A
Date Issued: November 2020



01295 272244
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Hand Dug Pit Photographs

HD01



HD02



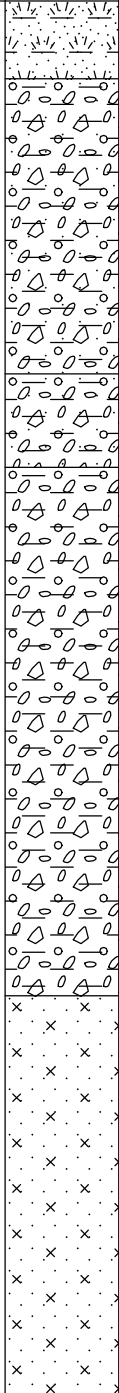
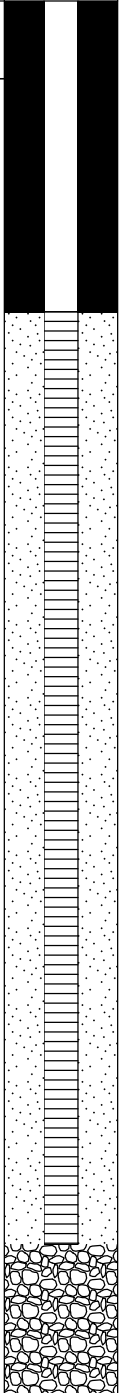
Project Title: Bartons Road, Havant
Client: Redrow Homes and Mr Phillip Dymoke White
BRD Reference: BRD3818-OP5-A
Date Issued: November 2020



01295 272244
info@brduk.com

PROBEHOLE RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Commenced: 26/10/2020 Date Completed: 26/10/2020 Method Used: Windowless Percussive Sampling Rig				Borehole No. WS101			
				Sheet 1 of 2			

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.10	J1			TOPSOIL: Medium dense, brown, very sandy, very gravelly silt. Gravel of fine to coarse, subangular to subrounded flint.	0.25 (38.68)		TS	
0.50	J2			Dense, orange brown, slightly clayey, slightly sandy GRAVEL and COBBLES of subangular to subrounded flint.				
0.80	D1				1.0			
1.20	SPT(C)	44 N		Dense, light orange brown, slightly clayey, sandy GRAVEL of fine to coarse, subangular to subrounded flint. 1.20 m: SPT(c): 7,11/10,11,11,12	1.20 (37.73)			
1.60	D2			Dense, orange brown, very clayey GRAVEL of fine to coarse, subangular to subrounded flint.	1.50 (37.43)			
2.00	SPT	34 N		2.00 m: SPT: 5,5/7,9,9,9 2.00 m: Becomes clay and gravel.	2.0			
2.20	D3							
2.50	J3							
3.00	SPT	20 N		3.00 m: SPT: 8,6/4,6,5,5	3.0			
4.00	SPT J5	4 N		4.00 m: SPT: 1,1/1,1,1,1	4.0			
4.00				Loose, light brown with some orange, clayey, silty SAND.	3.20 (35.73)			
					4.50			

General Remarks:
 Borehole terminated at 5.45m bgl.
 Hand dug to 1.20m for services clearance.
 Unable to get casing through clayey gravel at surface.
 Borehole collapsing from 3.20m bgl due to groundwater.
 Borehole fitted with gas and groundwater monitoring pipe and flush metal cover.

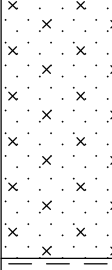
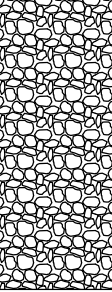
Surface Elevation Level:
38.928 mAOD

All dimensions in metres
 Log Scale 1:25

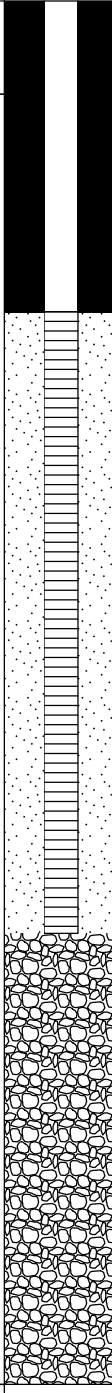


Telephone: 01295 272244
 Email: info@brduk.com

PROBEHOLE RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Commenced: 26/10/2020 Date Completed: 26/10/2020 Method Used: Windowless Percussive Sampling Rig				Borehole No. WS101				
				Sheet 2 of 2				
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
4.50	D4			Continued from 3.20m: Loose, light brown with some orange, clayey, silty SAND.			HEAD DEPOSITS	
5.00	SPT	6 N		5.00 m: SPT: 1,1/1,2,2,1	5.0			
				Stiff, grey brown CLAY.	5.35 (33.58) 5.45 (33.48)			
					6.0			
					7.0			
					8.0			
					9.0			
General Remarks: Borehole terminated at 5.45m bgl. Hand dug to 1.20m for services clearance. Unable to get casing through clayey gravel at surface. Borehole collapsing from 3.20m bgl due to groundwater. Borehole fitted with gas and groundwater monitoring pipe and flush metal cover.					Surface Elevation Level: 38.928 mAOD			
					All dimensions in metres Log Scale 1:25		Telephone: 01295 272244 Email: info@brduk.com	

PROBEHOLE RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Commenced: 26/10/2020 Date Completed: 26/10/2020 Method Used: Windowless Percussive Sampling Rig				Borehole No. WS102				
				Sheet 1 of 2				
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			TOPSOIL: Medium dense, brown, very sandy, very gravelly silt. Gravel of fine to coarse, subangular to subrounded flint.	0.30 (36.23)		TS	
0.60	J2			Orange brown, slightly clayey, slightly sandy GRAVEL and COBBLES of subangular to subrounded flint.				
1.10	D1			Dense, beige with some orange, slightly clayey, sandy GRAVEL. Gravel of fine to coarse, subangular to subrounded flint.	0.90 (35.63)			
1.20	SPT	33 N		1.20 m: SPT: 6,5/6,7,10,10				
1.60	D2			Medium dense, orange brown, slightly sandy, very clayey GRAVEL. Gravel of fine to coarse, subangular to subrounded flint.	1.60 (34.93)			
1.80	J3							
2.00	SPT	29 N		2.00 m: SPT: 7,9/8,6,6,9				
2.60	D3			2.60 m: Becoming sandy clay and gravel.				
3.00	SPT	17 N		Medium dense, orange brown, fine to coarse, subangular to subrounded flint GRAVEL. 3.00 m: SPT: 5,6/6,6,3,2 3.00 m: Borehole collapsing on encountering groundwater.	2.90 (33.63)			
3.50	D4			Firm, orange mottled light grey, slightly sandy, slightly gravelly CLAY. Gravel of fine to medium, subangular to subrounded flint.	3.40 (33.13)			
3.80	J4							
4.00	SPT	7 N		4.00 m: SPT: 2,1/2,2,2,1	4.0			
					4.45			

General Remarks:
 Borehole terminated at 4.45m bgl.
 Hand dug to 1.20m bgl for services clearance.
 Groundwater strike at 3.00m causing borehole collapse.
 Redrilled from 3.00m to 4.00m to install monitoring pipe.
 Borehole fitted with gas and groundwater monitoring pipe and flush metal cover.

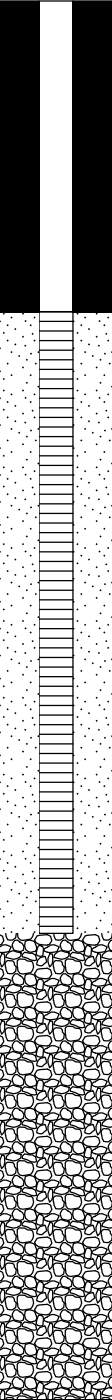
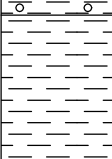
Surface Elevation Level:
36.527 mAOD

All dimensions in metres
 Log Scale 1:25



Telephone: 01295 272244
 Email: info@brduk.com

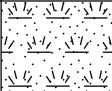
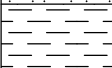
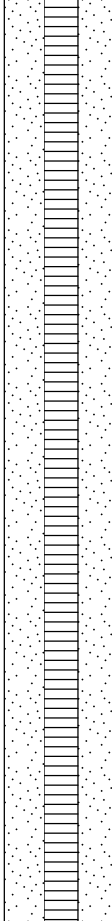
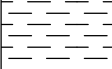
PROBEHOLE RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Commenced: 26/10/2020 Date Completed: 26/10/2020 Method Used: Windowless Percussive Sampling Rig				Borehole No. WS103					
				Sheet 1 of 2					
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill	
Depth	Type & No	Value							
0.10	J1			TOPSOIL: Medium dense, brown, very sandy, very gravelly silt. Gravel of fine to coarse, subangular to subrounded flint. Dense, orange brown CLAY and GRAVEL. Gravel of fine to coarse, subangular to subrounded flint.	0.25 (36.59)		TS		
0.50	J2								
0.70	D1								
1.00	SPT	39 N		1.00 m: SPT: 4,8/12,10,9,8	1.0				
1.30	J3								
1.50	D2								
2.00	SPT	40 N		2.00 m: SPT: 5,7/9,10,10,11	2.0				
2.60	J4			Stiff, brown mottled grey CLAY with relict rootlets. 3.00 m: SPT: 2,2/3,3,4,5 3.20 m: Becoming dark brown.	2.50 (34.34)		LONDON CLAY FORMATION		
2.70	PEN	4.5x3 kg/cm²							
2.70	D3								
3.00	SPT	15 N	3.00 m: SPT: 2,2/3,3,4,5		3.0				
3.70	PEN	4.5x3 kg/cm²							
4.00	SPT	15 N		4.00 m: SPT: 3,2/3,3,4,5 4.00 - 5.00 m: Occasional light grey / beige silty lenses.	4.0				
					4.50				
General Remarks: Borehole terminated at 5.45m bgl. Borehole fitted with gas and groundwater monitoring pipe and flush metal cover.					Surface Elevation Level: 36.839 mAOD		 Telephone: 01295 272244 Email: info@brduk.com		
					All dimensions in metres Log Scale 1:25				

PROBEHOLE RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Commenced: 26/10/2020 Date Completed: 26/10/2020 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS103		
						Sheet 2 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
4.50	D4			Continued from 2.50m: Stiff, brown mottled grey CLAY with relict rootlets.			LONDON CLAY	
4.80	J5							
5.00	SPT	11 N		5.00 m: SPT: 2,2/2,3,3,3	5.0			
					5.45 (31.39)			
					6.0			
					7.0			
					8.0			
					9.0			
General Remarks: Borehole terminated at 5.45m bgl. Borehole fitted with gas and groundwater monitoring pipe and flush metal cover.					Surface Elevation Level: 36.839 mAOD			
					All dimensions in metres Log Scale 1:25		Telephone: 01295 272244 Email: info@brduk.com	

PROBEHOLE RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Commenced: 26/10/2020 Date Completed: 26/10/2020 Method Used: Windowless Percussive Sampling Rig				Borehole No. WS104				
				Sheet 1 of 2				
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			TOPSOIL: Soft to firm, brown, gravelly, silty clay. Gravel of fine to coarse, subangular to subrounded flint.	0.30 (33.53)		TS	
0.50	D1			Soft to firm, brown with some light grey CLAY.				
0.60	PEN	3.0x3 kg/cm²		0.50 m: Becoming firm.			LONDON CLAY FORMATION	
0.70	J2							
1.00	SPT	7 N		1.00 m: SPT: 1,1/1,2,2,2	1.0			
1.40	PEN	4.0x3 kg/cm²		1.30 m: Becoming stiff.				
1.40	D2							
1.70	J3			1.60 m: Occasional pockets of calcareous aggregations.				
2.00	SPT	12 N		2.00 m: SPT: 2,2/2,3,3,4	2.0			
2.40	J4							
2.60	PEN	4.0x3 kg/cm²						
2.60	D3							
3.00	SPT	13 N		3.00 m: SPT: 2,1/3,3,3,4	3.0			
3.50	D4							
3.80	PEN	4.5x3 kg/cm²						
3.80	J5							
4.00	SPT	14 N		4.00 m: SPT: 2,3/3,3,4,4	4.0			
					4.45			
General Remarks: Borehole terminated at 4.45m bgl. Borehole fitted with gas and groundwater monitoring pipe and flush metal cover.				Surface Elevation Level: 33.829 mAOD		 Telephone: 01295 272244 Email: info@brduk.com		
				All dimensions in metres Log Scale 1:25				

PROBEHOLE RECORD

Client: Redrow Homes and Mr Phillip Dymoke White Project Title: Bartons Road, Havant Project No: BRD3818 Logged By: I Hibberd Date Commenced: 26/10/2020 Date Completed: 26/10/2020 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS105		
						Sheet 1 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			TOPSOIL: Soft to firm, brown, gravelly, silty clay. Gravel of fine to coarse, subangular to subrounded flint.	0.30 (32.18)		TS	
0.40	J2			Firm, yellow brown, very gravelly CLAY. Gravel of fine to coarse, subangular to subrounded flint.			HEAD DEPOSITS	
0.80	D1							
1.00	SPT	11 N		Very stiff to hard, dark brown mottled grey CLAY with slight desiccation.	1.00 (31.48)			
1.20	J3			1.00 m: SPT: 1, 1/2, 3, 3, 3				
1.50	PEN D2	>5.0x3 kg/cm²						
2.00	SPT	15 N		2.00 m: SPT: 2, 2/3, 4, 4, 4 2.00 - 4.45 m: Occasional calcareous aggregations and silt partings.	2.0		LONDON CLAY FORMATION	
2.60	PEN D3	5.0x3 kg/cm²		2.50 m: No further desiccation.				
2.60	J4							
2.70								
3.00	SPT	15 N		3.00 m: SPT: 2, 3/3, 4, 4, 4	3.0			
3.60	PEN D4	4.5x3 kg/cm²						
3.60								
4.00	SPT	13 N		4.00 m: SPT: 2, 2/3, 3, 3, 4	4.0			
					4.45			
General Remarks: Borehole terminated at 4.45m bgl. Borehole fitted with gas and groundwater monitoring pipe and flush metal cover.					Surface Elevation Level: 32.480 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

IN-SITU PERMEABILITY TEST

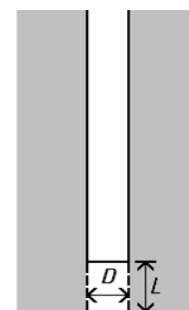
BS5930:1999+A2:2010 - Rising



Project No: BRD3818
Project: Bartons Road, Havant
Client: Redrow Homes & Mr Phillip Dymoke White

Test Details

Borehole Number WS101
Test Number 1
Depth of response zone below GL [a] 3.84 m
Depth of resting water level [b] 2.78 m
Height of casing above GL [c] 0.00 m
Depth of casing below GL [d] 1.00 m
Length of response zone [L] 2.84 m
Diameter of response zone [D] 0.15 m
Intake Factor [F] 4.91



Well point or hole extended in uniform soil

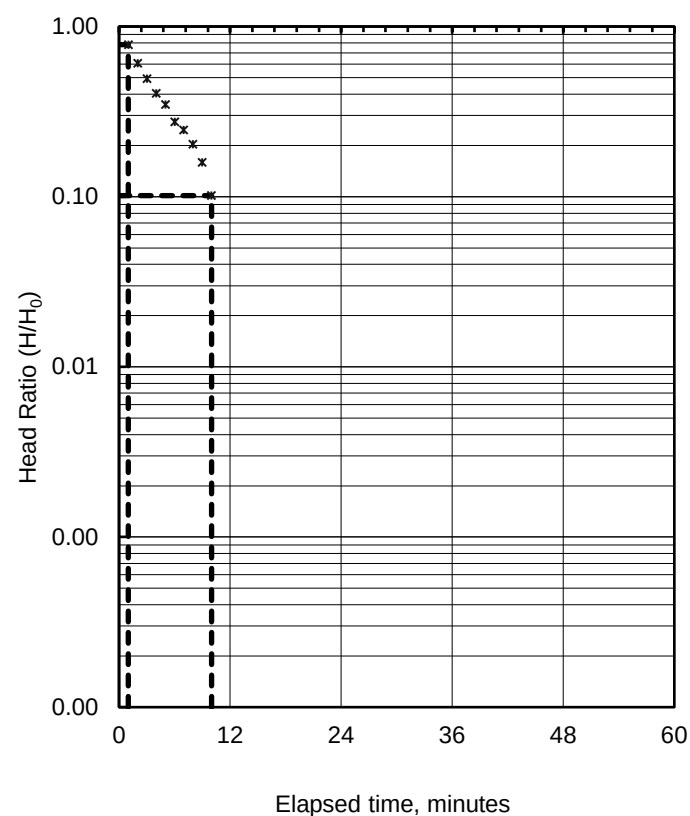
Supervising Engineer Dan Brown
Date of test 30/11/2020

Description of Soil at test level Light brown with some orange, silty SAND.

Test Record

Elapsed Time	Depth to Water	Head of water	H/H ₀
min	m	m	
0	3.47	-0.69	1.00
1	3.32	-0.54	0.78
2	3.20	-0.42	0.61
3	3.12	-0.34	0.49
4	3.06	-0.28	0.41
5	3.02	-0.24	0.35
6	2.97	-0.19	0.28
7	2.95	-0.17	0.25
8	2.92	-0.14	0.20
9	2.89	-0.11	0.16
10	2.85	-0.07	0.10
20	2.78	0.00	0.00

Plot of head ratio against elapsed time



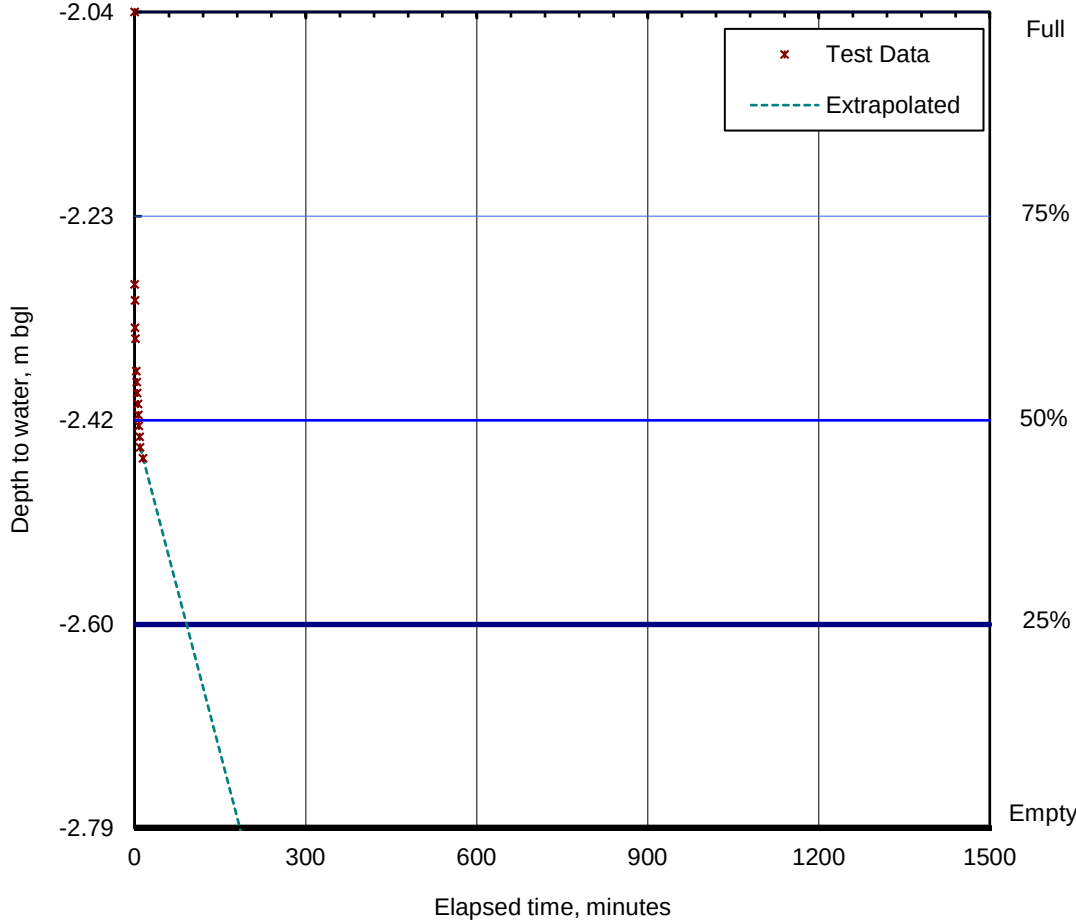
Calculation and Result

$$k = \frac{A}{F(t_2 - t_1) \cdot \log_e(H_1/H_2)} \quad \text{General Approach}$$

Cross-sectional area A = 0.0177 m²
Time between H1 and H2 = 9 minutes
Permeability k = 1.36 x 10⁻⁵ m/s

Remarks

SOAKAGE TEST RECORD

SOIL INFILTRATION RATE		
(BRE Digest 365 : Soakaway Test - within borehole)		
Client:	Redrow Homes & Mr Phillip Dymoke White	
Project Title	Bartons Road, Havant	
Project No.	BRD3818	
Test Details		
Trial Pit Number	WS102	
Test Number	1	
Borehole depth for test	2.79	m
Borehole diameter	0.15	m
Borehole area	0.0177	m
Depth to groundwater prior to test	2.45	m
Date of Test	30/11/2020	
Logged by	DB	
Description of Soil under Test	Orange brown, slightly sandy, clayey GRAVEL. Gravel of fine to coarse, subangular to subrounded flint.	
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time 
0	2.04	Depth to water, m bgl Full 75% 50% 25% Empty
0.3	2.29	
1	2.31	
1.3	2.33	
2	2.34	
3	2.37	
4	2.38	
5	2.39	
6	2.40	
7	2.41	
8	2.42	
9	2.43	
10	2.44	
15	2.45	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (0.2 mins) is the time for the water level to fall to 75% effective depth (2.23m bgl) and T_{25} (91* mins) is the time for the water level to fall to 25% effective depth (2.60m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 91$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.0066 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 0.1944 \text{ m}^2$ Soil Infiltration Rate $f = \underline{6.24 \times 10^{-6}} \text{ m/s}$		
Comments	Calculation based on extrapolated results. Use as a guide only. 50l of water added to borehole.	



Gas Monitoring Record

Project Name: Bartons Road, Havant

Client: Redrow Homes & Mr Phillip Dymoke White

Project No: BRD3818

Date:	30/10/2020	Ground conditions:	Wet and soft in areas	Recorded by:	DB
Time at start:	08:50	Weather conditions:	Overcast with light rain	Pressure trend:	Rising
Time at finish:	09:30	Air Temperature (°C):	10	Monitor serial no:	G501688

The gas monitoring equipment is a Geotech GA5000 portable analyser. As per manufacturers recommendations this is factory calibrated every six months and in addition BRD undertake calibration checks against bottled standard gases on at least a monthly basis. Gas monitor pump is run for three minutes unless otherwise stated and the steady readings are an average reading taken over this pump run time. Vapour monitoring equipment is miniRAE lite PGM-7350 Photo Ionisation Detector (PID) with 10.6 eV lamp calibrated for isobutylene. PID calibration check is performed on site against ambient air and also against a 100ppm isobutylene standard gas. Barometric pressure trend and ambient air temperature is recorded from weather websites at the nearest reported weather station.

CH₄ = Methane CO₂ = Carbon Dioxide O₂ = Oxygen H₂S = Hydrogen Sulphide CO = Carbon Monoxide NR = Not Recorded PID = Photo Ionisation Detector

GWL = Groundwater level measured from ground surface and top of standpipe. Base = Base of standpipe measured from ground surface.

Monitoring point				Gas Concentration								Pressure	Flow rate	Vapour	Comments
Borehole	GWL Ground (m)	GWL Pipe (m)	Base Ground (m)	Steady			Peak		Minimum	Peak		Baro - metric (mb)	Steady (l/hr)	PID (ppm)	
				CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CO (ppm)	H ₂ S (ppm)				
WS101	2.79	2.63	3.84	0.0	1.0	19.1	0.0	1.0	19.1	3	0	1015	-0.2	0.0	Flow rate peaked at 15.4 l/hr and fell to 0.2 l/hr after 2 minutes of monitoring. Piston effects.
WS102	2.41	2.30	2.79	0.0	2.3	18.3	0.0	2.3	18.3	1	0	1014	0.1	0.0	
WS103	1.07	0.97	4.20	0.0	0.2	20.1	0.0	0.2	20.1	>500ppm	1	1015	0.2	0.0	
WS104	2.67	2.75	4.13	0.0	0.2	20.8	0.0	0.5	20.2	0	0	1015	-0.1	0.0	
WS105	1.64	1.74	4.04	0.0	0.7	19.4	0.0	0.7	19.4	3	0	1015	4.3	0.0	



Gas Monitoring Record

Project Name: Bartons Road, Havant

Client: Redrow Homes & Mr Phillip Dymoke White

Project No: BRD3818

Date:	10/11/2020	Ground conditions:	Firm in areas / Soft in areas	Recorded by:	DB
Time at start:	9:20 AM	Weather conditions:	Overcast - sunny. Light breeze	Pressure trend:	Rising
Time at finish:	9:50 AM	Air Temperature (°C):	12	Monitor serial no:	G501688

The gas monitoring equipment is a Geotech GA5000 portable analyser. As per manufacturers recommendations this is factory calibrated every six months and in addition BRD undertake calibration checks against bottled standard gases on at least a monthly basis. Gas monitor pump is run for three minutes unless otherwise stated and the steady readings are an average reading taken over this pump run time. Vapour monitoring equipment is miniRAE lite PGM-7350 Photo Ionisation Detector (PID) with 10.6 eV lamp calibrated for isobutylene. PID calibration check is performed on site against ambient air and also against a 100ppm isobutylene standard gas. Barometric pressure trend and ambient air temperature is recorded from weather websites at the nearest reported weather station.

CH₄ = Methane CO₂ = Carbon Dioxide O₂ = Oxygen H₂S = Hydrogen Sulphide CO = Carbon Monoxide NR = Not Recorded PID = Photo Ionisation Detector

GWL = Groundwater level measured from ground surface and top of standpipe. Base = Base of standpipe measured from ground surface.

Monitoring point				Gas Concentration								Pressure	Flow rate	Vapour	Comments
Borehole	GWL Ground (m)	GWL Pipe (m)	Base Ground (m)	Steady			Peak		Minimum	Peak		Baro - metric (mb)	Steady (l/hr)	PID (ppm)	
				CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CO (ppm)	H ₂ S (ppm)				
WS101	2.86	2.70	3.71	0.0	1.2	19.3	0.0	1.2	19.3	0	0	1021	0.2	0.0	
WS102	2.50	2.39	2.79	0.0	2.2	18.2	0.1	2.2	18.1	2	0	1022	-0.3	0.0	
WS103	2.73	2.63	4.18	0.0	1.6	12.2	0.0	1.6	12.1	13	1	1021	5.4	0.0	
WS104	3.77	3.85	4.10	0.0	0.3	20.1	0.0	1.0	19.0	2	0	1022	-0.1	0.0	
WS105	2.93	3.03	4.09	0.0	1.6	17.4	0.0	1.6	17.4	4	0	1022	14.5	0.0	



Gas Monitoring Record

Project Name: Bartons Road, Havant

Client: Redrow Homes & Mr Phillip Dymoke White

Project No: BRD3818

Date:	16/11/2020	Ground conditions:	Firm in areas / soft in others	Recorded by:	DB
Time at start:	8:55 AM	Weather conditions:	Overcast and cool	Pressure trend:	Rising
Time at finish:	9:26 AM	Air Temperature (°C):	9	Monitor serial no:	G501315

The gas monitoring equipment is a Geotech GA5000 portable analyser. As per manufacturers recommendations this is factory calibrated every six months and in addition BRD undertake calibration checks against bottled standard gases on at least a monthly basis. Gas monitor pump is run for three minutes unless otherwise stated and the steady readings are an average reading taken over this pump run time. Vapour monitoring equipment is miniRAE lite PGM-7350 Photo Ionisation Detector (PID) with 10.6 eV lamp calibrated for isobutylene. PID calibration check is performed on site against ambient air and also against a 100ppm isobutylene standard gas. Barometric pressure trend and ambient air temperature is recorded from weather websites at the nearest reported weather station.

CH₄ = Methane CO₂ = Carbon Dioxide O₂ = Oxygen H₂S = Hydrogen Sulphide CO = Carbon Monoxide NR = Not Recorded PID = Photo Ionisation Detector

GWL = Groundwater level measured from ground surface and top of standpipe. Base = Base of standpipe measured from ground surface.

Monitoring point				Gas Concentration								Pressure	Flow rate	Vapour	Comments
Borehole	GWL Ground (m)	GWL Pipe (m)	Base Ground (m)	Steady			Peak		Minimum	Peak		Baro - metric (mb)	Steady (l/hr)	PID (ppm)	
				CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CO (ppm)	H ₂ S (ppm)				
WS101	2.21	2.05	3.68	0.1	1.3	19.7	0.1	1.3	19.6	0	0	1011	-0.2	0.0	Flow rate peaked at 15.9 l/hr and fell to 10.1 l/hr after 1 minutes of monitoring.
WS102	1.81	1.70	2.78	0.1	2.3	19.1	0.1	2.3	19.1	0	0	1012	-0.1	0.0	
WS103	2.58	2.48	4.17	0.1	1.8	12.0	0.1	1.8	11.9	9	0	1011	10.1	0.0	
WS104	3.68	3.76	4.09	0.1	0.3	21.0	0.1	0.8	20.1	0	0	1012	-0.2	0.0	
WS105	2.46	2.56	4.09	0.1	1.8	17.3	0.1	1.8	17.3	1	0	1012	10.2	0.0	

Gas Monitoring Record				Project Name: Bartons Road, Havant Client: Redrow Homes & Mr Phillip Dymoke White Project No: BRD3818											
				Date: 05/01/2021 Ground conditions: Soft to firm Recorded by: DB Time at start: 9:50 AM Weather conditions: Overcast and cold Pressure trend: Falling Time at finish: 10:21 AM Air Temperature (°C): 5 Monitor serial no: G501315											
The gas monitoring equipment is a Geotech GA5000 portable analyser. As per manufacturers recommendations this is factory calibrated every six months and in addition BRD undertake calibration checks against bottled standard gases on at least a monthly basis. Gas monitor pump is run for three minutes unless otherwise stated and the steady readings are an average reading taken over this pump run time. Vapour monitoring equipment is miniRAE lite PGM-7350 Photo Ionisation Detector (PID) with 10.6 eV lamp calibrated for isobutylene. PID calibration check is performed on site against ambient air and also against a 100ppm isobutylene standard gas. Barometric pressure trend and ambient air temperature is recorded from weather websites at the nearest reported weather station. CH₄ = Methane CO₂ = Carbon Dioxide O₂ = Oxygen H₂S = Hydrogen Sulphide CO = Carbon Monoxide NR = Not Recorded PID = Photo Ionisation Detector GWL = Groundwater level measured from ground surface and top of standpipe. Base = Base of standpipe measured from ground surface.															
Monitoring point				Gas Concentration								Pressure	Flow rate	Vapour	Comments
Borehole	GWL Ground (m)	GWL Pipe (m)	Base Ground (m)	Steady			Peak		Minimum	Peak		Baro - metric (mb)	Steady (l/hr)	PID (ppm)	
				CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CO (ppm)	H ₂ S (ppm)				
WS101	2.82	2.67	3.69	0.0	1.2	20.4	0.0	1.2	20.4	0	0	1015	0.1	0.1	No flow rate recorded on this visit. Flow Rate: The peak flow rate was 10.8 l/hr dropping to 0.8 l/hr after 2 minute. Returned back to WS105 to check flow rate after 10 minutes, and flow had risen to 4.4 l/hr. Monitored for 3 minutes. The results are as following: 0.0 minutes: 4.4 l/hr) 0.5 minutes: 2.3 l/hr 1.0 minutes: 1.3 l/hr minutes: 0.6 l/hr minutes: 0.4 l/hr minutes: 0.2 l/hr 1.5 2.0 3.0
WS102	2.50	2.34	2.79	0.0	1.5	20.3	0.1	1.5	20.3	0	0	1016	0.6	0.0	
WS103	1.94	1.83	4.20	0.0	2.1	5.3	0.0	2.1	5.3	0	0	1015	0.2	0.2	
WS104	3.09	3.09	4.09	0.0	0.6	21.3	0.0	1.0	19.8	0	0	1016	0.2	0.3	
WS105	1.09	1.09	4.10	0.0	2.0	10.7	0.0	2.0	10.7	0	0	1016	0.8	0.2	

Gas Monitoring Record				Project Name: Bartons Road, Havant Client: Redrow Homes & Mr Phillip Dymoke White Project No: BRD3818											
				Date: 04/02/2021 Time at start: 10:46 AM Time at finish: 11:15 AM				Ground conditions: Very soft and wet. Weather conditions: Overcast, cool and light to heavy rain fall. Air Temperature (°C): 8				Recorded by: DB Pressure trend: Steady Monitor serial no: G501315			
The gas monitoring equipment is a Geotech GA5000 portable analyser. As per manufacturers recommendations this is factory calibrated every six months and in addition BRD undertake calibration checks against bottled standard gases on at least a monthly basis. Gas monitor pump is run for three minutes unless otherwise stated and the steady readings are an average reading taken over this pump run time. Vapour monitoring equipment is miniRAE lite PGM-7350 Photo Ionisation Detector (PID) with 10.6 eV lamp calibrated for isobutylene. PID calibration check is performed on site against ambient air and also against a 100ppm isobutylene standard gas. Barometric pressure trend and ambient air temperature is recorded from weather websites at the nearest reported weather station. CH₄ = Methane CO₂ = Carbon Dioxide O₂ = Oxygen H₂S = Hydrogen Sulphide CO = Carbon Monoxide NR = Not Recorded PID = Photo Ionisation Detector GWL = Groundwater level measured from ground surface and top of standpipe. Base = Base of standpipe measured from ground surface.															
Monitoring point				Gas Concentration								Pressure	Flow rate	Vapour	Comments
Borehole	GWL Ground (m)	GWL Pipe (m)	Base Ground (m)	Steady			Peak		Minimum	Peak		Baro - metric (mb)	Steady (l/hr)	PID (ppm)	
				CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CO (ppm)	H ₂ S (ppm)				
WS101	2.34	2.20	3.69	0.0	1.1	19.7	0.0	1.1	19.7	0	0	1004	-0.4	0.5	Flow rate peaked at 20.2 l/hr falling to 5.3 l/hr after 4 minute of monitoring. Steady flow rate of 2.7 l/hr recorded. Flow rate peaked at 5.2 l/hr falling to 0.30 l/hr after 1 minute of monitoring. Piston effect. Flow Rates: WS103: Flow rate peaked at 20.2 l/hr falling to 5.3 (/hr after 4 minute of monitoring. Returned 20 minutes later to check levels and recorded a level of 2.7 l/hr
WS102	2.11	1.97	2.78	0.0	1.8	18.9	0.1	1.8	18.9	0	0	1004	0.2	0.4	
WS103	1.75	1.62	4.20	0.0	2.0	5.3	0.1	2.0	5.3	0	0	1005	2.7	0.6	
WS104	2.83	2.83	4.09	0.0	0.4	20.6	0.0	1.0	20.2	0	0	1006	0.0	0.7	
WS105	0.28	0.28	4.07	0.0	2.1	10.4	0.1	2.1	10.4	2	0	1006	0.3	0.1	



Gas Monitoring Record

Project Name: Bartons Road, Havant

Client: Redrow Homes & Mr Phillip Dymoke White

Project No: BRD3818

Date:	15/03/2021	Ground conditions:	Firm and soft	Recorded by:	DB
Time at start:	10:36 AM	Weather conditions:	Overcast with light wind.	Pressure trend:	Rising
Time at finish:	11:07 AM	Air Temperature (°C):	8	Monitor serial no:	G501688

The gas monitoring equipment is a Geotech GA5000 portable analyser. As per manufacturers recommendations this is factory calibrated every six months and in addition BRD undertake calibration checks against bottled standard gases on at least a monthly basis. Gas monitor pump is run for three minutes unless otherwise stated and the steady readings are an average reading taken over this pump run time. Vapour monitoring equipment is miniRAE lite PGM-7350 Photo Ionisation Detector (PID) with 10.6 eV lamp calibrated for isobutylene. PID calibration check is performed on site against ambient air and also against a 100ppm isobutylene standard gas. Barometric pressure trend and ambient air temperature is recorded from weather websites at the nearest reported weather station.

CH₄ = Methane CO₂ = Carbon Dioxide O₂ = Oxygen H₂S = Hydrogen Sulphide CO = Carbon Monoxide NR = Not Recorded PID = Photo Ionisation Detector

GWL = Groundwater level measured from ground surface and top of standpipe. Base = Base of standpipe measured from ground surface.

Monitoring point				Gas Concentration								Pressure	Flow rate	Vapour	Comments
Borehole	GWL Ground (m)	GWL Pipe (m)	Base Ground (m)	Steady			Peak		Minimum	Peak		Baro - metric (mb)	Steady (l/hr)	PID (ppm)	
				CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CO (ppm)	H ₂ S (ppm)				
WS101	2.96	2.81	3.64	0.0	1.1	20.0	0.0	1.1	19.9	0	0	1018	0.4	0.0	Piston effect.
WS102	2.69	2.56	2.79	0.0	1.4	19.5	0.0	1.4	19.5	0	0	1019	0.1	0.0	
WS103	1.61	1.51	4.19	0.0	2.2	5.2	0.0	2.2	5.3	0	0	1018	-1.9	0.0	
WS104	2.55	2.55	4.10	0.0	2.2	11.7	0.0	2.2	12.8	4	0	1019	1.6	0.0	
WS105	0.26	0.26	4.09	0.0	0.2	20.5	0.0	0.8	18.1	0	0	1019	0.1	0.0	



Groundwater Monitoring Record

Project: Bartons Road, Havant
Client: Redrow Homes & Mr Phillip Dymoke White
Project No: BRD3818

Borehole name	Date	Monitored by (initials)	Borehole depth (m)	Qty free product detected (mm)	Groundwater level below ground surface (m)	Groundwater level below top of standpipe (m)	Amount purged (l)	Post purge groundwater level below top of standpipe (m)	Comments
WS101	30/10/2020	DB	3.84	N/R	2.79	2.63	1.50	3.40	Brown sandy water with no sheen or odour.
WS102	30/10/2020	DB	2.79	N/R	2.41	2.30	7.00	3.55	Grey brown sandy water with no sheen or odour
WS103	30/10/2020	DB	4.20	N/R	1.07	0.97	0.00	2.48	Light grey brown sandy water.
WS104	30/10/2020	DB	4.13	N/R	2.67	2.75	3.00	4.07	Light grey brown sandy water.
WS105	30/10/2020	DB	4.04	N/R	1.64	1.74	6.00	3.92	Orange brown silty water.

APPENDIX 3



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BRD Environmental Ltd
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Banbury
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OX16 5HT

DETS Ltd
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Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410

DETS Report No: 20-12742

Site Reference: Bartons Road, Havant

Project / Job Ref: BRD3818

Order No: None Supplied

Sample Receipt Date: 30/10/2020

Sample Scheduled Date: 30/10/2020

Report Issue Number: 1

Reporting Date: 05/11/2020

Authorised by:

A handwritten signature in black ink, appearing to read "Dave Ashworth".

Dave Ashworth
Technical Manager

Dates of laboratory activities for each tested analyte are available upon request.

Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.



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Soil Analysis Certificate						
DETS Report No: 20-12742	Date Sampled	26/10/20	26/10/20	26/10/20	26/10/20	26/10/20
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Bartons Road, Havant	TP / BH No	WS101	WS102	WS102	WS104	WS104
Project / Job Ref: BRD3818	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	0.10	0.20	0.60	0.20	0.70
Reporting Date: 05/11/2020	DETS Sample No	507851	507852	507853	507854	507855

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	8.0	7.6	7.3	7.2	7.2
Total Sulphate as SO ₄	mg/kg	< 200	MCERTS					
Total Sulphate as SO ₄	%	< 0.02	MCERTS					
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	44	11	15	13	18
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.04	0.01	0.01	0.01	0.02
Total Sulphur	%	< 0.02	NONE					
Organic Matter	%	< 0.1	MCERTS	1.3	2.7	2	2.2	0.3
Arsenic (As)	mg/kg	< 2	MCERTS	3	3	5	6	18
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS	7	7	21	22	35
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	5	< 4	10	12	18
Lead (Pb)	mg/kg	< 3	MCERTS	15	17	13	25	13
Mercury (Hg)	mg/kg	< 1	MCERTS	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	< 3	< 3	10	9	24
Selenium (Se)	mg/kg	< 2	MCERTS	< 3	< 3	< 3	< 3	< 3
Zinc (Zn)	mg/kg	< 3	MCERTS	14	12	25	32	59

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)



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Soil Analysis Certificate						
DETS Report No: 20-12742	Date Sampled	28/10/20	28/10/20	28/10/20	26/10/20	26/10/20
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Bartons Road, Havant	TP / BH No	TP104	TP105	TP106	WS102	WS103
Project / Job Ref: BRD3818	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	0.10	0.20	0.20	1.80	1.30
Reporting Date: 05/11/2020	DETS Sample No	507856	507857	507858	507859	507860

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	7.2	7.4	6.7	7.5	7.7
Total Sulphate as SO ₄	mg/kg	< 200	MCERTS				< 200	< 200
Total Sulphate as SO ₄	%	< 0.02	MCERTS				< 0.02	< 0.02
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	11	11	< 10	< 10	12
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.01	0.01	< 0.01	< 0.01	0.01
Total Sulphur	%	< 0.02	NONE				< 0.02	< 0.02
Organic Matter	%	< 0.1	MCERTS	3.7	3.2	2.1		
Arsenic (As)	mg/kg	< 2	MCERTS	7	7	3		
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2	< 0.2	< 0.2		
Chromium (Cr)	mg/kg	< 2	MCERTS	19	20	8		
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2		
Copper (Cu)	mg/kg	< 4	MCERTS	11	12	5		
Lead (Pb)	mg/kg	< 3	MCERTS	25	32	15		
Mercury (Hg)	mg/kg	< 1	MCERTS	< 1	< 1	< 1		
Nickel (Ni)	mg/kg	< 3	MCERTS	7	7	< 3		
Selenium (Se)	mg/kg	< 2	MCERTS	< 3	< 3	< 3		
Zinc (Zn)	mg/kg	< 3	MCERTS	36	36	18		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)



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Soil Analysis Certificate						
DETS Report No: 20-12742	Date Sampled	26/10/20	26/10/20	26/10/20	28/10/20	28/10/20
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Bartons Road, Havant	TP / BH No	WS104	WS104	WS104	TP102	TP106
Project / Job Ref: BRD3818	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	1.40	2.40	3.50	1.30	0.60
Reporting Date: 05/11/2020	DETS Sample No	507861	507862	507863	507864	507865

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	7.7	7.9	8.2	8.2	7.6
Total Sulphate as SO ₄	mg/kg	< 200	MCERTS	< 200	< 200	< 200	< 200	< 200
Total Sulphate as SO ₄	%	< 0.02	MCERTS	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	18	16	13	< 10	11
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.02	0.02	0.01	< 0.01	0.01
Total Sulphur	%	< 0.02	NONE	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Organic Matter	%	< 0.1	MCERTS					
Arsenic (As)	mg/kg	< 2	MCERTS					
Cadmium (Cd)	mg/kg	< 0.2	MCERTS					
Chromium (Cr)	mg/kg	< 2	MCERTS					
Chromium (hexavalent)	mg/kg	< 2	NONE					
Copper (Cu)	mg/kg	< 4	MCERTS					
Lead (Pb)	mg/kg	< 3	MCERTS					
Mercury (Hg)	mg/kg	< 1	MCERTS					
Nickel (Ni)	mg/kg	< 3	MCERTS					
Selenium (Se)	mg/kg	< 2	MCERTS					
Zinc (Zn)	mg/kg	< 3	MCERTS					

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)



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Soil Analysis Certificate						
DETS Report No: 20-12742	Date Sampled	28/10/20				
BRD Environmental Ltd	Time Sampled	None Supplied				
Site Reference: Bartons Road, Havant	TP / BH No	TP110				
Project / Job Ref: BRD3818	Additional Refs	None Supplied				
Order No: None Supplied	Depth (m)	1.00				
Reporting Date: 05/11/2020	DETS Sample No	507866				

Determinand	Unit	RL	Accreditation				
pH	pH Units	N/a	MCERTS	7.5			
Total Sulphate as SO ₄	mg/kg	< 200	MCERTS	< 200			
Total Sulphate as SO ₄	%	< 0.02	MCERTS	< 0.02			
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	< 10			
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	< 0.01			
Total Sulphur	%	< 0.02	NONE	< 0.02			
Organic Matter	%	< 0.1	MCERTS				
Arsenic (As)	mg/kg	< 2	MCERTS				
Cadmium (Cd)	mg/kg	< 0.2	MCERTS				
Chromium (Cr)	mg/kg	< 2	MCERTS				
Chromium (hexavalent)	mg/kg	< 2	NONE				
Copper (Cu)	mg/kg	< 4	MCERTS				
Lead (Pb)	mg/kg	< 3	MCERTS				
Mercury (Hg)	mg/kg	< 1	MCERTS				
Nickel (Ni)	mg/kg	< 3	MCERTS				
Selenium (Se)	mg/kg	< 2	MCERTS				
Zinc (Zn)	mg/kg	< 3	MCERTS				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)



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Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 20-12742	Date Sampled	26/10/20	26/10/20	26/10/20	26/10/20	26/10/20
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Bartons Road, Havant	TP / BH No	WS101	WS102	WS102	WS104	WS104
Project / Job Ref: BRD3818	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	0.10	0.20	0.60	0.20	0.70
Reporting Date: 05/11/2020	DETS Sample No	507851	507852	507853	507854	507855

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



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Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 20-12742	Date Sampled	28/10/20	28/10/20	28/10/20		
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Bartons Road, Havant	TP / BH No	TP104	TP105	TP106		
Project / Job Ref: BRD3818	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	Depth (m)	0.10	0.20	0.20		
Reporting Date: 05/11/2020	DETS Sample No	507856	507857	507858		

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



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Tel : 01622 850410



Soil Analysis Certificate - TPH LQM Banded

DETS Report No: 20-12742	Date Sampled	26/10/20	26/10/20			
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Bartons Road, Havant	TP / BH No	WS102	WS104			
Project / Job Ref: BRD3818	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.60	0.70			
Reporting Date: 05/11/2020	DETS Sample No	507853	507855			

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



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Soil Analysis Certificate - BTEX / MTBE						
DETS Report No: 20-12742	Date Sampled	26/10/20	26/10/20			
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Bartons Road, Havant	TP / BH No	WS102	WS104			
Project / Job Ref: BRD3818	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.60	0.70			
Reporting Date: 05/11/2020	DETS Sample No	507853	507855			

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



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Soil Analysis Certificate - Semi Volatile Organic Compounds (SVOC)						
DETS Report No: 20-12742	Date Sampled	26/10/20	26/10/20			
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Bartons Road, Havant	TP / BH No	WS102	WS104			
Project / Job Ref: BRD3818	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.60	0.70			
Reporting Date: 05/11/2020	DETS Sample No	507853	507855			

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



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Soil Analysis Certificate - Organochlorine Pesticides						
DETS Report No: 20-12742	Date Sampled	26/10/20	26/10/20	28/10/20		
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Bartons Road, Havant	TP / BH No	WS101	WS102	TP106		
Project / Job Ref: BRD3818	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	Depth (m)	0.10	0.20	0.20		
Reporting Date: 05/11/2020	DETS Sample No	507851	507852	507858		

Determinand	Unit	RL	Accreditation					
Aldrin	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
alpha-HCH	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
beta-HCH	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
cis-chlordane	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
delta-HCH	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
Dieldrin	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
Endosulfan A	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
Endosulfan B	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
Endrin	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
gamma-HCH (Lindane)	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
Heptachlor	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
Heptachlor epoxide	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
Hexachlorobenzene (HCB)	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
Isodrin	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
Methoxychlor	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
o,p' - DDD	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
o,p' - DDE	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
o,p' - DDT	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
p,p' - DDD	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
p,p' - DDE	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
p,p' - DDT	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
trans-chlordane	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		
Trifluralin	mg/kg	< 0.02	NONE	< 0.02	< 0.02	< 0.02		



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Soil Analysis Certificate - Sample Descriptions

DETS Report No: 20-12742	
BRD Environmental Ltd	
Site Reference: Bartons Road, Havant	
Project / Job Ref: BRD3818	
Order No: None Supplied	
Reporting Date: 05/11/2020	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
507851	WS101	None Supplied	0.10	9.3	Brown sandy clay with stones
507852	WS102	None Supplied	0.20	12.6	Brown loamy sand with stones and vegetation
507853	WS102	None Supplied	0.60	10.6	Brown loamy sand with stones
507854	WS104	None Supplied	0.20	9.8	Brown sandy clay with stones
507855	WS104	None Supplied	0.70	23	Light brown clay
507856	TP104	None Supplied	0.10	21.1	Brown loamy sand with stones and vegetation
507857	TP105	None Supplied	0.20	14.2	Brown loamy sand with stones and brick
507858	TP106	None Supplied	0.20	14.7	Brown loamy sand with stones and vegetation
507859	WS102	None Supplied	1.80	7.8	Light brown sandy gravel with stones
507860	WS103	None Supplied	1.30	10.8	Light brown sandy clay with stones
507861	WS104	None Supplied	1.40	16.9	Light brown clay
507862	WS104	None Supplied	2.40	17.5	Light brown clay
507863	WS104	None Supplied	3.50	18.5	Light brown clay
507864	TP102	None Supplied	1.30	17.1	Light brown sandy clay with stones
507865	TP106	None Supplied	0.60	9.5	Light brown sandy clay with stones
507866	TP110	None Supplied	1.00	6.1	Light brown sandy gravel with stones

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

Insufficient Sample ^{I/S}

Unsuitable Sample ^{U/S}



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-12742

BRD Environmental Ltd

Site Reference: Bartons Road, Havant

Project / Job Ref: BRD3818

Order No: None Supplied

Reporting Date: 05/11/2020

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 - C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450°C	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO ₄) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO ₄) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO ₄) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCS	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received



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DETS Report No: 20-13040

Site Reference: Bartons Road, Havant

Project / Job Ref: BRD3818

Order No: None Supplied

Sample Receipt Date: 05/11/2020

Sample Scheduled Date: 05/11/2020

Report Issue Number: 1

Reporting Date: 11/11/2020

Authorised by:

A handwritten signature in black ink, appearing to read "Dave Ashworth".

Dave Ashworth
Technical Manager

Dates of laboratory activities for each tested analyte are available upon request.

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Water Analysis Certificate						
DETS Report No: 20-13040	Date Sampled	30/10/20	30/10/20	30/10/20		
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Bartons Road, Havant	TP / BH No	WS101	WS103	WS104		
Project / Job Ref: BRD3818	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	Depth (m)	0.10	0.20	0.60		
Reporting Date: 11/11/2020	DETS Sample No	508960	508961	508962		

Determinand	Unit	RL	Accreditation				
pH	pH Units	N/a	ISO17025	7.2	7.9	8.1	
Sulphate as SO ₄	mg/l	< 1	ISO17025	39	145	239	

Subcontracted analysis ^(S)

Insufficient sample ^{I/S}

Unsuitable Sample ^{U/S}



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Water Analysis Certificate - Methodology & Miscellaneous Information	
DETS Report No: 20-13040	
BRD Environmental Ltd	
Site Reference: Bartons Road, Havant	
Project / Job Ref: BRD3818	
Order No: None Supplied	
Reporting Date: 11/11/2020	

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



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Kent
ME17 2JN
t: 01622 850410

DETS Report No: 20-13390

Site Reference: Bartons Road, Havant

Project / Job Ref: BRD3818

Order No: None Supplied

Sample Receipt Date: 13/11/2020

Sample Scheduled Date: 13/11/2020

Report Issue Number: 1

Reporting Date: 18/11/2020

Authorised by:

A handwritten signature in black ink, appearing to read "Dave Ashworth".

Dave Ashworth
Technical Manager

Dates of laboratory activities for each tested analyte are available upon request.

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Soil Analysis Certificate						
DETS Report No: 20-13390	Date Sampled	10/11/20	10/11/20			
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Bartons Road, Havant	TP / BH No	HD01	HD02			
Project / Job Ref: BRD3818	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.20	0.10			
Reporting Date: 18/11/2020	DETS Sample No	510515	510516			

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	7.5	7.6			
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	24	121			
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.02	0.12			
Organic Matter	%	< 0.1	MCERTS	5.3	2.6			
Arsenic (As)	mg/kg	< 2	MCERTS	6	8			
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	0.2	0.3			
Chromium (Cr)	mg/kg	< 2	MCERTS	17	16			
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2			
Copper (Cu)	mg/kg	< 4	MCERTS	14	17			
Lead (Pb)	mg/kg	< 3	MCERTS	46	50			
Mercury (Hg)	mg/kg	< 1	MCERTS	< 1	< 1			
Nickel (Ni)	mg/kg	< 3	MCERTS	8	9			
Selenium (Se)	mg/kg	< 2	MCERTS	< 3	< 3			
Zinc (Zn)	mg/kg	< 3	MCERTS	49	116			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)



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Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 20-13390	Date Sampled	10/11/20	10/11/20			
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Bartons Road, Havant	TP / BH No	HD01	HD02			
Project / Job Ref: BRD3818	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.20	0.10			
Reporting Date: 18/11/2020	DETS Sample No	510515	510516			

Determinand	Unit	RL	Accreditation				
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1		
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1		
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1		
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1		
Phenanthrene	mg/kg	< 0.1	MCERTS	0.12	0.13		
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1		
Fluoranthene	mg/kg	< 0.1	MCERTS	0.31	0.27		
Pyrene	mg/kg	< 0.1	MCERTS	0.28	0.24		
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	0.15		
Chrysene	mg/kg	< 0.1	MCERTS	0.17	0.16		
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.20	0.21		
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1		
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	0.13	0.15		
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1		
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1		
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1		
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6		



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Soil Analysis Certificate - Sample Descriptions

DETS Report No: 20-13390	
BRD Environmental Ltd	
Site Reference: Bartons Road, Havant	
Project / Job Ref: BRD3818	
Order No: None Supplied	
Reporting Date: 18/11/2020	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
510515	HD01	None Supplied	0.20	18.5	Brown loamy sand with stones and vegetation
510516	HD02	None Supplied	0.10	13.4	Brown loamy sand with stones and brick

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

Insufficient Sample ^{I/S}

Unsuitable Sample ^{U/S}



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-13390

BRD Environmental Ltd

Site Reference: Bartons Road, Havant

Project / Job Ref: BRD3818

Order No: None Supplied

Reporting Date: 18/11/2020

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 - C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450°C	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO ₄) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO ₄) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO ₄) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCS	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received



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DETS Report No: 20-13468

Site Reference: Bartons Road, Havant

Project / Job Ref: BRD3818

Order No: None Supplied

Sample Receipt Date: 16/11/2020

Sample Scheduled Date: 16/11/2020

Report Issue Number: 1

Reporting Date: 20/11/2020

Authorised by:

A handwritten signature in black ink, appearing to read "Dave Ashworth".

Dave Ashworth
Technical Manager

Dates of laboratory activities for each tested analyte are available upon request.

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Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3

DETS Report No: 20-13468		Date Sampled	28/10/20		Landfill Waste Acceptance Criteria Limits				
BRD Environmental Ltd		Time Sampled	None Supplied						
Site Reference: Bartons Road, Havant		TP / BH No	TP110						
Project / Job Ref: BRD3818		Additional Refs	None Supplied						
Order No: None Supplied		Depth (m)	1.00						
Reporting Date: 20/11/2020		DETS Sample No	510822						
Determinand		Unit	MDL						Inert Waste Landfill Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill Hazardous Waste Landfill 3%5%6% -- -- 10% 6 -- -- 1 -- -- 500 -- -- 100 -- -- -- >6 -- -- To be evaluated To be evaluated
TOC ^{MU}		%	< 0.10.5						
Loss on Ignition		%	< 0.011.20						
BTEX ^{MU}		mg/kg	< 0.05< 0.05						
Sum of PCBs		mg/kg	< 0.1< 0.1						
Mineral Oil ^{MU}		mg/kg	< 10< 10						
Total PAH ^{MU}		mg/kg	< 1.7< 1.7						
pH ^{MU}		pH Units	N/a7.7						
Acid Neutralisation Capacity		mol/kg (+/-)	< 1< 1						
Eluate Analysis			2:1 mg/l	8:1 mg/l		Cumulative 10:1 mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)		
Arsenic ^U			< 0.01	< 0.01		< 0.2	0.5	2	25
Barium ^U			< 0.02	< 0.02		< 0.1	20	100	300
Cadmium ^U			< 0.0005	< 0.0005		< 0.02	0.04	1	5
Chromium ^U			< 0.005	< 0.005		< 0.20	0.5	10	70
Copper ^U			< 0.01	< 0.01		< 0.5	2	50	100
Mercury ^U			< 0.0005	< 0.0005		< 0.005	0.01	0.2	2
Molybdenum ^U			< 0.001	< 0.001		< 0.1	0.5	10	30
Nickel ^U			< 0.007	< 0.007		< 0.2	0.4	10	40
Lead ^U			< 0.005	< 0.005		< 0.2	0.5	10	50
Antimony ^U			< 0.005	< 0.005		< 0.05	0.06	0.7	5
Selenium ^U			< 0.005	< 0.005		< 0.05	0.1	0.5	7
Zinc ^U			< 0.005	0.005		< 0.2	4	50	200
Chloride ^U			3	10		89	800	15000	25000
Fluoride ^U			< 0.5	< 0.5		< 1	10	150	500
Sulphate ^U			2	6		57	1000	20000	50000
TDS			37	37		370	4000	60000	100000
Phenol Index			< 0.01	< 0.01		< 0.5	1	-	-
DOC		6.2	10.2		98.1	500	800	1000	
Leach Test Information									
Sample Mass (kg)		0.19							
Dry Matter (%)		92.1							
Moisture (%)		8.6							
Stage 1									
Volume Eluate L2 (litres)		0.34							
Filtered Eluate VE1 (litres)		0.18							
Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion									
Stated limits are for guidance only and DETS Ltd cannot be held responsible for any discrepancies with current legislation									
M Denotes MCERTS accredited test									
U Denotes ISO17025 accredited test									



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Soil Analysis Certificate - Sample Descriptions

DETS Report No: 20-13468	
BRD Environmental Ltd	
Site Reference: Bartons Road, Havant	
Project / Job Ref: BRD3818	
Order No: None Supplied	
Reporting Date: 20/11/2020	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
&\$ 510822	TP110	None Supplied	1.00	7.9	Brown sandy clay with stones

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

Insufficient Sample ^{1/5}

& samples received in inappropriate containers for hydrocarbon analysis

\$ samples exceeded recommended holding times



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-13468

BRD Environmental Ltd

Site Reference: Bartons Road, Havant

Project / Job Ref: BRD3818

Order No: None Supplied

Reporting Date: 20/11/2020

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

D Dried
AR As Received

Parameter	Matrix Type	Suite Reference	Expanded Uncertainty Measurement	Unit
TOC	Soil	BS EN 12457	13.49	%
Loss on Ignition	Soil	BS EN 12457	17	%
BTEX	Soil	BS EN 12457	14	%
Sum of PCBs	Soil	BS EN 12457	23	%
Mineral Oil	Soil	BS EN 12457	9	%
Total PAH	Soil	BS EN 12457	20	%
pH	Soil	BS EN 12457	0.399	Units
Acid Neutralisation Capacity	Soil	BS EN 12457	18	%
Arsenic	Leachate	BS EN 12457	16.63	%
Barium	Leachate	BS EN 12457	14.29	%
Cadmium	Leachate	BS EN 12457	14.44	%
Chromium	Leachate	BS EN 12457	18.06	%
Copper	Leachate	BS EN 12457	21.27	%
Mercury	Leachate	BS EN 12457	24.13	%
Molybdenum	Leachate	BS EN 12457	12.55	%
Nickel	Leachate	BS EN 12457	20.08	%
Lead	Leachate	BS EN 12457	13.43	%
Antimony	Leachate	BS EN 12457	18.85	%
Selenium	Leachate	BS EN 12457	18.91	%
Zinc	Leachate	BS EN 12457	13.71	%
Chloride	Leachate	BS EN 12457	16	%
Fluoride	Leachate	BS EN 12457	19.4	%
Sulphate	Leachate	BS EN 12457	19.63	%
TDS	Leachate	BS EN 12457	12	%
Phenol Index	Leachate	BS EN 12457	14	%
DOC	Leachate	BS EN 12457	10	%
Clay Content	Soil	BS 3882: 2015	15	%
Silt Content	Soil	BS 3882: 2015	14	%
Sand Content	Soil	BS 3882: 2015	13	%
Loss on Ignition	Soil	BS 3882: 2015	17	%
pH	Soil	BS 3882: 2015	0.399	Units
Carbonate	Soil	BS 3882: 2015	16	%
Total Nitrogen	Soil	BS 3882: 2015	12	%
Phosphorus (Extractable)	Soil	BS 3882: 2015	24	%
Potassium (Extractable)	Soil	BS 3882: 2015	20	%
Magnesium (Extractable)	Soil	BS 3882: 2015	26	%
Zinc	Soil	BS 3882: 2015	14.9	%
Copper	Soil	BS 3882: 2015	16	%
Nickel	Soil	BS 3882: 2015	17.7	%
Available Sodium	Soil	BS 3882: 2015	23	%
Available Calcium	Soil	BS 3882: 2015	23	%
Electrical Conductivity	Soil	BS 3882: 2015	10	%



TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 13/11/2020



Contract	Bartons Road, Havant		
Serial No.	37723_1		
Client: BRD Environmental Ltd BRD Environmental Ltd Hawthorne Villa 1 Old Parr Road Banbury Oxfordshire OX16 5HT		Soil Property Testing Ltd 15, 16, 18 Halcyon Court, St Margaret's Way, Stukeley Meadows, Huntingdon, Cambridgeshire, PE29 6DG Tel: 01480 455579 Email: enquiries@soilpropertytesting.com Website: www.soilpropertytesting.com	
Samples Submitted By: BRD Environmental Ltd Samples Labelled: Bartons Road, Havant		Approved Signatories: ☐ J.C. Garner B.Eng (Hons) FGS Technical Director & Quality Manager ☐ S.P. Townend Chairman ☐ W. Johnstone Materials Lab Manager ☒ D. Sabnis Operations Manager 	
Date Received: 30/10/2020		Samples Tested Between: 30/10/2020 and 13/11/2020	
Remarks: For the attention of Ian Hibberd Your Reference No: BRD3818			
Notes: 1 All remaining samples or remnants from this contract will be disposed of after 21 days from today, unless we are notified to the contrary. 2 (a) UKAS - United Kingdom Accreditation Service. (b) Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. 3 Tests marked "NOT UKAS ACCREDITED" in this test report are not included in the UKAS Accreditation Schedule for this testing laboratory. 4 This test report may not be reproduced other than in full except with the prior written approval of the issuing laboratory.			



TEST REPORT

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DATE ISSUED: 13/11/2020



0998

Contract		Bartons Road, Havant																			
Serial No.		37723_1										Target Date		13/11/2020							
Scheduled By		BRD Environmental Ltd																			
SCHEDULE OF LABORATORY TESTS																					
Schedule Remarks																					
Bore Hole No.	Type	Sample Ref.	Top Depth	Particle Size Distribution (BS1377) Water Content (BS59) Liquid/Plastic Limits Wet Sieve Preparation																Sample Remarks	
TP102	B	1	0.80	1																	
TP103	D	1	0.70		1	1	1														
TP109	B	1	0.60	1																	
TP109	D	2	1.40		1	1	1														
WS101	D	2	2.20		1	1	1														
WS102	D	1	1.10		1	1	1														
WS104	D	2	1.40		1	1															
WS104	D	4	3.50		1	1															
WS105	D	2	1.50		1	1															
WS105	D	3	2.60		1	1															
Totals				2	8	8	4												End of Schedule		



TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 13/11/2020



0998

Contract		Bartons Road, Havant												
Serial No.		37723_1												
SUMMARY OF WATER CONTENT, LIQUID LIMIT, PLASTIC LIMIT, PLASTICITY INDEX AND LIQUIDITY INDEX														
Borehole /Pit No.	Depth (m)	Type	Ref.	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasti- city Index (%)	Liquid- ity Index	Sample Preparation				Description	Class
									Method	Ret'd 0.425mm (%)	Corr'd W/C <0.425mm	Curing Time (hrs)		
TP103	0.70	D	1	10.9	48	19	29	-0.28	Wet Sieved	78 (M)	N/R*	27	Brown, black and white fine to coarse angular to subangular chert GRAVEL in a firm orangish brown slightly sandy silty clay matrix.	CI
TP109	1.40	D	2	13.4	52	20	32	-0.21	Wet Sieved	62 (M)	N/R*	26	Brown, black and white fine to coarse angular to subangular chert GRAVEL in a firm orangish brown slightly sandy clay matrix, with rare recently active roots.	CH
WS101	2.20	D	2	11.4	43	18	25	-0.26	Wet Sieved	67 (M)	N/R*	27	Brown, black and white fine to coarse angular to subrounded chert GRAVEL in a firm orangish brown slightly sandy clay matrix.	CI
WS102	1.10	D	1	9.2	23	14	9	-0.53	Wet Sieved	74 (M)	N/R*	27	Brown, black and white fine to coarse angular to subangular chert GRAVEL in a soft yellowish brown sandy silty clay matrix.	CL
WS104	1.40	D	2	36.9	75	26	49	0.22	From Natural	0 (A)		26	Firm yellowish brown CLAY with rare recently active roots.	CV
WS104	3.50	D	4	28.1	72	26	46	0.05	From Natural	0 (A)		26	Stiff yellowish brown CLAY with occasional bluish grey mottling, and rare decayed roots.	CV
WS105	1.50	D	2	22.9	72	25	47	-0.04	From Natural	0 (A)		26	Very stiff yellowish brown CLAY with occasional bluish grey mottling, and rare decayed roots.	CV
WS105	2.60	D	3	24.7	73	26	47	-0.03	From Natural	0 (A)		26	Very stiff closely fissured yellowish brown CLAY with occasional bluish grey mottling, and decayed roots.	CV
Method Of Preparation: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2:1990:4.2														
Method of Test: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2:1990:3.2, 4.4, 5.3, 5.4														
Type of Sample Key: U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter														
Comments: *Corrected water content assume material greater than 0.425mm is non-porous. See BS1377: Part 2: 1990 Clause 3 Note 1. Where N/R, corrected water content is not reported due to material type.														
Table Notation: Ret'd 0.425mm: (A) = Assumed, (M) = Measured														



TEST REPORT

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DATE ISSUED: 13/11/2020

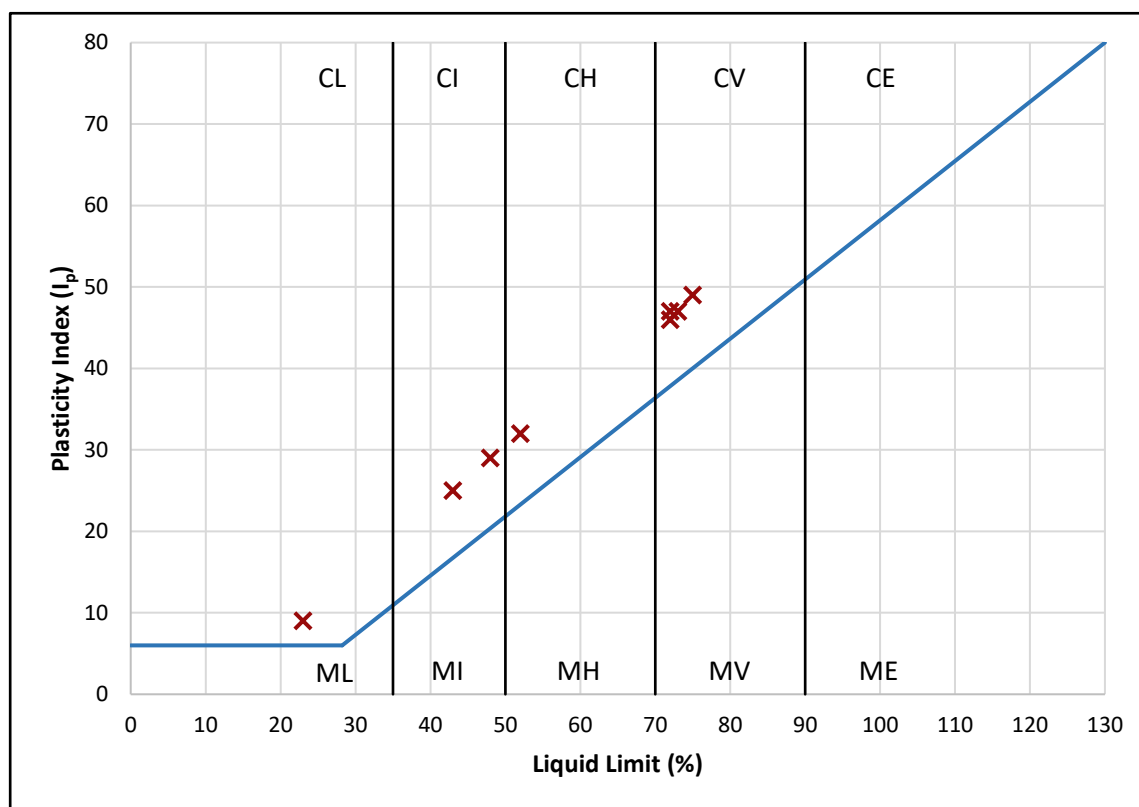


0998

Contract	Bartons Road, Havant
Serial No.	37723_1

PLOT OF PLASTICITY INDEX AGAINST LIQUID LIMIT USING CASAGRANDE CLASSIFICATION CHART

Plasticity				
Low	Medium	High	Very High	Extremely High



Plasticity Chart BS5930: 2015: Figure 8

NHBC Volume Change Potential	
High	
Medium	
Low	

Method of Preparation:	BS 1377: Part 2: 1990: 4.2
Method of Test:	BS1377: Part 2: 3.2, 4.4, 5.3, 5.4
Type of Sample Key:	U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter
Comments:	Volume Change Potential: NHBC Standards Chapter 4.2 Unmodified Plasticity Index



TEST REPORT

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DATE ISSUED: 13/11/2020



0998

Contract		Bartons Road, Havant						
Serial No.		37723_1						
DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX								
Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks		
		Type	Reference					
TP103	0.70	D	1	10.9	Brown, black and white fine to coarse angular to subangular chert GRAVEL in a firm orangish brown slightly sandy silty clay matrix.			
PREPARATION					Liquid Limit	48 %		
Method of preparation					Wet sieved over 0.425mm sieve	Plastic Limit	19 %	
Sample retained 0.425mm sieve (Measured)					78 %	Plasticity Index	29 %	
Corrected water content for material passing 0.425mm					Not reported	Liquidity Index	-0.28	
Sample retained 2mm sieve (Measured)					76 %	NHBC Modified (I'p)	6 %	
Curing time				27 hrs	Clay Content	Not analysed	Derived Activity	Not analysed
C=CLAY Plasticity Index % (Ip) M=SILT High Medium Low NHBC Volume Change Potential Liquid Limit % Plasticity Chart BS5930: 2015: Figure 8								
Method of Preparation: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2 Method of Test: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4 Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter Comments: Corrected water content not reported due to material type. Corrected water content assume material greater than 0.425mm non-porous. See BS1377: Part2: 1990 Clause 3 Note 1 Volume Change Potential: NHBC Standards Chapter 4.2 Unmodified Plasticity Index Note: Modified Plasticity Index I'p = Ip x (% less than 425microns/100)								



TEST REPORT

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0998

Contract		Bartons Road, Havant					
Serial No.		37723_1					
DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX							
Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks	
		Type	Reference				
TP109	1.40	D	2	13.4	Brown, black and white fine to coarse angular to subangular chert GRAVEL in a firm orangish brown slightly sandy clay matrix, with rare recently active roots.		
PREPARATION					Liquid Limit	52 %	
Method of preparation					Wet sieved over 0.425mm sieve	Plastic Limit	20 %
Sample retained 0.425mm sieve (Measured)					62 %	Plasticity Index	32 %
Corrected water content for material passing 0.425mm					Not reported	Liquidity Index	-0.21
Sample retained 2mm sieve (Measured)					58 %	NHBC Modified (I'p)	12 %
Curing time			26 hrs	Clay Content	Not analysed	Derived Activity	Not analysed
C=CLAY Plasticity Index % (Ip) M=SILT High Medium Low NHBC Volume Change Potential Liquid Limit % Plasticity Chart BS5930: 2015: Figure 8							
Method of Preparation: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2 Method of Test: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4 Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter Comments: Corrected water content not reported due to material type. Corrected water content assume material greater than 0.425mm non-porous. See BS1377: Part2: 1990 Clause 3 Note 1 Volume Change Potential: NHBC Standards Chapter 4.2 Unmodified Plasticity Index Note: Modified Plasticity Index I'p = Ip x (% less than 425microns/100)							



TEST REPORT

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0998

Contract		Bartons Road, Havant					
Serial No.		37723_1					
DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX							
Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks	
		Type	Reference				
WS101	2.20	D	2	11.4	Brown, black and white fine to coarse angular to subrounded chert GRAVEL in a firm orangish brown slightly sandy clay matrix.		
PREPARATION					Liquid Limit 43 %		
Method of preparation Wet sieved over 0.425mm sieve					Plastic Limit 18 %		
Sample retained 0.425mm sieve (Measured) 67 %					Plasticity Index 25 %		
Corrected water content for material passing 0.425mm Not reported					Liquidity Index -0.26		
Sample retained 2mm sieve (Measured) 57 %					NHBC Modified (I'p) 8 %		
Curing time 27 hrs		Clay Content Not analysed			Derived Activity Not analysed		
C=CLAY Plasticity Index % (Ip) M=SILT High Medium Low NHBC Volume Change Potential Liquid Limit % Plasticity Chart BS5930: 2015: Figure 8							
Method of Preparation: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2 Method of Test: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4 Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter Comments: Corrected water content not reported due to material type. Corrected water content assume material greater than 0.425mm non-porous. See BS1377: Part2: 1990 Clause 3 Note 1 Volume Change Potential: NHBC Standards Chapter 4.2 Unmodified Plasticity Index Note: Modified Plasticity Index I'p = Ip x (% less than 425microns/100)							



TEST REPORT

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DATE ISSUED: 13/11/2020



0998

Contract		Bartons Road, Havant								
Serial No.		37723_1								
DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX										
Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks				
		Type	Reference							
WS102	1.10	D	1	9.2	Brown, black and white fine to coarse angular to subangular chert GRAVEL in a soft yellowish brown sandy silty clay matrix.					
PREPARATION					Liquid Limit	23 %				
Method of preparation					Wet sieved over 0.425mm sieve	Plastic Limit	14 %			
Sample retained 0.425mm sieve (Measured)					74 %	Plasticity Index	9 %			
Corrected water content for material passing 0.425mm					Not reported	Liquidity Index	-0.53			
Sample retained 2mm sieve (Measured)					67 %	NHBC Modified (I'p)	2 %			
Curing time		27 hrs		Clay Content	Not analysed	Derived Activity	Not analysed			
C=CLAY Plasticity Index % (Ip) M=SILT <table border="1"> <tr> <td>High</td> <td rowspan="3">NHBC Volume Change Potential</td> </tr> <tr> <td>Medium</td> </tr> <tr> <td>Low</td> </tr> </table>							High	NHBC Volume Change Potential	Medium	Low
High	NHBC Volume Change Potential									
Medium										
Low										
Plasticity Chart BS5930: 2015: Figure 8										
Method of Preparation: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2 Method of Test: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4 Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter Comments: Corrected water content not reported due to material type. Corrected water content assume material greater than 0.425mm non-porous. See BS1377: Part2: 1990 Clause 3 Note 1 Volume Change Potential: NHBC Standards Chapter 4.2 Unmodified Plasticity Index Note: Modified Plasticity Index I'p = Ip x (% less than 425microns/100)										



TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 13/11/2020



0998

Contract		Bartons Road, Havant									
Serial No.		37723_1									
DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX											
Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks					
		Type	Reference								
WS104	1.40	D	2	36.9	Firm yellowish brown CLAY with rare recently active roots.						
PREPARATION					Liquid Limit	75 %					
Method of preparation					From natural	Plastic Limit	26 %				
Sample retained 0.425mm sieve (Assumed)					0 %	Plasticity Index	49 %				
Corrected water content for material passing 0.425mm						Liquidity Index	0.22				
Sample retained 2mm sieve (Assumed)					0 %	NHBC Modified (I'p)	n/a				
Curing time			26 hrs	Clay Content	Not analysed	Derived Activity	Not analysed				
C=CLAY Plasticity Index % (I_p) M=SILT <table border="1"> <tr> <td>High</td> <td rowspan="3">NHBC Volume Change Potential</td> </tr> <tr> <td>Medium</td> </tr> <tr> <td>Low</td> </tr> </table> Liquid Limit %								High	NHBC Volume Change Potential	Medium	Low
High	NHBC Volume Change Potential										
Medium											
Low											
Plasticity Chart BS5930: 2015: Figure 8											
Method of Preparation: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2											
Method of Test: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4											
Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter											
Comments:											



TEST REPORT

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0998

Contract		Bartons Road, Havant									
Serial No.		37723_1									
DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX											
Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks					
		Type	Reference								
WS104	3.50	D	4	28.1	Stiff yellowish brown CLAY with occasional bluish grey mottling, and rare decayed roots.						
PREPARATION					Liquid Limit	72 %					
Method of preparation					From natural	Plastic Limit	26 %				
Sample retained 0.425mm sieve (Assumed)					0 %	Plasticity Index	46 %				
Corrected water content for material passing 0.425mm						Liquidity Index	0.05				
Sample retained 2mm sieve (Assumed)					0 %	NHBC Modified (I'p)	n/a				
Curing time		26 hrs		Clay Content	Not analysed	Derived Activity	Not analysed				
C=CLAY Plasticity Index % (Ip) M=SILT <table border="1"> <tr> <td>High</td> <td rowspan="3">NHBC Volume Change Potential</td> </tr> <tr> <td>Medium</td> </tr> <tr> <td>Low</td> </tr> </table> Liquid Limit %								High	NHBC Volume Change Potential	Medium	Low
High	NHBC Volume Change Potential										
Medium											
Low											
Plasticity Chart BS5930: 2015: Figure 8											
Method of Preparation: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2 Method of Test: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4 Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter Comments:											



TEST REPORT

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DATE ISSUED: 13/11/2020



0998

Contract		Bartons Road, Havant							
Serial No.		37723_1							
DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX									
Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks			
		Type	Reference						
WS105	1.50	D	2	22.9	Very stiff yellowish brown CLAY with occasional bluish grey mottling, and rare decayed roots.				
PREPARATION					Liquid Limit	72 %			
Method of preparation					From natural	Plastic Limit 25 %			
Sample retained 0.425mm sieve (Assumed)					0 %	Plasticity Index 47 %			
Corrected water content for material passing 0.425mm						Liquidity Index -0.04			
Sample retained 2mm sieve (Assumed)					0 %	NHBC Modified (I'p) n/a			
Curing time			26 hrs	Clay Content	Not analysed	Derived Activity Not analysed			
C=CLAY Plasticity Index % (Ip) M=SILT <table border="1"> <tr><td>High</td></tr> <tr><td>Medium</td></tr> <tr><td>Low</td></tr> </table> NHBC Volume Change Potential Liquid Limit % Plasticity Chart BS5930: 2015: Figure 8							High	Medium	Low
High									
Medium									
Low									
Method of Preparation: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2 Method of Test: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4 Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter Comments:									



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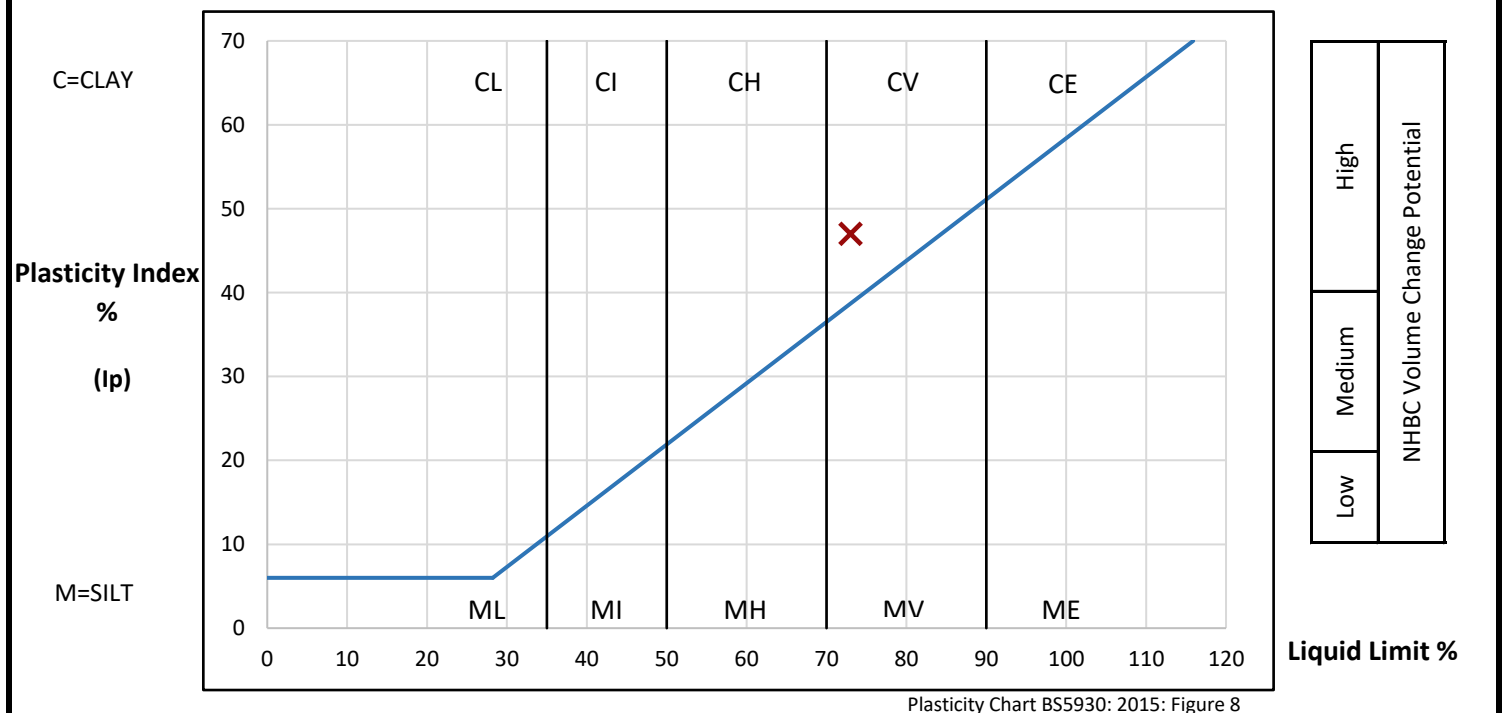
0998

Contract	Bartons Road, Havant
Serial No.	37723_1

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

Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks
		Type	Reference			
WS105	2.60	D	3	24.7	Very stiff closely fissured yellowish brown CLAY with occasional bluish grey mottling, and decayed roots.	

PREPARATION			Liquid Limit	73 %		
Method of preparation			From natural	Plastic Limit	26 %	
Sample retained 0.425mm sieve (Assumed)			0 %	Plasticity Index	47 %	
Corrected water content for material passing 0.425mm				Liquidity Index	-0.03	
Sample retained 2mm sieve (Assumed)			0 %	NHBC Modified (I'p)	n/a	
Curing time		26 hrs	Clay Content	Not analysed	Derived Activity	Not analysed



Method of Preparation: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2
 Method of Test: BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4
 Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter
 Comments:



TEST REPORT

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DATE ISSUED: 13/11/2020



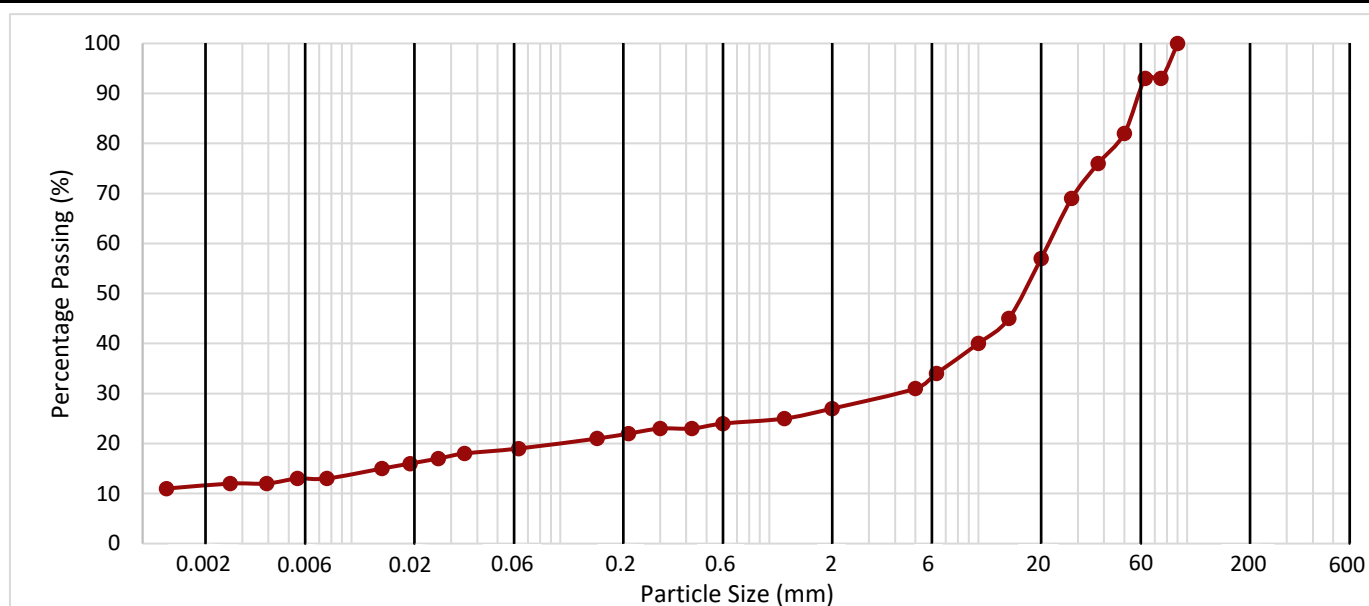
0998

Contract	Bartons Road, Havant
Serial No.	37723_1

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Pit No.	Depth (m)	Sample		Description	Remarks
		Type	Reference		
TP102	0.80	B	1	Black, white and brown angular to rounded chert GRAVEL in a soft orangish brown slightly sandy silty clay matrix with occasional light grey mottling	Dry mass of sample required 35kg. Mass of sample submitted 13.187kg. Sample Unrepresentative BS1377:Part 2:1990 Table 3.

Method of Test: **Wet Sieve + Hydrometer** Method of Pretreatment: **Not required**



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

H y d r o m e t e r	Particle Size (mm)	Passing (%)	Silt by Dry Mass (%)
	0.0347	18	7
	0.0260	17	
	0.0191	16	
	0.0140	15	
	0.0076	13	Clay by Dry Mass (%)
	0.0055	13	
	0.0039	12	
	0.0026	12	
	0.0013	11	12

Sieve Size (mm)	Passing (%)	Sand By Dry Mass (%)
2.00	27	8
1.18	25	
0.600	24	
0.425	23	
0.300	23	
0.212	22	
0.150	21	
0.063	19	

Fines By Dry Mass (%)	
<0.063mm	19

Sieve Size (mm)	Passing (%)	2mm+ By Dry Mass (%)
300		73
125		
90	100	
63	93	
50	82	
37.5	76	
28	69	
20	57	
14	45	
10	40	
6.3	34	
5	31	

Method of Preparation: BS1377: Part 1: 2016: 8.3 & 8.4.5
 Method of test: BS1377: Part 2: 1990: 9.2,9.5
 Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter
 Comments:



TEST REPORT

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0998

Contract	Bartons Road, Havant
Serial No.	37723_1

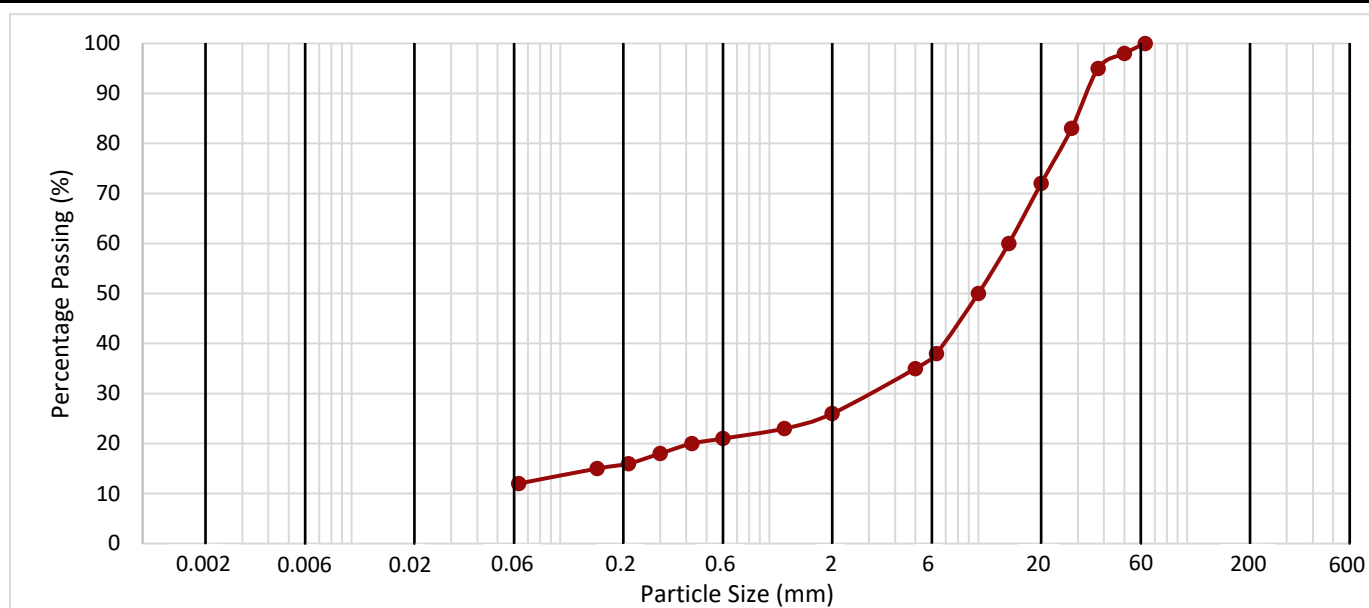
DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Pit No.	Depth (m)	Sample		Description	Remarks
		Type	Reference		
TP109	0.60	B	1	Brown, white and black angular to rounded chert GRAVEL in a firm brown and orangish brown slightly sandy silty clay matrix	

Method of Test: Wet Sieve

Method of Pretreatment:

Not required



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

Hydrometer	Particle Size (mm)	Passing (%)	Silt by Dry Mass (%)
	Particle Size (mm)	Passing (%)	Clay by Dry Mass (%)

Sieve Size (mm)	Passing (%)	Sand By Dry Mass (%)
2.00	26	14
1.18	23	
0.600	21	
0.425	20	
0.300	18	
0.212	16	
0.150	15	
0.063	12	

Fines By Dry Mass (%)	
<0.063mm	12

Sieve Size (mm)	Passing (%)	2mm+ By Dry Mass (%)
300		74
125		
90		
63	100	
50	98	
37.5	95	
28	83	
20	72	
14	60	
10	50	
6.3	38	
5	35	

Method of Preparation: BS1377: Part 1: 2016: 8.3 & 8.4.5
 Method of test: BS1377: Part 2: 1990: 9.2
 Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter
 Comments:



TEST REPORT
ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 19/11/2020



0998

Contract	Bartons Road, Havant		
Serial No.	37723_2		
Client: BRD Environmental Ltd BRD Environmental Ltd Hawthorne Villa 1 Old Parr Road Banbury Oxfordshire OX16 5HT		Soil Property Testing Ltd 15, 16, 18 Halcyon Court, St Margaret's Way, Stukeley Meadows, Huntingdon, Cambridgeshire, PE29 6DG Tel: 01480 455579 Email: enquiries@soilpropertytesting.com Website: www.soilpropertytesting.com	
Samples Submitted By: BRD Environmental Ltd Samples Labelled: Bartons Road, Havant		Approved Signatories: ☐ J.C. Garner B.Eng (Hons) FGS Technical Director & Quality Manager ☐ S.P. Townend Chairman ☐ W. Johnstone Materials Lab Manager ☒ D. Sabnis Operations Manager 	
Date Received: 30/10/2020		Samples Tested Between: 30/10/2020 and 19/11/2020	
Remarks: For the attention of Ian Hibberd Your Reference No: BRD3818			
Notes: 1 All remaining samples or remnants from this contract will be disposed of after 21 days from today, unless we are notified to the contrary. 2 (a) UKAS - United Kingdom Accreditation Service. (b) Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. 3 Tests marked "NOT UKAS ACCREDITED" in this test report are not included in the UKAS Accreditation Schedule for this testing laboratory. 4 This test report may not be reproduced other than in full except with the prior written approval of the issuing laboratory.			



TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 19/11/2020



0998

Contract		Bartons Road, Havant																		
Serial No.		37723_2												Target Date		18/11/2020				
Scheduled By		BRD Environmental Ltd																		
SCHEDULE OF LABORATORY TESTS																				
Schedule Remarks																				
Bore Hole No.	Type	Sample Ref.	Top Depth	Particle Size Distribution (BS1377)																Sample Remarks
TS101	B	1	0.05	1																
Totals				1																End of Schedule



TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 19/11/2020



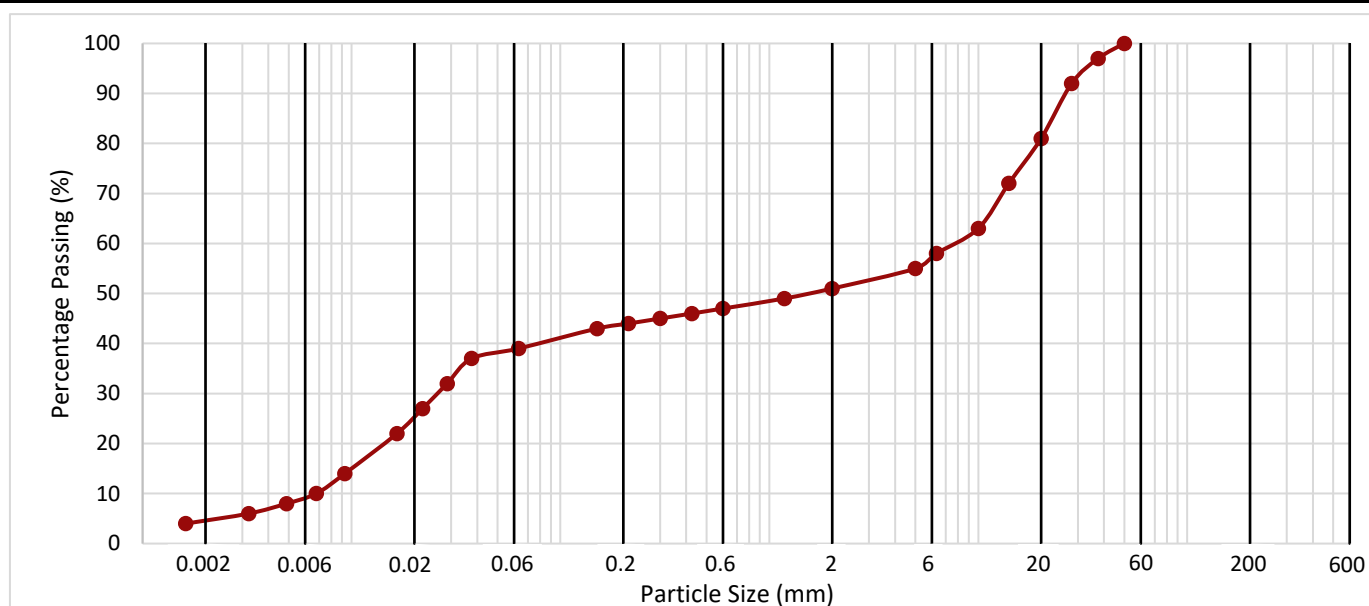
0998

Contract	Bartons Road, Havant
Serial No.	37723_2

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Pit No.	Depth (m)	Sample		Description	Remarks
		Type	Reference		
TS101	0.05	B	1	Brown slightly clayey slightly sandy gravelly SILT with frequent recently active roots. Gravel is black, white and brown subangular and subrounded chert and rare yellowish white quartzite	

Method of Test: **Wet Sieve + Hydrometer** Method of Pretreatment: **Not required**



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

H y d r o m e t e r	Particle Size (mm)	Passing (%)	Silt by Dry Mass (%)
	0.0376	37	35
	0.0287	32	
	0.0219	27	
	0.0165	22	
	0.0093	14	Clay by Dry Mass (%)
	0.0068	10	
	0.0049	8	
	0.0032	6	
	0.0016	4	4

Sieve Size (mm)	Passing (%)	Sand By Dry Mass (%)
2.00	51	12
1.18	49	
0.600	47	
0.425	46	
0.300	45	
0.212	44	
0.150	43	
0.063	39	

Fines By Dry Mass (%)	
<0.063mm	39

Sieve Size (mm)	Passing (%)	2mm+ By Dry Mass (%)
300		49
125		
90		
63		
50	100	
37.5	97	
28	92	
20	81	
14	72	
10	63	
6.3	58	
5	55	

Method of Preparation: BS1377: Part 1: 2016: 8.3 & 8.4.5
 Method of test: BS1377: Part 2: 1990: 9.2,9.5
 Type of Sample Key: U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter
 Comments:

APPENDIX 4



— APPROXIMATE SITE BOUNDARY

NOT TO SCALE

Project:

Land to the west of Spire Portsmouth Hospital, Bartons Road, Havant, Hampshire PO9 5NP

Client:

White Farming Ltd c/o C&A Consulting Engineers

Date:

June 2018

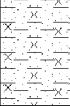
Ref:

GWPR2493

Trial Hole Location Plan

Figure 4

ground&water

Ground and Water Ltd								Borehole No WS1 Sheet 1 of 1	
Project Name Land W/SW Spire Portsmouth Hospital				Project No. GWPR2493		Co-ords: -		Hole Type WLS	
Location: Bartons Road, Havant, PO9 5NP						Level: -		Scale 1:50	
Client: White Farming Limited						Dates: 08/05/2018		Logged By JH	
Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30	D		0.30			TOPSOIL: Brown gravelly sand. Sand is fine to coarse grained. Gravel is abundant, fine to coarse, sub-angular to sub-rounded flint.	
		0.50	D					HEAD DEPOSITS: Brown/orange sandy gravelly CLAY. Sand is fine to coarse grained. Gravel is abundant, fine to coarse, sub-angular to sub-rounded flint.	
		0.80	D		0.70			LONDON CLAY FORMATION: Brown/orange sandy silty CLAY. Sand is fine grained.	
		1.50	D		1.50			LONDON CLAY FORMATION: Brown orange grey mottled CLAY.	
		2.50	D		3.00			End of Borehole at 3.00 m	

Ground and Water Ltd										Borehole No WS2 Sheet 1 of 1	
Project Name Land W/SW Spire Portsmouth Hospital					Project No. GWPR2493		Co-ords: -			Hole Type WLS	
Location: Bartons Road, Havant, PO9 5NP							Level: -			Scale 1:50	
Client: White Farming Limited							Dates: 08/05/2018			Logged By JH	
Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		0.30	D		0.30			TOPSOIL: Brown gravelly sand. Sand is fine to coarse grained. Gravel is abundant, fine to coarse, sub-angular to sub-rounded flint. HEAD DEPOSITS: Brown/orange sandy gravelly CLAY. Sand is fine to coarse grained. Gravel is very abundant, fine to coarse, sub-angular to sub-rounded flint.		1	
		0.50	D								
		0.80	D								
		1.50	D								
		2.50	D								
					3.00			End of Borehole at 3.00 m		3	
									4		
									5		
									6		
									7		
									8		
									9		
Remarks: No groundwater encountered. Roots noted to 0.30m bgl.											

Ground and Water Ltd						Trialpit No TP4 Sheet 1 of 1		
Project Name Land W/SW Spire Portsmouth Hospital			Project No. GWPR2493		Co-ords: - Level: -		Date 23/03/2018	
Location: Bartons Road, Havant, PO9 5NP					Dimensions: - Depth 1.70m		Scale 1:25	
Client: White Farming Limited							Logged By JH	
Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description		
Depth (m)	Type	Results						
0.30	D		0.40			TOPSOIL: Dark brown gravelly sand. Sand is fine to coarse grained. Gravel is occasional to abundant, fine to medium, sub-angular to sub-rounded flint.	1	
0.50	D					HEAD DEPOSITS: Brown sandy GRAVEL. Sand is fine to coarse grained. Gravel is abundant, fine to coarse, sub-angular to sub-rounded flint.		
0.80	D					HEAD DEPOSITS: Light brown/orange sandy clayey GRAVEL. Sand is fine to coarse grained. Gravel is abundant, fine to very coarse, sub-angular to sub-rounded flint. Becoming more clayey at 1.00m bgl.		
1.00	D					2		
1.50	D		1.50		HEAD DEPOSITS: Red/orange gravelly CLAY. Gravel is occasional to abundant, fine to coarse, sub-angular to sub-rounded flint.			
1.70	D		1.70				3	
						Trialpit Complete at 1.70 m		4
Remarks: Roots noted to 0.40m bgl.								
Groundwater: No groundwater encountered.								

