Report Title:

Geo-Environmental Site Investigation

Project Name:

Land South West of Well Row, Bayford

Report Reference: BRD4052-OR1-A

Date: February 2022

BRD Environmental Ltd
Hawthorne Villa, 1 Old Parr Road,
Banbury, Oxfordshire, OX16 5HT
01295 272244 info@brduk.com
www.brduk.com

REPORT CONTROL SHEET

REPORT TITLE	GEO-ENVIRONMENTAL SITE INVESTIGATION
PROJECT	LAND SOUTH WEST OF WELL ROW, BAYFORD
CLIENT	BONNEL HOMES

REPORT REFERENCE	ISSUE DETAIL	DATE	PREPARED BY	CHECKED BY
BRD4052-OR1-A	First Issue	11/02/2022	R Davies & A Leon	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

Hawthorne Villa, 1 Old Parr Road, Banbury, Oxfordshire. OX16 5HT
T: 01295 272244 www.brduk.com info@brduk.com

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 6
   - 3.1. INVESTIGATION DESIGN 6
   - 3.2. BRD FIELDWORK 6
   - 3.3. LABORATORY TESTING 7
4. GROUND CONDITIONS 9
   - 4.1. OVERVIEW 9
   - 4.2. TOPSOIL AND MADE GROUND TOPSOIL 9
   - 4.3. SUPERFICIAL DEPOSITS 9
   - 4.4. BEDROCK 10
   - 4.5. GEOTECHNICAL COMMENTS 10
   - 4.6. CONTAMINATION OBSERVATIONS 10

4.7. GROUNDWATER BEHAVIOUR 10
4.8. GROUNDWATER MONITORING 10
5. GEOTECHNICAL PROPERTIES 11
5.1. COARSE SOIL PARAMETERS 11
5.2. FINE SOIL PARAMETERS 11
5.3. SULPHATE AND pH 14
6. GEOTECHNICAL ASSESSMENT 15
6.1. INTRODUCTION 15
6.2. EXCAVATIONS 15
6.3. SLOPE STABILITY 16
6.4. SUB-SURFACE CONCRETE 16
6.5. SOAKAWAYS 17
6.6. PAVEMENT CONSTRUCTION 17
6.7. PRELIMINARY FOUNDATION RECOMMENDATIONS 17
7. RISK ESTIMATION - SOILS 21
7.1. HUMAN HEALTH 21
7.2. WATER ENVIRONMENT 22
7.3. BUILDING MATERIALS 23
8. RISK EVALUATION 24
8.1. REVISED CONCEPTUAL MODEL 24
8.2. UPDATED CONTAMINATION RISK ASSESSMENT 24
8.3. RISK MANAGEMENT 25
8.4. WASTE SOIL DISPOSAL 25
9. HEALTH AND SAFETY FILE INFORMATION 26
9.1. INTRODUCTION 26
9.2. HAZARDS 26
9.3. HAZARDOUS MATERIALS 26
9.4. UTILITY SERVICES 26
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. BRD4052-OP2-A
	Site Photographs	Ref. BRD4052-OP3-A
	Revised Conceptual Site Model	Ref. BRD4052-OP5-A
	Preliminary Site Plan	Ivan J Clarke & John W. Barrett, architectural design consultants. Initial Plan. Ref. N/A, Date: N/A
	Exploratory Hole Location Plan	Ref. BRD4052-OD1-A
APPENDIX 2	EXPLORATORY HOLE & MONITORING RECORDS	
	Log of hand dug pit	Ref. HD01
	Photographic records of hand dug pit.	Ref. BRD4052-OP4-A
	Logs of boreholes.	Ref. WS01-WS04
	BRE365 soakage test records.	1 x A4 pages
	Groundwater monitoring records.	1 x A4 pages
APPENDIX 3	LABORATORY TEST RESULTS	
	DETS report 21-14849	12 x A4 pages
	SPT report 39947_1	9 x A4 pages

SUMMARY REPORT - GENERAL INFORMATION

SUBJECT	COMMENTS
CURRENT SITE CONDITION	The site currently comprises a disused playground, which has had the play equipment removed and much of the vegetation recently removed.
PROPOSED DEVELOPMENT	It is proposed that the site will be developed as a single residential dwelling and associated private driveway and garden area.
HISTORICAL SUMMARY	The site was developed from part of a large field into part of a garden to a neighbouring vicarage at some point between 1899 and 1923. By 1999 the site is shown as a playground, the play equipment had been removed and the site had become overgrown by 2019.
PUBLISHED GEOLOGY	The site is shown to be underlain by superficial deposits comprising of Sand and Gravel of Uncertain Age and Origin in the eastern corner of the site, the rest of the site is shown to be devoid of superficial deposits. The shallowest bedrock unit is shown to be the London Clay Formation.
ACTUAL GROUND CONDITIONS	The investigation has proved a thin cover of Topsoil / Made Ground Topsoil overlying the Sand and Gravel of Uncertain Age and Origin across most of the site which in turn was underlain by the London Clay Formation.
HYDROGEOLOGY	The site is situated upon superficial deposits designated a Secondary A Aquifer. The underlying bedrock geology is designated as an Unproductive Strata. The site is located within a groundwater Source Protection 3 (Total Catchment).
HYDROLOGY	The closest water feature to the site is a pond located approximately 50m to the south east. The site is not in an area indicated to be at risk of flooding.
PREVIOUS GROUND REPORTS	BRD is not aware of any previous ground investigations having been conducted at the site.

SUMMARY REPORT - GEOTECHNICAL

SUBJECT	COMMENTS
EXCAVATIONS	It should be possible to forward excavations employing normal equipment. Limited groundwater control in the form of pumping from sumps is likely to be required. It is likely that requirements of the Party Wall Act will apply to the development.
SLOPE STABILITY	There are steep slopes at the site, but no obvious signs of instability have been observed. The stability of the slopes should be actively considered with planning any changes to the slopes as part of the development.
SUB-SURFACE CONCRETE	Sand & Gravel: Design Sulphate Class of DS-1 and Aggressive Chemical Environment for Concrete class of AC-2z applies. London Clay Formation: Design Sulphate Class of DS-3 and Aggressive Chemical Environment for Concrete class of AC-2s applies but should be subject to further testing.
SOAKAWAYS	Site is not suitable for surface water disposal to soakaways or other forms of infiltration device.
PAVEMENT DESIGN	A preliminary design California Bearing Ratio (CBR) of 4% has been recommended.
FOUNDATIONS	
LIKELY FOUNDATION TYPE	A thickened edge raft foundation is anticipated at semi-basement level. However, due to tree influence on required foundation depths, the need for temporary support to the excavation for the semi-basement structure will be required together with trench fill footings. The whole foundation will require appropriate reinforcement.
VOLUME CHANGE POTENTIAL	High i.e. significant swelling or shrinking with moisture content changes.
ESTIMATED FOUNDATION DEPTHS	The minimum footing depth required is 1.0m, however due to the tree influence and basement floor construction foundations depths to about 2.7m depth will be required.
HEAVE PROTECTION	Will be required.

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	No plausible sources of landfill gas have been identified.
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.
REMEDIATION	No remedial works are considered necessary to facilitate the development at this stage.
ASBESTOS	No asbestos has been detected in the soil sample tested.
WASTE SOIL DISPOSAL	It is considered that the topsoil disposed of from the site, even though it is uncontaminated, is unlikely to constitute 'inert waste' due to its high organic matter content. It is considered that the sub-soils disposed of from the site would be classified as 'non-hazardous waste' and would be characterised for disposal to landfill as 'inert waste'.

SUMMARY REPORT - KEY RECOMMENDATIONS

RECOMMENDATIONS
It would be prudent for further groundwater monitoring to be undertaken to assess the variation in the water table with seasonal or short term weather effects. Further testing of the London Clay Formation is recommended to confirm classification. If concrete at depths greater than 2.5m below existing ground level are planned as it may be pyrite. Samples could be taken for analysis once the design depths have been confirmed.

1. INTRODUCTION TO TECHNICAL REPORT

1.1. CONTRACT DETAILS

CLIENT	Bonnel Homes Limited trading as Bonnel Homes.
SITE	Land situated at Well Row in the village of Bayford, Hertfordshire.
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 purpose of the report is to present the findings of a ground 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:

Desk based research through the purchase of an Envirocheck report, including:

- Environmental database search.
- Environment Agency data.
- BGS radon maps.
- Available historical Ordnance Survey plans.

Interpretation of the geological, hydrogeological and hydrology setting of the site from published sources.

Mobilisation to site and production of health and safety documentation.

Undertake a Cable Avoidance Tool (CAT) scan at each exploratory point location.

One day of windowless sampling using a percussive drilling rig to provide approximately 4-5No. boreholes to a nominal depth of 5-6m, ground conditions permitting. Undertake Standard Penetration Tests (SPT) at 1m intervals.

Installation of a 3m depth combined gas and groundwater monitoring well (nominal 50mm diameter) into 1No. borehole. Installation will be finished with a flush fitting metal stopcock cover.

A falling head permeability test or simple soakage test (as appropriate the ground conditions) will also be undertaken within the monitoring well to determine likely soil permeability or infiltration rates.

All exploratory points will be logged and sampled in general accordance with BS5930:2015 by supervising Geo-Environmental Consultant. In-situ geotechnical testing of fine soils using a Hand Shear Vane and/or Pocket Penetrometer.

Determination of the location of exploratory points by tape measurements or the use of a handheld recreational GPS unit.

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:

- 5No. Metals Suite - As, Cd, Cr, CrVI, Hg, Pb, Se, Cu, Ni and Zn.
- 5No. Inorganics Suite – water soluble sulphate, pH, organic matter.
- 5No. Speciated Polycyclic Aromatic Hydrocarbons (PAH).
- 1No. Banded aliphatic/aromatic Total Petroleum Hydrocarbons (TPH).
- 1No. Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and Methyl Tertiary Butyl Ether (MTBE) compounds.
- 1No. Semi-Volatile Organic Compounds (SVOC) suite.
- 1No. Asbestos quantification.

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:

- 5No. Moisture content.
- 5No. Plasticity indices.
- 5No. pH and water soluble sulphate analysis.
- 5No. Total sulphate and sulphur analysis.

Provision of a combined factual and interpretative investigation report. Factual findings to include all exploratory point records 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.

After preliminary work, the scope was expanded to include the following items:

1No. return groundwater monitoring visit to determine resting groundwater levels and to undertake a falling head permeability test or simple soakage test (as appropriate the ground conditions) within one of the monitoring wells to determine likely soil permeability or infiltration rates.

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	Land south west of Well Row, Bayford, Hertford, Hertfordshire, SG13 8PW.
NATIONAL GRID REFERENCE	530980E, 208560N.

2.2. SITE DESCRIPTION

SUBJECT	COMMENTS
CURRENT SITE DESCRIPTION	The site currently comprises a disused playground, which has had the play equipment removed and much of the vegetation recently removed. The site is approximately rectangular in shape and covers an area of approximately 0.08 hectares. The site slopes from the north east to the south west by approximately 2.8m with an 'L' shaped embankment present in the centre of the site between approximately 1.20m and 0.20m in height. The embankment is surfaced by overgrown grass, brambles and bamboo. Given the topography of the surrounding area and the shape of the embankment, it would appear the embankment was most likely formed by cutting into the slope on the site, most likely to form a level area from when the site was part of a private garden area. There is a mature oak tree located in the south west of the site, there is a row of mature conifers present along the north western site boundary, a mature laurel tree is present in the northern corner of the site. There are also several mature trees present along the south western and south eastern site boundaries however, it was not possible to identify any of the other tree species during the walkover. There are several tree stumps present in the site where trees and bushes have recently been felled, there were laurel sapling growing from some of the tree stumps present in the east of the site.
SURROUNDING LAND USE	The site is located within a mixed agricultural and residential area. The site is bounded to the north east by Well Row road, by residential properties to the south east and north west and by an open field to the south west.
PROPOSED DEVELOPMENT	It is proposed that the site will be developed as a single residential dwelling and associated private driveway and garden area.
HISTORICAL SUMMARY	The site was developed from part of a large field into part of a garden to a neighbouring vicarage at some point between 1899 and 1923. By 1999 the site is shown as a playground, the play equipment had been removed and the site had become overgrown by 2019.

SUBJECT	COMMENTS
PUBLISHED GEOLOGY	The site is shown to be underlain by superficial deposits comprising of Sand and Gravel of Uncertain Age and Origin in the eastern corner of the site, the rest of the site is shown to be devoid of superficial deposits. The shallowest bedrock unit is shown to be the London Clay Formation.
RADON	Radon protection measures are not required.
HYDROGEOLOGY	The superficial deposits comprising of Sand and Gravel of Uncertain Age and Origin in the eastern corner of the site are designated a Secondary A Aquifer. The shallowest bedrock unit, the London Clay Formation is designated as an unproductive strata. The site is located within a Source Protection Zone 3 (Total Catchment).
HYDROLOGY	The closest water feature to the site is a pond located approximately 50m to the south east. The nearest stream is an unnamed tributary of the River Lee located approximately 420m to the south west which flows in a north before joining the River Lee, approximately 1.7km to the north which flows east. The site is not in an area indicated to be at risk of flooding.

2.3. PREVIOUS INVESTIGATIONS

BRD is not aware of any previous ground investigations having been conducted at the site.

3. GROUND INVESTIGATION

3.1. INVESTIGATION DESIGN

METHODOLOGY	Windowless sample boreholes were selected as a monitoring installation was required, because access was limited and because in-situ density tests were required in the coarse soils. A hand dug pit was selected as access to the south western end of the site was limited by the overgrown embankment.	
DATES OF SITE WORKS	The main field works were undertaken on 16th December 2021.	
CONSTRAINTS TO EXPLORATORY HOLE LAYOUT	It was not certain that the windowless sample drilling rig would be able to get back up the embankment in the centre of the site and as such no borehole were undertaken in the south western end of the site.	
EXPLORATORY HOLE SPACING	Approximately 8m grid.	
LAYOUT RATIONALE	SOURCE / FEATURE	EXPLORATORY HOLE
CONTAMINATION SOURCES TARGETED	General site coverage.	WS01-WS04 and HD01.
GROUND FEATURES TARGETED	General site coverage.	WS01-WS04 and HD01.
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 a part of a garden area and a playground, BRD has scheduled a suite of typically occurring contaminants and a suite of contaminants required to determine water supply pipe specifications.	

3.2. BRD FIELDWORK

HAND DUG INSPECTION PITS	
REFERENCES	HD01
DEPTH RANGE	0.80m.
BACKFILL	The inspection pit was backfilled with arisings upon completion.

WINDOWLESS SAMPLING BOREHOLES	
REFERENCES	WS01 to WS04.
DEPTH RANGE	From 2.45m to 6.45m.
RIG TYPE	Premier Drilling Rig.
INSTALLATION / BACKFILL	Boreholes WS01, WS03 and WS04 were backfilled with arisings only. Borehole WS01 had a monitoring well installed. This comprised 50mm nominal diameter standpipe fitted with a gas tap finished with a flush metal cover. The slotted response length of the well is shown on the individual log. Bentonite seals are also indicated on the log. The filter medium used was pea gravel.

MONITORING	
TYPE	Groundwater monitoring.
DATES	14/01/2022
GROUNDWATER SAMPLING METHOD	No samples taken, only groundwater levels measured.

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	5
Liquid and plastic limits	5
pH and Water soluble Sulphate	5
Total Sulphur and Sulphate	5

SOIL CHEMICAL TESTING	
The soil samples for contamination and 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	5
Speciated Polycyclic Aromatic Hydrocarbons (PAH)	5
Total Petroleum Hydrocarbons (TPH) with full carbon banding and aliphatic/aromatic split	1
Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) plus Methyl Tert Butyl Ether (MTBE)	1
Fibrous Material Screen (for Asbestos)	1
Semi-Volatile Organic Compounds (SVOCs)	1
Waste Acceptance Criteria (WAC) testing	1

4. GROUND CONDITIONS

4.1. OVERVIEW

The ground conditions encountered differed slightly from the published geology maps with a thin cover of Topsoil / Made Ground Topsoil overlying the Sand and Gravel of Uncertain Age and Origin across most of the site which in turn was underlain by the London Clay Formation.

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

4.2. TOPSOIL AND MADE GROUND TOPSOIL

Topsoil was encountered across the site in boreholes WS01 and WS02 and in hand dug pit HD01 from ground level to depths of between 0.10m below ground level (m bgl) and 0.30m bgl. The topsoil was described as either dark brown, slightly silty, slightly gravelly, clayey sand or a dark brown, slightly silty, slightly gravelly clay. Gravel of fine to coarse, angular to sub-rounded flint and quartzite with many rootlets and roots up to 30mm in diameter.

The Made Ground Topsoil was encountered in borehole WS03 and WS04 in the northern corner of the site from ground level to a depth of 0.40m bgl. The Made Ground Topsoil was described as either dark brown, slightly silty, slightly gravelly, clayey sand or a dark brown, slightly silty, slightly gravelly clay. Gravel of fine to coarse, angular to sub-rounded flint, quartzite and rare brick with many rootlets and roots up to 30mm in diameter

4.3. SUPERFICIAL DEPOSITS

4.3.1. Sand and Gravel of Uncertain Age and Origin

The Sand and Gravel of Uncertain Age and Origin, hereinafter referred to as 'Sand & Gravel' was encountered across most of the site to a depth of between 0.40m bgl, deepening in the south east of the site to between 2.00m bgl and 2.10m bgl. The Sand & Gravel was variable in nature and typically encountered as one or more of the following strata:

Stiff, orange brown, silty, gravelly CLAY with occasional rootlets. Gravel of fine to coarse, sub-angular to rounded flint and quartzite.

Medium dense, orange brown, clayey, sandy GRAVEL of fine to coarse, sub-angular to rounded flint and quartzite.

Medium dense, brown becoming orange brown, gravelly to very gravelly, medium SAND. Gravel of fine to coarse, angular to sub-rounded flint and quartzite.

Stiff, orange brown, sandy, very gravelly CLAY. Gravel of fine to coarse, angular to sub-rounded flint and quartzite.

Very stiff, fissured, orange brown mottled brown, slightly silty CLAY with occasional rootlets and rare flint and quartzite gravel.

4.4. BEDROCK

4.4.1. London Clay Formation

The London Clay Formation was encountered either underlying the Sand & Gravel or from surface in the northern corner of the site in borehole WS04. It was proven to a maximum depth of 6.45m bgl. The London Clay Formation was typically encountered as either firm to stiff, fissured, orange brown with some grey mottling, slightly silty clay with rare relict rootlets. Or a stiff to very stiff, fissured, brown with some grey mottling, slightly silty clay with rare relict rootlets.

4.5. GEOTECHNICAL COMMENTS

The slopes across the site and the embankment towards the centre area might be have an impact on the site development.

4.6. CONTAMINATION OBSERVATIONS

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

4.7. GROUNDWATER BEHAVIOUR

Groundwater was not encountered whilst forwarding the exploratory holes, but the gravelly to very gravelly sand layer within the Sand & Gravel in borehole WS02 was noted to be wet between 0.90m bgl and 1.00m bgl.

4.8. GROUNDWATER MONITORING

DATE	RESTING GROUNDWATER RANGE	COMMENTS
14/01/22	1.15m bgl.	Only borehole WS02, located in the higher eastern end of the site, was installed with a monitoring well. The monitoring visit undertaken following a period of relatively wet weather recorded standing groundwater at a relatively shallow depth of 1.15m bgl. This is groundwater perched within the superficial Sand and Gravel upon the effectively impermeable London Clay.

5. GEOTECHNICAL PROPERTIES

5.1. COARSE SOIL PARAMETERS

5.1.1. Variable Head Permeability

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
WS02	2.07×10^{-7} m/s	GL-1.0m: Medium dense, orange brown, gravelly to very gravelly medium SAND. 1.0-2.0m: Medium dense, slightly sandy, very clayey GRAVEL.

5.1.2. Standard Penetration Tests (SPTs)

Two SPTs were undertaken in the coarse soils of the Sand & Gravel superficial deposits at a depth of 1.0m bgl in boreholes WS01 and WS02. The N-values were of 14 and 17 indicative of medium dense relative density soils.

5.2. FINE SOIL PARAMETERS

5.2.1. Index Property Testing

SOIL TYPE	Sand & Gravel.
PLASTICITY INDEX (PI)	Oversize particles present.
MODIFIED PI	8% - Non shrinkable soil type (clayey gravel bed). 17% - Low volume change potential (gravelly clay bed).
COMMENTS	The Sand & Gravel deposits were recorded comprising from gravel to clayey beds. The coarse deposits, sand and gravel, are recorded as non-shrinkable soils, whereas the clayey beds have been recorded with a low volume change potential.
NHBC CLASS	Low volume change potential.

SOIL TYPE	London Clay Formation.
PLASTICITY INDEX (PI)	43% - 58%
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 Penetrometer

SOIL TYPE	London Clay Formation.
DISCUSSION OF CORRECTED RESULTS	The recorded undrained shear strength was in the range of 45kPa to 113kPa, averaging 79kPa which is indicative of high strength soil type.

5.2.2.2. Standard Penetration Test Correlations

A total of 18No. Standard Penetration Tests were undertaken in the clayey soils recorded on site.

N-values recorded in the London Clay bedrock from 5 to 20 being indicative of firm to stiff soils, typically values increase with depth.

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, f1, selected on the basis of plasticity index recorded in the samples tested in the London Clay. A hammer efficiency value for the windowless sample rig of Er=86% based on the annual calibration certificate provided by the sub-contractor.

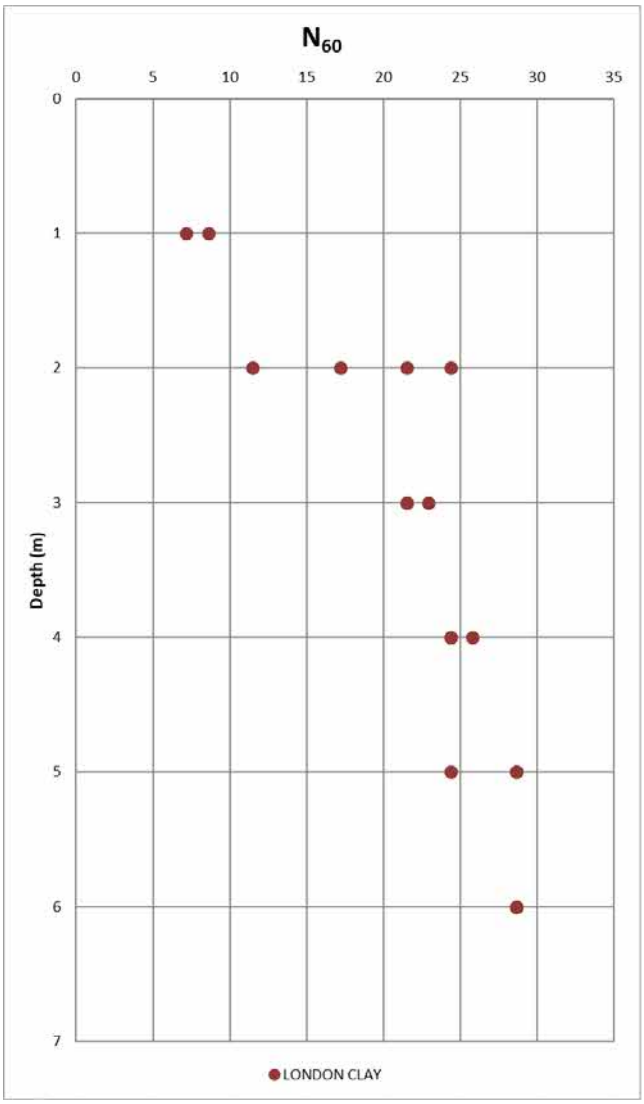
At a depth of 1.0m, equivalent undrained shear strengths for the London Clay of 32kPa and 39kPa, have been recorded, indicative of low strength soil type.

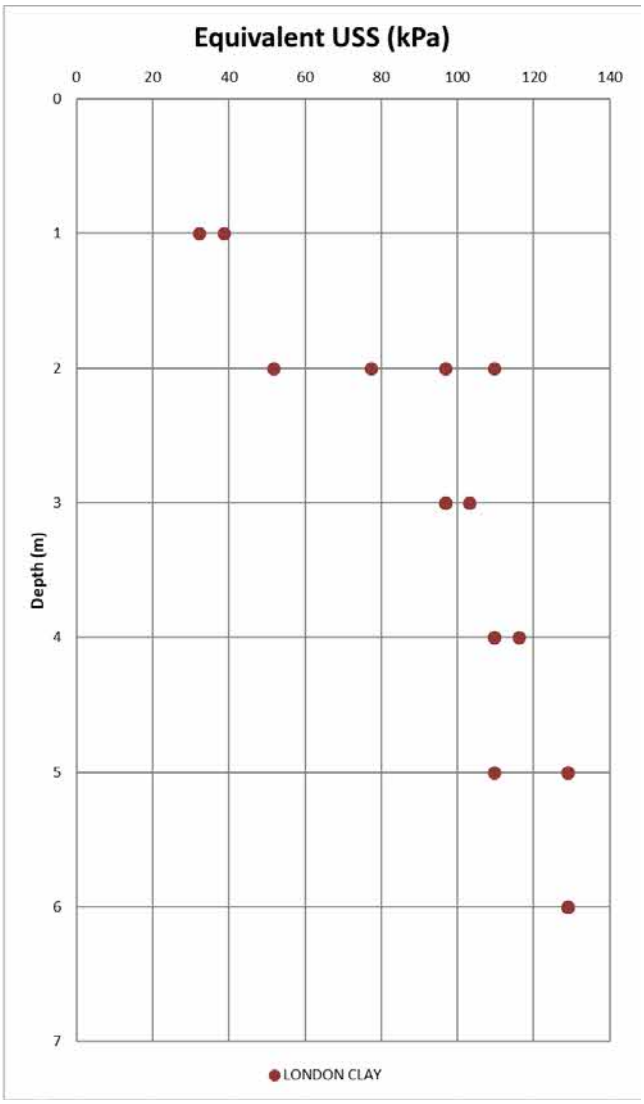
Below, at 2.0m depth equivalent undrained shear strengths of between 52kPa and 111kPa have been recorded, with values ranging that are indicative of medium to high strength.

Between 3.0m and 4.0m bgl, equivalent undrained shear strengths of between 97kPa and 116kPa have been recorded, which are indicative of high strength.

Between 5.0m and 6.0m depth, equivalent undrained shear strengths of between 110kPa and 129kPa have been recorded, which are indicative of high strength soils.

The following charts show the distribution with depth of the N_{60} values recorded in every borehole together with the derived equivalent undrained shear strength values.


N60
0
5
10
15
20
25
30
35
Depth (m)
0
1
2
3
4
5
6
7
LONDON CLAY


Equivalent USS (kPa)
0
20
40
60
80
100
120
140
Depth (m)
0
1
2
3
4
5
6
7
LONDON CLAY

5.3. SULPHATE AND pH

	ALL ON-SITE SOILS EXCEPT LONDON CLAY FORMATION			
	Sulphate		pH	
Characteristic Value	420 mg/l		5.5 units	
Justification	Mean of highest two results rounded to nearest 100mg/l.		Mean of lowest 20% results.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	7	67 - 533 mg/l	7	5.5 - 6.5 units
Groundwater	-	Not tested	-	Not tested
Total Potential Sulphate	2	Not applicable as pyrite unlikely in the samples tested.		

	LONDON CLAY FORMATION			
	Sulphate		pH	
Characteristic Value	1,980 mg/l		6.6 units	
Justification	Highest measured concentration rounded to nearest 100mg/l.		Lowest measured value.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	3	363 - 1,980 mg/l	3	6.6 - 7.3 units
Groundwater	-	N/A	-	N/A
Total Potential Sulphate	3	No pyrite recorded in the samples tested.		

The London Clay is a strata where pyrite is geologically common recorded. However, this investigation has not recorded any elevated sulphate content and pyrite content in the samples tested.

6. GEOTECHNICAL ASSESSMENT

6.1. INTRODUCTION

The following advice and recommendations are based on the construction of three storey residential property including a partial semi-basement floor. 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 2.

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

6.2. EXCAVATIONS

STABILITY	Any excavation requiring man entry should be battered back to a safe angle, supported by an appropriate proprietary trench support system or adequately shored to provide safe working conditions. Shoring to any excavation requiring man entry must be designed by a suitably qualified and experienced engineer. Any support system will require regular inspection as detailed in published guidelines to ensure the excavation support is adequate and appropriate for the ground conditions present. It is anticipated that narrow trench excavations will remain relatively stable and open for short periods, but minor spalling of side walls could still occur. Trench excavations encountering the groundwater are likely to suffer side wall collapse. 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.
EQUIPMENT	It should be possible to progress excavations with conventional equipment.
GROUNDWATER CONTROL	It is anticipated that groundwater control in the form of pumping from sumps formed in the base of excavations will be required. Any groundwater control system should be designed and operated to minimise the loss of fines from the soil matrix as this could adversely affect settlement. Due to the shallow groundwater recorded in the superficial deposits and slope across the site, it is recommended that a system of land drainage is installed to intercept and divert shallow groundwater around the proposed structure in advance of construction. Groundwater levels at the time of construction will have a critical impact on the ease of which the structure can be built. It is therefore recommended that groundwater monitoring is undertaken to assess the variation in the water table with seasonal or short term weather effects.
PARTY WALL ISSUES	Whilst the Party Wall Act is unlikely to apply, it may be prudent to conduct condition surveys of adjacent structures prior to construction so as to be able to contest any spurious damage claims arising from construction activities.

6.3. SLOPE STABILITY

In the front area of the site, the slopes are relatively shallow and show no obvious signs of instability. However, towards the centre of the site there is an embankment of a maximum height of 1.20m.

The stability of the slopes should be considered with planning any changes to the slope as part of the development. For example, removal of vegetation, changing the groundwater behaviour, cutting at the toe of the slope or loading the top of the slope could all cause instability.

The proposed development plans to build a new property on top of the embankment. The new structure will take advantage of the site slopes to develop a semi-basement in the lowest part of the embankment. Due to the site slopes, for the construction of the basement floor retaining walls will be required.

6.4. SUB-SURFACE CONCRETE

ALL ON-SITE SOILS EXCEPT LONDON CLAY FORMATION.	
SITE / SOIL CATEGORY	Natural ground.
DESIGN SULPHATE CLASS	DS-1
GROUNDWATER REGIME	Mobile.
AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) CLASS	AC-2z

LONDON CLAY FORMATION	
SITE / SOIL CATEGORY	Natural ground.
DESIGN SULPHATE CLASS	DS-3
GROUNDWATER REGIME	Static.
AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) CLASS	AC-2s
COMMENTS	Further testing of the London Clay Formation is recommended to confirm classification. If concrete at depths greater than 2.5m are planned as it may be pyrite.

6.5. SOAKAWAYS

A rising head permeability test was undertaken in the gravelly clayey soils of the Sand & Gravel and a permeability order of 10^{-7}m/s was recorded which is indicative of poor infiltration media.

It is considered that the disposal of collected surface water to soakaways will not be feasible at this site due to the cohesive nature and therefore anticipated low permeability of the underlying soils and a positive drainage solution to a local sewer should be pursued.

6.6. PAVEMENT CONSTRUCTION

From consideration of the observed ground conditions and the plasticity of the Sand & Gravel deposits, it is recommended that a preliminary design California Bearing Ratio (CBR) of 4% is assumed. The cohesive deposits will be prone to rapid degradation during wet weather working and this should be avoided where possible.

From consideration of the observed ground conditions and the plasticity of the London Clay, 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

The proposed development indicates a semi-basement floor favoured by the slope existing on the site. Based on the provided information, the semi-basement beneath the building footprints will require maximum excavation depths of around 2m for the north, south and east elevations . The proposed semi-basement will therefore be constructed within the London Clay Formation.

6.7.1. Excavation / Temporary Works

Although only one groundwater monitoring visit has been undertaken, the standing groundwater levels associated with the Sand & Gravel deposits have been recorded relatively shallow as it is perched upon the London Clay, the levels may be subject to seasonal variations. It would therefore be prudent to maintain the existing monitoring well and to continue to monitor groundwater levels up to the construction phase.

Around a large proportion of the proposed structures there is sufficient room available to construct the semi-basement within an open excavation. The sides of the excavation should be cut at an angle no greater than 33° (1V:1.5H). Such sides should be relatively stable for short periods (i.e. a few weeks), but minor spalling and slumping may occur that will require removal. It is recommended that the cut slope is covered in plastic tarpaulin in order to protect the slope by degradation from precipitation. If steeper slopes are cut, then temporary support should be provided to the slope. Temporary drainage may be required at the base of cut slopes to direct any inflow of groundwater to a sump where it can be removed by pumping.

It is anticipated that the need to limit ground disturbance in the root protection zone to retained trees will prevent the use of an open excavation for the entire structure. Where vertical cuts into the slope are required for basement construction, then temporary support will be required. In

the extreme, it could be that a piled retaining structure is required. However, given the cost that would entail it would like to be more prudent to re-design the basement to avoid the use of piling.

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

6.7.2. Semi-basement Retaining Walls

Based on the proposed development it is considered that a cantilever retaining wall will be required for the north, south and eastern faces of the proposed semi-basement.

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

Stratum	Bulk Density γB (kN/m^3)	Undrained Shear Strength Su (kPa)	Angle of Shearing Resistance φ'peak (°)	Apparent Cohesion c' (kPa)
Sand & Gravel (sands/gravel)	20[1]	0[1]	30[2]	0[2]
Sand & Gravel (clay)	19[1]	30[1]	27[2]	0[2]
London Clay Formation	20[1]	$= \frac{z + 1.1426}{0.0472}$ [3]Increasing with depth (z)	22[2]	0[2]

(1) Assumed value based on recorded ground conditions.
(2) Code of Practice for Foundations BS8004:2015 and Tomlinson 7th Edition.
(3) Equivalent Undrained Shear Strength relationship with depth from SPT values conversion.

It would be prudent to assume in calculating hydrostatic pressures, that water will be present behind the retaining walls to the full height of the structure.

6.7.3. Waterproofing

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

6.7.4. Semi-basement Heave and Floor Slab

Maximum excavation of 2.0m deep semi-basement will result in the removal of approximately 40kPa of overburden pressure. Heave will likely comprise both an "immediate" elastic component that may be expected to occur within the construction period and long-term swelling that would, theoretically, occur over a period of many years. These movements are likely to be largely

mitigated by the basement slab and the weight of the structure. It may still be prudent to conduct a detailed analysis of the likely movements once the basement design has been finalised.

Following the excavation for the semi-basement, it should be possible to adopt a ground bearing reinforced floor slab provided the slab level is beneath the depth of tree influence (which it is likely to be). The base of the excavations should be inspected and subject to proof-rolling. Any soft spots should be excavated and replaced with lean-mix concrete or suitably-compacted coarse-grained fill.

It is suggested that a compacted blanket layer of free draining granular fill is placed across the formation and the concrete reinforced raft constructed upon this. The granular blanket will facilitate the collection of any groundwater entering the semi-basement excavation during construction and allow it to drain to the low point in the site to the west or be removed by pumping.

Due to the high groundwater level, there is a risk of 'flotation' of the semi-basement and to counter this problem, soil anchors or a thickened base construction are the usual solutions. For this development, thickening the reinforced concrete floor of the basement is likely to be the preferred solution.

6.7.5. Foundations

Based on the future development and ground conditions, a thickened edge reinforced raft foundation can be considered across the majority of the semi-basement proposed structure. The remainder of the house without a basement can be trench fill footings, but reinforced to tie it into the basement structure so there is not differential movement. Foundations will naturally be taken through made ground/topsoil to bear upon the soils of the London Clay Formation.

A presumed bearing value of 110kN/m^2 is considered appropriate for foundations bearing upon the clay soils of the London Clay Formation. Immediate and long term settlement should be within tolerable limits and take place over several years.

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.

An analysis of tree influence on foundation depths has been completed based on the provided tree survey dated on January 2022. This revealed that maximum excavation depths due to the influence zone of trees are slightly deeper than the depth of the proposed semi-basement level. Due to the mature oak tree to the bottom of the site and the boundary line of cypress trees, footings between 0.7m and 1.0m below a Finish Floor Level (FFL) of 89.70m have been inferred. Additionally, northern elevation out the basement floor construction will require foundation depths of about 2.7m due to the cypress boundary trees. Although, the foundation depths exceed the limits of conventional trench fill footings based on the excavation required for the semi-basement floor it is considered that under Engineer design and supervision the construction of trench fill footings to such depths would be feasible. This is because the effective depth of the excavation required will be reduced by virtue of the excavation required to accommodate the basement.

At the front of the proposed structure there is no semi-basement level. Trench fill foundations should be suitable for this part of the structure, based on the tree influence foundation depths of between 1.3m and 2.2m depth are required due to tree influence. The footings should be reinforced and structurally tied into the semi-basement structure. It may be necessary for safety reasons to undertake the deeper parts in two stages with a first phase of mass pour concrete,

letting that set, construction the reinforcement cage at the shallower depth so created and then the second phase concrete pour.

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, foundations will need to be designed to accommodate potential long term moisture related soil heave. Such precautions against heave should be designed and constructed in accordance with NHBC Standards.

A number of trees and tree stumps are located across the site. It will be necessary to remove all unwanted trees, stumps and root structures prior to commencing with the development. Any resultant void deeper than the floor slab raft should be backfilled accordingly with respect to the preferred foundation design.

Perched groundwater associated with the superficial Sand & Gravel deposits is likely to be encountered during the excavations. It is therefore likely that a 'dig and pour' approach will need to be adopted to be able to construct the foundations. Again, the two phase approach to the deeper trench fill may help in this situation. It is an inherent risk of 'dig and pour' that spoil disposal and concrete volumes could increase.

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.

6.8. RECOMMENDATIONS FOR FURTHER GEOTECHNICAL WORK

It would be prudent for further groundwater monitoring to be undertaken to assess the variation in the water table with seasonal or short term weather effects.

Further testing of the London Clay Formation is recommended to confirm classification. If concrete at depths greater than 2.5m below existing ground level are planned as it may be pyrite. Samples could be taken for analysis once the design depths have been confirmed.

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	5	27	37	0
Cadmium	mg/kg	5	0.3	22	0
Chromium (total)	mg/kg	5	30	21	0
Chromium (hexavalent)	mg/kg	5	<2	910	0
Copper	mg/kg	5	18	2,400	0
Lead	mg/kg	5	61	200	0
Mercury	mg/kg	5	<1	11	0
Nickel	mg/kg	5	14	180	0
Selenium	mg/kg	5	<3	250	0
Zinc	mg/kg	5	78	3,700	0
pH	Units	10	5.5	<5-10>	0
Naphthalene	mg/kg	5	<0.1	2.3	0
Acenaphthylene	mg/kg	5	<0.1	170	0
Acenaphthene	mg/kg	5	<0.1	210	0
Fluorene	mg/kg	5	<0.1	170	0
Phenanthrene	mg/kg	5	<0.1	95	0
Anthracene	mg/kg	5	<0.1	2,400	0
Fluoranthene	mg/kg	5	0.18	280	0
Pyrene	mg/kg	5	0.16	620	0
Benzo(a)anthracene	mg/kg	5	<0.1	7.2	0
Chrysene	mg/kg	5	<0.1	15	0
Benzo(b)fluoranthene	mg/kg	5	<0.1	2.6	0
Benzo(k)fluoranthene	mg/kg	5	<0.1	77	0
Benzo(a)pyrene	mg/kg	5	<0.1	2.2	0
Indeno(1,2,3-cd)pyrene	mg/kg	5	<0.1	27	0
Dibenzo(a,h)anthracene	mg/kg	5	<0.1	0.24	0
Benzo(ghi)perylene	mg/kg	5	<0.1	320	0
TPH Aliphatic C5-C6	mg/kg	1	<0.01	42	0
TPH Aliphatic C6-C8	mg/kg	1	<0.05	100	0
TPH Aliphatic C8-C10	mg/kg	1	<2	27	0
TPH Aliphatic C10-C12	mg/kg	1	<2	130	0
TPH Aliphatic C12-C16	mg/kg	1	<3	1,100	0
TPH Aliphatic C16-C35	mg/kg	1	<10	65,000	0
TPH Aliphatic C35-C44	mg/kg	1	<10	65,000	0

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
TPH Aromatic C5-C7	mg/kg	1	<0.01	70	0
TPH Aromatic C7-C8	mg/kg	1	<0.05	130	0
TPH Aromatic C8-C10	mg/kg	1	<2	34	0
TPH Aromatic C10-C12	mg/kg	1	<2	74	0
TPH Aromatic C12-C16	mg/kg	1	<2	140	0
TPH Aromatic C16-C21	mg/kg	1	<3	260	0
TPH Aromatic C21-C35	mg/kg	1	<10	1,100	0
TPH Aromatic C35-C44	mg/kg	1	<10	1,100	0
Benzene	mg/kg	1	<2	0.87	0
Toluene	mg/kg	1	<5	130	0
Ethylbenzene	mg/kg	1	<2	47	0
Xylene (total of all types)	mg/kg	1	<2	56	0
Methyl Tert Butyl Ether (MTBE)	mg/kg	1	<5	49	0
Semi-Volatile Organic Compounds (SVOCs)	mg/kg	1	None detected	LOD*	0
Asbestos	Presence	1	None detected	Fibres Present	0
Notes: *Limit of detection: Given the large amount of compounds in this group, coupled with the lack of GAC for certain compounds, any concentrations above the limit of detection will be highlighted in the first instance.					

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	10	5.6	<5.5	0
Sulphate (w/s)	mg/l	10	1630	500	4
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	mg/kg	1	None detected	2	0
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	mg/kg	1	None detected	10	0
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	mg/kg	1	None detected	500	0
Sum of BTEX + MTBE above detection limits	mg/kg	1	None detected	0.1	0
Naphthalene	mg/kg	5	<0.1	0.5	0
Benzo(a)pyrene	mg/kg	5	<0.1	0.5	0

RESULTS EXCEEDING BUILDING MATERIALS ASSESSMENT CRITERIA	
WATER SOLUBLE SULPHATE	Concentrations of water soluble sulphate are such that they could detrimentally impact sub-surface concrete. The impact on concrete mix design is a geotechnical issue that is considered separately and so no further comment is made on these results within this contamination assessment.

8. RISK EVALUATION

8.1. REVISED CONCEPTUAL MODEL

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

ADDITIONAL POLLUTANT LINKAGES	During the ground investigation, no additional sources of contamination were identified.
INVALID POLLUTANT LINKAGES	No valid pollutant linkages identified.
LIMITATIONS AND UNCERTAINTIES	All of the potential contamination sources have been targeted by the exploratory holes and therefore it is considered that a sufficient number of exploratory points have been completed for contamination assessment purposes.

8.2. UPDATED CONTAMINATION RISK ASSESSMENT

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

SOURCES AND CONTAMINANTS	PATHWAYS (REFERENCE FROM MODEL)	RECEPTORS	POTENTIAL RISK
Historic private garden and public playground. Polycyclic Aromatic Hydrocarbons (PAHs) Metals	Ingestion Inhalation	Future Residents	Negligible Risk
	Consumption of home grown produce		Negligible Risk
	Direct Contact	Water Supply Pipes	Negligible Risk
	Horizontal & vertical migration	Groundwater	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 significant risks identified.

RISK TO WATER ENVIRONMENT
No significant risks identified.

RISK TO BUILDING MATERIALS AND SERVICES
No significant risks identified.

8.3. RISK MANAGEMENT

8.3.1. Introduction

As expected from its historical use, no significant contamination risks have been identified at the site. As such it is considered that no further contamination assessment is required and it is considered that the site is suitable for its proposed end use

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

8.3.2. Further Contamination Assessment

It is considered that no further ground investigation is required for contamination assessment purposes.

8.3.3. Outline Remediation Strategy

Due to the absence of contamination risks, no remediation is considered necessary.

8.4. 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 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.

It is considered that the sub-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'.

9. HEALTH AND SAFETY FILE INFORMATION

9.1. INTRODUCTION

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

9.2. HAZARDS

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

9.2.1. 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.

9.3. 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.

9.4. UTILITY SERVICES

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

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

The utility service companies should be contacted for records of their own equipment.

REPORT SPECIFIC REFERENCES

British Geological Survey sheet 239 "Hertford" Solid and Drift edition (1:50,000) published 1978.

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

Contamination Sampling

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

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

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

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

GEOTECHNICAL ASSESSMENT

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

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

GEOTECHNICAL PARAMETERS

Soakage Tests

Soakage tests comprise the filling of a test pit with water and recording the time taken for the water to drain away. The 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: $_{60} = _{60}$ 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 $_{60} = _{60}$ 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 425μm. Whilst the NHBC Standards were developed for residential buildings, the advice is equally applicable to a large number of other types of low rise structures.

Hand Shear Vane

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

Pocket Penetrometers

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

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

CONTAMINATION ASSESSMENT METHODOLOGY

UK Policy

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

The three main drivers for contamination assessment and remediation are:

Voluntary action.

Development as part of the planning regime.

Regulatory action to mitigate unacceptable risks e.g. Part 2A of the Environmental Protection Act 1990.

Pollutant Linkages

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

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

The deliberate application of chemicals e.g. the spraying of herbicide/pesticide.

Migration of pollutants from adjacent land.

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

Conceptual Site Model

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

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

Technical Guidance

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

'Investigation of Potentially Contaminated Sites - Code of Practice - BS 10175:2011+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
PHASE1	Generally limited to desk based research and a site walkover survey to develop an initial conceptual site model and identify what risks, if any, are likely to be presented by the site.	Hazard Identification and Assessment A preliminary stage of risk assessment concerned with identifying and characterising the hazards that may be associated with a particular site and identifying potential pollutant linkages.
PHASE 2	This phase is concerned with establishing whether contamination is present, usually through intrusive ground investigation, and then evaluating the degree and magnitude of the associated risks.	Risk Estimation A stage concerned with estimating the likelihood that receptors will suffer adverse effects if they come into contact with, or are otherwise affected by, a hazardous substance or agent under defined conditions. Risk Evaluation A stage of risk assessment concerned with evaluating the acceptability of estimated risks, taking into account the nature and scale of the risk estimates, any uncertainties associated with the assessment and the broad costs and benefits of taking action to mitigate risks.
PHASE 3	The appraisal and selection of remediation techniques, their implementation and verification.	Risk Management The process whereby decisions are made to accept a known or assessed risk and/or the implementation of action to reduce the consequences or probabilities of occurrence.

Risk Classification

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

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

The severity of the potential consequence [taking into account both the potential severity of the hazard and the sensitivity of the receptor].

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

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

These risk classifications are defined as follows:

Very High Risk - There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remediation action.

High Risk - Harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate remediation action.

Moderate Risk - It is possible that without appropriate remediation action harm could arise to a designated receptor. It is relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely that such harm would be relatively mild.

Low Risk - It is possible that harm could arise to a designated receptor from an identified hazard. It is likely that, at worst if any harm was realised any effects would be mild.

Negligible Risk - The presence of an identified hazard does not give rise to the potential to cause harm to a designated receptor.

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

RISK ESTIMATION - SOILS

Introduction to Soil Human Health Generic Assessment Criteria (GAC)

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

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

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

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

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

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

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

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

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

Human Health - Soil Generic Assessment Criteria

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

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
Arsenic	37	40	640	C4SL
Cadmium	22	150	410	
Chromium (total)[$]	910	910	8,600	S4UL
Chromium VI	21	21	49	C4SL
Lead	200	310	2,330	
Mercury*	11	15	320	S4UL
Selenium	250	430	12,000	
Nickel	180	180	980	
Copper	2400	7,100	68,000	
Zinc	3,700	40,000	730,000	
pH	<5 - 10> units			Professional judgement
Naphthalene	2.3	2.3	190	S4UL
Acenaphthylene	170	2,900	83,000	
Acenaphthene	210	3,000	84,000	
Fluorene	170	2,800	63,000	
Phenanthrene	95	1,300	22,000	
Anthracene	2,400	31,000	520,000	
Fluoranthene	280	1,500	23,000	
Pyrene	620	3,700	54,000	
Benzo(a)anthracene	7.2	11	170	
Chrysene	15	30	350	
Benzo(b)fluoranthene	2.6	3.9	44	
Benzo(k)fluoranthene	77	110	1,200	
Benzo(a)pyrene	2.2	3.2	35	
Indeno(1,2,3-cd)pyrene	27	45	500	
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	
Xylene^	56	79	5,900	
MTBE	49	73	7,900	EIC/AGS/CL:AIRE GAC

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

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

Water Environment - Soil Generic Assessment Criteria

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

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

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

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

BRD is aware of regional Environment Agency groundwater and contaminated land teams 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 in naturally in the ground environment. Microbial decay of organic matter under anaerobic conditions and geological processes can lead to the generation of Methane and Carbon Dioxide, but can also include traces gases such as Hydrogen sulphide and Carbon monoxide.

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

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

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

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

Radon is a naturally occurring colourless and odourless gas that is radioactive. It is formed by the radioactive decay of radium which in turn is derived from the radioactive decay of uranium, both of which are minerals that can be found in many soil types. Whilst it is recognised that the air inside every 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:

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

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

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 (CH4 or CO2 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	-

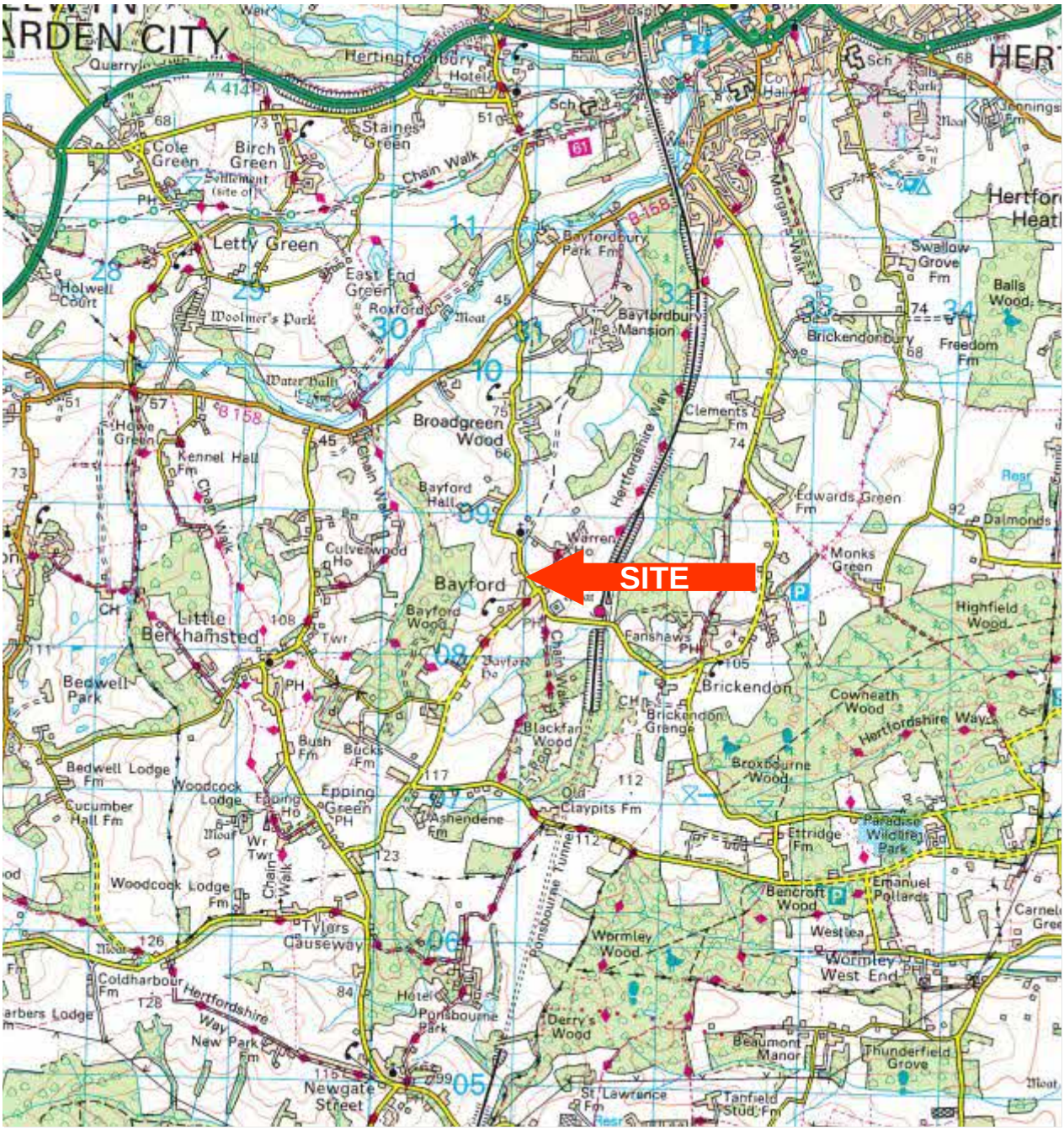
Low rise housing with gardens - NHBC 'Traffic Lights'

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

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

APPENDIX 1

Site Location Plan



Not to scale.

Project Title:	Land South West of Well Row, Bayford
Client:	Bonnel Homes
BRD Reference:	BRD4052-OP2-A
Date Issued:	January 2022

BRD
01295 272244
info@brduk.com

Site Walkover Photographs

Plate 1: View south west showing the north eastern end of the site in the foreground and the mature oak tree in the south west of the site in background.

Plate 2: View north showing the northern corner of the site and the mature laurel present in the northern corner of the site.

Project Title:	Land South West of Well Row, Bayford
Client:	Bonnel Homes
BRD Reference:	BRD4052-OP3-A
Date Issued:	January 2022

BRD
01295 272244
info@brduk.com

Site Walkover Photographs

Plate 3: View south showing some of the tree stumps with laurel saplings growing from them present along the south eastern site boundary.

Plate 4: View north east showing the embankment in the centre of the site.

BRD
01295 272244
info@brduk.com

Site Walkover Photographs

Plate 5: View south east showing the embankment in the centre of the site.

Plate 6: View south west showing the south western end of the site and the mature oak tree present in the south western end of the site.

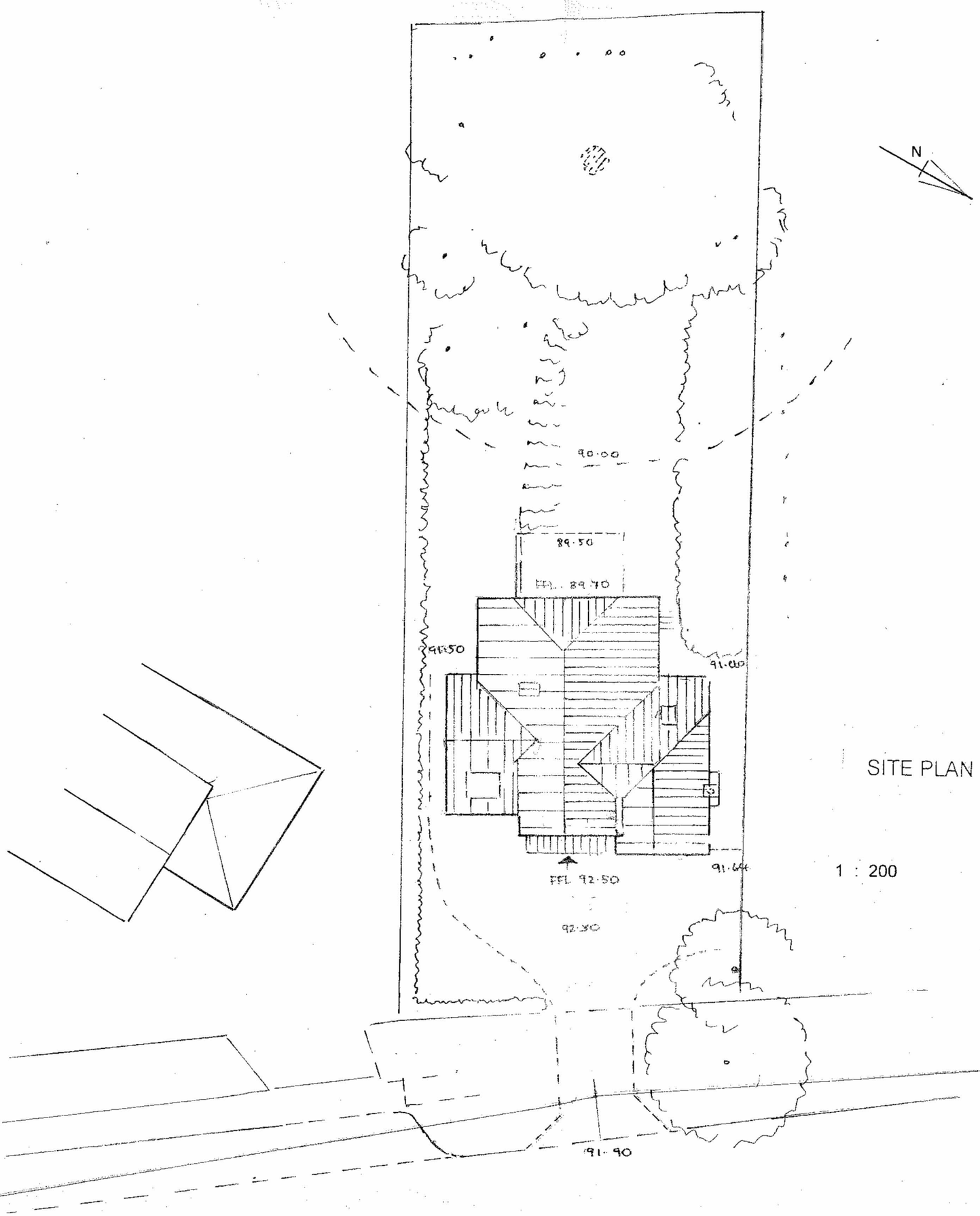
BRD
01295 272244
info@brduk.com

Site Walkover Photographs

Plate 7: View south showing some of the tree stumps present in the south of the site.

Plate 8: View north showing the row of mature conifers present along the north western site boundary.

BRD
01295 272244
info@brduk.com



SITE PLAN

1 : 200

Scale 1 : 200 at A3 Sheet Size

Initial Plan

Proposed Dwelling with
Integral Garage ; Land
at Well Row, Bayford
SG13 8PX

Ivan J. Clarke & John W. Barrett
10A High Street, Welwyn
Hertfordshire AL6 9EQ
Tel. 01438 712804
e-mail johnandivan@btconnect.com

Scales
Date
Ref.

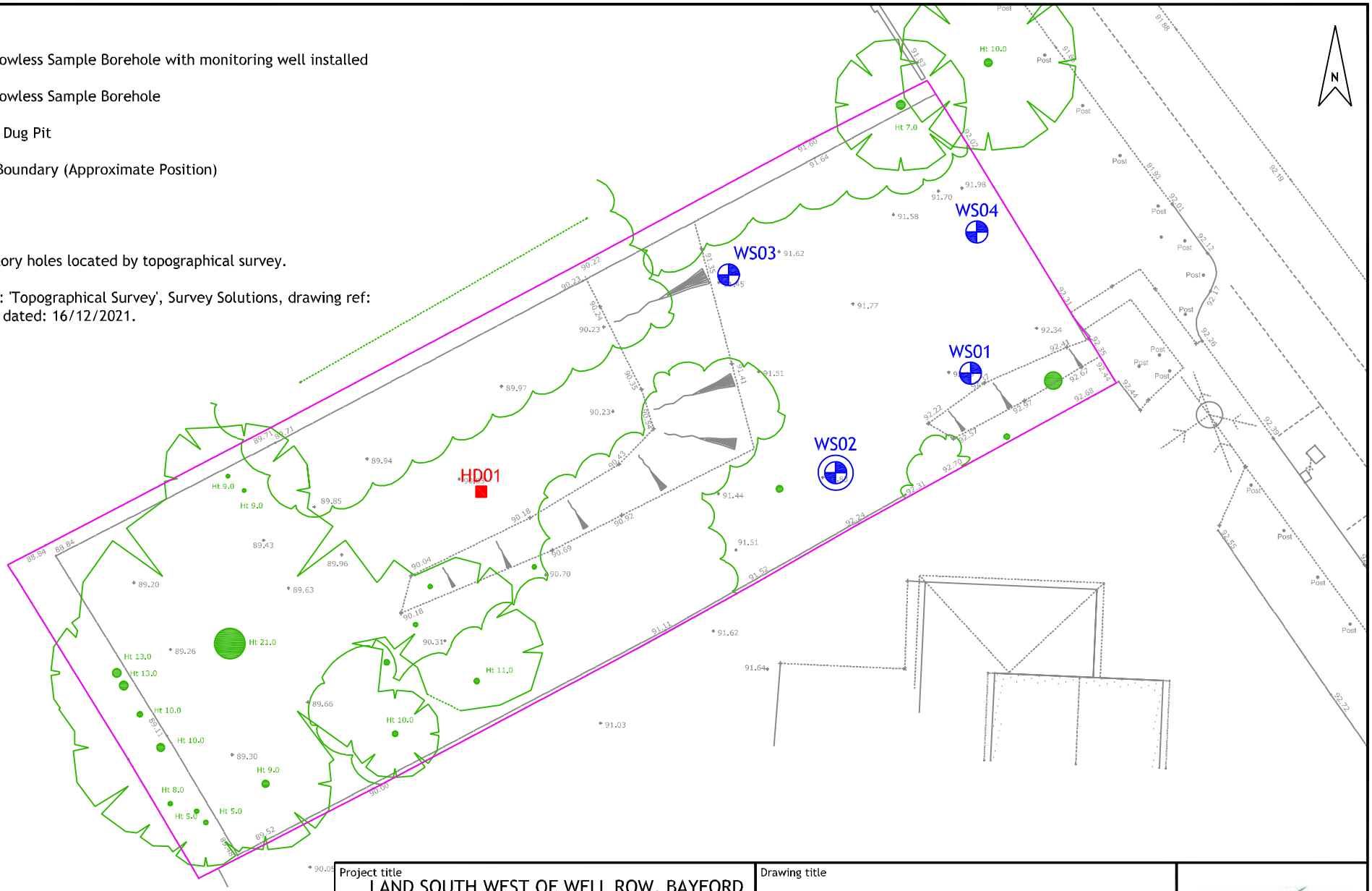
Key:

- Windowless Sample Borehole with monitoring well installed
- Windowless Sample Borehole
- Hand Dug Pit
- Site Boundary (Approximate Position)

Notes:

All exploratory holes located by topographical survey.

Drawing ref: 'Topographical Survey', Survey Solutions, drawing ref: 38197BDLS, dated: 16/12/2021.



Project title: LAND SOUTH WEST OF WELL ROW, BAYFORD		Drawing title: EXPLORATORY POINT PLAN
Client: BONNEL HOMES		
Scale: 1:250	Original drg. size/colour: A4 / C	Date: 14/01/2022
Drawn: RD	Checked: RD	Approved: BD
		Drawing Number: BRD4052-OD1
		Rev: A

BRD

APPENDIX 2

INSPECTION PIT RECORD

Client: Bonnel Homes
Project Title: Land South West of Well Row, Bayford
Project No: BRD4052
Logged By: R Davies
Date Completed: 16/12/2021
Method Used: Hand Dug

Pit No.

HD01

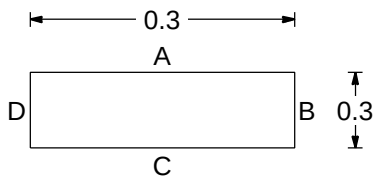
Sheet 1 of 1

Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.05	J1		TOPSOIL: Grass over dark brown, slightly silty, slightly gravelly clay with many rootlets. Gravel of fine to coarse, angular to sub-rounded flint and quartzite.	0.10 (90.03)	TS	
			Firm to stiff, orange brown, slightly sandy, very gravelly CLAY with occasional rootlets. Gravel of fine to coarse, sub-angular to sub-rounded flint and quartzite.	0.40 (89.73)	SAND & GRAVEL	
0.70	D1		Firm becoming stiff, fissured, orange brown becoming brown with some grey mottling, slightly silty CLAY with occasional rootlets.	0.80 (89.33)	LONDON CLAY FORMATION	
				1		

Pit Stability: Generally stable throughout
Groundwater: Not encountered

Surface Elevation Level:
90.134 mAOD

Plan of Inspection Pit:



General Remarks:

All dimensions in metres
Log Scale 1:10

Telephone: 01295 272244
Email: info@brduk.com

Trial Pit Photographs

HD01

Project Title: Land South West of Well Row, Bayford
Client: Bonnel Homes
BRD Reference: BRD4052-OP4-A
Date Issued: January 2022

BRD
01295 272244
info@brduk.com

PROBEHOLE RECORD

Client: Bonnel Homes
Project Title: Land South West of Well Row, Bayford
Project No: BRD4052
Logged By: R Davies
Date Commenced: 16/12/2021
Date Completed: 16/12/2021
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS01

Sheet 1 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.10	J1			TOPSOIL: Dark brown, slightly silty clay with many rootlets and roots up to 30mm in diameter, rare quartzite and flint gravel.	0.30 (91.92)		TS	
0.70	J2			Stiff, orange brown, silty, gravelly CLAY with occasional rootlets. Gravel of fine to coarse, sub-angular to rounded flint and quartzite.				
0.80	D1				0.90 (91.32)			
1.00	SPT B1	14 N		Medium dense, orange brown, clayey, sandy GRAVEL of fine to coarse, sub-angular to rounded flint and quartzite. 1.00 m: SPT: 2,4 / 3,3,4,4	1.0		SAND AND GRAVEL	
1.60	D2			Stiff, orange brown, sandy, very gravelly CLAY. Gravel of fine to coarse, angular to sub-rounded flint and quartzite.	1.40 (90.82)			
				Medium dense, orange brown, clayey, sandy GRAVEL of fine to coarse, sub-angular to rounded flint and quartzite.	1.70 (90.52)			
2.00	SPT	15 N		2.00 m: SPT: 2,2 / 3,3,4,5	2.0			
				Stiff, fissured, brown with some grey mottling, slightly silty CLAY with rare relict rootlets.	2.10 (90.12)			
2.70	PEN	2.5x3 kg/cm²						
2.80	D3							
3.00	SPT	16 N		3.00 m: SPT: 2,3 / 3,4,4,5 3.00 m: Becoming very stiff with no further relict rootlets.	3.0		LONDON CLAY FORMATION	
3.70	D4							
3.90	PEN	3.0/3.5/3.0 kg/cm²						
4.00	SPT	17 N		4.00 m: SPT: 2,2 / 3,4,5,5	4.0			
					4.50			

General Remarks:

Surface Elevation Level:
92.218 mAOD

All dimensions in metres
Log Scale 1:25

Telephone: 01295 272244
Email: info@brduk.com

PROBEHOLE RECORD

Client: Bonnel Homes
Project Title: Land South West of Well Row, Bayford
Project No: BRD4052
Logged By: R Davies
Date Commenced: 16/12/2021
Date Completed: 16/12/2021
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS01

Sheet 2 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
				Continued from 2.10m-4.50m: Stiff, fissured, brown with some grey mottling, slightly silty CLAY with rare relict rootlets.				
4.70	PEN	3.75/4.00/3.50 kg/cm²						
4.80	D5							
5.00	SPT	20 N		5.00 m: SPT: 3,3 / 4,4,6,6	5.0			
				5.30 m: Rare fine calcareous concretions and single medium gravel sized ferruginous nodule.				
5.60	PEN	4.00x2/4.75 kg/cm²						
5.80	D6							
6.00	SPT	20 N		6.00 m: SPT: 3,3 / 4,4,6,6	6.0			
					6.45 (85.77)		LONDON CLAY FORMATION	
					7.0			
					8.0			
					9.0			

General Remarks:

Surface Elevation Level:
92.218 mAOD

All dimensions in metres
Log Scale 1:25

Telephone: 01295 272244
Email: info@brduk.com

PROBEHOLE RECORD

Client: Bonnel Homes
Project Title: Land South West of Well Row, Bayford
Project No: BRD4052
Logged By: R Davies
Date Commenced: 16/12/2021
Date Completed: 16/12/2021
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS02

Sheet 1 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
				TOPSOIL: Dark brown, slightly silty, slightly gravelly, clayey sand with rootlets and roots up to 30mm in diameter. Gravel of fine to coarse, angular to sub-rounded flint and quartzite.	0.30 (91.60)		TS	
0.20	J1							
0.40	B1			Medium dense, brown becoming orange brown, gravelly to very gravelly SAND. Gravel of fine to coarse, angular to sub-rounded flint and quartzite.			SAND AND GRAVEL	
				0.90 - 1.00 m: Wet.	1.0 1.00 (90.90)			
1.00	SPT	17 N		Medium dense, orange brown and light beige grey, slightly sandy, very clayey GRAVEL. Gravel of fine to coarse, angular to sub-rounded flint and quartzite.				
				1.00 m: SPT: 3,4 / 4,4,4,5				
1.50	B2							
2.00	SPT	17 N			2.0 2.00 (89.90)			
				Stiff to very stiff, fissured, brown with some grey mottling, slightly silty CLAY with rare relict rootlets and rare fine calcareous concretions.			LONDON CLAY FORMATION	
				2.00 m: SPT: 3,3 / 3,4,5,5				
2.60	D1							
2.80	PEN	3.00x2/2.75 kg/cm²						
3.00	SPT	15 N			3.0			
				3.00 m: SPT: 2,3 / 3,3,4,5				
				3.50 m: No further relict rootlets.				
3.70	PEN	2.75/3.50x2 kg/cm²						
3.80	D2							
4.00	SPT	18 N		4.00 m: SPT: 2,2 / 3,4,5,6	4.0			
					4.50			

General Remarks:

Surface Elevation Level:
91.898 mAOD

All dimensions in metres
Log Scale 1:25

Telephone: 01295 272244
Email: info@brduk.com

PROBEHOLE RECORD

Client: Bonnel Homes
Project Title: Land South West of Well Row, Bayford
Project No: BRD4052
Logged By: R Davies
Date Commenced: 16/12/2021
Date Completed: 16/12/2021
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS02

Sheet 2 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
4.70	PEN	3.5x3 kg/cm²		*Continued from 2.00m-4.50m:* Stiff to very stiff, fissured, brown with some grey mottling, slightly silty CLAY with rare relict rootlets and rare fine calcareous concretions.				
4.90	D3							
5.00	SPT	20 N		5.00 m: SPT: 2,3 / 4,4,6,6 5.00 m: No recovery in SPT.	5.0			
5.70	D4							
5.80	PEN	4.5/4.0/4.5 kg/cm²						
6.00	SPT	20 N		6.00 m: SPT: 2,4 / 4,4,6,6	6.0			
					6.45 (85.45)		LONDON CLAY FORMATION	
					7.0			
					8.0			
					9.0			

General Remarks:

Surface Elevation Level:
91.898 mAOD

All dimensions in metres
Log Scale 1:25

Telephone: 01295 272244
Email: info@brduk.com

PROBEHOLE RECORD

Client: Bonnel Homes
Project Title: Land South West of Well Row, Bayford
Project No: BRD4052
Logged By: R Davies
Date Commenced: 16/12/2021
Date Completed: 16/12/2021
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS03

Sheet 1 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.10	J1			MADE GROUND: Grass over, dark brown, slightly silty, slightly gravelly, clayey, sand topsoil with rootlets and roots up to 30mm in diameter. Gravel of fine to coarse, angular to rounded flint, quartzite and brick.			MG	
					0.40 (91.17)			
				Very stiff, fissured, orange brown mottled brown, slightly silty CLAY with occasional rootlets and rare flint and quartzite gravel.			SAND & GRAVEL	
0.70	J2							
0.80	D1							
1.00	SPT	5 N		1.00 m: SPT: 1,1 / 1,1,1,2	1.0			
					1.20 (90.37)			
				Firm to stiff, fissured, orange brown with some grey mottling, slightly silty CLAY with rare relict rootlets.			LONDON CLAY FORMATION	
1.60	PEN	1.75/1.50/1.75 kg/cm²						
1.70	D2							
					1.80 (89.77)			
1.90	D3			Stiff, fissured, brown with some grey mottling, slightly silty CLAY with rare relict rootlets.				
2.00	SPT	8 N		2.00 m: SPT: 1,1 / 1,2,2,3	2.0			
2.60	D4							
2.70	PEN	2.50x2/2.75 kg/cm²						
3.00	SPT	15 N		3.00 m: SPT: 2,3 / 3,3,4,5 3.00 m: No further relict rootlets.	3.0			
3.80	PEN	3.25x3 kg/cm²		3.70 m: 15mm thick band of silt.				
3.90	D5							
4.00	SPT	17 N		4.00 m: SPT: 2,2 / 3,4,5,5	4.0			
					4.50			

General Remarks:

Surface Elevation Level:
91.567 mAOD

All dimensions in metres
Log Scale 1:25

Telephone: 01295 272244
Email: info@brduk.com

PROBEHOLE RECORD

Client: Bonnel Homes
Project Title: Land South West of Well Row, Bayford
Project No: BRD4052
Logged By: R Davies
Date Commenced: 16/12/2021
Date Completed: 16/12/2021
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS03

Sheet 2 of 2

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
				Continued from 1.80m-4.50m: Stiff, fissured, brown with some grey mottling, slightly silty CLAY with rare relict rootlets.				
4.70	D6							
4.90	PEN	3.50x2/3.25 kg/cm²						
5.00	SPT	17 N		5.00 m: SPT: 2,3 / 3,4,5,5	5.0			
5.70	PEN	3.75/4.00/3.75 kg/cm²						
5.90	D7							
6.00	SPT	20 N		6.00 m: SPT: 2,3 / 4,4,6,6	6.0			
					6.45 (85.12)		LONDON CLAY FORMATION	
					7.0			
					8.0			
					9.0			

General Remarks:

Surface Elevation Level:
91.567 mAOD

All dimensions in metres
Log Scale 1:25

Telephone: 01295 272244
Email: info@brduk.com

PROBEHOLE RECORD

Client: Bonnel Homes
Project Title: Land South West of Well Row, Bayford
Project No: BRD4052
Logged By: R Davies
Date Commenced: 16/12/2021
Date Completed: 16/12/2021
Method Used: Windowless Percussive Sampling Rig

Borehole No.

WS04

Sheet 1 of 1

Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			MADE GROUND: Dark brown, slightly silty, slightly gravelly, clay topsoil with many rootlets. Gravel of fine to coarse, angular to rounded flint, quartzite and rare brick.			MG	
					0.40 (91.58)			
				Firm becoming stiff, fissured, orange brown becoming brown with some grey mottling, slightly silty CLAY with rare relict rootlets.			LONDON CLAY FORMATION	
0.70	J2							
0.80	PEN	2.00/1.75/2.00 kg/cm²						
0.90	D1							
1.00	SPT	6 N		1.00 m: SPT: 1,1 / 1,1,2,2	1.0			
1.70	PEN	2.50x2/2.75 kg/cm²						
1.80	D2							
2.00	SPT	12 N		2.00 m: SPT: 1,2 / 2,3,3,4	2.0			
					2.45 (89.53)			
					3.0			
					4.0			

General Remarks:

Surface Elevation Level:
91.975 mAOD

All dimensions in metres
Log Scale 1:25

Telephone: 01295 272244
Email: info@brduk.com

SOAKAGE TEST RECORD

SOIL INFILTRATION RATE

(BRE Digest 365 : Soakaway Test - within borehole)

Client: Bonnel Homes
Project Title Lans South West of Well Row, Bayford
Project No. BRD4052

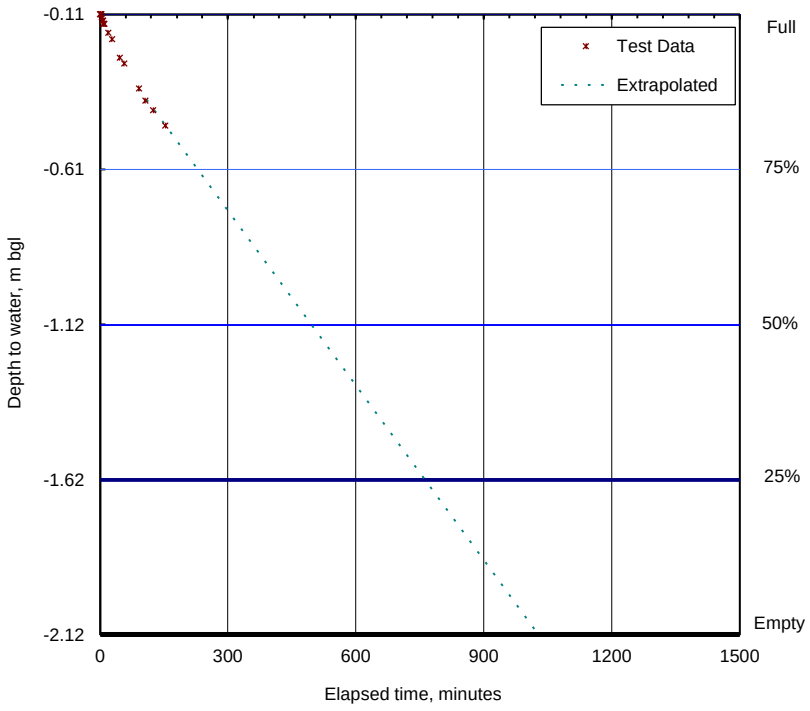
Test Details

Trial Pit Number	WS02	
Test Number	1	
Borehole depth for test	2.12	**m**
Borehole diameter	0.10	**m**
Borehole area	0.0079	**m**
Depth to groundwater prior to test	1.15	**m**
Date of Test	14/01/2022	
Logged by	R Davies	
Description of Soil under Test	0-1.0m: Medium dense, orange brown, gravelly to very gravelly medium 1.0-2.0m: Medium dense, slightly sandy, very clayey GRAVEL/very gravell	

Test Record

Elapsed Time min	Depth to Water m
0	0.11
1	0.11
2	0.11
3	0.11
4	0.12
5	0.12
6	0.13
7	0.13
8	0.14
9	0.14
10	0.14
19	0.17
28	0.19
46	0.25
56	0.27
91	0.35
106	0.39
125	0.42
153	0.47

Plot of water level against elapsed time



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* = (V75-V25)/A50(T75-T25)**

where, T75 (230* mins) is the time for the water level to fall to 75% effective depth (0.61m bgl)
and T25 (763* mins) is the time for the water level to fall to 25% effective depth (1.62m bgl)
thus, T75-T25 is the time for the water level to fall from 75% to 25% effective depth:

T75-T25 = 533 mins

V75-V25 is the effective storage volume in the trial pit between 75% and 25% effective depth:

V75-V25 = 0.0079 m^3

and A50 is the internal surface area of the trial pit up to 50% effective depth and including the base area:

A50 = 0.3236 m^2

Soil Infiltration Rate *f* = 7.63 x 10 ^{7} m/s

Comments Calculation based on extrapolated results. Use as a guide only.

Groundwater Monitoring Record

Project: Land South West of Well Row, Bayford
Client: Bonnel Homes
Project No: BRD4052

Borehole name	Date	Monitored by (initials)	Borehole depth (m)	Qty free product detected (mm)	Groundwater level below ground surface (m)	Groundwater level below top of standpipe (m)	Amount purged (l)	Post purge groundwater level below top of standpipe (m)	Comments
WS02	14/01/2022	RD	2.12	-	1.15	1.05	-	-	Groundwater level measured only, no samples taken.

APPENDIX 3

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

Derwentside Environmental Testing Services Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410

DETS Report No: 21-14849

Site Reference:	Land South West of Well Row, Bayford
Project / Job Ref:	BRD4052
Order No:	None Supplied
Sample Receipt Date:	20/12/2021
Sample Scheduled Date:	20/12/2021
Report Issue Number:	1
Reporting Date:	04/01/2022

Authorised by:

[redacted]

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.

For Topsoil and WAC analysis the expanded uncertainty measurement should be considered while evaluating results against compliance values.

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

Soil Analysis Certificate						
DETS Report No: 21-14849	Date Sampled	17/12/21	17/12/21	17/12/21	17/12/21	17/12/21
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Land South West of Well Row, Bayford	TP / BH No	WS01	WS01	WS03	WS04	HD01
Project / Job Ref: BRD4052	Additional Refs	J1	J2	J1	J1	J1
Order No: None Supplied	Depth (m)	0.10	0.80	0.10	0.20	0.05
Reporting Date: 04/01/2022	DETS Sample No	579943	579944	579945	579946	579947

Determinand	Unit	RL	Accreditation					
Asbestos Quantification (S)	%	< 0.001	ISO17025				< 0.001	
pH	pH Units	N/a	MCERTS	6.0	5.5	6.5	5.6	6.1
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	533	308	235	274	67
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.53	0.31	0.23	0.27	0.07
Total Sulphur	%	< 0.02	NONE					
Organic Matter (SOM)	%	< 0.1	MCERTS	4.8	1.9	5	4.1	5.7
Arsenic (As)	mg/kg	< 2	MCERTS	11	13	9	27	9
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	0.3	< 0.2	0.2	0.3	< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS	15	30	17	21	17
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	15	12	15	18	11
Lead (Pb)	mg/kg	< 3	MCERTS	61	11	46	49	40
Mercury (Hg)	mg/kg	< 1	MCERTS	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	8	14	9	11	5
Selenium (Se)	mg/kg	< 2	MCERTS	< 3	< 3	< 3	< 3	< 3
Zinc (Zn)	mg/kg	< 3	MCERTS	69	58	74	78	69

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

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

Soil Analysis Certificate						
DETS Report No: 21-14849	Date Sampled	17/12/21	17/12/21	17/12/21	17/12/21	17/12/21
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Land South West of Well Row, Bayford	TP / BH No	WS01	WS01	WS03	WS03	WS04
Project / Job Ref: BRD4052	Additional Refs	D2	D3	D1	D3	D2
Order No: None Supplied	Depth (m)	1.60	2.80	0.80	1.90	1.80
Reporting Date: 04/01/2022	DETS Sample No	579948	579949	579950	579951	579952

Determinand	Unit	RL	Accreditation					
Asbestos Quantification (S)	%	< 0.001	ISO17025					
pH	pH Units	N/a	MCERTS	5.7	7.3	5.6	6.6	7.1
Total Sulphate as SO_4	mg/kg	< 200	MCERTS	377	823	300	733	1630
Total Sulphate as SO_4	%	< 0.02	MCERTS	0.04	0.08	0.03	0.07	0.16
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	92	374	76	363	1980
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.09	0.37	0.08	0.36	1.98
Total Sulphur	%	< 0.02	NONE	< 0.02	0.03	< 0.02	0.03	0.07
Organic Matter (SOM)	%	< 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 Method Description page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)

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

Soil Analysis Certificate - Speciated PAHs							
DETS Report No: 21-14849	Date Sampled	17/12/21	17/12/21	17/12/21	17/12/21	17/12/21
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Land South West of Well Row, Bayford	TP / BH No	WS01	WS01	WS03	WS04	HD01
Project / Job Ref: BRD4052	Additional Refs	J1	J2	J1	J1	J1
Order No: None Supplied	Depth (m)	0.10	0.80	0.10	0.20	0.05
Reporting Date: 04/01/2022	DETS Sample No	579943	579944	579945	579946	579947

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	0.14	< 0.1	0.18	< 0.1	< 0.1
Pyrene	mg/kg	< 0.1	MCERTS	0.14	< 0.1	0.16	< 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

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

Soil Analysis Certificate - TPH LQM Banded						
DETS Report No: 21-14849	Date Sampled	17/12/21				
BRD Environmental Ltd	Time Sampled	None Supplied				
Site Reference: Land South West of Well Row, Bayford	TP / BH No	WS01				
Project / Job Ref: BRD4052	Additional Refs	J2				
Order No: None Supplied	Depth (m)	0.80				
Reporting Date: 04/01/2022	DETS Sample No	579944				

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

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

Soil Analysis Certificate - BTEX / MTBE						
DETS Report No: 21-14849	Date Sampled	17/12/21				
BRD Environmental Ltd	Time Sampled	None Supplied				
Site Reference: Land South West of Well Row, Bayford	TP / BH No	WS01				
Project / Job Ref: BRD4052	Additional Refs	J2				
Order No: None Supplied	Depth (m)	0.80				
Reporting Date: 04/01/2022	DETS Sample No	579944				

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

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

Soil Analysis Certificate - Semi Volatile Organic Compounds (SVOC)						
DETS Report No: 21-14849	Date Sampled	17/12/21				
BRD Environmental Ltd	Time Sampled	None Supplied				
Site Reference: Land South West of Well Row, Bayford	TP / BH No	WS01				
Project / Job Ref: BRD4052	Additional Refs	J2				
Order No: None Supplied	Depth (m)	0.80				
Reporting Date: 04/01/2022	DETS Sample No	579944				

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

DETS Ltd
L, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3

DETS Report No: 21-14849		Date Sampled	17/12/21				Landfill Waste Acceptance Criteria Limits		
BRD Environmental Ltd		Time Sampled	None Supplied				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Site Reference: Land South West of Well Row, Bayford		TP / BH No	WS01						
Project / Job Ref: BRD4052		Additional Refs	J2						
Order No: None Supplied		Depth (m)	0.80						
Reporting Date: 04/01/2022		DETS Sample No	579944						
Determinand	Unit	MDL							
TOC[MU]	%	< 0.1	1.1				3%	5%	6%
Loss on Ignition	%	< 0.01	6.40				--	--	10%
BTEX[MU]	mg/kg	< 0.05	< 0.05				6	--	--
Sum of PCBs	mg/kg	< 0.1	< 0.1				1	--	--
Mineral Oil[MU]	mg/kg	< 10	< 10				500	--	--
Total PAH[MU]	mg/kg	< 1.7	< 1.7				100	--	--
pH[MU]	pH Units	N/a	5.5				--	>6	--
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	< 1				--	To be evaluated	To be evaluated
Eluate Analysis			2:1 mg/l	8:1 mg/l		Cumulative 10:1 mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)		
Arsenic[U]			< 0.01	< 0.01		< 0.2	0.5	2	25
Barium[U]			0.03	< 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	0.016		< 0.2	4	50	200
Chloride[U]			6	5		55	800	15000	25000
Fluoride[U]			< 0.5	< 0.5		< 1	10	150	500
Sulphate[U]			22	8		86	1000	20000	50000
TDS			73	38		392	4000	60000	100000
Phenol Index			< 0.01	< 0.01		< 0.5	1	-	-
DOC			24.7	25.6		256	500	800	1000
Leach Test Information									
Sample Mass (kg)			0.22						
Dry Matter (%)			81.3						
Moisture (%)			23						
Stage 1									
Volume Eluate L2 (litres)			0.31						
Filtered Eluate VE1 (litres)			0.06						

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 discrepencies with current legislation
M Denotes MCERTS accredited test
U Denotes ISO17025 accredited test

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

Soil Analysis Certificate - Sample Descriptions
DETS Report No: 21-14849
BRD Environmental Ltd
Site Reference: Land South West of Well Row, Bayford
Project / Job Ref: BRD4052
Order No: None Supplied
Reporting Date: 04/01/2022

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
579943	WS01	J1	0.10	20.2	Brown loamy sand with vegetation
579944	WS01	J2	0.80	18.7	Light brown sandy clay with stones
579945	WS03	J1	0.10	16.7	Brown sandy clay with stones and plastic
579946	WS04	J1	0.20	20	Brown sandy clay with stones
579947	HD01	J1	0.05	17.6	Brown sandy clay with stones and vegetation
579948	WS01	D2	1.60	7.3	Light brown sandy clay with stones
579949	WS01	D3	2.80	17.1	Light brown clay
579950	WS03	D1	0.80	16.2	Light brown clay
579951	WS03	D3	1.90	17.6	Light brown clay
579952	WS04	D2	1.80	17.2	Light brown clay

Moisture content is part of procedure E003 & is not an accredited test
Insufficient Sample I/S
Unsuitable Sample U/S

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

Soil Analysis Certificate - Methodology & Miscellaneous Information
DETS Report No: 21-14849
BRD Environmental Ltd
Site Reference: Land South West of Well Row, Bayford
Project / Job Ref: BRD4052
Order No: None Supplied
Reporting Date: 04/01/2022

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	Fraction Organic Carbon (FOC)	Determination of TOC by combustion analyser.	E027
Soil	D	Organic Matter (SOM)	Determination of TOC by combustion analyser.	E027
Soil	D	TOC (Total Organic Carbon)	Determination of TOC by combustion analyser.	E027
Soil	AR	Exchangeable Ammonium	Determination of ammonium by discrete analyser.	E029
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

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

UKAS TESTING
4480

Water Analysis Certificate - Methodology & Miscellaneous Information
DETS Report No: 21-14849
BRD Environmental Ltd
Site Reference: Land South West of Well Row, Bayford
Project / Job Ref: BRD4052
Order No: None Supplied
Reporting Date: 04/01/2022

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	F	Ammoniacal Nitrogen	Determination of ammoniacal nitrogen by discrete analyser.	E126
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 dete	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 dichlorometha	E108
Water	UF	Petroleum Ether Extract (PEE)	Gravimetrically determined through liquid:liquid extraction with petroleum ether	E111
Water	UF	pH	Determination of pH by electrometric measurement	E107
Water	F	Phosphate	Determination of phosphate by filtration & analysed by ion chromatography	E109
Water	UF	Redox Potential	Determination of redox potential by electrometric measurement	E113
Water	F	Sulphate (as SO4)	Determination of sulphate by filtration & analysed by ion chromatography	E109
Water	UF	Sulphide	Determination of sulphide by distillation followed by colorimetry	E118
Water	F	SVOC	Determination of semi-volatile organic compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E106
Water	UF	Toluene Extractable Matter (TEM)	Gravimetrically determined through liquid:liquid extraction with toluene	E111
Water	UF	Total Organic Carbon (TOC)	Low heat with persulphate addition followed by IR detection	E110
Water	F	TPH CWG (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C35. C5 to C8 by headspace GC-MS	E104
Water	F	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C44. C5 to C8 by headspace GC-MS	E104
Water	UF	VOCs	Determination of volatile organic compounds by headspace GC-MS	E101
Water	UF	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E101

Key

F Filtered
UF Unfiltered

Parameter	Matrix Type	Suite Reference	Expanded Uncertainity Measurement	Unit
TOC	Soil	BS EN 12457	20.0	%
Loss on Ignition	Soil	BS EN 12457	35.0	%
BTEX	Soil	BS EN 12457	14.0	%
Sum of PCBs	Soil	BS EN 12457	23.0	%
Mineral Oil	Soil	BS EN 12457	9.0	%
Total PAH	Soil	BS EN 12457	11.6	%
pH	Soil	BS EN 12457	0.28	Units
Acid Neutralisation Capacity	Soil	BS EN 12457	18.0	%
Arsenic	Leachate	BS EN 12457	18.7	%
Barium	Leachate	BS EN 12457	11.6	%
Cadmium	Leachate	BS EN 12457	20.3	%
Chromium	Leachate	BS EN 12457	18.3	%
Copper	Leachate	BS EN 12457	24.3	%
Mercury	Leachate	BS EN 12457	23.7	%
Molybdenum	Leachate	BS EN 12457	14.7	%
Nickel	Leachate	BS EN 12457	16.1	%
Lead	Leachate	BS EN 12457	15.7	%
Antimony	Leachate	BS EN 12457	17.9	%
Selenium	Leachate	BS EN 12457	22.0	%
Zinc	Leachate	BS EN 12457	17.4	%
Chloride	Leachate	BS EN 12457	15.3	%
Fluoride	Leachate	BS EN 12457	16.4	%
Sulphate	Leachate	BS EN 12457	20.6	%
TDS	Leachate	BS EN 12457	12.0	%
Phenol Index	Leachate	BS EN 12457	14.0	%
DOC	Leachate	BS EN 12457	10.0	%
Clay Content	Soil	BS 3882: 2015	15.0	%
Silt Content	Soil	BS 3882: 2015	14.0	%
Sand Content	Soil	BS 3882: 2015	13.0	%
Loss on Ignition	Soil	BS 3882: 2015	35.0	%
pH	Soil	BS 3882: 2015	0.14	Units
Carbonate	Soil	BS 3882: 2015	16.0	%
Total Nitrogen	Soil	BS 3882: 2015	12.0	%
Phosphorus (Extractable)	Soil	BS 3882: 2015	24.0	%
Potassium (Extractable)	Soil	BS 3882: 2015	20.0	%
Magnesium (Extractable)	Soil	BS 3882: 2015	26.0	%
Zinc	Soil	BS 3882: 2015	14.9	%
Copper	Soil	BS 3882: 2015	16.0	%
Nickel	Soil	BS 3882: 2015	17.7	%
Available Sodium	Soil	BS 3882: 2015	23.0	%
Available Calcium	Soil	BS 3882: 2015	23.0	%
Electrical Conductivity	Soil	BS 3882: 2015	10.0	%

TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD

DATE ISSUED: 18/01/2022

0998

Contract	**Land South West of Well Row, Bayford**
Serial No.	**39947_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:

Land South West of Well Row, Bayford

Approved Signatories:

☑ **J.C. Garner B.Eng (Hons) FGS**
Technical Director & Quality Manager

☐ **W. Johnstone**
Materials Lab Manager

[redacted]

Date Received: 21/12/2021

Samples Tested Between: 21/12/2021 **and** 18/01/2022

Remarks:

For the attention of Rob Davies
Your Reference No: BRD4052

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. 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.
5. The results within this report only relate to the items tested or sampled.

TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD

DATE ISSUED: 18/01/2022

0998

Contract	Land South West of Well Row, Bayford		
Serial No.	39947_1	Target Date	18/01/2022
Scheduled By	BRD Environmental Ltd		
Schedule Remarks			

Bore Hole No.	Type	Sample Ref.	Top Depth	Water Content (BSEN)	Liquid/Plastic Limits	Wet Sieve Preparation															Sample Remarks
WS01	D	1	0.80	1	1	1															
WS02	B	2	1.50	1	1	1															
WS03	D	2	1.70	1	1																
WS03	D	4	2.60	1	1																
WS04	D	1	0.90	1	1																
Totals				5	5	2															End of Schedule

TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD

DATE ISSUED: 18/01/2022

0998

Contract	Land South West of Well Row, Bayford
Serial No.	39947_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)		
WS01	0.80	D	1	17.3	54	21	33	-0.11	Wet Sieved	50 (M)	34.6*	67	Stiff yellowish brown slightly sandy gravelly CLAY with rare recently active roots. Gravel is brown, black and white fine to coarse angular to subrounded chert	CH
WS02	1.50	B	2	7.2	48	15	33	-0.24	Wet Sieved	75 (M)	28.9*	66	Brown, black and white fine to coarse angular to rounded chert and quartzite GRAVEL in a firm mottled orangish brown and light grey sandy silty clay matrix	CI
WS03	1.70	D	2	27.7	68	25	43	0.06	From Natural	0 (A)		72	Stiff yellowish brown CLAY with occasional recently active and decayed roots and rare bluish grey mottling	CH
WS03	2.60	D	4	28.2	72	24	48	0.09	From Natural	0 (A)		71	Stiff closely fissured mottled bluish grey and yellowish brown CLAY with frequent decayed roots	CV
WS04	0.90	D	1	40.5	83	25	58	0.27	From Natural	<1% (A)		71	Firm yellowish brown CLAY with occasional light grey mottling, rare fine chert gravel and recently active 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.

Table Notation: Ret'd 0.425mm: (A) = Assumed, (M) = Measured

TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD

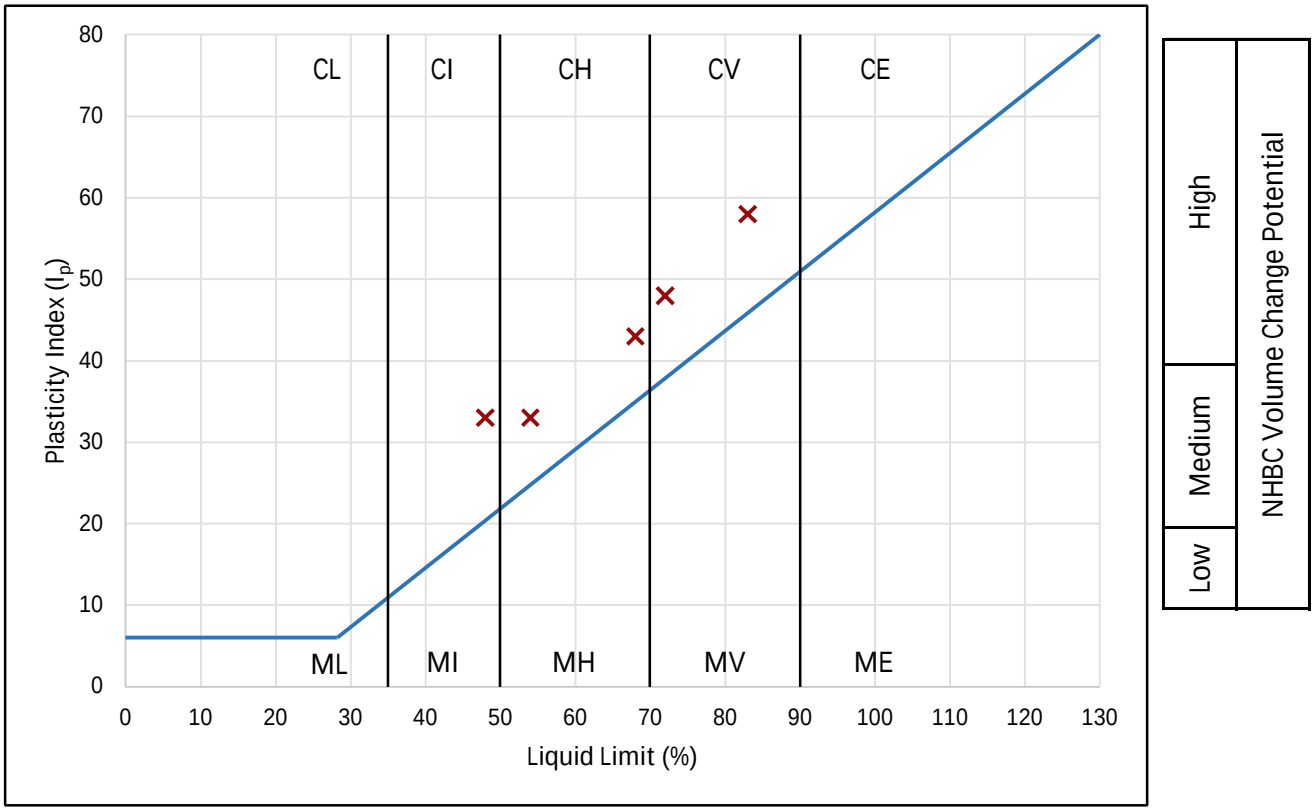
DATE ISSUED: 18/01/2022

0998

Contract	Land South West of Well Row, Bayford
Serial No.	39947_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

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

ISSUED BY SOIL PROPERTY TESTING LTD

DATE ISSUED: 18/01/2022

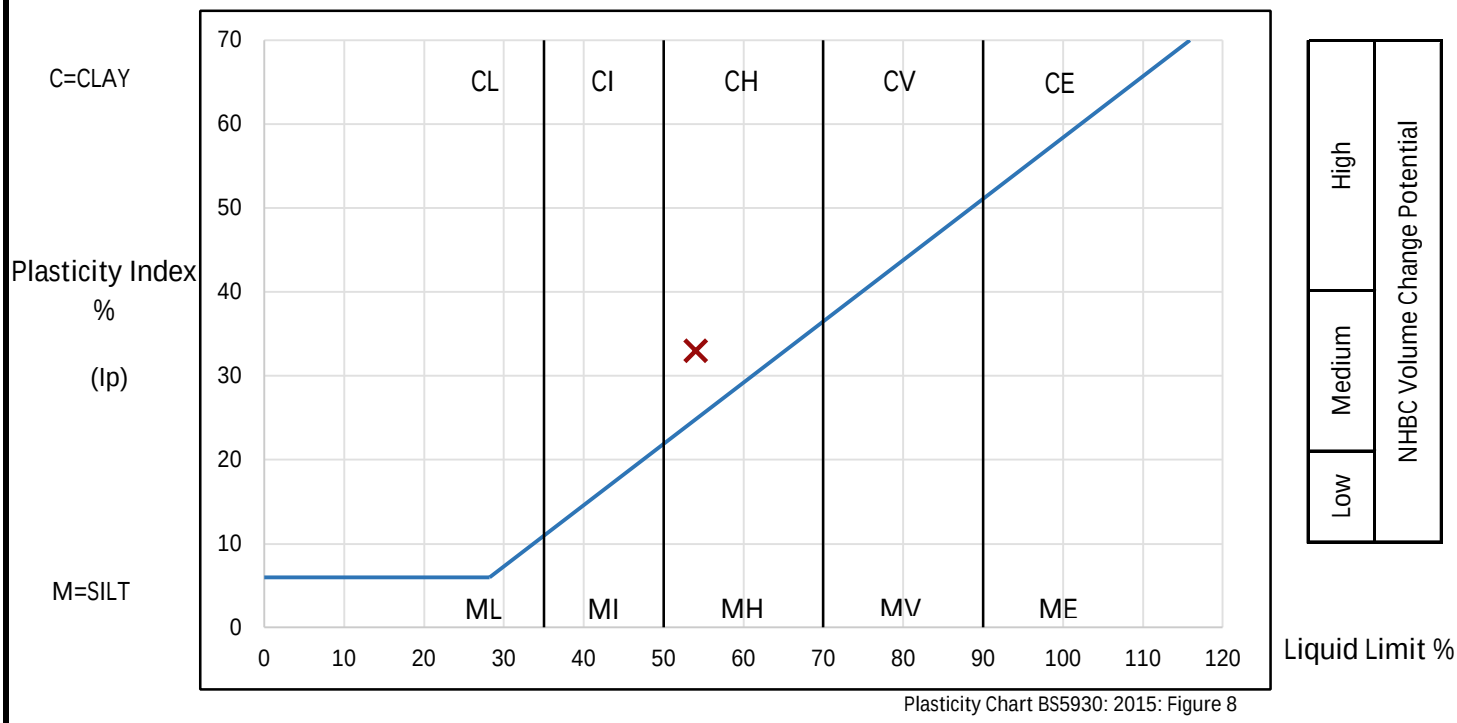
0998

Contract	Land South West of Well Row, Bayford
Serial No.	39947_1

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

Borehole / Pit No.	Depth m	Sample Type	Sample Reference	Water Content (W) %	Description	Remarks
WS01	0.80	D	1	17.3	Stiff yellowish brown slightly sandy gravelly CLAY with rare recently active roots. Gravel is brown, black and white fine to coarse angular to subrounded chert	

PREPARATION			Liquid Limit	54 %
Method of preparation	Wet sieved over 0.425mm sieve		Plastic Limit	21 %
Sample retained 0.425mm sieve	(Measured)	50 %	Plasticity Index	33 %
Corrected water content for material passing 0.425mm		34.6 %	Liquidity Index	-0.11
Sample retained 2mm sieve	(Measured)	44 %	NHBC Modified (I'p)	17 %
Curing time	67 hrs	Clay Content: Not analysed	Derived Activity	Not analysed



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 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: 18/01/2022

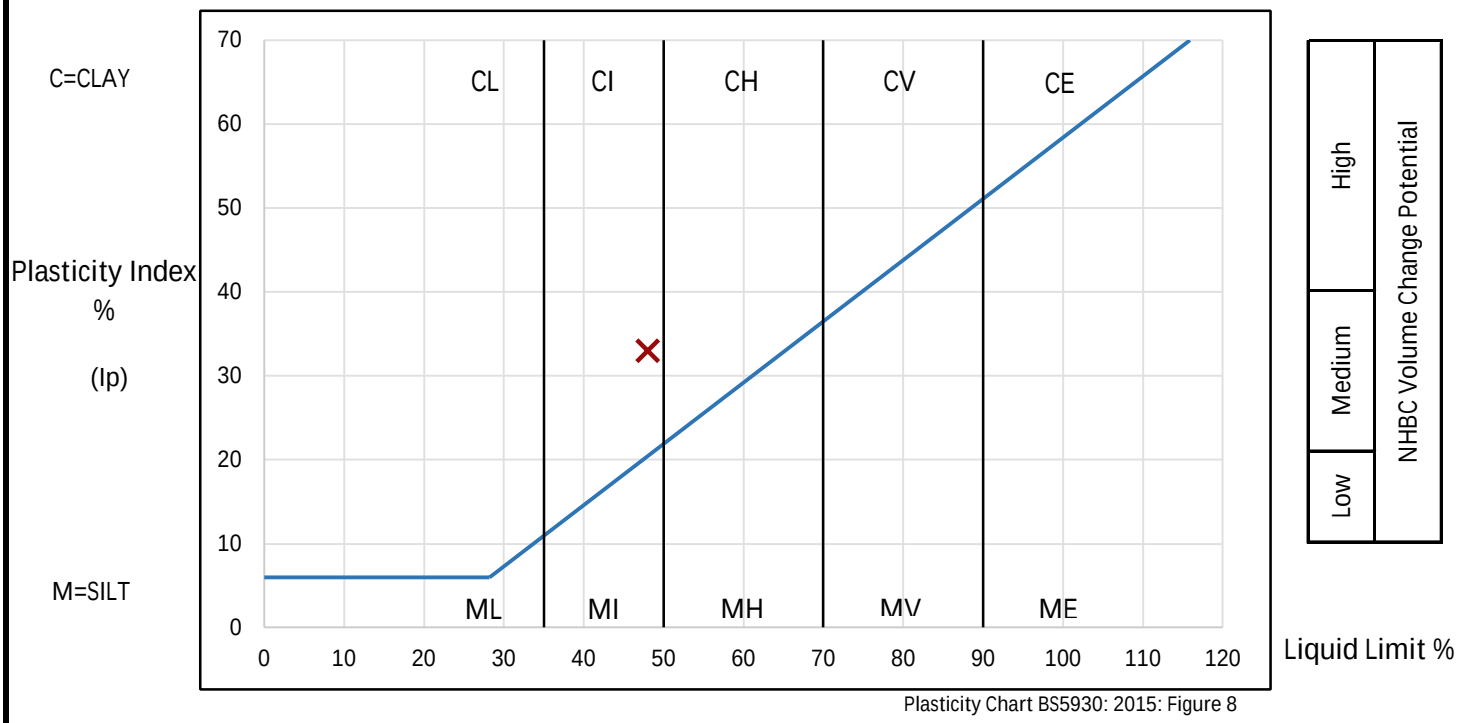
0998

Contract	Land South West of Well Row, Bayford
Serial No.	39947_1

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

Borehole / Pit No.	Depth m	Sample Type	Sample Reference	Water Content (W) %	Description	Remarks
WS02	1.50	B	2	7.2	Brown, black and white fine to coarse angular to rounded chert and quartzite GRAVEL in a firm mottled orangish brown and light grey sandy silty clay matrix	

PREPARATION			Liquid Limit	48 %
Method of preparation	Wet sieved over 0.425mm sieve		Plastic Limit	15 %
Sample retained 0.425mm sieve	(Measured)	75 %	Plasticity Index	33 %
Corrected water content for material passing 0.425mm		28.9 %	Liquidity Index	-0.24
Sample retained 2mm sieve	(Measured)	63 %	NHBC Modified (I'p)	8 %
Curing time	66 hrs	Clay Content: Not analysed	Derived Activity	Not analysed



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 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: 18/01/2022

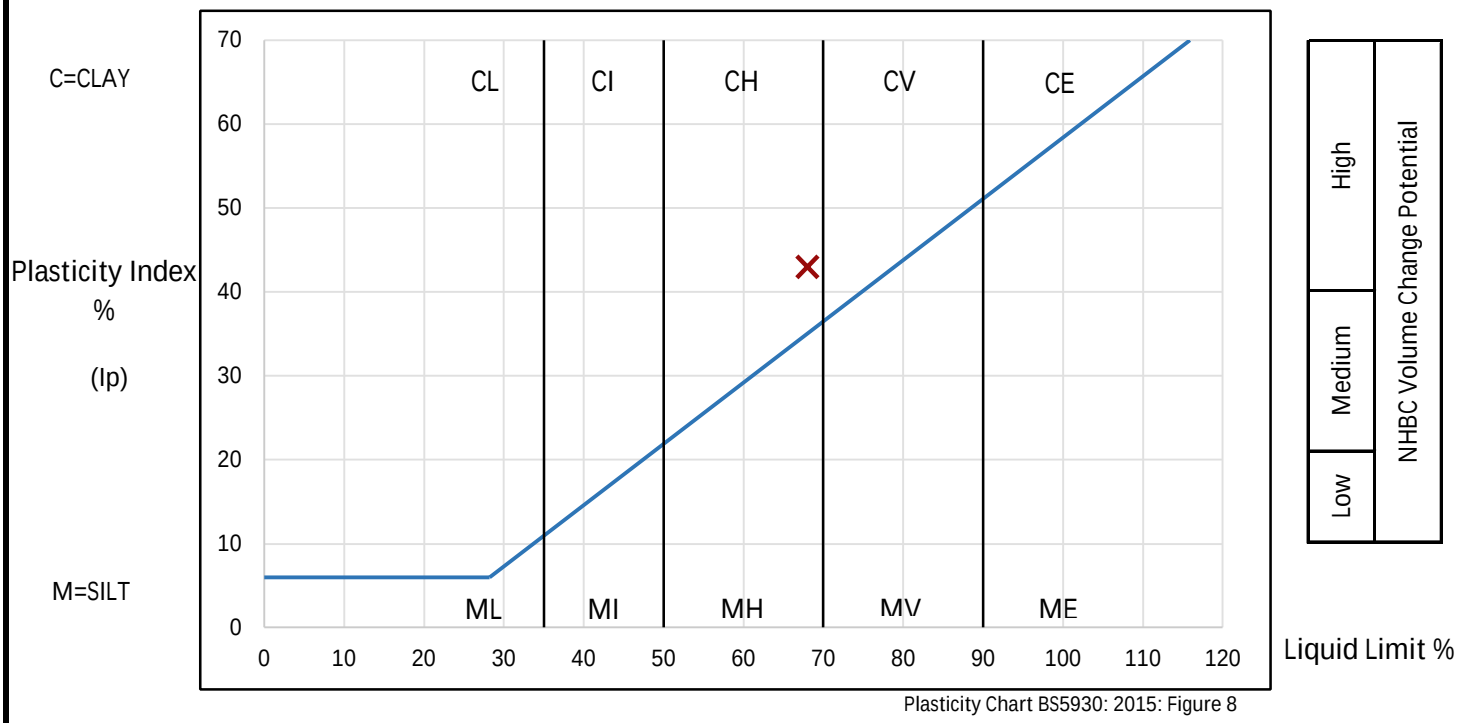
0998

Contract	Land South West of Well Row, Bayford
Serial No.	39947_1

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

Borehole / Pit No.	Depth m	Sample Type	Sample Reference	Water Content (W) %	Description	Remarks
WS03	1.70	D	2	27.7	Stiff yellowish brown CLAY with occasional recently active and decayed roots and rare bluish grey mottling	

PREPARATION			Liquid Limit	68 %
Method of preparation		From natural	Plastic Limit	25 %
Sample retained 0.425mm sieve	(Assumed)	0 %	Plasticity Index	43 %
Corrected water content for material passing 0.425mm			Liquidity Index	0.06
Sample retained 2mm sieve	(Assumed)	0 %	NHBC Modified (I'p)	n/a
Curing time	72 hrs	Clay Content: Not analysed	Derived Activity	Not analysed



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

ISSUED BY SOIL PROPERTY TESTING LTD

DATE ISSUED: 18/01/2022

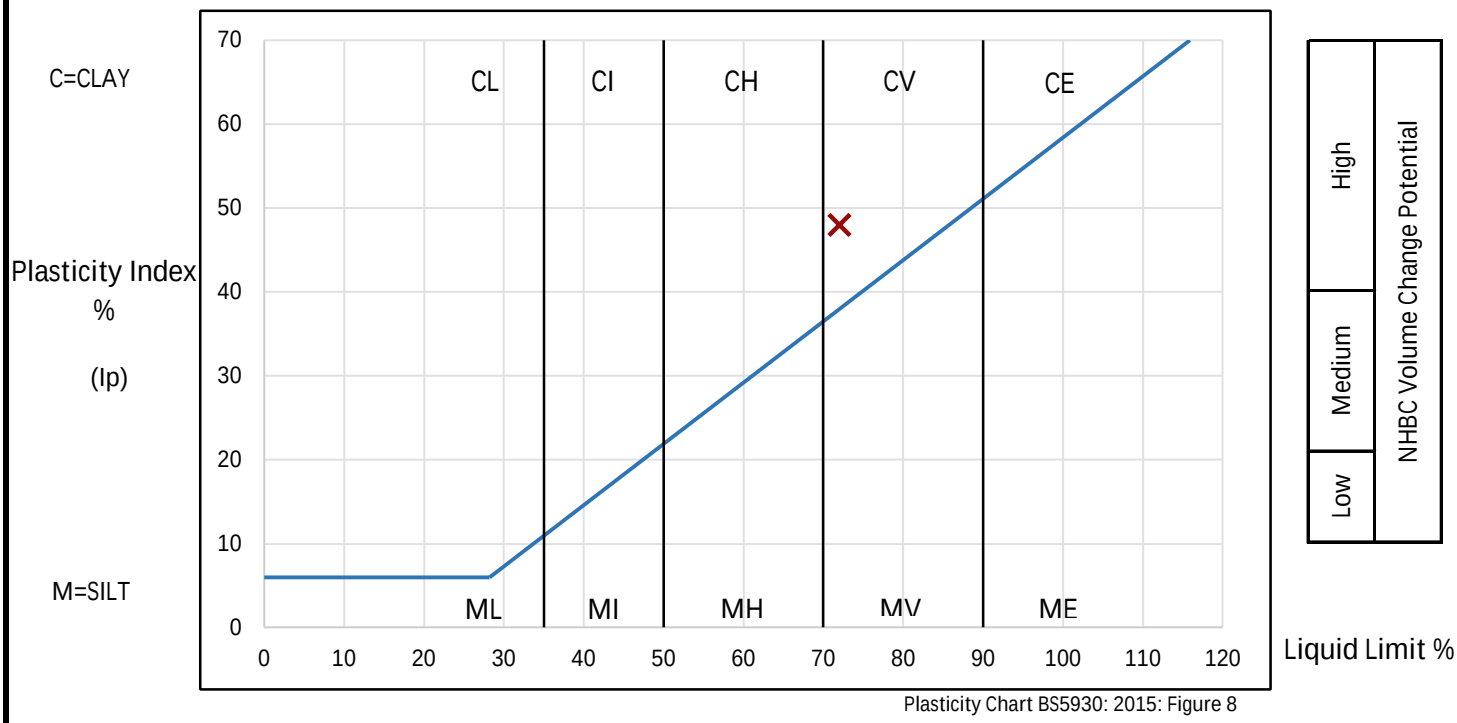
0998

Contract	Land South West of Well Row, Bayford
Serial No.	39947_1

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

Borehole / Pit No.	Depth m	Sample Type	Sample Reference	Water Content (W) %	Description	Remarks
WS03	2.60	D	4	28.2	Stiff closely fissured mottled bluish grey and yellowish brown CLAY with frequent decayed roots	

PREPARATION			Liquid Limit	72 %
Method of preparation		From natural	Plastic Limit	24 %
Sample retained 0.425mm sieve	(Assumed)	0 %	Plasticity Index	48 %
Corrected water content for material passing 0.425mm			Liquidity Index	0.09
Sample retained 2mm sieve	(Assumed)	0 %	NHBC Modified (I'p)	n/a
Curing time	71 hrs	Clay Content Not analysed	Derived Activity	Not analysed



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

ISSUED BY SOIL PROPERTY TESTING LTD

DATE ISSUED: 18/01/2022

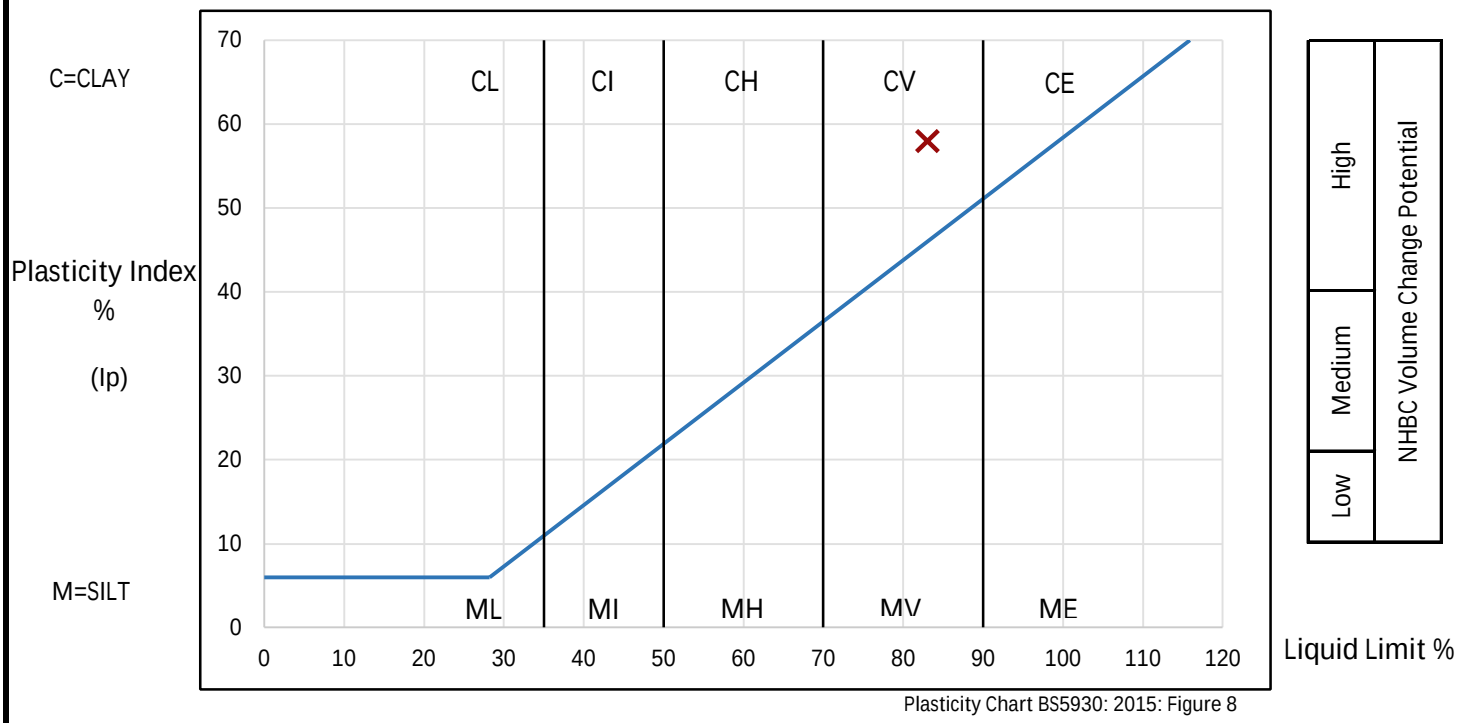
0998

Contract	Land South West of Well Row, Bayford
Serial No.	39947_1

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

Borehole / Pit No.	Depth m	Sample Type	Sample Reference	Water Content (W) %	Description	Remarks
WS04	0.90	D	1	40.5	Firm yellowish brown CLAY with occasional light grey mottling, rare fine chert gravel and recently active roots	

PREPARATION				Liquid Limit	83 %
Method of preparation	From natural/gravel picked out by hand			Plastic Limit	25 %
Sample retained 0.425mm sieve	(Assumed)	0 %		Plasticity Index	58 %
Corrected water content for material passing 0.425mm				Liquidity Index	0.27
Sample retained 2mm sieve	(Assumed)	<1 %		NHBC Modified (I'p)	n/a
Curing time	71 hrs	Clay Content	Not analysed	Derived Activity	Not analysed



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:	