



Report
Title:

Phase 2 Geo-Environmental Site Investigation

Project
Name:

Barnard Road, Norwich



Report
Reference:

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REPORT CONTROL SHEET

REPORT TITLE	PHASE 2 GEO-ENVIRONMENTAL SITE INVESTIGATION
PROJECT	BARNARD ROAD, NORWICH
CLIENT	HONEYVIEW INVESTMENTS LTD

REPORT REFERENCE	ISSUE DETAIL	DATE	PREPARED BY	CHECKED BY
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BRD Environmental Limited

Geotechnical and Environmental Services

- Ground Investigation
- Japanese Knotweed Removal
- Soil, Water and Gas Testing
- Contamination Assessment
- Geotechnical Advice
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Phase 2 Geo-Environmental Site Investigation
Barnard Road, Norwich
BRD4290-OR2-A Barnard Rd SI

REPORT LAYOUT

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

SUMMARY REPORT

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

TECHNICAL REPORT

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

1. INTRODUCTION TO TECHNICAL REPORT	1
1.1. CONTRACT DETAILS	1
1.2. SCOPE OF WORKS	1
1.3. REPORT LIMITATIONS	3
2. SITE CHARACTERISTICS	4
2.1. SITE SETTING	4
2.2. SITE DESCRIPTION	4
2.3. PREVIOUS INVESTIGATIONS	5
2.4. PRELIMINARY CONCEPTUAL MODEL	5
3. GROUND INVESTIGATION	8
3.1. INVESTIGATION DESIGN	8
3.2. BRD FIELDWORK	9
3.3. LABORATORY TESTING	10
4. GROUND CONDITIONS	12
4.1. OVERVIEW	12
4.2. ARTIFICIAL GROUND	12
4.3. TOPSOIL	12
4.4. SUPERFICIAL DEPOSITS	13
4.5. BEDROCK	13



4.6.	GEOTECHNICAL COMMENTS	13
4.7.	CONTAMINATION OBSERVATIONS	13
4.8.	GROUNDWATER BEHAVIOUR	13
4.9.	GROUNDWATER MONITORING	14
5.	GEOTECHNICAL PROPERTIES	15
5.1.	COARSE SOIL PARAMETERS	15
5.2.	FINE SOIL PARAMETERS	16
5.3.	SULPHATE AND pH	17
6.	GEOTECHNICAL ASSESSMENT	18
6.1.	INTRODUCTION	18
6.2.	EXCAVATIONS	18
6.3.	SLOPE STABILITY	18
6.4.	SUB-SURFACE CONCRETE	19
6.5.	SOAKAWAYS	19
6.6.	PAVEMENT CONSTRUCTION	19
6.7.	PRELIMINARY FOUNDATION RECOMMENDATIONS	20
6.8.	RECOMMENDATIONS FOR FURTHER GEOTECHNICAL WORK	22
7.	RISK ESTIMATION - SOILS	23
7.1.	HUMAN HEALTH	23
7.2.	WATER ENVIRONMENT	25
7.3.	BUILDING MATERIALS	26
8.	RISK ESTIMATION - GAS	27
8.1.	INTRODUCTION	27
8.2.	RESULTS SUMMARY	27
9.	RISK EVALUATION	28
9.1.	REVISED CONCEPTUAL MODEL	28
9.2.	UPDATED CONTAMINATION RISK ASSESSMENT	28
9.3.	RISK MANAGEMENT	30
9.4.	WASTE SOIL DISPOSAL	30
10.	HEALTH AND SAFETY FILE INFORMATION	31
10.1.	INTRODUCTION	31
10.2.	HAZARDS	31
10.3.	EXISTING STRUCTURES	31

10.4.	HAZARDOUS MATERIALS	31
10.5.	UTILITY SERVICES	31
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. BRD4290-OP2-A
	Exploratory Hole Location Plan	Ref. BRD4290-OD1-A
	Revised Conceptual Site Model	Ref. BRD4290-OP6-A
APPENDIX 2	EXPLORATORY HOLE & MONITORING RECORDS	
	Logs of boreholes.	Ref. WS01-WS11
	Falling head permeability test.	1 x A4 pages
	Gas monitoring records.	1 x A4 pages
	Groundwater monitoring records.	1 x A4 pages
APPENDIX 3	LABORATORY TEST RESULTS	
	DETS report 23-10827	15 x A4 pages
	SPT report 43164_1	11 x A4 pages

SUMMARY REPORT - GENERAL INFORMATION

SUBJECT	COMMENTS
CURRENT SITE CONDITION	The site currently consists of a bowling alley building together with a car park to the front (south) and a tarmac hardstanding area to the rear (north). Areas of trees and vegetation are present around the periphery as well as open grass areas in the northern and southern sections.
PROPOSED DEVELOPMENT	There are no formal development proposals at this stage, but it is understood that it is planned to construct a supermarket across the northern section of the site and residential apartments in the southern section.
HISTORICAL SUMMARY	The site remained undeveloped until the existing building was constructed in the early 1990s. The surrounding industrial estate and hotel were constructed a few years prior to the site development.
PUBLISHED GEOLOGY	The site is shown to be underlain by superficial deposits comprising the Lowestoft Formation (southern end) and the Sheringham Cliffs Formation (northern end). The former consists of a glacial Till (gravelly clays) and the latter comprise glacial sands and gravels. The shallowest bedrock unit is shown to comprise the Chalk but with the Crag Group (sand and gravel) also shown in the immediate vicinity.
ACTUAL GROUND CONDITIONS	The ground conditions encountered were broadly as anticipated from the published geology with the sandy soils of the Sheringham Cliffs Formation being the dominant soil type. Whilst some clay soils were encountered as part of the Sheringham Cliffs Formation, no soils consistent with the Lowestoft Formation (shown to be present in the southern part of the site) were encountered at the site. The Chalk bedrock was encountered in 4No. of the 11No boreholes and at depths in the range 3.1m to 5.6m below ground level (bgl). The Crag Group was not encountered. Localised Made Ground was encountered in the vicinity of the building.
HYDROGEOLOGY	The Sheringham Cliffs Formation is classified as a Secondary A Aquifer. The Lowestoft Formation is classified as a Secondary Undifferentiated Aquifer. The Chalk is classified as a Principal Aquifer. The site is located within a groundwater Source Protection Zone 3 (Total Catchment).
HYDROLOGY	The closest main watercourse is the River Yare together with a series of flooded gravel pits located around 700m to the south west of the site at their closest point. The river flows to the 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. However, BRD has undertaken geo-environmental desk study research and this has been reported separately.

SUMMARY REPORT - GEOTECHNICAL

SUBJECT	COMMENTS
EXCAVATIONS	It should be possible to forward excavations employing normal equipment. The use of hydraulic breaking equipment will be required for forwarding excavations at the site where existing sub-surface structures are present. Specific groundwater control unlikely to be required at this site.
SLOPE STABILITY	It is considered that slope stability is unlikely to be a concern at this site.
SUB-SURFACE CONCRETE	Design Sulphate Class of DS-1 and Aggressive Chemical Environment for Concrete class of AC-1s applies.
SOAKAWAYS	Site may be suitable for surface water disposal to soakaways or other forms of infiltration devices, but subject to further investigation together with careful design and construction.
PAVEMENT DESIGN	A preliminary design California Bearing Ratio (CBR) of less than 2% has been recommended to account for the ground disturbance that will result from the demolition of the existing of the building. For formations on natural soils, targeted testing of the plasticity of the soils at sub-grade and in-situ CBR tests are recommended to determine design values.
FOUNDATIONS	
LIKELY FOUNDATION TYPE	At this stage, the investigation is relatively preliminary as access has been restricted in some areas, i.e. the building footprint. In addition, no firm development proposals have been produced at this stage. However, based on the investigation completed to date, it is evident that there is some variation in the Sheringham Cliffs Formation, including some areas of loose soils. The areas of loose ground may be indicative of dissolution features, but equally may just reflect the variation of the Sheringham Cliffs Formation soils. Either way, it is considered that further ground investigation targeting future structures will be required to determine the feasibility of employing a shallow foundation solution and establish parameters for their design. Following the further investigation, it may be proved that shallow reinforced spread foundations (isolated pads and/or footings) could be employed with a restricted design bearing capacity. Alternatively, ground improvement or piles may be more appropriate.
VOLUME CHANGE POTENTIAL	Non shrinkable soils to Low volume change potential i.e. minimal swelling or shrinking with moisture content changes.
ESTIMATED FOUNDATION DEPTHS	The minimum foundation depth required is whatever is the deeper of that required to fully penetrate the Made Ground or disturbance caused by demolition, or to 0.75m, or 1.00m where required to allow for restricted new tree planting. If required, depth of potential ground treatment or pile lengths to be determined by specialist piling contractor.
HEAVE PROTECTION	Will not be required.

SUMMARY REPORT - CONTAMINATION ISSUES

SUBJECT	COMMENTS
SOIL RISKS TO HUMAN HEALTH	No unacceptable contamination in respect of human health have been identified by this investigation.
LANDFILL GAS	No plausible sources of landfill gas have been identified, and the confirmatory monitoring visit completed reinforces a lack of elevated ground gases.
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 samples tested. No suspected asbestos containing materials has been observed in the soils inspected.
WASTE SOIL DISPOSAL	The topsoil is suitable for re-use at the site. Should any subsoils need to be disposed of as waste, then they would be classified as non-hazardous waste and characterised as inert waste for landfill purposes.

SUMMARY REPORT - KEY RECOMMENDATIONS

RECOMMENDATIONS

As identified in the desk study, now that the preliminary intrusive ground investigation has been completed, a site specific Cavities Occurrence Assessment (COA) should be obtained to determine in more detail the potential for dissolution features to be present on the site.

Once the development layout is determined, then further ground investigation will be required for foundation purposes to determine whether spread foundations could be employed and to increase the exploratory hole density in order to assess the potential for further areas of loose/soft areas of ground. It would be best to undertake the further investigation once the existing structures have been demolished. The investigation will likely comprise a combination of trial pits, dynamic probing and/or static Cone Penetration Testing (CPT) specifically targeting future structures.

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

A tree survey is required as this information is required for detailed foundation design. This survey with topographic survey data should be undertaken prior to any site clearance to accurately record the location of any previously felled trees and existing trees both within the site and close to the site boundaries. The survey should record the trunk location, height and species of the trees.

No further contamination assessment is necessary at this stage. This report, together with the desk study, should be used in support of the future planning application for the site in order to demonstrate a lack of any soil contamination risks.

1. INTRODUCTION TO TECHNICAL REPORT

1.1. CONTRACT DETAILS

CLIENT	Honeyview Investments Ltd.
SITE	Land situated at Barnard Road, Norwich, Norfolk.
CLIENT'S ADVISORS	BRD Environmental Limited (BRD) has been commissioned by Henry Riley Property and Construction Consultants on behalf of the Client.
REPORT CONTEXT	It is understood that the Client intends to demolish the existing building and construct a new commercial unit and residential apartment block on the site.
REPORT TYPE	Geo-environmental site investigation (i.e. combined geotechnical ground investigation and Phase 2 contamination assessment).
REPORT OBJECTIVES	The site has been the subject of a desk study referenced as follows: • 'Phase 1 Geo-Environmental Desk Study - Barnard Road, Norwich', BRD Environmental Ltd, Report Ref. BRD4290-OR1-A, August 2023. The desk study identified several potential soil contamination sources as well as potential ground related hazards. The purpose of this report is to present the findings of an intrusive 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:

- Mobilisation to site and production of health and safety documentation.
- Provision of welfare facilities and temporary fencing to segregate site works.
- Two days of windowless sampling using a percussive drilling rig to provide approximately 10-12No. boreholes to a nominal depth of 3m-5m, ground conditions permitting. Undertake Standard Penetration Tests (SPT) at 1m intervals. All borehole locations with hard surface cover will be broken out with a hydraulic breaker.
- Installation of a 5m depth combined gas and groundwater monitoring well (nominal 50mm diameter) into 3No. boreholes. Installations will be finished with a flush fitting metal stopcock cover.
- All exploratory points will be logged and sampled in general accordance with BS5930:2015 and CIRIA C574 "Engineering in Chalk" by supervising Geo-Environmental Consultant.
- In-situ geotechnical testing of fine soils using a Hand Shear Vane and/or Pocket Penetrometer.
- A photo-ionisation detector (PID) will be used during the site works to assist in identifying and delineating any volatile organic contamination.

- Determination of the accurate location and level of exploratory points by topographical GPS unit.
- Apart from the 3No. proposed monitoring wells, reinstatement of all other borehole locations with cold lay macadam at surface. Disposal of surplus spoil following the reinstatement and construction of monitoring wells.
- Geo-Environmental Technician to undertake 1No. combined gas, vapour and groundwater monitoring visits. For gas, the determination of oxygen, carbon dioxide, methane, hydrogen sulphide and carbon monoxide concentrations, together with atmospheric pressure and flow rates, using portable equipment. For vapours, determination of the concentration of volatile organic compounds by photo ionisation detector. For groundwater, the determination of groundwater levels.
- During the monitoring visit, a falling head permeability test or simple soakage test (as appropriate the ground conditions) will also be undertaken within one of the monitoring wells to determine likely soil permeability or infiltration rates.
- Chemical testing of soil samples with the budget based on the following testing schedule:
 - 6No. Metals Suite - As, Cd, Cr, CrVI, Hg, Pb, Se, Cu, Ni and Zn.
 - 6No. Inorganics Suite - water soluble sulphate, pH, organic matter.
 - 6No. Speciated Polycyclic Aromatic Hydrocarbons (PAH).
 - 3No. Banded aliphatic/aromatic Total Petroleum Hydrocarbons (TPH).
 - 3No. Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and Methyl Tertiary Butyl Ether (MTBE) compounds.
 - 3No. Semi-Volatile Organic Compounds (SVOC) suite.
 - 3No. 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:
 - 4No. Moisture content.
 - 4No. Plasticity indices.
 - 3No. Particle size distribution by wet sieve and follow on hydrometer.
 - 6No. pH and water soluble sulphate analysis.
 - 6No. Total sulphate and sulphur analysis.
- Provision of a combined factual and interpretative investigation report. Factual findings to include all exploratory point records, monitoring and test results. Interpretative reporting to include a summary of information from desk study research, a Generic Quantitative Contamination Risk Assessment (GQRA), waste classification and a Geotechnical Assessment providing comments on pavement design, concrete classification, soakaway feasibility, foundation design recommendations.

1.3. REPORT LIMITATIONS

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

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

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

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

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

2. SITE CHARACTERISTICS

2.1. SITE SETTING

SITE ADDRESS AND POST CODE	10 Barnard Road, Bowthorpe Employment Area, Norwich, Norfolk, NR5 9JB.
NATIONAL GRID REFERENCE	617680E, 309940N.

2.2. SITE DESCRIPTION

SUBJECT	COMMENTS
CURRENT SITE DESCRIPTION	The site currently consists of a bowling alley building together with a car park to the front (south) and a tarmac hardstanding area to the rear (north). Areas of trees and vegetation are present around the periphery as well as open grass areas in the northern and southern sections. The site is rectangular in shape and covers an area of approximately 1.47 hectares. The majority of the site is relatively flat. In the northern section is a grassy area which slopes up to Dereham Road by around 2m-3m. In the strip of land to the west of the building, a grass bank slopes up by around 0.5m-1m to the level of the adjacent industrial buildings. Notable features include two above ground fuel tanks immediately adjacent to the western boundary, as well as some waste oil drums in the same area, all associated with the neighbouring units.
SURROUNDING LAND USE	The site is located in the Bowthorpe Park Industrial Estate, but with commercial land (hotel) to the east and residential land to the north. Immediately to the west are industrial units, as well as beyond Barnard Road to the south.
PROPOSED DEVELOPMENT	There are no formal development proposals at this stage, but it is understood that it is planned to construct a supermarket across the northern section of the site and residential apartments in the southern section.
HISTORICAL SUMMARY	The site remained undeveloped until the existing building was constructed in the early 1990s. The surrounding industrial estate and hotel were constructed a few years prior to the site development.
PUBLISHED GEOLOGY	The site is shown to be underlain by superficial deposits comprising the Lowestoft Formation (southern end) and the Sheringham Cliffs Formation (northern end). The former consists of a glacial Till (gravelly clays) and the latter comprise glacial sands and gravels. The shallowest bedrock unit is shown to comprise the Chalk but with the Crag Group (sand and gravel) also shown in the immediate vicinity.
RADON	Radon protection measures are not required.

SUBJECT	COMMENTS
HYDROGEOLOGY	The Sheringham Cliffs Formation is classified as a Secondary A Aquifer. The Lowestoft Formation is classified as a Secondary Undifferentiated Aquifer. Both the Chalk and the Grag Group are classified as Principal Aquifers. The site is located within a groundwater Source Protection Zone 3 (Total Catchment).
HYDROLOGY	The closest main watercourse is the River Yare together with a series of flooded gravel pits located around 700m to the south west of the site at their closest point. The river flows to the east. The site is not in an area indicated to be at risk of flooding.

2.3. PREVIOUS INVESTIGATIONS

BRD is unaware of any previous ground investigations having been conducted at the site. However, the site has been the subject of geo-environmental desk study research by BRD and this has been reported separately in “Phase 1 Geo-Environmental Desk Study - Barnard Road, Norwich”, BRD Environmental Ltd, ref. BRD4290-OR1-A, dated August 2023. This current report should be read in conjunction with the previous desk study report.

2.4. PRELIMINARY CONCEPTUAL MODEL

2.4.1. Potential Contamination Sources

Based on the previous BRD desk study, the following potential contamination sources have been identified:

- Existing bowling alley and car park - potential minor spills of oils / degreasers from moving mechanisms, and minor spills of fuels /oils in the car park areas.
- Potential Made Ground soils associated with the original construction of the building and surrounding area.
- Fuel and oil tanks on western boundary.
- Potential contamination from the surrounding industrial land use.

2.4.2. Invalid Contamination Linkages

No potential ground gas sources have been identified at the site and therefore no ground gas assessment is warranted within this report, albeit that it is still proposed to undertake confirmatory ground gas monitoring during the proposed groundwater monitoring visit.

2.4.3. Preliminary Conceptual Model

The preliminary risks, based on the potential contaminant linkages, are detailed in the table below.

POTENTIAL SOURCES AND CONTAMINANTS	PATHWAYS	RECEPTORS	POTENTIAL RISK
Existing bowling alley and car park.	Direct contact Ingestion of soils / dusts Inhalation of dusts / vapours	Future residents and site workers / visitors	Low
	Vertical and horizontal migration	Groundwater environment	Low
	Direct contact	Sub-surface building materials and services	Negligible
Potential Made Ground soils associated with the original construction of the building and surrounding area.	Direct contact Ingestion of soils / dusts Inhalation of dusts / vapours	Future residents and site workers / visitors	Moderate / Low
	Vertical and horizontal migration	Groundwater environment	Low
	Direct contact	Sub-surface building materials and services	Low
Fuel and oil tanks on western boundary	Cross contamination at the site boundary leading to: Direct contact Ingestion of soils / dusts Inhalation of dusts / vapours	Future residents and site workers / visitors	Moderate / Low
	Cross contamination at the site boundary leading to: Direct contact	Sub-surface building materials and services	Low
Surrounding industrial land use	Cross contamination at the site boundary leading to: Direct contact Ingestion of soils / dusts Inhalation of dusts / vapours	Future residents and site workers / visitors	Low
	Cross contamination at the site boundary leading to: Direct contact	Sub-surface building materials and services	Negligible

2.4.4. Preliminary Geotechnical Assessment

At the previous desk study phase, the following geotechnical considerations were identified.

Glacial Sand and Gravel soils are anticipated in the upper part across most of the site and these would generally support shallow foundations for low rise buildings. In the southern part of the site, clayey Glacial Till soils may be present and foundation depths in this area could be affected by the presence of existing or proposed trees due to the potential swelling and shrinking of the clays with changing moisture content. However, spread foundations would typically still be appropriate.

The site is in an area with a moderate to high potential for ground dissolution stability hazards. Dissolution features can occur where permeable soils, such as sand or gravel, overlie the Chalk, and mildly acidic water can dissolve the underlying rock. This can result in pockets of loose sand and gravel filling the voids associated with the dissolution features and in turn can dictate specialist foundations and/or ground treatment. A site specific Cavities Occurrence Assessment (COA) should be obtained from Stantec (formerly Peter Brett Associates), which is the body which holds such records, to determine in more detail the potential for dissolution features to be present on the site. However, the findings of the intrusive ground investigation (the subject of this report) would inform the findings of the COA and therefore it would be best instructed once the investigation has been completed.

The underlying soils, with the exception of the Lowestoft Formation (if present), should provide good infiltration rates for soakaway drainage. Should an increased risk from dissolution features be identified, then this may have a bearing on the necessary offset distance from soakaways to proposed new structures.

3. GROUND INVESTIGATION

3.1. INVESTIGATION DESIGN

METHODOLOGY	Due to the active nature of the site, windowless sample boreholes were chosen as the most appropriate ground investigation technique. These boreholes can be drilled with minimal disturbance, will confirm the geological sequence, will return in-situ soil data and will allow the construction of gas/groundwater monitoring wells.	
DATES OF SITE WORKS	The main field works were undertaken on 15 th to 17 th August 2023. A single monitoring visit was undertaken on 23 rd August 2023.	
CONSTRAINTS TO EXPLORATORY HOLE LAYOUT	The existing building represented the main constraint to the exploratory hole layout as it covers a fairly large proportion of the site. The strip of land to the west of the building was also constrained to some extent as there is a sloping grass bank where it was not possible to undertake any boreholes or fully scan for services. However, a hand dug pit was still completed in this area to target the above ground tanks. Across the grass bank in the north western area there are two plastic gas feeds to the site which are not possible to trace, as well as a heavily overgrown area. Therefore, this location was also given a wide exclusion zone. Overall a relatively good spread of exploratory holes was completed in order to gain a good understanding of the ground conditions across the site.	
EXPLORATORY HOLE SPACING	Approximately 30m grid.	
LAYOUT RATIONALE	SOURCE / FEATURE	EXPLORATORY HOLE
CONTAMINATION SOURCES TARGETED	Car park areas.	WS01, WS02, WS09, WS10.
	Bowling alley machinery.	WS07, WS08 to WS10.
	Neighbouring above ground fuel tanks and oil drums.	WS05 and WS08.
	Potential cross contamination from off site industrial land to the west.	WS01, WS05, WS08, WS09.
	General Site coverage with potential Made Ground.	WS01 to WS11.
GROUND FEATURES TARGETED	Potential deeper Made Ground on the northerly grass bank.	WS11.
	General site coverage with potential for dissolution features.	WS01 to WS11.

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 (where present) as this stratum represents the soils most likely to be contaminated. Occasional deeper samples were obtained in order to assess any potential risks to future buried services, or cross boundary migration via groundwater etc. Samples from the granular sub-base haven't been analysed as these are unlikely to be contaminated as they comprised quarried products.
ANALYSIS PLAN	Given the relatively low risk of contamination at the site and based on the potential contaminants identified within the Hazard Identification section of the Phase 1 contamination assessment, BRD has scheduled a suite of typically occurring contaminants that are more commonly encountered on light industrial sites. Near the above ground fuel tanks, and in the vicinity of the car park and bowling alley machinery, there is an increased potential for hydrocarbon related contaminants including petroleum hydrocarbons and benzene, toluene, ethylbenzene and xylene (BTEX) compounds. Therefore, the testing from samples in these areas has been increased.

3.2. BRD FIELDWORK

WINDOWLESS SAMPLING BOREHOLES	
REFERENCES	WS01 to WS11.
DEPTH RANGE	The boreholes extended from 1.10m to 6.45m bgl. The proposed depth was typically 5.45m bgl, however, the following exceptions are noted. Borehole WS01 refused at 3.90m in dense sand preventing deeper drilling. Borehole WS04 became blocked with a flint cobble at 4.00m bgl preventing further drilling, however, the Chalk had already been encountered by this point. Borehole WS08 comprised a hand dug pit only, due to access restrictions and utility service constraints. Therefore, it was terminated at 1.10m depth once the natural soils had been encountered.
RIG TYPE	Premier Drilling Rig.
INSTALLATION / BACKFILL	Boreholes WS3, WS5 and WS9 had monitoring wells installed. These comprised 50mm nominal diameter standpipes fitted with a gas tap finished with a flush metal cover. The slotted response length of the well is shown on the individual logs. Bentonite seals are also indicated on the logs. The filter medium used was pea gravel. The remaining 8No. boreholes were backfilled with arisings only. In areas of tarmac hardstanding (WS01, WS02, WS09 and WS10) the surface was reinstated with cold lay tarmac.

MONITORING	
TYPE	Ground gases and vapour. Groundwater levels monitoring.
DATES	23 rd August 2023.
OTHER	A simple infiltration test was undertaken in WS03 during the monitoring visit.

3.3. LABORATORY TESTING

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

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	4
Liquid and plastic limits	4
Particle size distribution by wet sieve and hydrometer	3
pH and Water soluble Sulphate	6
Total Sulphur and Sulphate	6

4. GROUND CONDITIONS

4.1. OVERVIEW

The ground conditions encountered were broadly as anticipated from the published geology with the sandy soils of the Sheringham Cliffs Formation being the dominant soil type. Whilst some clay soils were encountered within, no soils consistent with the Lowestoft Formation (shown on the geological maps to be present in the southern part of the site) were encountered.

The Chalk bedrock was encountered in 4No. of the 11No. boreholes and at slightly shallower depths than anticipated. Where encountered, both in the northern and southern sections, the interface with the Chalk was at depths in the range 3.1m to 5.6m below ground level (bgl). This would suggest that the surface of the Chalk undulates beneath the site. Whilst occasional soft or loose soils were encountered, there was no evidence of any significant solution features or the like. Bedrock soils of the Cragg Group were not encountered.

Only limited Made Ground was encountered at the site and it is evident that when the site was developed in the early 1990's, the levels were cut into the existing gentle slope, rather than any filling being required to create the level site.

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

4.2. ARTIFICIAL GROUND

4.2.1. Hardstanding & Sub-Base

The tarmac hardstanding was excavated through in WS01 and WS02 in the southern car park area and WS09 and WS10 in the northern hardstanding area. Both the tarmac and sub-base were found to be consistent, with the tarmac layer being between 100mm to 140mm thick. The underlying sub-base was all the same material and extended to depths in the range 0.25m to 0.35m bgl. It consisted of a quarried 'Type 1' aggregate.

4.2.2. Made Ground

Localised Made Ground to depths of up to 0.9m was encountered in WS04, WS05, WS06 and WS8 which are all in close proximity to the building and some of which were relatively close to known drainage infrastructure. The Made Ground all comprised reworked natural soils and is likely present as a consequence of the ground disturbance from the construction of the building and placing of utility services at the site when the building was constructed.

The Made Ground typically comprised a 'brown gravelly sand. Gravel of fine to coarse, subrounded to angular flint, brick and concrete'.

4.3. TOPSOIL

Topsoil or reworked topsoil was encountered in all of the borehole locations away from the tarmac hardstanding. Undisturbed topsoil was encountered in WS03 in the landscaping in the south eastern corner of the site, and WS11 on the sloping ground in the north eastern corner of the site. Elsewhere, reworked topsoil was encountered in WS04 at the northern end of the southern landscaped area and in WS05 to WS08 in the thin strips of landscaping around the building.

The undisturbed topsoil extended to depths in the range 0.25m to 0.30m bgl and was typically described as 'dark brown slightly gravelly SAND with some rootlets. Gravel of fine to coarse subrounded to angular flint'.

The reworked Made Ground topsoil was very similar to the natural topsoil, but sometimes contained occasional extraneous material including fragments of brick, concrete, plastic and /or glass, where they had been incorporated into the topsoil.

4.4. SUPERFICIAL DEPOSITS

4.4.1. Sheringham Cliffs Formation

The Sheringham Cliffs Formation is widespread across the site and encountered in all of the exploratory holes and extending to depths of between 3.1m and 5.6m bgl (where proven). In several of the other holes where the Chalk was not encountered, these soils extended beyond 5.45m bgl and therefore could extend deeper in some areas.

The dominant soil type comprised a 'medium dense light brown or orange brown slightly gravelly SAND. Gravel of fine to coarse subrounded to angular flint' and this was encountered beneath the Made Grond or Topsoil in all of the exploratory holes. Sometimes this material extended throughout the borehole (WS02, WS06, WS07, WS09 and WS11) or in other locations, from depths of around 1.5m, clay or silt layers of 1m or so thickness were present within.

A typical example of a clay band would be 'firm brown sandy slightly gravelly CLAY. Gravel of fine to coarse subrounded to angular flint'. The silt, less commonly encountered, was described as 'firm grey with orange brown patches, sandy clayey SILT'.

4.5. BEDROCK

4.5.1. Chalk

The Chalk was encountered in WS02, WS04 and WS06 in the southern and central part of the site and WS09 in the north western part of the site. Where present it was at depths ranging from 3.1m to 5.6m bgl. The percussive drilling application results in significant disturbance of the Chalk structure and therefore full chalk descriptions (CIRIA C574) are not possible. The recovered Chalk was described as 'CHALK recovered as light brown to off white slightly gravelly silty clay. Gravel of fine to coarse angular flint'.

4.6. GEOTECHNICAL COMMENTS

In WS02, the sand soils were noted to become loose at a depth of 4.0m (based on drilling behaviour) then a band of clay soils encountered from 4.5m to 5.6m (just above the Chalk), was noted to be soft in nature. The borehole was extended by another metre at which point the Chalk was encountered and this exhibited an increased strength.

What appeared to be low strength soils were also encountered in WS04 at 1m to 2m in the sandy soils of the Sheringham Cliffs Formation and also in WS06 at 1m depth in the same soils.

The low strength soils all corresponded with where the Chalk was encountered at relatively shallow depths.

4.7. CONTAMINATION OBSERVATIONS

No visual or olfactory evidence of contamination was noted during the forwarding of exploratory holes. In particular there was no evidence of any fuel or oil contamination in the vicinity of the above ground fuel tanks.

4.8. GROUNDWATER BEHAVIOUR

Groundwater was not encountered whilst forwarding any of the exploratory holes.

4.9. GROUNDWATER MONITORING

DATE	RESTING GROUNDWATER RANGE	COMMENTS
23/08/23	From >5.00m to >5.06m bgl.	All three monitoring wells installed at the site were found to be dry during the return monitoring visit.

5. GEOTECHNICAL PROPERTIES

5.1. COARSE SOIL PARAMETERS

5.1.1. Infiltration test

During the monitoring visit, which confirmed that all of the monitoring wells were dry, a simple infiltration test was conducted in WS03. This involved rapidly emptying 30 litres of water into the monitoring well and observing the water levels for around 80 minutes. The records of the test are presented in the appendices.

Utilising an adapted BRE365 soakage test calculation method (as the original guidance is not directly applicable for use in with boreholes) an infiltration rate of 2.88×10^{-6} m/s has been calculated, which is relatively low.

It is noted during the test, that the water levels fell very rapidly from around 2m to 4m bgl in ten minutes, then fell much more slowly beyond this point. In WS03 a gravelly sand was present to a depth of 3.1m, followed by sandy clayey silt to a depth of 4.60m, then followed by very clayey sand to the base. It is likely that the initial rapid fall relates to the upper sand soils, then the silt and clayey sand resulted in much slower infiltration.

It is therefore evident that the gravelly sands present in the upper layers offer good infiltration rates, whereas the rates are lower for the silty / clayey soils beneath. The majority of the site contains the gravelly sand soils in the upper few metres or deeper and therefore it is anticipated that good infiltration rates would typically be observed at the site.

If infiltration devices are to be utilised, then formal soakage tests in accordance with BRE365 should be completed in their proposed locations across the site.

5.1.2. Standard Penetration Tests

The 30No. Standard Penetration tests (SPTs) undertaken in sand dominant Sheringham Cliffs Formation soils recorded N-Values varying from 0 (i.e. self weight) to 34. There was also a single SPT that refused, i.e. N-value >50, at the base of WS01. The results indicate that this soil varies from very loose to dense in terms of relative density. Over half of the results are indicative of medium dense soils.

Of particular note is borehole WS02 where loose soils were noted with depth and the very loose soils recorded at shallow depth in WS04. These are discussed later in the report.

5.1.3. Particle Size Distribution

The grading curves of the 3No. samples of Sheringham Cliffs Formation subject to Particle Size Distribution (PSD) determination revealed the soil to vary between two different profiles.

The samples from 2.0m in WS02 and 1.1m in WS09 displayed similar distribution curves describing the soils as a relatively well graded slightly clayey slightly gravelly very silty SAND varying to very sandy SILT. The fines content varied from 32% to 38% and so the soil can sometimes be of intermediate characteristics between a fine and coarse soil type.

The sample from 1.1m in WS11 had a different distribution that was poorly graded with the soil dominated in the sand fraction, predominately medium sand, with minimal fines and gravel content.

5.2. FINE SOIL PARAMETERS

5.2.1. Index Property Testing

SOIL TYPE	Sheringham Cliffs Formation - clay bands.
PLASTICITY INDEX (PI)	Oversize particles present.
MODIFIED PI	5% to 12%.
NHBC CLASS	Non shrinkable soil type to Low volume change potential.
COMMENTS	Samples specifically targeting clay rich bands within the Sheringham Cliffs Formation showed variable plasticity. One of the PI results plotted below the A-Line on the plasticity index and another on the A-Line. This shows the soil was varying between behaving as a clay or a silt. This mirrors two of the PSD results that recorded variable fines content.

5.2.2. Standard Penetration Tests

5.2.2.1. *Sheringham Cliffs Formation*

Due to the variability of the soil type, correlations of the Standard Penetration Test N-value results to an undrained shear strength are not considered appropriate. The 10No. SPTs within the more clayey bands of the Sheringham Cliffs Formation displayed considerable scatter with N-values varying from 2 to 27 indicative of very soft to stiff consistency.

5.2.2.2. *Chalk*

The 8No. SPTs undertaken in the chalk bedrock recorded N-values in the range to 8 to 25, averaging 13. It is likely that the Chalk is in a structureless state at the depths tested and the SPTs suggest that it is reasonably competent.

5.3. SULPHATE AND pH

	ALL SOILS TESTED			
	Sulphate		pH	
Characteristic Value	100 mg/l		7.0 units	
Justification	Highest measured concentration rounded to nearest 100mg/l.		Lowest measured value.	
	No. of tests	Results Range	No. of tests	Results Range
Soil	12	<10 to 17 mg/l	12	7.0 to 8.0 units
Groundwater	Not tested			
Total Potential Sulphate	5	Not applicable as pyrite unlikely in the samples tested.		

6. GEOTECHNICAL ASSESSMENT

6.1. INTRODUCTION

At the time of writing, there are no formal development proposals. The following advice and recommendations are based on the construction of a supermarket across the northern section of the site and residential apartments in the southern section.

From assessment of the nature of the ground conditions and the type of proposed structures, it is considered that the situation falls within EC7 Geotechnical Category 1 with parts possibly in Category 2.

Once the nature of the development is confirmed then the results of this investigation will 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 shallow trench excavations will remain relatively stable and open for short periods, but minor spalling of side walls could still occur. Deep trench excavations are likely to suffer side wall collapse.
EQUIPMENT	It should be possible to progress excavations with conventional equipment. The removal of sub-surface structures following demolition will require the use of hydraulic breaking equipment.
GROUNDWATER CONTROL	Specific groundwater control is unlikely to be required at this site for shallow excavations (less than 2.5m). Limited pumping from sumps or bailing out may be required to deal with slight seepages or surface water ingress during periods of inclement weather.

6.3. SLOPE STABILITY

The site is relatively flat and no significant changes in level as part of the development are anticipated. The slopes at the periphery of the site are relatively shallow, the change in levels is not substantial and the slopes show no obvious signs of instability. It is therefore considered that slope stability is unlikely to be a significant concern at this site.

Any change in levels required should be cut to a slope no greater than one in four (vertical : horizontal) (14°) which should provide reasonable long term stability. It should be noted that shallower slopes may be required for other reasons such as access for landscaping maintenance. Alternatively, changes in level should be supported by appropriately designed and constructed retaining walls.

6.4. SUB-SURFACE CONCRETE

Classification of the ACEC has been undertaken in accordance with the BRE SD1:2005 Concrete in Aggressive Ground.

ALL SOILS TESTED	
SITE / SOIL CATEGORY	Natural ground.
DESIGN SULPHATE CLASS	DS-1
GROUNDWATER REGIME	Static.
ACEC CLASS	AC-1s
COMMENTS	Static groundwater conditions have been selected as groundwater is expected to be permanently below the lowest level of proposed construction.

6.5. SOAKAWAYS

A simplified soakage test was conducted in one of the boreholes, which indicated that the more granular sand dominant soils of the Sheringham Cliffs Formation soils should offer potential for the use of infiltration devices. The more clayey bands will not offer sufficient infiltration. Wide area 'crate' style soakaways, trench soakaways or ring soakaways linked by permeable pipes are recommended as this will increase the chance of intercepting more permeable horizons within Sheringham Cliffs Formation.

As identified in the desk study, the underlying Chalk can be prone to dissolution features, and therefore this would need to be considered in relation to the location of proposed soakaways, as they would need to be located away from buildings and roads. The presence of solution features and the density of the underlying Chalk will have a bearing on the offset distance from soakaways to structures. Further guidance in relation to soakaways is presented in CIRIA C574 and it should be noted that if a worst-case high risk of solution features is identified, then soakaways would need to be sited at least 20m from any foundations or structures.

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

6.6. PAVEMENT CONSTRUCTION

Due to the depth of made ground covering the site and the ground disturbance likely due to the removal of the existing structures, it is recommended that a preliminary design California Bearing Ratio (CBR) of less than 2% is assumed at this stage.

For formations on natural soils, targeted testing of the plasticity of the soils at sub-grade and in-situ CBR tests are recommended to determine design values for natural soils.

The existing tarmac at the site shows extensive cracking in some areas, suggesting possible differential settlement. This may be a reflection of the variation in the nature of the natural

soils. Consideration should be given to incorporating geo-grid reinforcement into the foundations of future paved areas to reduce the adverse effects of differential settlement.

The soils at the site will likely be prone to rapid degradation during wet weather working and this should be avoided where possible. To reduce the loss of granular construction materials into the sub-grade, utilising a geotextile starter layer across the formation level is recommended.

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.

6.7. PRELIMINARY FOUNDATION RECOMMENDATIONS

6.7.1. Introduction

At this stage, the investigation is relatively preliminary as access has been restricted in some areas i.e. the building footprint. In addition, no firm development proposals have been produced at this stage. However, based on the investigation completed to date, it is evident that there is some variation in the Sheringham Cliffs Formation, including some areas of loose soils. The areas of loose ground may be indicative of dissolution features, but equally may just reflect the variation of the Sheringham Cliffs Formation soils. Either way, it is considered that further ground investigation targeting future structures will be required to determine the feasibility of employing a shallow foundation solution and establish parameters for their design.

In parallel, a site specific Cavities Occurrence Assessment (COA) can now be commissioned to determine in more detail the potential for dissolution features to be present on the site, which in turn can feed into the further investigation design described above.

Following the further investigation, it may be proved that shallow reinforced spread foundations (isolated pads and/or footings) could be employed with a restricted design bearing capacity. Alternatively, ground improvement or piles may be appropriate.

6.7.2. Floor Slabs

In the northern half of the site the ground will be disturbed to such a depth that fully suspended floor slabs or suspended cast insitu floor slabs will likely be required.

In the southern half of the site, subject to the removal of any made ground, soft spots or topsoil and replacement with suitable compacted granular fill, the ground may be suitable for the adoption of reinforced ground bearing floor slabs.

6.7.3. Spread Foundations

It may be possible to employ spread foundations in the form of reinforced isolated pad foundations or footings, but due to the presence of loose/soft areas of ground, then once the development layout is determined some further ground investigation will be required to determine an appropriate design bearing capacity. The design bearing capacity should ensure that immediate and long term settlement is within tolerable limits. However, the foundation solution and design is also subject to the findings of the COA and further investigation as they may confirm the presence of dissolution features.

The clay bands within the Sheringham Cliffs Formation have been shown to vary between being a non-shrinkable soil and having a low volume change potential when assessed against NHBC standards. The minimum foundation depth required due to the low volume change is 0.75 m, but 1.00m 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. It should be noted that where trees are in groups the resulting competition for resources can lead to deeper root systems than allowed for in the NHBC Standards. In any event, foundations should be taken below any roots encountered in foundation trench excavation. Where the required foundation depth varies around a structure, this can be accommodated by forming steps in the foundation as per NHBC Standards.

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

The excavator must be set up with care and operated correctly to ensure trench or excavation walls are vertical and base horizontal as any slight inclination will result in eccentric loading on spread foundations.

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

Where existing structures are to be demolished it is difficult to predict potential footing depths as the demolition works and foundation removal are likely to disturb the soils and therefore locally over deepened footings should be anticipated in areas of former structures.

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

6.7.4. Ground Improvement

It may be possible for the ground to be improved by the use of vibro-replacement stone or concrete columns. After ground improvement by such techniques, shallow reinforced strip footings could then be employed. Discussions with specialist contractors should be held to confirm that this technique is suitable for the ground conditions at the site.

Ground improvement techniques such as dynamic compaction, excavation and replacement with suitable engineered fill, and surcharging for to allow the use of shallow spread foundations are not generally accepted by construction warranty providers, e.g. NHBC, and are therefore not discussed.

6.7.5. Piling

It is possible that as a result of the recommended further ground investigation that a spread foundation solution is not appropriate and that a piled foundation design may be required. Alternatively, the proposed structures may have column loads that are too high to be supported by spread foundations and so piles may have to be employed.

6.8. RECOMMENDATIONS FOR FURTHER GEOTECHNICAL WORK

As identified in the desk study, now that the preliminary intrusive ground investigation has been completed, a site specific Cavities Occurrence Assessment (COA) should be obtained to determine in more detail the potential for dissolution features to be present on the site.

Once the development layout is determined, then further ground investigation will be required for foundation purposes to determine whether spread foundation could be employed and to increase the exploratory hole density to assess the potential for further areas of loose/soft areas of ground. It would be best to undertake the further investigation once the existing structures have been demolished. The investigation will likely comprise a combination of trial pits, dynamic probing and/or static Cone Penetration Testing (CPT) specifically targeting future structures.

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

A tree survey is required as this information is required for detailed foundation design. This survey with topographic survey data should be undertaken prior to any site clearance to accurately record the location of any previously felled trees and existing trees both within the site and close to the site boundaries. The survey should record the trunk location, height and species of the trees.

7. RISK ESTIMATION - SOILS

7.1. HUMAN HEALTH

The Generic Assessment Criteria (GAC) employed below are for residential land use in the first instance as this is the most conservative land use in relation to the outline proposals for the site.

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
Arsenic	mg/kg	6	11	37	0
Cadmium	mg/kg	6	<0.2	22	0
Chromium (total)	mg/kg	6	9	910	0
Chromium (hexavalent)	mg/kg	6	<2	21	0
Copper	mg/kg	6	7	2,400	0
Lead	mg/kg	6	25	200	0
Mercury	mg/kg	6	<1	11	0
Nickel	mg/kg	6	8	180	0
Selenium	mg/kg	6	<2	250	0
Zinc	mg/kg	6	43	3,700	0
pH	Units	12	7.0-8.0	<5-10>	0
Naphthalene	mg/kg	6	< 0.1	2.3	0
Acenaphthylene	mg/kg	6	< 0.1	170	0
Acenaphthene	mg/kg	6	< 0.1	210	0
Fluorene	mg/kg	6	< 0.1	170	0
Phenanthrene	mg/kg	6	0.31	95	0
Anthracene	mg/kg	6	< 0.1	2,400	0
Fluoranthene	mg/kg	6	0.42	280	0
Pyrene	mg/kg	6	0.36	620	0
Benzo(a)anthracene	mg/kg	6	0.22	7.2	0
Chrysene	mg/kg	6	0.17	15	0
Benzo(b)fluoranthene	mg/kg	6	0.24	2.6	0
Benzo(k)fluoranthene	mg/kg	6	< 0.1	77	0
Benzo(a)pyrene	mg/kg	6	0.22	2.2	0
Indeno(1,2,3-cd)pyrene	mg/kg	6	0.14	27	0
Dibenzo(a,h)anthracene	mg/kg	6	< 0.1	0.24	0
Benzo(ghi)perylene	mg/kg	6	0.13	320	0
TPH Aliphatic C5-C6	mg/kg	3	<0.01	42	0
TPH Aliphatic C6-C8	mg/kg	3	<0.05	100	0
TPH Aliphatic C8-C10	mg/kg	3	<2	27	0
TPH Aliphatic C10-C12	mg/kg	3	<2	130	0
TPH Aliphatic C12-C16	mg/kg	3	<3	1,100	0
TPH Aliphatic C16-C35	mg/kg	3	<10	65,000	0
TPH Aliphatic C35-C44	mg/kg	3	<10	65,000	0

CONTAMINANT	UNITS	NUMBER OF TESTS	MAXIMUM CONCENTRATION	GAC	NUMBER EXCEEDING GAC
TPH Aromatic C5-C7	mg/kg	3	<0.01	70	0
TPH Aromatic C7-C8	mg/kg	3	<0.05	130	0
TPH Aromatic C8-C10	mg/kg	3	<2	34	0
TPH Aromatic C10-C12	mg/kg	3	<2	74	0
TPH Aromatic C12-C16	mg/kg	3	<2	140	0
TPH Aromatic C16-C21	mg/kg	3	<3	260	0
TPH Aromatic C21-C35	mg/kg	3	<10	1,100	0
TPH Aromatic C35-C44	mg/kg	3	<10	1,100	0
Benzene	mg/kg	3	<0.002	0.87	0
Toluene	mg/kg	3	<0.005	130	0
Ethylbenzene	mg/kg	3	<0.002	47	0
Xylene (total of all types)	mg/kg	3	<0.002	56	0
Methyl Tert Butyl Ether (MTBE)	mg/kg	3	<0.005	49	0
<i>Semi-Volatile Organic Compounds (SVOCs) above detection limit:</i>					
2-Methylnaphthalene	mg/kg	3	0.2	LOD*	1
Dibenzofuran	mg/kg	3	0.1	LOD*	1
Carbazole	mg/kg	3	0.2	LOD*	1
Asbestos Quantification	%	3	<0.001	0.001	0
Hydrocarbon Vapour (PID)	ppm	14	0.0	50	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.					

DISCUSSION OF RESULTS	
METALS	None of the metal compounds are elevated above the human health assessment criteria.
PAH	None of the PAH compounds are elevated above the human health assessment criteria.
TPH	None of the TPH compounds are elevated above the human health assessment criteria.
BTEX & MTBE	None of the BTEX or MTBE compounds are elevated above the human health assessment criteria.
VOC / SVOC	Three SVOC compounds were recorded a concentration fractionally elevated above the detection limit. This comprised 2-methylnaphthalene recorded at a concentration of 0.2mg/kg, dibenzofuran at a concentration of 0.1mg/kg and carbazole recorded at a concentration of 0.2mg/kg, all from the sample of Made Ground from WS05. Whilst these compounds do not have their own GAC, they are very similar in nature to some of the PAH compounds which are below their respective GAC. Given the trace concentrations detected, the presence of these compounds is not of any cause for concern.
ASBESTOS	Asbestos has not been detected in any of the samples analysed or visually identified in any of the soils at the site.

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	12	7.0-8.0	<5.5	0
Sulphate (w/s)	mg/l	12	17	500	0
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	mg/kg	3	<LOD	2	0
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	mg/kg	3	<LOD	10	0
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	mg/kg	3	<LOD	500	0
Sum of BTEX + MTBE above detection limits	mg/kg	3	<LOD	0.1	0
Phenols	mg/kg	3	<LOD	2	0
Cresols and chlorinated phenols	mg/kg	3	<LOD	2	0
Naphthalene	mg/kg	6	<0.1	0.5	0
Benzo(a)pyrene	mg/kg	6	0.22	0.5	0

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

8. RISK ESTIMATION - GAS

8.1. INTRODUCTION

Confirmatory ground gas monitoring was conducted as part of the monitoring visit to check the groundwater levels in the wells. No sources of ground gases were identified in the desk study and therefore the results of the single monitoring visited are presented for confirmation purposes.

8.2. RESULTS SUMMARY

PARAMETER	MINIMUM	MAXIMUM	COMMENTS
Methane	0.0%	0.0%	No significant concentrations recorded.
Carbon Dioxide	0.0%	3.0%	No significant concentrations recorded.
Oxygen	17.7%	19.2%	The oxygen levels were typically depleted as carbon dioxide concentrations increased.
Hydrogen Sulphide	0ppm	0ppm	No significant concentrations recorded.
Carbon Monoxide	0ppm	1ppm	No significant concentrations recorded.
VOC - (PID)	0.0ppm	0.0ppm	No significant concentrations recorded.
Atmospheric pressure	1019mB	1019mB	The monitoring visit was undertaken during a period of relatively high pressure.
Groundwater levels	>5.00m	>5.06m	All of the monitoring wells were dry at the time of the monitoring visit.
Flow rate	<0.0 l/hr	<0.0l/hr	No positive flow rates were recorded.

The single gas monitoring visit completed has provided further evidence of a lack of any ground gases being present at the site.

9. RISK EVALUATION

9.1. REVISED CONCEPTUAL MODEL

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

ADDITIONAL CONTAMINANT LINKAGES	During the ground investigation, no additional sources of contamination were identified.
INVALID CONTAMINANT LINKAGES	None of the potential contamination linkages identified at the start of the ground investigation were proven to be valid. The targeted sampling around the bowling alley and car park has not identified any contamination from these potential sources. The targeted sampling around the adjacent above ground fuel tanks has not identified any contamination. The localised Made Ground present at the site comprises reworked natural soils and does not contain any contaminants. Finally, no contamination which could be attributed to any off site sources has been identified.
LIMITATIONS AND UNCERTAINTIES	Due to access restrictions, it was not possible to undertake any exploratory holes under the existing building floor slab. Coupled with this, access to the north western section of the site was restricted due to dense vegetation and the presence of live services. However, the site only offered a low contamination potential and all of the potential contamination sources have been targeted by the exploratory holes. Therefore it is considered that a sufficient number of exploratory points have been completed for contamination assessment purposes.

9.2. UPDATED CONTAMINATION RISK ASSESSMENT

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

POTENTIAL SOURCES AND CONTAMINANTS	PATHWAYS (REFERENCE FROM MODEL)	RECEPTORS	POTENTIAL RISK
Existing bowling alley and car park.	Direct contact Ingestion of soils / dusts Inhalation of dusts / vapours	Future residents and site workers / visitors	Negligible
	Vertical and horizontal migration	Groundwater environment	Negligible
	Direct contact	Sub-surface building materials and services	Negligible

POTENTIAL SOURCES AND CONTAMINANTS	PATHWAYS (REFERENCE FROM MODEL)	RECEPTORS	POTENTIAL RISK
Potential Made Ground soils associated with the original construction of the building and surrounding area.	Direct contact Ingestion of soils / dusts Inhalation of dusts / vapours	Future residents and site workers / visitors	Negligible
	Vertical and horizontal migration	Groundwater environment	Negligible
	Direct contact	Sub-surface building materials and services	Negligible
Fuel and oil tanks on western boundary	Cross contamination at the site boundary leading to: Direct contact Ingestion of soils / dusts Inhalation of dusts / vapours	Future residents and site workers / visitors	Negligible
	Cross contamination at the site boundary leading to: Direct contact	Sub-surface building materials and services	Negligible
Surrounding industrial land use	Cross contamination at the site boundary leading to: Direct contact Ingestion of soils / dusts Inhalation of dusts / vapours	Future residents and site workers / visitors	Negligible
	Cross contamination at the site boundary leading to: Direct contact	Sub-surface building materials and services	Negligible

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

SOIL RISKS TO HUMAN HEALTH

Following the intrusive investigation, no soil risks to human health have been identified at the site and all of the potential pollutant linkages are proven to be invalid.

GROUND GAS RISKS

No risks from ground gases have been identified at the site.

RISK TO WATER ENVIRONMENT

Following the intrusive investigation, no risks to the water environment have been identified at the site.

RISK TO BUILDING MATERIALS AND SERVICES

No risks to building materials and services have been identified at the site.

9.3. RISK MANAGEMENT

9.3.1. Introduction

The intrusive investigation has not identified any soil contamination risks at the site.

It is recommended that this report is used in support of the future planning application for the site to confirm a lack of contamination risks.

9.3.2. Further Contamination Assessment

No further contamination assessment is necessary at this stage.

However, as no exploratory holes were undertaken beneath the building footprint, attendance by a Geo-Environmental consultant during the removal of existing foundations as part of the demolition should be considered. Inspection of the subsequent excavations and the undertaking of a couple of trial pits would address the limitations in the exploratory point layout.

9.3.3. Outline Remediation Strategy

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

9.4. WASTE SOIL DISPOSAL

Topsoil should be viewed as a resource rather than a waste. As the topsoil is suitable for residential garden use in terms of contamination, the topsoil at the site could be stripped and re-used for the new development. As the topsoil is only in localised areas, it is unlikely that there would be a significant surplus. 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 Made Ground or any natural 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 has been completed and the results are in the Appendices which confirm the soil tested complies with the inert waste limits. The waste code from the European Waste Catalogue (EWC) 2002 for the soils would be 17 05 04 'Soil and Stones, not containing dangerous substances'.

10. HEALTH AND SAFETY FILE INFORMATION

10.1. INTRODUCTION

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

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

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

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

10.2. HAZARDS

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

10.2.1. Contamination

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

10.2.2. Asbestos

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

10.3. EXISTING STRUCTURES

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

10.4. HAZARDOUS MATERIALS

BRD did not construct anything with hazardous materials.

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

10.5. 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. A PAS128 utilities survey has recently been completed for the site.

REPORT SPECIFIC REFERENCES

- 'Phase 1 Geo-Environmental Desk Study - Barnard Road, Norwich', BRD Environmental Ltd, Report Ref. BRD4290-OR1-A, August 2023.
- British Geological Survey sheet 161 "Norwich" Solid and Drift edition (1:50,000) published 1975.



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+A1:2020, British Standards Institution, 2020. Soil samples for chemical and geotechnical analysis are taken from the exploratory holes at intervals dictated by the nature of the soils and the objectives of the investigation.

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

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

Hand Dug Inspection Pits

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

Trial Pits

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

Windowless Sampling Boreholes

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

Hand Held Window Sampling

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

Cable Percussive Boreholes

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



Rotary Boreholes

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

Dynamic Probing

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

Static Cone Penetration Tests

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

Dynamic Penetrometer

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

Gas Monitoring

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

Vapour Monitoring

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

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

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

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

Groundwater Level Monitoring

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

Geotechnical Sampling

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

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

Contamination Sampling

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

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

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

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

GEOTECHNICAL ASSESSMENT

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

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

GEOTECHNICAL PARAMETERS

Soakage Tests

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

Standard Penetration Tests

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

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

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

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

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

Sulphate

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

Index Property Tests

In accordance with National House Building Council (NHBC) Standards Chapter 4.2 - Building near trees, the laboratory plasticity indexes are assessed against their volume change potential. The Modified Plasticity Index is defined as the Plasticity Index of the soil multiplied by the percentage of particles with a nominal diameter of less than 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.

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

CONTAMINATION ASSESSMENT METHODOLOGY

UK Policy

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

The three main drivers for contamination assessment and remediation are:

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

Contaminant linkages

For a contamination risk to exist there must be a 'contaminant 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 contaminant 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 contaminant 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 contaminant 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.
- Land Contamination Risk Management, Environment Agency, 2021.
- 'Guidance for the safe development of housing on land affected by contamination - R&D66: 2008', NHBC/Environment Agency, 2008.

Risk Assessment Methodology

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

PHASE	DESCRIPTION	RISK ASSESSMENT STAGE
PHASE 1	Generally limited to desk based research and a site walkover survey to develop an initial conceptual site model and identify what risks, if any, are likely to be presented by the site.	Hazard Identification and Assessment A preliminary stage of risk assessment concerned with identifying and characterising the hazards that may be associated with a particular site and identifying potential contaminant 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 only produced limited results to date. 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 deemed appropriate, the results have also been assessed with reference to the required statistical tests presented within CL:AIRE Professional Guidance: "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) ⁵	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	

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
TPH Aliphatic C35-C44	65,000	65,000	1,600,000	
TPH Aromatic C5-C7	70	370	26,000	
TPH Aromatic C7-C8	130	860	56,000	
TPH Aromatic C8-C10	34	47	3,500	
TPH Aromatic C10-C12	74	250	16,000	
TPH Aromatic C12-C16	140	1,800	36,000	
TPH Aromatic C16-C21	260	1,900	28,000	
TPH Aromatic C21-C35	1,100	1,900	28,000	
TPH Aromatic C35-C44	1,100	1,900	28,000	
Benzene	0.87	3.3	98	C4SL
Toluene	130	880	56,000	S4UL
Ethylbenzene	47	83	5,700	
Xylene [^]	56	79	5,900	
MTBE	49	73	7,900	EIC/AGS/CL:AIRE GAC

Notes:

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

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

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

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

Water Environment - Soil Generic Assessment Criteria

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

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

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

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

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

Building Materials and Services - Soil Generic Assessment Criteria

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

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

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

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

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

RISK ESTIMATION - GROUNDWATER

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

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

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

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

RISK ESTIMATION - GROUND GAS

Introduction

A variety of potentially hazardous gases occur naturally in the ground environment. Microbial decay of organic matter under anaerobic conditions and geological processes can lead to the generation of Methane and Carbon Dioxide, but can also include 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 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+A1:2019 - Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings' BSi 2019.

Gas Screening Value

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

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

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

Characteristic Gas Situation

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

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

Low rise housing with gardens - NHBC 'Traffic Lights'

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

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

APPENDIX 1

Site Location Plan



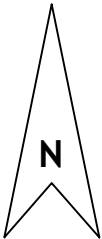
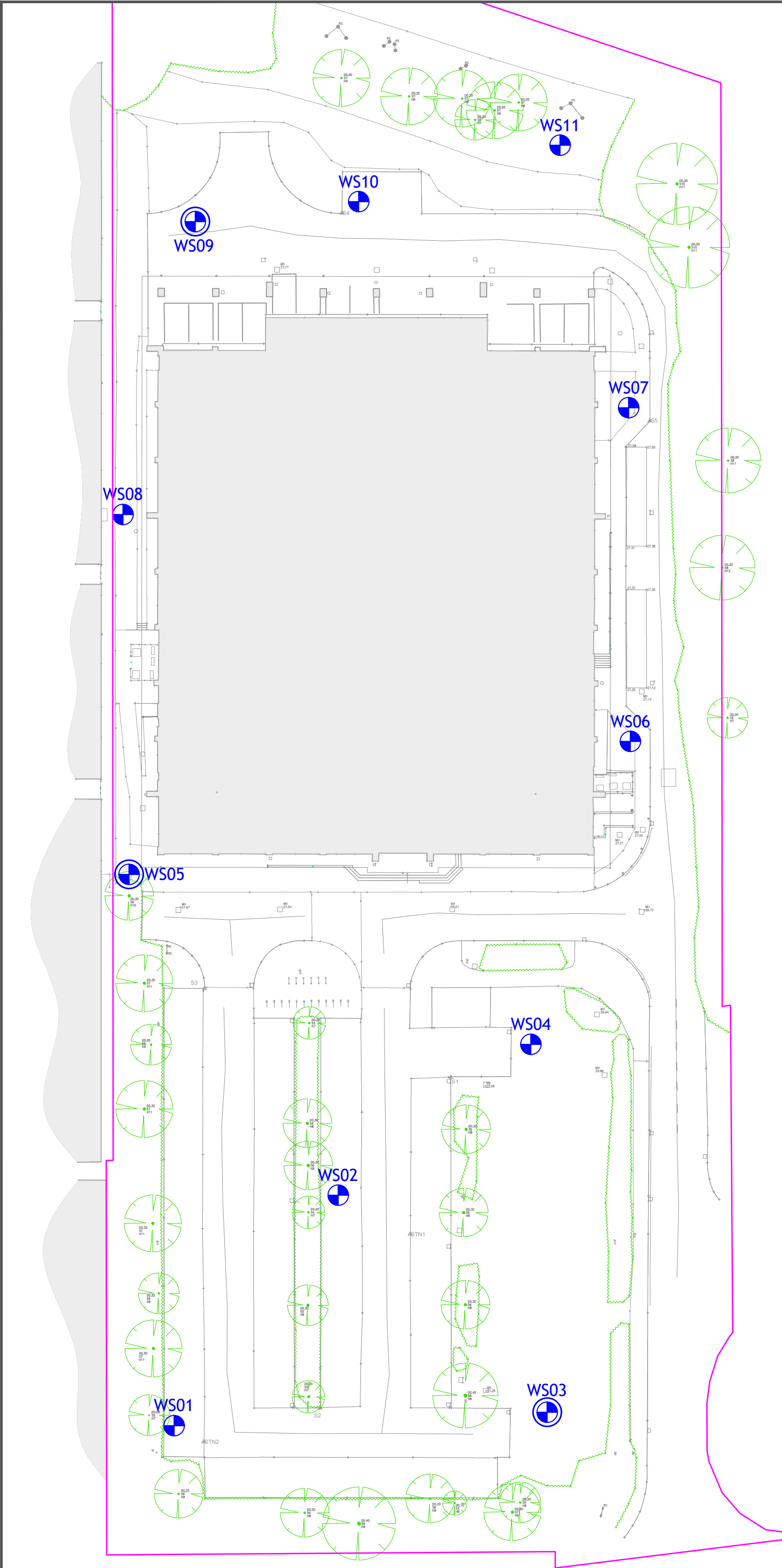
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Not to scale.

Project Title: Barnard Road, Norwich
Client: Honeyview Investments Ltd
BRD Reference: BRD4290-OP2-A
Date Issued: August 2023



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info@brduk.com



- Key:**
- WS01 BRD Windowless Sample Borehole Locations
 - WS01 BRD Windowless Sample Borehole Locations with Monitoring Well Installations.
 - Site Boundary

Notes:

Drawing reproduced from Carter Jonas
Project: Namco, Barnard Rd, Norwich
Title: Topographical Survey
Dwg No: J0073959-23-01_Issue03
Dated: 01/08/2023

All BRD exploratory point are located using a topographical grade GPS.

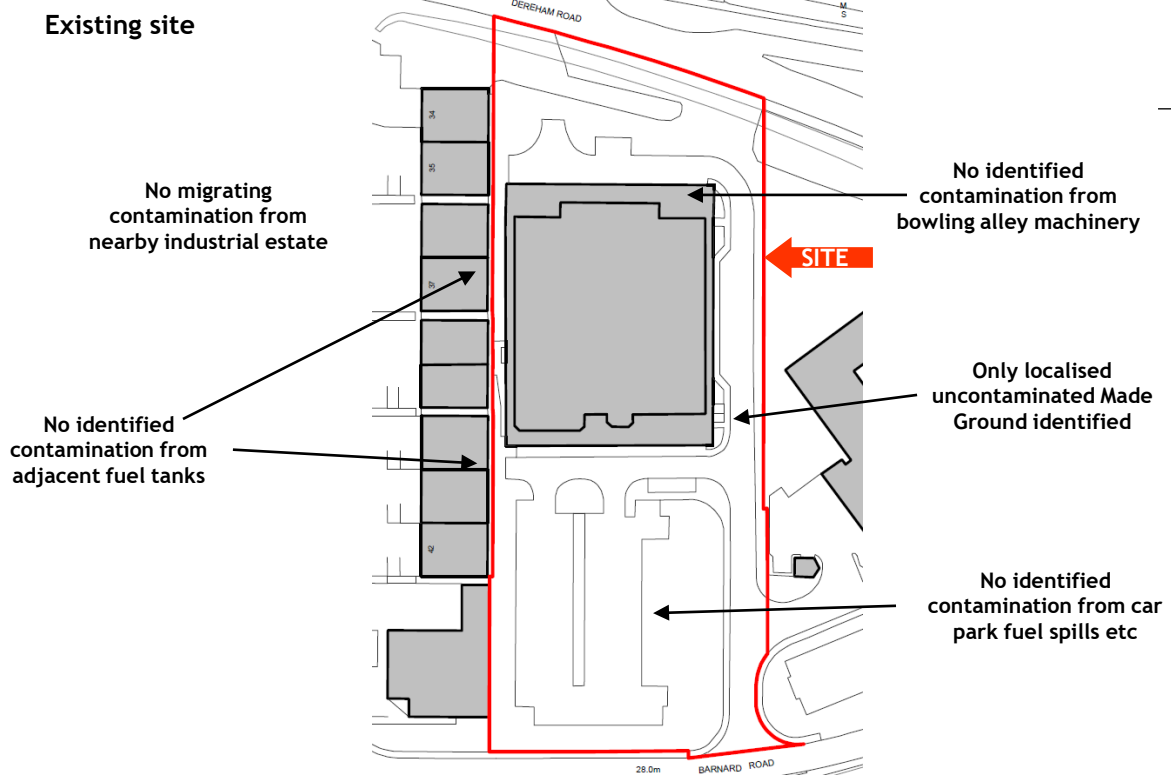
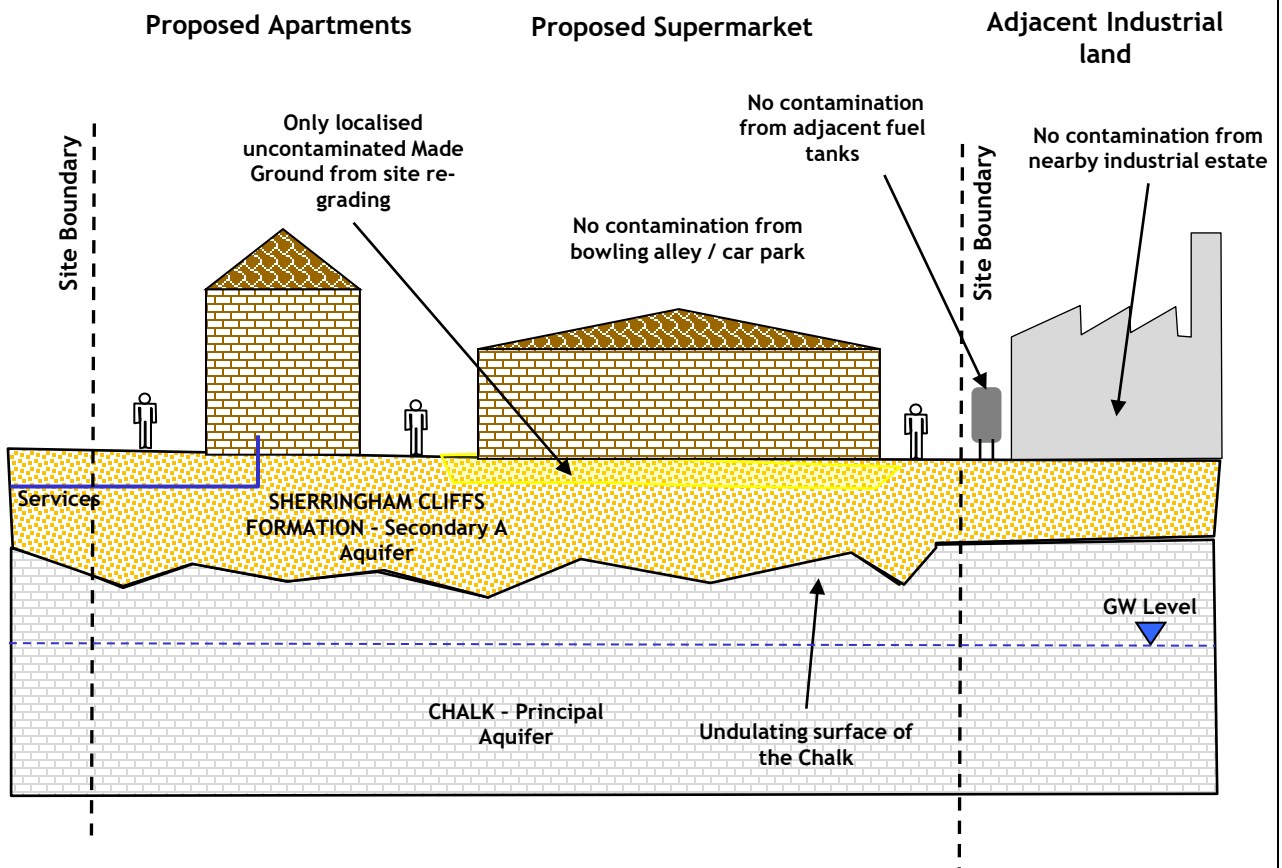
All site boundaries are approximate only.

Revision	Date	Description	Drawn	Approved
Drawing title				
EXPLORATORY POINT PLAN				
Project title				
BARNARD ROAD, NORWICH				
Client				
HONEYVIEW INVESTMENTS LTD				
Scale		Original drg. size/colour	Date	
1:500		A3 / C	08/09/2023	
Drawn		Checked	Approved	
DB		MM	JB	
Drawing Number				Rev
BRD4290-OD1				A



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Revised Conceptual Model



Project Title: Barnard Road, Norwich
 Client: Honeyview Investments Ltd
 BRD Reference: BRD4290-OP6-A
 Date Issued: September 2023

APPENDIX 2

PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 15/08/2023 Date Completed: 15/08/2023 Method Used: Windowless Percussive Sampling Rig				Borehole No. WS01				
				Sheet 1 of 1				
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.60 0.60	J1 PID	0.0 ppm		TARMAC	0.14 (27.65)		MG	
				MADE GROUND: Type 1 sub-base.	0.35 (27.44)			
Yellow brown, slightly gravelly SAND with occasional cobbles of fine to coarse, sub-rounded to angular flint.				SHERINGHAM CLIFFS FORMATION				
1.20	SPT	11 N			1.20 m: SPT; 3,4/4,3,2,2	1.0		
1.60	D1				Firm, orange brown, sandy, slightly gravelly CLAY. Gravel of fine, angular flint.	1.50 (26.29)		
2.00	SPT D2	27 N			Firm, light yellow / grey, clayey, sandy SILT. 2.00 m: SPT; 4,4/6,6,7,8 2.20 m: Becoming light yellow/grey silty fine SAND.	1.80 (25.99)		
2.70	D3					2.0		
3.00 3.00	SPT J2 PID	15 N 0.0 ppm			2.90 m: Purplish brown, very clayey. 3.00 m: SPT; 8,4/3,3,4,5	3.0		
3.50	D4				3.30 - 3.70 m: Grey, silty CLAY.			
3.90	SPT	>50 N			3.90m: SPT: 18,7 for 33mm/15,15,17,3 for 10mm	3.90 (23.89)		
				4.0				
General Remarks: Refusal at 3.90m in dense sand.					Surface Elevation Level: 27.793 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 15/08/2023 Date Completed: 15/08/2023 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						
0.40 0.40	J1 PID	0.0 ppm		TARMAC	0.10 (27.31)		MG	
				MADE GROUND: Type 1 sub-base.	0.25 (27.16)			
1.00 1.10 1.10 1.20	B1 J2 PID SPT	0.0 ppm 16 N		Medium dense, brown becoming orange brown slightly gravelly SAND. Gravel of fine to coarse, angular flint.	1.0 1.10 (26.31)		SHERINGHAM CLIFFS FORMATION	
1.90 2.00	D1 SPT	11 N		Medium dense, light yellow brown, silty, fine SAND. 1.20 m: SPT; 2,2/3,4,4,5 2.00 m: SPT: 2,2/3,4,4,5 2.50 m: Becoming clayey and gravelly. Gravel of fine to coarse, sub-rounded to angular flint.	2.0 3.0			
3.00	SPT	5 N		3.00 m: SPT: 2,2/1,1,2,1 3.00 - 4.00 m: 25% recovery.	4.0			
4.00	SPT	4 N		4.00 m: SPT: 2,2/1,1,1,1 4.00 - 5.00 m: 30% recovery.	4.50			
General Remarks: Terminated at 6.45m in natural soils.					Surface Elevation Level: 27.405 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 15/08/2023 Date Completed: 15/08/2023 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						
5.00 5.10	SPT D2	2 N		Soft to firm, reddish brown, sandy CLAY. 5.00 m: SPT: 1,0/1,0,1,0	5.0		S.C.F	
6.00	SPT D3	11 N		CHALK: Recovered as yellow to cream with brown veining, gravelly CLAY. Gravel of very weak low density chalk. 6.00 m: SPT: 3,2/3,2,3,3	5.60 (21.81) 6.0 6.45 (20.96)			
					7.0 8.0 9.0			
General Remarks: Terminated at 6.45m in natural soils.					Surface Elevation Level: 27.405 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 16/08/2023 Date Completed: 16/08/2023 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			TOPSOIL: Dark brown, slightly gravelly SAND with some rootlets. Gravel of fine to coarse, sub-rounded to angular flint.	0.30 (27.09)		TS	
0.80	J2			Medium dense, light brown, slightly gravelly SAND. Gravel of fine to coarse, sub-rounded to angular flint.				
1.10	D1			0.90 m: Clayey.	1.0		SHERINGHAM CLIFFS FORMATION	
1.20	SPT	17 N		1.20 m: SPT; 3,3/5,4,4,4				
1.70	J3			Firm, brown, sandy, slightly gravelly CLAY. Gravel of fine to coarse, sub-rounded to angular flint.	1.50 (25.89)			
1.90	D2			2.00 m: Moist, greyish brown, very sandy.	2.0			
2.00	SPT	15 N		2.00 m: SPT; 4,5/4,4,4,3				
3.00	SPT	5 N		Medium dense, orange brown, slightly gravelly SAND. Gravel of fine to coarse, sub-rounded to angular flint.	2.60 (24.79)			
				3.00 m: SPT; 1,1/1,1,1,2	3.0			
				Firm, grey with orange brown patches, sandy, clayey SILT.	3.10 (24.29)			
3.80	D3			4.00 m: SPT; 1,1/1,2,1,2	4.0			
4.00	SPT	6 N						
General Remarks: Installed with 50mm standpipe, gas tap and flush metal cover. Terminated at 5.45m in natural soils.					Surface Elevation Level: 27.386 mAOD			
					All dimensions in metres Log Scale 1:25		Telephone: 01295 272244 Email: info@brduk.com	

PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 16/08/2023 Date Completed: 16/08/2023 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						
5.00	SPT	5 N		Medium dense, orange brown, very clayey SAND.	4.60 (22.79)		S.C.F.	
				5.00 m: SPT; 1,1/1,2,1,1 5.10 m: Some pockets of very sandy CLAY.	5.0			
					5.45 (21.94)			
					6.0			
					7.0			
					8.0			
					9.0			
General Remarks: Installed with 50mm standpipe, gas tap and flush metal cover. Terminated at 5.45m in natural soils.					Surface Elevation Level: 27.386 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

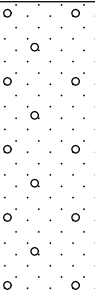
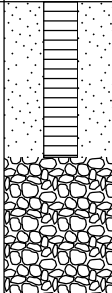
PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 16/08/2023 Date Completed: 16/08/2023 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 TOPSOIL: Dark brown, slightly gravelly sand. Gravel of fine to coarse and cobbles of flint and concrete.	0.30 (26.85)		MG/TS	
0.60	J2			MADE GROUND: Brown gravelly sand. Gravel of fine to coarse, sub-rounded to angular flint, brick and concrete. 0.60 - 0.70 m: Abundant brick.	0.70 (26.45)		MG	
1.00	D1			Loose, brown, slightly gravelly, slightly clayey SAND. Gravel of fine to coarse, sub-rounded to angular flint.	1.0		SHERINGHAM CLIFFS FORMATION	
1.20	SPT	0 N		1.20 m: SPT; 1,0/0,0,0,0				
2.00	SPT B1	2 N		2.00 m: SPT; 2,0/1,0,1,0	2.0			
2.80	D2			Soft to firm, brown, sandy, gravelly CLAY. Gravel of fine to coarse, sub-rounded to angular flint.	2.20 (24.95)			
3.00	SPT	25 N		2.90 m: Some pockets of chalk and becoming very gravelly. 3.00 m: SPT; 7,13/8,7,6,4	3.0		CHALK	
3.90	D3			Structureless CHALK recovered as light brown to off white gravelly, silty, moist clay. Gravel of fine to coarse, very weak, angular chalk.	3.10 (24.05)			
4.00	SPT	9 N		4.00 m: SPT; 2,3/2,2,2,3 4.00 m: Encountered flint cobbles.	4.0			
					4.45			
General Remarks: Borehole terminated at 4.45m in natural soils. Cobbles at depth prevented further drilling.					Surface Elevation Level: 27.148 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

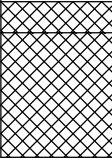
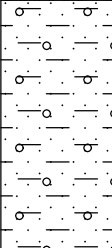
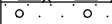
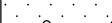
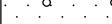
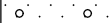
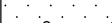
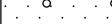
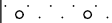
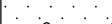
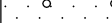
PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 15/08/2023 Date Completed: 15/08/2023 Method Used: Windowless Percussive Sampling Rig				Borehole No. WS05				
				Sheet 1 of 2				
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.50	PID J1	0.0 ppm		MADE GROUND TOPSOIL: Brown, slightly gravelly, slightly clayey sand with occasional rootlets. Gravel of fine to medium, sub-rounded to angular flint. MADE GROUND: Brown, gravelly sand. Gravel of fine to coarse, sub-rounded to angular flint and brick.	0.10 (28.78)		MADE GROUND	
1.10 1.20	D1 SPT	21 N		Medium dense, orange brown, slightly gravelly, slightly clayey SAND. Gravel of fine to coarse, angular to sub-rounded flint. 1.20 m: Occasional roots extending to 1.20m. 1.20 m: SPT; 3,4/4,6,5,6 1.50 m: Gravelly.	0.90 (27.98) 1.0			
1.90 1.90 2.00	J2 PID SPT	0.0 ppm 28 N		2.00 m: SPT; 5,4/6,6,8,8 2.10 m: No longer gravelly.	2.0			
2.90 3.00	D2 SPT	10 N		Firm, brown, slightly sandy, slightly gravelly CLAY. 2.60 - 2.70 m: Very gravelly. 3.00 m: SPT; 2,1/2,3,2,3 3.00 - 3.40 m: Pocket of light grey, slightly gravelly SAND. Gravel of fine to coarse, sub-rounded to angular flint. 3.60 m: Relict rootlets present.	2.60 (26.28) 3.0			
3.90 4.00	D3 SPT	30 N		Medium dense to dense, light brown/ beige to orange, slightly gravelly to gravelly SAND. Gravel of fine to coarse, sub-rounded to angular flint. 4.00 m: SPT; 8,7/5,8,8,9	4.0 4.00 (24.88)			
					4.50			
General Remarks: Installed with 50mm stdnpipe, gas tap and flush metal cover. Terminated at 5.45m in natural soils.					Surface Elevation Level: 28.875 mAOD			
					All dimensions in metres Log Scale 1:25			
					Telephone: 01295 272244 Email: info@brduk.com			

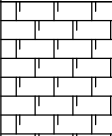
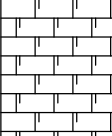
PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 15/08/2023 Date Completed: 15/08/2023 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS05		
						Sheet 2 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
4.90	J3	0.0		Continued from 4.0m: Medium dense to dense, light brown/ beige to orange brown, slightly gravelly to gravelly SAND. Gravel of fine to coarse, sub-rounded to angular flint.	5.0		S.C.F.	
4.90	PID	ppm		4.90 m: Sub-rounded white crystalline pebbles at 4.90m				
5.00	SPT	34 N		5.00 m: SPT; 9,7/7,7,9,11				
					5.45 (23.43)			
					6.0			
					7.0			
					8.0			
					9.0			
General Remarks: Installed with 50mm stdnpipe, gas tap and flush metal cover. Terminated at 5.45m in natural soils.					Surface Elevation Level: 28.875 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

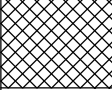
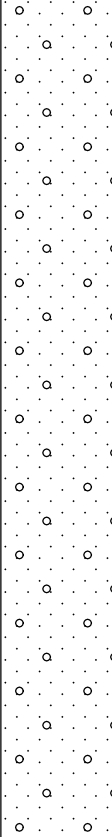
PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 16/08/2023 Date Completed: 16/08/2023 Method Used: Windowless Percussive Sampling Rig				Borehole No. WS06				
				Sheet 1 of 2				
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.30	J1			MADE GROUND TOPSOIL: Dark brown, gravelly sand. Gravel of fine to coarse, sub-rounded to angular flint and occasional plastic and glass. MADE GROUND: Brown, gravelly, slightly clayey sand. Gravel of fine to coarse, sub-rounded to angular flint and occasional brick.	0.10 (27.20)		M/T	
0.80	J2			Medium dense, brown to orange brown, slightly clayey, slightly gravelly (with occasional cobbles) SAND. Gravel of fine to coarse, sub-rounded to angular flint.	0.50 (26.80)		MG	
1.20	SPT	2 N		1.20 m: SPT; 0,0/1,0,0,1	1.0		SHERINGHAM CLIFFS FORMATION	
1.80	D1			Yellow brown becoming orange brown, slightly gravelly SAND. Gravel of fine to medium, sub-rounded to angular flint.	1.30 (26.00)			
2.00	SPT	19 N		2.00 m: SPT; 3,3/4,5,5,5	2.0			
2.90	D2			2.80 m: Very clayey pocket.	3.0			
3.00	SPT	37 N		3.00 m: SPT; 5,7/8,10,10,9				
				3.20 m: Light brown/ beige in colour, gravelly.				
3.90	D3			CHALK recovered as light brown to off white, slightly gravelly, silty CLAY. Gravel of fine to coarse, angular flint.	3.50 (23.80)		CHALK	
4.00	SPT	9 N		4.00 m: Becoming moist. 4.00 m: SPT; 3,2/2,3,2,2	4.0			
					4.50			
General Remarks: Terminated at 5.45m in natural soils.					Surface Elevation Level: 27.3 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 16/08/2023 Date Completed: 16/08/2023 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS06		
						Sheet 2 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
4.60	J3			Continued from 3.5m: CHALK recovered as light brown to off white, slightly gravelly, silty CLAY. Gravel of fine to coarse, angular flint.			CHALK	
5.00	SPT	8 N		5.00 m: SPT; 2,2/2,2,2,2	5.0			
					5.45 (21.85)			
					6.0			
					7.0			
					8.0			
					9.0			
General Remarks: Terminated at 5.45m in natural soils.					Surface Elevation Level: 27.3 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

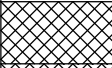
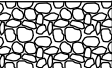
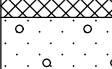
PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 16/08/2023 Date Completed: 16/08/2023 Method Used: Windowless Percussive Sampling Rig					Borehole No. WS07			
					Sheet 1 of 2			
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.20	J1			MADE GROUND TOPSOIL: Dark brown, gravelly sand. Gravel of fine to coarse, sub-rounded to angular flint and occasional plastic and glass.	0.30 (27.44)		MG/TS	
0.80	J2			Medium dense, light brown to yellow brown, slightly gravelly SAND. Gravel of fine, sub-rounded to angular flint.	1.0			
1.20	SPT	11 N		1.20 m: Brown/orange brown colour. 1.20 m: SPT; 2, 1/3, 2, 3, 3	2.0			
1.70	D1							
2.00	SPT	14 N		2.00 m: SPT; 22, /3, 3, 4, 4				
3.00	SPT	9 N			3.0 3.00 (24.74)			
3.70	D2			3.60 m: Slightly clayey pockets and rare dark brown slightly organic patches.				
4.00	SPT	15 N		4.00 m: SPT; 3, 2/3, 4, 4, 4	4.0			
					4.50			
General Remarks: Terminated at 5.45m in natural soils.					Surface Elevation Level: 27.744 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 16/08/2023 Date Completed: 16/08/2023 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS07		
						Sheet 2 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
4.90	D3	26 N		Continued from 3.00m bgl: Medium dense to dense, light grey, fine SAND.	4.70 (23.04)		S.C.F.	
5.00	SPT			Firm, brown to orange brown, sandy SILT.	5.0			
				5.00 m: SPT; 4,4/4,7,7,8	5.45 (22.29)			
					6.0			
					7.0			
					8.0			
					9.0			
General Remarks: Terminated at 5.45m in natural soils.					Surface Elevation Level: 27.744 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 16/09/2023 Date Completed: 16/09/2023 Method Used: Hand Dug						Borehole No. WS08		
						Sheet 1 of 1		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.10 0.10	J1 PID	0.0 ppm		MADE GROUND TOPSOIL: Dark brown, gravelly sand. Gravel of fine to coarse, sub-rounded to angular flint and occasional brick, concrete and plastic.	0.20 (28.28)		M/TS	
0.60 0.60	J2 PID	0.0 ppm		MADE GROUND: Brown gravelly sand. Gravel of fine to coarse, sub-rounded to angular flint and occasional brick and concrete.			MG	
0.60 0.60	J2 PID	0.0 ppm		0.60 m: Broken black plastic gutter section crossing the pit.	0.70 (27.78)			
1.00 1.00	J3 PID	0.0 ppm		Medium dense, light brown, gravelly SAND. Gravel of fine to coarse, sub-rounded to angular flint.	1.0 (27.38)		S.C.F	
					1.10 (27.38)			
					2.0			
					3.0			
					4.0			
General Remarks: Hand dug pit only due to sloping ground and potential for buried services. Terminated at 1.1m depth on natural soils proven at limit of hand digging.				Surface Elevation Level: 28.484 mAOD		 Telephone: 01295 272244 Email: info@brduk.com		
				All dimensions in metres Log Scale 1:25				

PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 15/08/2023 Date Completed: 15/08/2023 Method Used: Windowless Percussive Sampling Rig				Borehole No. WS09				
				Sheet 1 of 2				
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.40	PID J1	0.0 ppm		TARMAC	0.12 (27.86)		MG	
				MADE GROUND: Type 1 sub-base.	0.35 (27.63)			
1.10	B1			Medium dense, brown to orange brown, silty, slightly gravelly SAND. Gravel of fine to coarse, sub-rounded to angular flint.			SHERINGHAM CLIFFS FORMATION	
1.20	SPT	11 N			1.20 m: Not silty, rare gravel. 1.20 m: SPT; 2,2/2,3,3,3			
1.90	J2	0.0		2.00 - 3.00 m: Poor recovery 2.00 m: SPT; 3,5/5,5,7,9	2.0			
1.90	PID	ppm			2.30 m: Thin clay band.			
2.00	SPT	26 N		2.50 m: Gravelly with some chert pebbles.				
3.00	SPT	12 N		3.00 m: SPT; 4,3/3,3,3,3	3.0			
				CHALK recovered as light brown to off-white, slightly gravelly, silty CLAY. Gravel of fine to coarse, angular flint.	3.10 (24.88)		CHALK	
3.90	D1			4.00 m: SPT; 8,4/3,5,3,3	4.0			
4.00	SPT	14 N				4.50		
General Remarks: Installed with 50mm stdnpipe, gas tap and flush metal cover. Terminated at 5.45m in natural soils.					Surface Elevation Level: 27.982 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

PROBEHOLE RECORD

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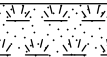
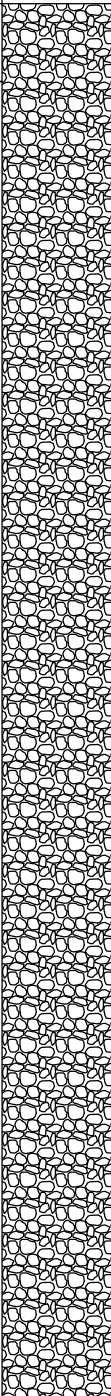
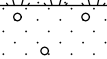
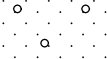
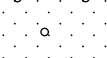
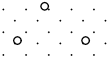
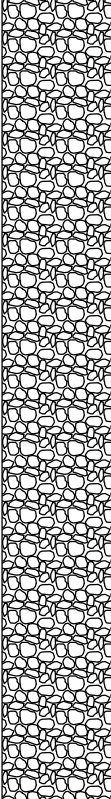
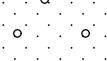
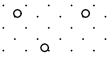
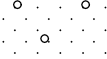
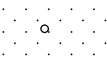
PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 16/09/2023 Date Completed: 16/08/2023 Method Used: Windowless Percussive Sampling Rig					Borehole No. WS10			
					Sheet 1 of 2			
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
0.40 0.40 0.50	J1 PID D1	0.0 ppm		TARMAC	0.10 (27.96)		MG	
				MADE GROUND: Type 1 sub-base.	0.30 (27.76)			
0.80 0.80	J2 PID	0.0 ppm		Firm, purplish brown, slightly gravelly, slightly sandy CLAY. Gravel of fine to coarse, sub-rounded to angular flint.	0.70 (27.36)		SHERINGHAM CLIFFS FORMATION	
1.20 0.80	SPT D2	24 N		Medium dense, orange brown, clayey SAND with occasional pockets of grey/ beige SILT.	1.0			
1.90 2.00	D3 SPT	20 N		1.20 m: No further pockets of silt, slightly clayey, slightly gravelly of fine to coarse, subrounded to angular flint. 1.20 m: SPT; 3,4/5,5,7,7				
2.90 3.00	D4 SPT	11 N		2.00 m: SPT; 4,5/5,6,4,5 2.20 m: Becoming light grey beige, with some clay laminae.	2.0			
3.90 4.00	D5 SPT J3	9 N		3.00 m: SPT; 4,4/3,2,3,3	3.0			
				Soft to firm, light grey, silty CLAY.	3.40 (24.66)			
				4.00 m: SPT; 1,1/1,3,2,3	4.0			
					4.50			
General Remarks: Terminated at 5.45m in natural soils.					Surface Elevation Level: 28.059 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 16/09/2023 Date Completed: 16/08/2023 Method Used: Windowless Percussive Sampling Rig						Borehole No. WS10		
						Sheet 2 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
5.00	SPT	7 N		Medium dense, yellow brown, clayey, slightly gravelly SAND. Gravel of fine to coarse, sub-rounded to angular flint.			S.C.F.	
				5.00 m: SPT; 1,2/1,2,2,2	5.0			
					5.45 (22.61)			
					6.0			
					7.0			
					8.0			
					9.0			
General Remarks: Terminated at 5.45m in natural soils.					Surface Elevation Level: 28.059 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

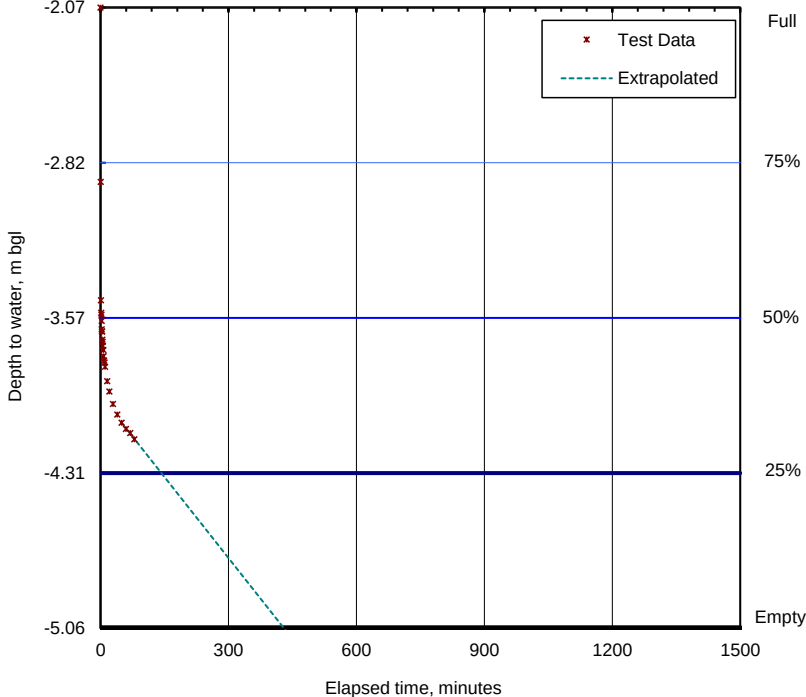
PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 15/08/2023 Date Completed: 15/08/2023 Method Used: Windowless Percussive Sampling Rig							Borehole No. WS11 Sheet 1 of 2		
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill	
Depth	Type & No	Value							
0.10	J1	9 N		TOPSOIL: Dark brown, slightly gravelly, slightly clayey sand. Gravel of fine to coarse, sub-rounded to angular flint.	0.25 (29.16)		TS		
				Medium dense, dry, light brown, slightly gravelly to gravelly SAND. Gravel of fine to coarse, sub-rounded to angular flint.					
0.70	J2			0.80 m: Normal moisture content.					
1.10 1.20	B1 SPT			1.10 m: Not gravelly. 1.20 m: SPT; 1,1/2,2,2,3					
2.00	SPT	8 N		1.90 m: Yellow brown colour. 2.00 m: SPT; 1,2/2,2,2,2	2.0		SHERINGHAM CLIFFS FORMATION		
2.60	D1								
3.00	SPT	9 N		3.00 m: SPT; 1,2/2,2,3,2	3.0				
3.50	J3								
4.00	SPT	7 N		4.00 m: SPT; 1,1/2,1,2,2	4.0				
					4.50				
General Remarks: Terminated at 5.45m in natural soils.					Surface Elevation Level: 29.41 mAOD All dimensions in metres Log Scale 1:25		 Telephone: 01295 272244 Email: info@brduk.com		

PROBEHOLE RECORD

Client: Honeyview Investments Ltd Project Title: Barnard Rd, Norwich Project No: BRD4290 Logged By: M Morgan Date Commenced: 15/08/2023 Date Completed: 15/08/2023 Method Used: Windowless Percussive Sampling Rig					Borehole No. WS11			
					Sheet 2 of 2			
Samples & Tests			Water	Description of Strata	Depth / (Level)	Legend	Geology	Installation /Backfill
Depth	Type & No	Value						
5.00	SPT	10 N		Continued from 0.25m bgl: Medium dense, dry, light brown, slightly gravelly to gravelly SAND. Gravel of fine to coarse, sub-rounded to angular flint. 4.80 m: Some flint gravel. 5.00 m: SPT; 4,2/2,3,3,2	5.0		S.C.F.	
5.30	D2			Firm brown, sandy, gravelly CLAY. Gravel of fine to medium, sub-rounded to angular flint and quartzite.	5.10 (24.31) 5.45 (23.96)			
					6.0			
					7.0			
					8.0			
					9.0			
General Remarks: Terminated at 5.45m in natural soils.					Surface Elevation Level: 29.41 mAOD		 Telephone: 01295 272244 Email: info@brduk.com	
					All dimensions in metres Log Scale 1:25			

SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test - within borehole)			
Client: Honeyview Investments Ltd Project Title: Barnard Road, Norwich Project No.: BRD4290			
Test Details			
Trial Pit Number	WS03		
Test Number	1		
Borehole depth for test	5.06	m	
Borehole diameter	0.10	m	
Borehole area	0.0079	m	
Depth to groundwater prior to test	Dry	m	
Date of Test	23/08/2023		
Logged by	Sam Walker		
Description of Soil under Test	Slightly gravelly SAND over slightly clayey SILT over very clayey SAND. (SHERINGHAM CLIFFS FORMATION)		
Test Record			
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time	
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6.5 7.5 8.5 9.5 10.5 15.5 20.5 29.5 39.5 49.5 59.5 69.5 79.5	2.07 2.91 3.48 3.54 3.55 3.58 3.62 3.63 3.63 3.67 3.68 3.70 3.72 3.75 3.77 3.78 3.80 3.87 3.92 3.98 4.03 4.07 4.10 4.12 4.15		
Summary of Calculations and Result			
Soil infiltration rate, f , is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (0.4 mins) is the time for the water level to fall to 75% effective depth (2.82m bgl) and T_{25} (143* mins) is the time for the water level to fall to 25% effective depth (4.31m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 142 \text{ mins}$ $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.0117 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 0.4775 \text{ m}^2$ Soil Infiltration Rate f = <u>2.88×10^{-6}</u> m/s			
Comments Calculation based on extrapolated results. Use as a guide only.			



Gas Monitoring Record

Project Name: Barnard Rd, Norwich
Client: Honeyview Investments, Ltd
Project No: BRD4290

Date: 23/08/2023 Ground conditions: Dry Recorded by: SW
Time at start: 10:23 Weather conditions: Sunny, some clouds Pressure trend: Falling
Time at finish: 10:48 Air Temperature (°C): 19 Monitor serial no: G501688

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

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

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

Monitoring point				Gas Concentration								Pressure	Flow rate	Vapour	Comments
Borehole	GWL Ground (m)	GWL Pipe (m)	Base Ground (m)	Steady			Peak		Minimum	Peak		Baro - metric (mb)	Steady (l/hr)	PID (ppm)	
				CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CO (ppm)	H ₂ S (ppm)				
WS03	dry	dry	5.06	0.0	3.0	17.8	0.0	3.0	17.7	1	0	1019	-0.8	0.0	
WS05	dry	dry	5.00	0.0	2.0	19.2	0.0	2.0	19.2	0	0	1019	-0.5	0.0	
WS09	dry	dry	5.04	0.0	0.8	19.2	0.1	0.8	19.2	0	0	1019	-0.7	0.0	



Groundwater Monitoring Record

Project: Barnard Rd, Norwich
Client: Honeyview Investments, Ltd.
Project No: BRD4290

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
WS03	23/08/2023	SW	5.06	N/A	dry	dry	N/A	N/A	No purging or water sampling.
WS05	23/08/2023	SW	5.00	N/A	dry	dry	N/A	N/A	No purging or water sampling.
WS09	23/08/2023	SW	5.04	N/A	dry	dry	N/A	N/A	No purging or water sampling.

APPENDIX 3



Matthew Morgan
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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: 23-10827

Site Reference: Barnard Road

Project / Job Ref: BRD4290

Order No: None Supplied

Sample Receipt Date: 23/08/2023

Sample Scheduled Date: 23/08/2023

Report Issue Number: 1

Reporting Date: 30/08/2023

Authorised by:

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.



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Soil Analysis Certificate					
DETS Report No: 23-10827	Date Sampled	15/08/23	16/08/23	16/08/23	16/08/23
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Barnard Road	TP / BH No	WS01	WS03	WS04	WS04
Project / Job Ref: BRD4290	Additional Refs	J1	J1	J1	J2
Order No: None Supplied	Depth (m)	0.60	0.10	0.20	0.60
Reporting Date: 30/08/2023	DETS Sample No	671413	671414	671415	671416

Determinand	Unit	RL	Accreditation					
Asbestos Quantification ^(S)	%	< 0.001	ISO17025				< 0.001	
pH	pH Units	N/a	MCERTS	7.7	7.6	8.0		8.0
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	< 10	< 10	< 10		17
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	< 0.01	< 0.01	< 0.01		0.02
Total Sulphur	%	< 0.02	NONE					
Organic Matter (SOM)	%	< 0.1	MCERTS	1	2.4	2.3		2.3
Arsenic (As)	mg/kg	< 2	MCERTS	6	5	7		7
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2	< 0.2	< 0.2		< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS	7	7	7		9
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2		< 2
Copper (Cu)	mg/kg	< 4	MCERTS	4	5	6		7
Lead (Pb)	mg/kg	< 3	MCERTS	4	11	15		25
Mercury (Hg)	mg/kg	< 1	MCERTS	< 1	< 1	< 1		< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	8	5	5		7
Selenium (Se)	mg/kg	< 2	MCERTS	< 2	< 2	< 2		< 2
Zinc (Zn)	mg/kg	< 3	MCERTS	22	22	25		43

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)

(n) Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation



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Soil Analysis Certificate					
DETS Report No: 23-10827	Date Sampled	16/08/23	16/08/23	16/08/23	16/08/23
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Barnard Road	TP / BH No	WS06	WS07	WS08	WS11
Project / Job Ref: BRD4290	Additional Refs	J1	J2	J2	J1
Order No: None Supplied	Depth (m)	0.30	0.80	0.60	0.10
Reporting Date: 30/08/2023	DETS Sample No	671418	671419	671420	671421

Determinand	Unit	RL	Accreditation				
Asbestos Quantification ^(S)	%	< 0.001	ISO17025	< 0.001		< 0.001	
pH	pH Units	N/a	MCERTS			7.0	7.2
Total Sulphate as SO ₄	mg/kg	< 200	MCERTS				< 200
Total Sulphate as SO ₄	%	< 0.02	MCERTS				< 0.02
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS			< 10	< 10
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS			< 0.01	< 0.01
Total Sulphur	%	< 0.02	NONE				< 0.02
Organic Matter (SOM)	%	< 0.1	MCERTS			0.7	2.1
Arsenic (As)	mg/kg	< 2	MCERTS			11	7
Cadmium (Cd)	mg/kg	< 0.2	MCERTS			< 0.2	< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS			8	8
Chromium (hexavalent)	mg/kg	< 2	NONE			< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS			6	7
Lead (Pb)	mg/kg	< 3	MCERTS			6	19
Mercury (Hg)	mg/kg	< 1	MCERTS			< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS			8	6
Selenium (Se)	mg/kg	< 2	MCERTS			< 2	< 2
Zinc (Zn)	mg/kg	< 3	MCERTS			28	32

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)



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Soil Analysis Certificate

DETS Report No: 23-10827	Date Sampled	15/08/23	15/08/23	15/08/23	15/08/23	16/08/23
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Barnard Road	TP / BH No	WS02	WS01	WS08	WS09	WS06
Project / Job Ref: BRD4290	Additional Refs	J2	J2	J3	J2	J3
Order No: None Supplied	Depth (m)	1.10	3.00	1.00	1.90	4.60
Reporting Date: 30/08/2023	DETS Sample No	671423	671424	671425	671426	671427

Determinand	Unit	RL	Accreditation	(n)		(n)	
Asbestos Quantification ^(S)	%	< 0.001	ISO17025				
pH	pH Units	N/a	MCERTS	7.2	7.3	7.1	7.3
Total Sulphate as SO ₄	mg/kg	< 200	MCERTS	< 200	< 200	< 200	< 200
Total Sulphate as SO ₄	%	< 0.02	MCERTS	< 0.02	< 0.02	< 0.02	< 0.02
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	< 10	< 10	< 10	< 10
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	< 0.01	< 0.01	< 0.01	< 0.01
Total Sulphur	%	< 0.02	NONE	< 0.02	< 0.02	< 0.02	< 0.02
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)



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Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 23-10827	Date Sampled	15/08/23	16/08/23	16/08/23	15/08/23	16/08/23
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Barnard Road	TP / BH No	WS01	WS03	WS04	WS05	WS08
Project / Job Ref: BRD4290	Additional Refs	J1	J1	J1	J1	J2
Order No: None Supplied	Depth (m)	0.60	0.10	0.20	0.50	0.60
Reporting Date: 30/08/2023	DETS Sample No	671413	671414	671415	671417	671420

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	0.31	< 0.1
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.12	0.42	< 0.1
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.36	< 0.1
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.22	< 0.1
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.17	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.24	< 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	0.22	< 0.1
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.14	< 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	0.13	< 0.1
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	< 1.6	2.2	< 1.6



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Soil Analysis Certificate - Speciated PAHs

DETS Report No: 23-10827	Date Sampled	16/08/23				
BRD Environmental Ltd	Time Sampled	None Supplied				
Site Reference: Barnard Road	TP / BH No	WS11				
Project / Job Ref: BRD4290	Additional Refs	J1				
Order No: None Supplied	Depth (m)	0.10				
Reporting Date: 30/08/2023	DETS Sample No	671421				

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



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Soil Analysis Certificate - TPH LQM Banded

DETS Report No: 23-10827	Date Sampled	15/08/23	15/08/23	16/08/23		
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Barnard Road	TP / BH No	WS01	WS05	WS08		
Project / Job Ref: BRD4290	Additional Refs	J1	J1	J2		
Order No: None Supplied	Depth (m)	0.60	0.50	0.60		
Reporting Date: 30/08/2023	DETS Sample No	671413	671417	671420		

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6 : HS 1D MS AL	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01		
Aliphatic >C6 - C8 : HS 1D MS AL	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05		
Aliphatic >C8 - C10 : EH CU 1D AL	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aliphatic >C10 - C12 : EH CU 1D AL	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aliphatic >C12 - C16 : EH CU 1D AL	mg/kg	< 3	MCERTS	< 3	< 3	< 3		
Aliphatic >C16 - C35 : EH CU 1D AL	mg/kg	< 10	MCERTS	< 10	< 10	< 10		
Aliphatic >C35 - C44 : EH CU 1D AL	mg/kg	< 10	NONE	< 10	< 10	< 10		
Aliphatic (C5 - C44) : HS 1D MS+EH CU 1D AL	mg/kg	< 30	NONE	< 30	< 30	< 30		
Aromatic >C5 - C7 : HS 1D MS AR	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01		
Aromatic >C7 - C8 : HS 1D MS AR	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05		
Aromatic >C8 - C10 : EH CU 1D AR	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C10 - C12 : EH CU 1D AR	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C12 - C16 : EH CU 1D AR	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C16 - C21 : EH CU 1D AR	mg/kg	< 3	MCERTS	< 3	< 3	< 3		
Aromatic >C21 - C35 : EH CU 1D AR	mg/kg	< 10	MCERTS	< 10	< 10	< 10		
Aromatic >C35 - C44 : EH CU 1D AR	mg/kg	< 10	NONE	< 10	< 10	< 10		
Aromatic (>C5 - C44) : HS 1D MS+EH CU 1D AR	mg/kg	< 30	NONE	< 30	< 30	< 30		
Total >C5 - C44 : HS 1D MS+EH CU 1D Total	mg/kg	< 60	NONE	< 60	< 60	< 60		



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Soil Analysis Certificate - BTEX / MTBE						
DETS Report No: 23-10827	Date Sampled	15/08/23	15/08/23	16/08/23		
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Barnard Road	TP / BH No	WS01	WS05	WS08		
Project / Job Ref: BRD4290	Additional Refs	J1	J1	J2		
Order No: None Supplied	Depth (m)	0.60	0.50	0.60		
Reporting Date: 30/08/2023	DETS Sample No	671413	671417	671420		

Determinand	Unit	RL	Accreditation					
Benzene : HS 1D MS	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
Toluene : HS 1D MS	ug/kg	< 5	MCERTS	< 5	< 5	< 5		
Ethylbenzene : HS 1D MS	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
p & m-xylene : HS 1D MS	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
o-xylene : HS 1D MS	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
MTBE : HS 1D MS	ug/kg	< 5	MCERTS	< 5	< 5	< 5		



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Soil Analysis Certificate - Semi Volatile Organic Compounds (SVOC)						
DETS Report No: 23-10827	Date Sampled	15/08/23	15/08/23	16/08/23		
BRD Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Barnard Road	TP / BH No	WS01	WS05	WS08		
Project / Job Ref: BRD4290	Additional Refs	J1	J1	J2		
Order No: None Supplied	Depth (m)	0.60	0.50	0.60		
Reporting Date: 30/08/2023	DETS Sample No	671413	671417	671420		

Determinand	Unit	RL	Accreditation				
Phenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	
1,2,4-Trichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	
2-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	
Nitrobenzene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
0-Cresol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	
bis(2-chloroethoxy)methane	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
bis(2-chloroethyl)ether	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
2,4-Dichlorophenol	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
2-Chlorophenol	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	
1,3-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	
1,4-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	
1,2-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	
2,4-Dimethylphenol	mg/kg	< 0.15	ISO17025	< 0.15	< 0.15	< 0.15	
Isophorone	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	
Hexachloroethane	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
p-Cresol	mg/kg	< 0.15	MCERTS	< 0.15	< 0.15	< 0.15	
2,4,6-Trichlorophenol	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
2,4,5-Trichlorophenol	mg/kg	< 0.15	MCERTS	< 0.15	< 0.15	< 0.15	
2-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	
4-Chloro-3-methylphenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	
2-Methylnaphthalene	mg/kg	< 0.1	MCERTS	< 0.1	0.2	< 0.1	
Hexachlorocyclopentadiene	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	
Hexachlorobutadiene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	
2,6-Dinitrotoluene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Dimethyl phthalate	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	
2-Chloronaphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
4-Chloroaniline	mg/kg	< 0.15	NONE	< 0.15	< 0.15	< 0.15	
4-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	
4-Chlorophenyl phenyl ether	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
3-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	
4-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	
4-Bromophenyl phenyl ether	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Hexachlorobenzene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
2,4-Dinitrotoluene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Diethyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Dibenzofuran	mg/kg	< 0.1	MCERTS	< 0.1	0.1	< 0.1	
Azobenzene	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	
Dibutyl phthalate	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	
Carbazole	mg/kg	< 0.1	ISO17025	< 0.1	0.2	< 0.1	
bis(2-ethylhexyl)phthalate	mg/kg	< 0.15	ISO17025	< 0.15	< 0.15	< 0.15	
Benzyl butyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	
Di-n-octyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	

Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3																																							
DETS Report No: 23-10827		Date Sampled		16/08/23		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3" style="text-align: left; padding: 5px;">Landfill Waste Acceptance Criteria Limits</th> </tr> <tr> <th style="width: 33%; padding: 5px;">Inert Waste Landfill</th> <th style="width: 33%; padding: 5px;">Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill</th> <th style="width: 33%; padding: 5px;">Hazardous Waste Landfill</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 5px;">3%</td> <td style="text-align: center; padding: 5px;">5%</td> <td style="text-align: center; padding: 5px;">6%</td> </tr> <tr> <td style="text-align: center; padding: 5px;">--</td> <td style="text-align: center; padding: 5px;">--</td> <td style="text-align: center; padding: 5px;">10%</td> </tr> <tr> <td style="text-align: center; padding: 5px;">6</td> <td style="text-align: center; padding: 5px;">--</td> <td style="text-align: center; padding: 5px;">--</td> </tr> <tr> <td style="text-align: center; padding: 5px;">1</td> <td style="text-align: center; padding: 5px;">--</td> <td style="text-align: center; padding: 5px;">--</td> </tr> <tr> <td style="text-align: center; padding: 5px;">500</td> <td style="text-align: center; padding: 5px;">--</td> <td style="text-align: center; padding: 5px;">--</td> </tr> <tr> <td style="text-align: center; padding: 5px;">100</td> <td style="text-align: center; padding: 5px;">--</td> <td style="text-align: center; padding: 5px;">--</td> </tr> <tr> <td style="text-align: center; padding: 5px;">--</td> <td style="text-align: center; padding: 5px;">>6</td> <td style="text-align: center; padding: 5px;">--</td> </tr> <tr> <td style="text-align: center; padding: 5px;">--</td> <td style="text-align: center; padding: 5px; color: red;">To be evaluated</td> <td style="text-align: center; padding: 5px; color: red;">To be evaluated</td> </tr> </tbody> </table>				Landfill Waste Acceptance Criteria Limits			Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill	3%	5%	6%	--	--	10%	6	--	--	1	--	--	500	--	--	100	--	--	--	>6	--	--	To be evaluated	To be evaluated
Landfill Waste Acceptance Criteria Limits																																							
Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill																																					
3%	5%	6%																																					
--	--	10%																																					
6	--	--																																					
1	--	--																																					
500	--	--																																					
100	--	--																																					
--	>6	--																																					
--	To be evaluated	To be evaluated																																					
BRD Environmental Ltd		Time Sampled		None Supplied																																			
Site Reference: Barnard Road		TP / BH No		WS07																																			
Project / Job Ref: BRD4290		Additional Refs		J2																																			
Order No: None Supplied		Depth (m)		0.80																																			
Reporting Date: 30/08/2023		DETS Sample No		671419																																			
Determinand	Unit	MDL																																					
TOC ^{MU}	%	< 0.1				0.5																																	
Loss on Ignition ^{MU}	%	< 0.01				0.40																																	
BTEX ^{MU}	mg/kg	< 0.05				< 0.05																																	
Sum of PCBs	mg/kg	< 0.1				< 0.1																																	
Mineral Oil ^{MU}	mg/kg	< 10				< 10																																	
Total PAH ^{MU}	mg/kg	< 1.7				< 1.7																																	
pH ^{MU}	pH Units	N/a				8.0																																	
Acid Neutralisation Capacity	mol/kg (+/-)	< 1				< 1																																	
Eluate Analysis		2:1 mg/l		8:1 mg/l		Cumulative 10:1 mg/kg		Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)																															
Arsenic ^U		< 0.01		< 0.01		< 0.2		0.5	2																														
Barium ^U		< 0.02		< 0.02		0.1		20	100																														
Cadmium ^U		< 0.0005		< 0.0005		< 0.02		0.04	1																														
Chromium ^U		< 0.005		< 0.005		< 0.20		0.5	10																														
Copper ^U		< 0.01		< 0.01		< 0.5		2	50																														
Mercury ^U		< 0.0005		< 0.0005		< 0.005		0.01	0.2																														
Molybdenum ^U		0.001		< 0.001		< 0.1		0.5	10																														
Nickel ^U		< 0.007		< 0.007		< 0.2		0.4	10																														
Lead ^U		< 0.005		< 0.005		< 0.2		0.5	10																														
Antimony ^U		< 0.005		< 0.005		< 0.05		0.06	0.7																														
Selenium ^U		< 0.005		< 0.005		< 0.05		0.1	0.5																														
Zinc ^U		0.013		0.008		< 0.2		4	50																														
Chloride ^U		< 1		2		39		800	15000																														
Fluoride ^U		< 0.5		< 0.5		< 1		10	150																														
Sulphate ^U		2		2		44		1000	20000																														
TDS		43		27		504		4000	60000																														
Phenol Index ^U		< 0.01		< 0.01		< 0.5		1	-																														
DOC ^U		6.9		12.4		219		500	800																														
Leach Test Information																																							
Sample Mass (kg)		0.09																																					
Dry Matter (%)		96.3																																					
Moisture (%)		3.8																																					
Stage 1																																							
Volume Eluate L2 (litres)		0.17																																					
Filtered Eluate VE1 (litres)		0.08																																					

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

Stated limits are for guidance only and DETS Ltd cannot be held responsible for any discrepancies with current legislation

M Denotes MCERTS accredited test

U Denotes ISO17025 accredited test



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Soil Analysis Certificate - Sample Descriptions

DETS Report No: 23-10827	
BRD Environmental Ltd	
Site Reference: Barnard Road	
Project / Job Ref: BRD4290	
Order No: None Supplied	
Reporting Date: 30/08/2023	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
671413	WS01	J1	0.60	3	Light brown sandy clay with stones
671414	WS03	J1	0.10	10.9	Brown sandy clay with stones and vegetation
671415	WS04	J1	0.20	7.5	Brown sandy clay with stones
671417	WS05	J1	0.50	7.1	Light brown sandy clay with stones and vegetation
671419	WS07	J2	0.80	3.1	Orange sandy clay with stones
671420	WS08	J2	0.60	6.1	Brown sandy clay with stones
671421	WS11	J1	0.10	6.2	Brown sandy clay with stones and vegetation
671422	WS05	J2	1.90	3.7	Orange sandy clay with stones
671423	WS02	J2	1.10	6	Orange sandy clay with stones
671424	WS01	J2	3.00	6	Brown sand
671425	WS08	J3	1.00	10	Brown sand with stones
671426	WS09	J2	1.90	7.2	Light brown sand
671427	WS06	J3	4.60	18	White chalk

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

Insufficient Sample ^{1/5}

Unsuitable Sample ^{1/5}



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 23-10827

BRD Environmental Ltd

Site Reference: Barnard Road

Project / Job Ref: BRD4290

Order No: None Supplied

Reporting Date: 30/08/2023

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 diphénylcarbazide 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 @ 450°C	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as 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



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Water Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 23-10827

BRD Environmental Ltd

Site Reference: Barnard Road

Project / Job Ref: BRD4290

Order No: None Supplied

Reporting Date: 30/08/2023

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 detection	E110
Water	UF	Electrical Conductivity	Determination of electrical conductivity by electrometric measurement	E123
Water	F	EPH (C10 - C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E104
Water	F	Fluoride	Determination of Fluoride by filtration & analysed by ion chromatography	E109
Water	F	Hardness	Determination of Ca and Mg by ICP-MS followed by calculation	E102
Leachate	F	Leachate Preparation - NRA	Based on National Rivers Authority leaching test 1994	E301
Leachate	F	Leachate Preparation - WAC	Based on BS EN 12457 Pt1, 2, 3	E302
Water	F	Metals	Determination of metals by filtration followed by ICP-MS	E102
Water	F	Mineral Oil (C10 - C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	Nitrate	Determination of nitrate by filtration & analysed by ion chromatography	E109
Water	UF	Monohydric Phenol	Determination of phenols by distillation followed by colorimetry	E121
Water	F	PAH - Speciated (EPA 16)	Determination of PAH compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E105
Water	F	PCB - 7 Congeners	Determination of PCB compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E108
Water	UF	Petroleum Ether Extract (PEE)	Gravimetrically determined through liquid:liquid extraction with petroleum ether	E111
Water	UF	pH	Determination of pH by electrometric measurement	E107
Water	F	Phosphate	Determination of phosphate by filtration & analysed by ion chromatography	E109
Water	UF	Redox Potential	Determination of redox potential by electrometric measurement	E113
Water	F	Sulphate (as SO4)	Determination of sulphate by filtration & analysed by ion chromatography	E109
Water	UF	Sulphide	Determination of sulphide by distillation followed by colorimetry	E118
Water	F	SVOC	Determination of semi-volatile organic compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E106
Water	UF	Toluene Extractable Matter (TEM)	Gravimetrically determined through liquid:liquid extraction with toluene	E111
Water	UF	Total Organic Carbon (TOC)	Low heat with persulphate addition followed by IR detection	E110
Water	F	TPH CWG (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C35. C5 to C8 by headspace GC-MS	E104
Water	F	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C44. C5 to C8 by headspace GC-MS	E104
Water	UF	VOCs	Determination of volatile organic compounds by headspace GC-MS	E101
Water	UF	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E101

Key

F Filtered
UF Unfiltered



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



List of HWOL Acronyms and Operators

DETS Report No: 23-10827

BRD Environmental Ltd

Site Reference: Barnard Road

Project / Job Ref: BRD4290

Order No: None Supplied

Reporting Date: 30/08/2023

Acronym	Description
HS	Headspace analysis
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent
CU	Clean-up - e.g. by florisil, silica gel
1D	GC - Single coil gas chromatography
2D	GC-GC - Double coil gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics only
AR	Aromatics only
#1	EH_2D_Total but with humics mathematically subtracted
#2	EH_2D_Total but with fatty acids mathematically subtracted
	Operator - underscore to separate acronyms (exception for +)
+	Operator to indicate cumulative eg. EH+HS_Total or EH_CU+HS_Total

Det - Acronym
Benzene - HS_1D_MS
Ethylbenzene - HS_1D_MS
MTBE - HS_1D_MS
Mineral Oil (C10 - C40) (BS EN 12457-3) - EH_CU_1D_AL
TPH CWG - Aromatic >C16 - C21 - EH_CU_1D_AR
TPH LQM - Aliphatic >C10 - C12 - EH_CU_1D_AL
TPH LQM - Aliphatic >C12 - C16 - EH_CU_1D_AL
TPH LQM - Aliphatic >C16 - C35 - EH_CU_1D_AL
TPH LQM - Aliphatic >C35 - C44 - EH_CU_1D_AL
TPH LQM - Aliphatic >C5 - C44 - HS_1D_MS+EH_CU_1D_AL
TPH LQM - Aliphatic >C5 - C6 - HS_1D_MS_AL
TPH LQM - Aliphatic >C6 - C8 - HS_1D_MS_AL
TPH LQM - Aliphatic >C8 - C10 - EH_CU_1D_AL
TPH LQM - Aromatic >C10 - C12 - EH_CU_1D_AR
TPH LQM - Aromatic >C12 - C16 - EH_CU_1D_AR
TPH LQM - Aromatic >C21 - C35 - EH_CU_1D_AR
TPH LQM - Aromatic >C35 - C44 - EH_CU_1D_AR
TPH LQM - Aromatic >C5 - C44 - HS_1D_MS+EH_CU_1D_AR
TPH LQM - Aromatic >C5 - C7 - HS_1D_MS_AR
TPH LQM - Aromatic >C7 - C8 - HS_1D_MS_AR
TPH LQM - Aromatic >C8 - C10 - EH_CU_1D_AR
TPH LQM - Total >C5 - C44 - HS_1D_MS+EH_CU_1D_Total
Toluene - HS_1D_MS
Total BTEX (BS EN 12457-3) - HS_1D_MS_Total
m & p-xylene - HS_1D_MS
o-Xylene - HS_1D_MS

Parameter	Matrix Type	Suite Reference	Expanded Uncertainty Measurement	Unit
TOC	Soil	BS EN 12457	10.4	%
Loss on Ignition	Soil	BS EN 12457	16.9	%
BTEX	Soil	BS EN 12457	14.0	%
Sum of PCBs	Soil	BS EN 12457	21.1	%
Mineral Oil	Soil	BS EN 12457	9.0	%
Total PAH	Soil	BS EN 12457	17.9	%
pH	Soil	BS EN 12457	0.282	Units
Acid Neutralisation Capacity	Soil	BS EN 12457	18.0	%
Arsenic	Leachate	BS EN 12457	19.5	%
Barium	Leachate	BS EN 12457	12.2	%
Cadmium	Leachate	BS EN 12457	17.2	%
Chromium	Leachate	BS EN 12457	20.7	%
Copper	Leachate	BS EN 12457	14.1	%
Mercury	Leachate	BS EN 12457	16.7	%
Molybdenum	Leachate	BS EN 12457	13.3	%
Nickel	Leachate	BS EN 12457	14.0	%
Lead	Leachate	BS EN 12457	12.1	%
Antimony	Leachate	BS EN 12457	16.1	%
Selenium	Leachate	BS EN 12457	15.5	%
Zinc	Leachate	BS EN 12457	14.0	%
Chloride	Leachate	BS EN 12457	15.7	%
Fluoride	Leachate	BS EN 12457	19.1	%
Sulphate	Leachate	BS EN 12457	27.6	%
TDS	Leachate	BS EN 12457	10.0	%
Phenol Index	Leachate	BS EN 12457	12.9	%
DOC	Leachate	BS EN 12457	20.4	%
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	16.9	%
pH	Soil	BS 3882: 2015	0.282	Units
Carbonate	Soil	BS 3882: 2015	12.0	%
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	19.8	%
Copper	Soil	BS 3882: 2015	23.2	%
Nickel	Soil	BS 3882: 2015	32.6	%
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: 08/09/2023



Contract	Barnard Road, Norwich		
Serial No.	43164_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: Barnard Road, Norwich		Approved Signatories: ☒ J.C. Garner B.Eng (Hons) FGS Technical Director & Quality Manager ☐ W. Johnstone Materials Lab Manager 	
Date Received: 21/08/2023		Samples Tested Between: 21/08/2023 and 08/09/2023	
Remarks: For the attention of Matt Morgan Your Reference No: BRD4290			
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.			

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TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 08/09/2023



Contract		Barnard Road, Norwich												
Serial No.		43164_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	1.60	D	1	13.3	31	15	16	-0.11	Wet Sieved	25 (M)	17.7*	30	Stiff yellowish brown slightly gravelly slightly sandy silty CLAY. Gravel is fine and medium angular to subrounded chert	CL
WS03	1.90	D	2	10.5	18	12	6	-0.26	Wet Sieved	14 (M)	12.2*	29	Firm mottled light grey and yellowish brown slightly gravelly sandy silty CLAY/very clayey SAND. Gravel is fine and medium angular to subrounded quartzite and chert	CL/ML
WS04	2.80	D	2	10.0	20	15	5	-1.01	Wet Sieved	30 (M)	14.2*	29	Yellowish brown gravelly clayey silty SAND. Gravel is fine and medium angular to subrounded chert	ML
WS10	1.20	D	2	17.4	27	15	12	0.20	Wet Sieved	11 (M)	19.5*	27	Soft mottled light bluish grey and yellowish brown slightly gravelly slightly sandy silty CLAY. Gravel is fine and medium angular to subrounded chert	CL
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

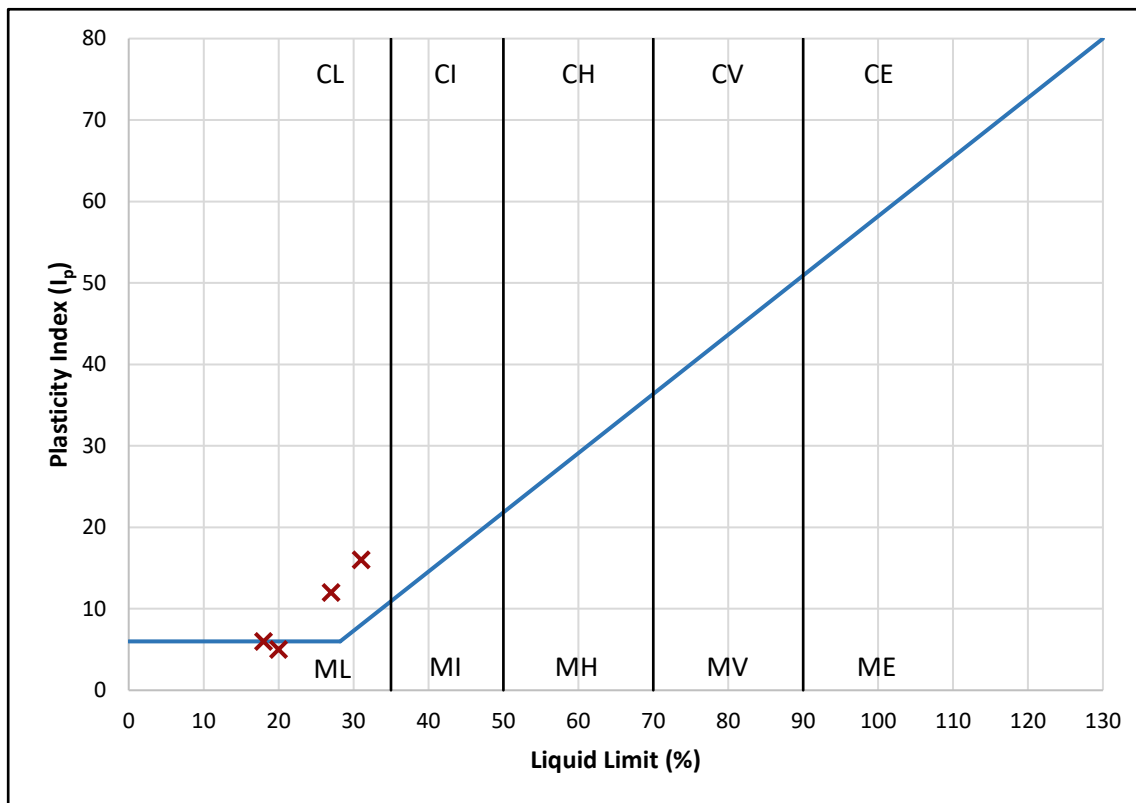
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DATE ISSUED: 08/09/2023



Contract	Barnard Road, Norwich
Serial No.	43164_1

PLOT OF PLASTICITY INDEX AGAINST LIQUID LIMIT USING CASAGRANDE CLASSIFICATION CHART

Plasticity				
Low	Medium	High	Very High	Extremely High



High	NHBC Volume Change Potential
Medium	
Low	

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



TEST REPORT

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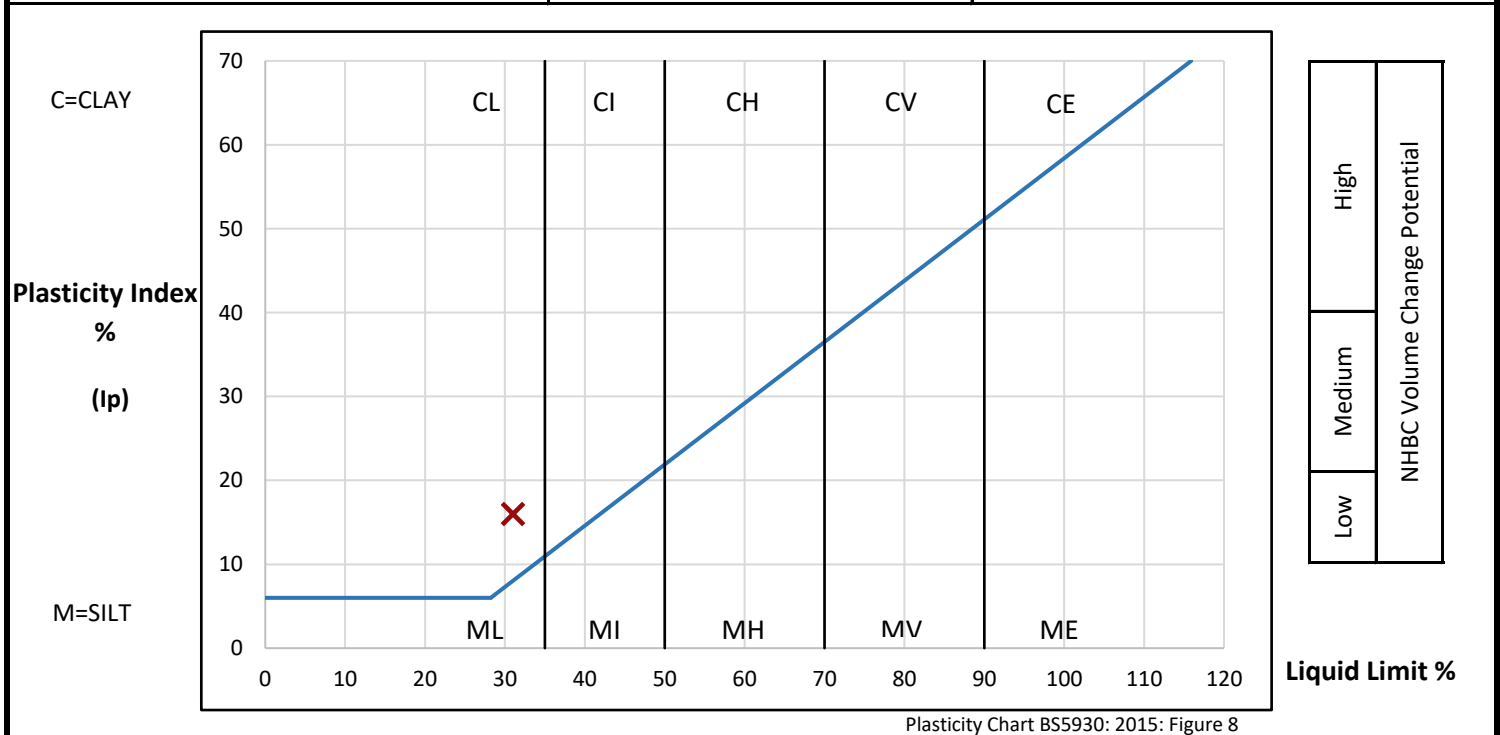


Contract	Barnard Road, Norwich
Serial No.	43164_1

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

Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks
		Type	Reference			
WS01	1.60	D	1	13.3	Stiff yellowish brown slightly gravelly slightly sandy silty CLAY. Gravel is fine and medium angular to subrounded chert	

PREPARATION			Liquid Limit	31 %	
Method of preparation		Wet sieved over 0.425mm sieve	Plastic Limit	15 %	
Sample retained 0.425mm sieve	(Measured)	25 %	Plasticity Index	16 %	
Corrected water content for material passing 0.425mm			Liquidity Index	-0.11	
Sample retained 2mm sieve	(Measured)	16 %	NHBC Modified (I'p)	12 %	
Curing time	30 hrs	Clay Content	Not analysed	Derived Activity	Not analysed



Method of Preparation:	BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 4.2
Method of Test:	BS EN ISO: 17892-1: 2014 & BS 1377: Part 2: 1990: 3.2, 4.4, 5.3, 5.4
Type of Sample Key:	U=Undisturbed, B=Bulk, D=Disturbed, J=Jar, W=Water, SPT=Split Spoon Sample, C=Core Cutter
Comments:	Corrected water content assume material greater than 0.425mm non-porous. See BS1377: Part2: 1990 Clause 3 Note 1 Volume Change Potential: NHBC Standards Chapter 4.2 Unmodified Plasticity Index Note: Modified Plasticity Index I'p = Ip x (% less than 425microns/100)



TEST REPORT

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Contract	Barnard Road, Norwich						
Serial No.	43164_1						
DETERMINATION OF WATER CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY INDEX AND LIQUIDITY INDEX							
Borehole / Pit No.	Depth m	Sample TypeReference		Water Content (W) %	Description	Remarks	
WS03	1.90	D	2	10.5	Firm mottled light grey and yellowish brown slightly gravelly sandy silty CLAY/very clayey SAND. Gravel is fine and medium angular to subrounded quartzite and chert		
PREPARATION					Liquid Limit	18 %	
Method of preparation					Wet sieved over 0.425mm sieve	Plastic Limit	12 %
Sample retained 0.425mm sieve (Measured)					14 %	Plasticity Index	6 %
Corrected water content for material passing 0.425mm					12.2 %	Liquidity Index	-0.26
Sample retained 2mm sieve (Measured)					7 %	NHBC Modified (I'p)	5 %
Curing time			29 hrs	Clay Content	Not analysed	Derived Activity	Not analysed
C=CLAY M=SILT Plasticity Index % (Ip) 70 60 50 40 30 20 10 0 0102030405060708090100110120 CLCI CHCVCE MLMI MH MV ME Plasticity Chart BS5930: 2015: Figure 8 High Medium Low NHBC Volume Change Potential Liquid Limit %							
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)	



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Contract	Barnard Road, Norwich						
Serial No.	43164_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	2.80	D	2	10.0	Yellowish brown gravelly clayey silty SAND. Gravel is fine and medium angular to subrounded chert		
PREPARATION					Liquid Limit	20 %	
Method of preparation					Wet sieved over 0.425mm sieve	Plastic Limit	15 %
Sample retained 0.425mm sieve (Measured)					30 %	Plasticity Index	5 %
Corrected water content for material passing 0.425mm					14.2 %	Liquidity Index	-1.01
Sample retained 2mm sieve (Measured)					17 %	NHBC Modified (I'p)	4 %
Curing time			29 hrs	Clay Content	Not analysed	Derived Activity	Not analysed
C=CLAY M=SILT Plasticity Index % (Ip) 70 60 50 40 30 20 10 0 0 10 20 30 40 50 60 70 80 90 100 110 120 CL CI CH CV CE ML MI MH MV ME Plasticity Chart BS5930: 2015: Figure 8 High Medium Low NHBC Volume Change Potential Liquid Limit %							
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)							



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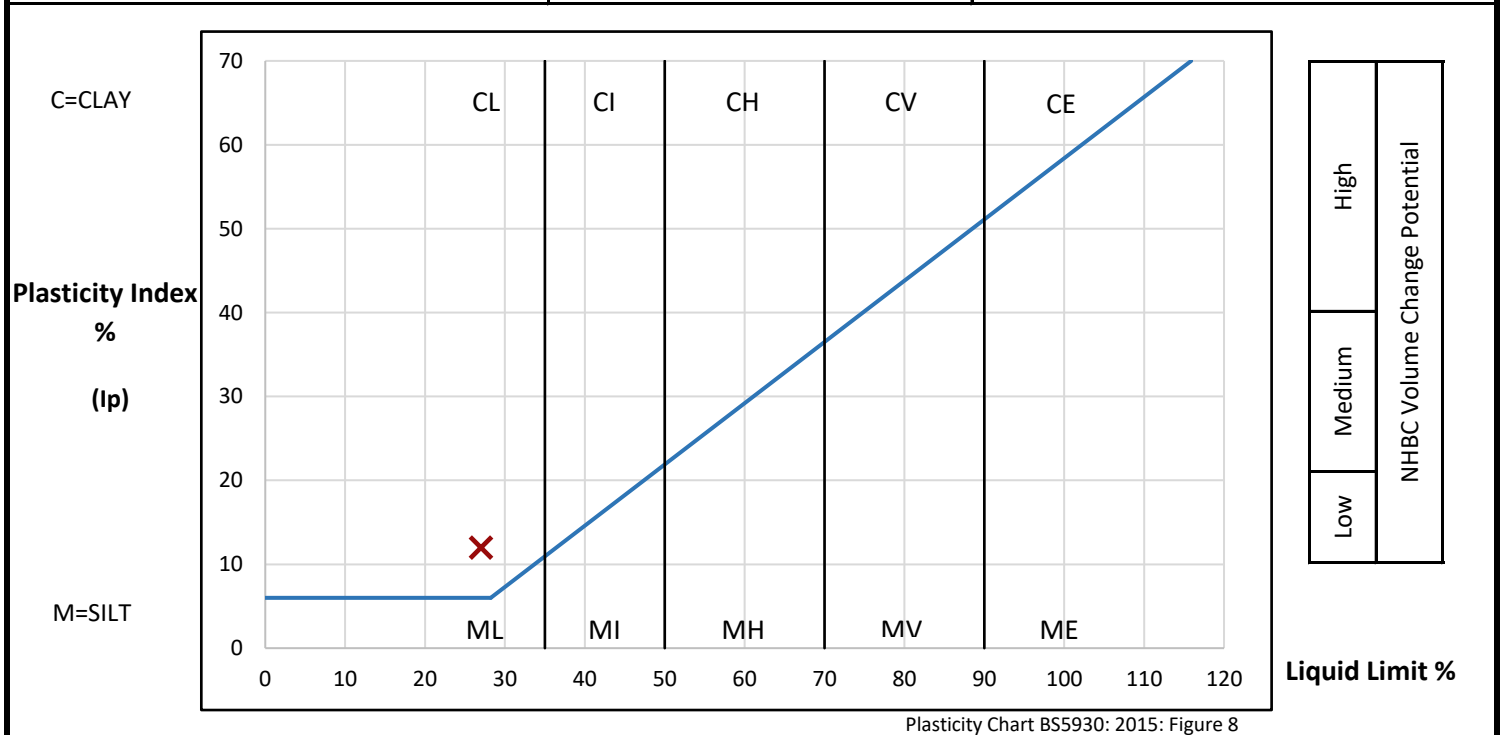


Contract	Barnard Road, Norwich
Serial No.	43164_1

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

Borehole / Pit No.	Depth m	Sample		Water Content (W) %	Description	Remarks
		Type	Reference			
WS10	1.20	D	2	17.4	Soft mottled light bluish grey and yellowish brown slightly gravelly slightly sandy silty CLAY. Gravel is fine and medium angular to subrounded chert	

PREPARATION			Liquid Limit	27 %	
Method of preparation		Wet sieved over 0.425mm sieve	Plastic Limit	15 %	
Sample retained 0.425mm sieve	(Measured)	11 %	Plasticity Index	12 %	
Corrected water content for material passing 0.425mm			Liquidity Index	0.20	
Sample retained 2mm sieve	(Measured)	6 %	NHBC Modified (I'p)	11 %	
Curing time	27 hrs	Clay Content	Not analysed	Derived Activity	Not analysed



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



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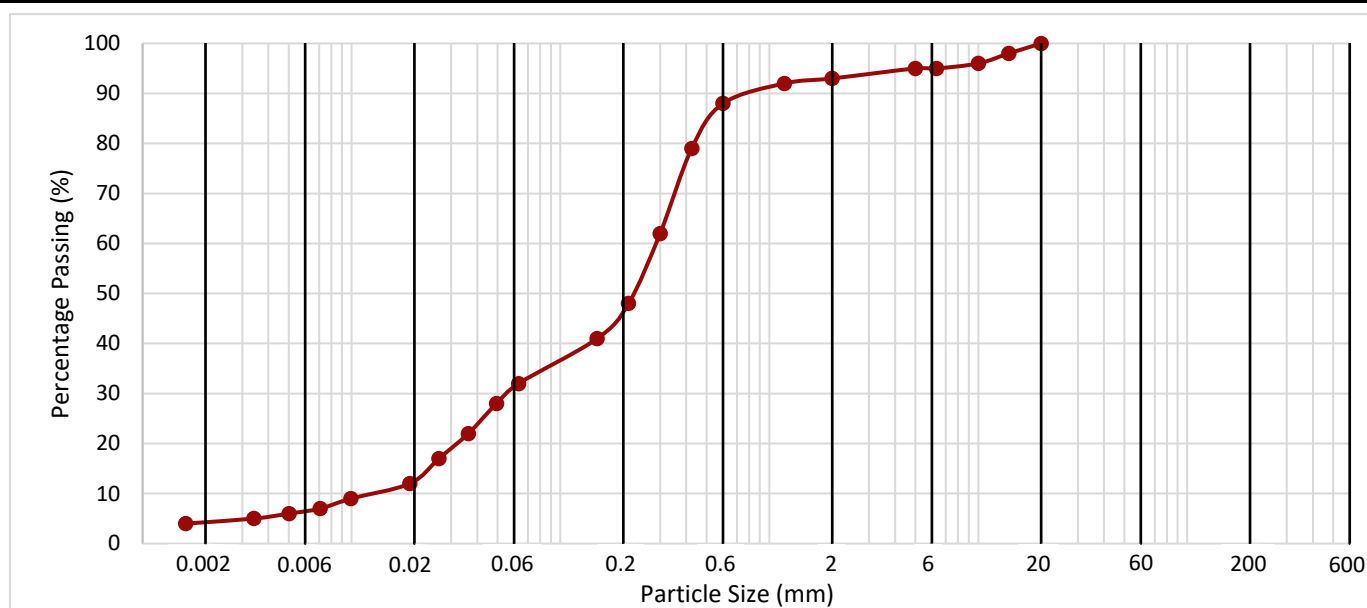


Contract	Barnard Road, Norwich
Serial No.	43164_1

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Pit No.	Depth (m)	Sample		Description	Remarks
		Type	Reference		
WS04	2.00	B	1	Brown slightly gravelly slightly clayey very silty SAND. Gravel is brown, black and white subangular and subrounded chert	

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



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

H y d r o m e t e r	Particle Size (mm)	Passing (%)	Silt by Dry Mass (%)
	0.0494	28	28
	0.0362	22	
	0.0262	17	
	0.0190	12	Clay by Dry Mass (%)
	0.0099	9	
	0.0071	7	
	0.0050	6	4
	0.0034	5	
	0.0016	4	

Sieve Size (mm)	Passing (%)	Sand By Dry Mass (%)
2.00	93	61
1.18	92	
0.600	88	
0.425	79	
0.300	62	
0.212	48	
0.150	41	
0.063	32	

Fines By Dry Mass (%)	
<0.063mm	32

Sieve Size (mm)	Passing (%)	2mm+ By Dry Mass (%)
300		7
125		
90		
63		
50		
37.5		
28		
20	100	
14	98	
10	96	
6.3	95	
5	95	

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



TEST REPORT

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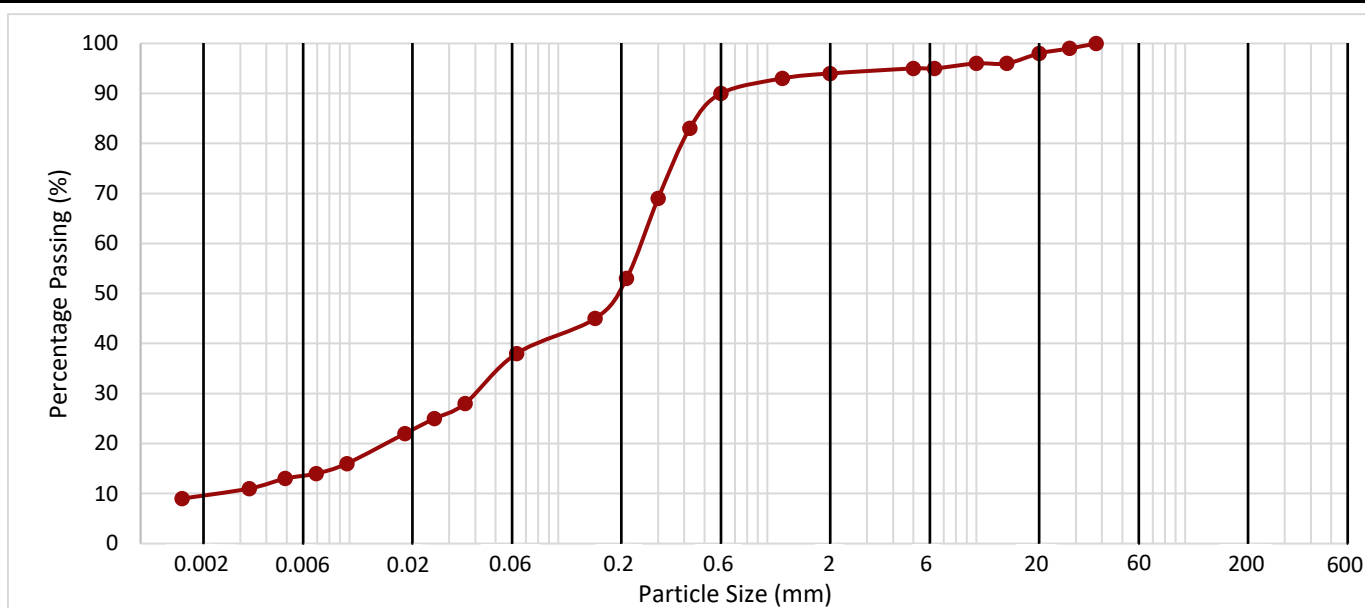


Contract	Barnard Road, Norwich
Serial No.	43164_1

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Pit No.	Depth (m)	Sample		Description	Remarks
		Type	Reference		
WS09	1.10	B	1	Dark orangish brown slightly gravelly sandy clayey SILT. Gravel is white, black and brown angular to subrounded chert with rare white rounded and subrounded quartzite	

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



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

H y d r o m e t e r	Particle Size (mm)	Passing (%)	Silt by Dry Mass (%)
	0.0357	28	28
	0.0255	25	
	0.0184	22	
	0.0097	16	Clay by Dry Mass (%)
	0.0069	14	
	0.0049	13	
	0.0033	11	10
	0.0016	9	

Sieve Size (mm)	Passing (%)	Sand By Dry Mass (%)
2.00	94	56
1.18	93	
0.600	90	
0.425	83	
0.300	69	
0.212	53	
0.150	45	
0.063	38	

Fines By Dry Mass (%)	
<0.063mm	38

Sieve Size (mm)	Passing (%)	2mm+ By Dry Mass (%)
300		6
125		
90		
63		
50		
37.5	100	
28	99	
20	98	
14	96	
10	96	
6.3	95	
5	95	

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



TEST REPORT

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DATE ISSUED: 08/09/2023



Contract	Barnard Road, Norwich
Serial No.	43164_1

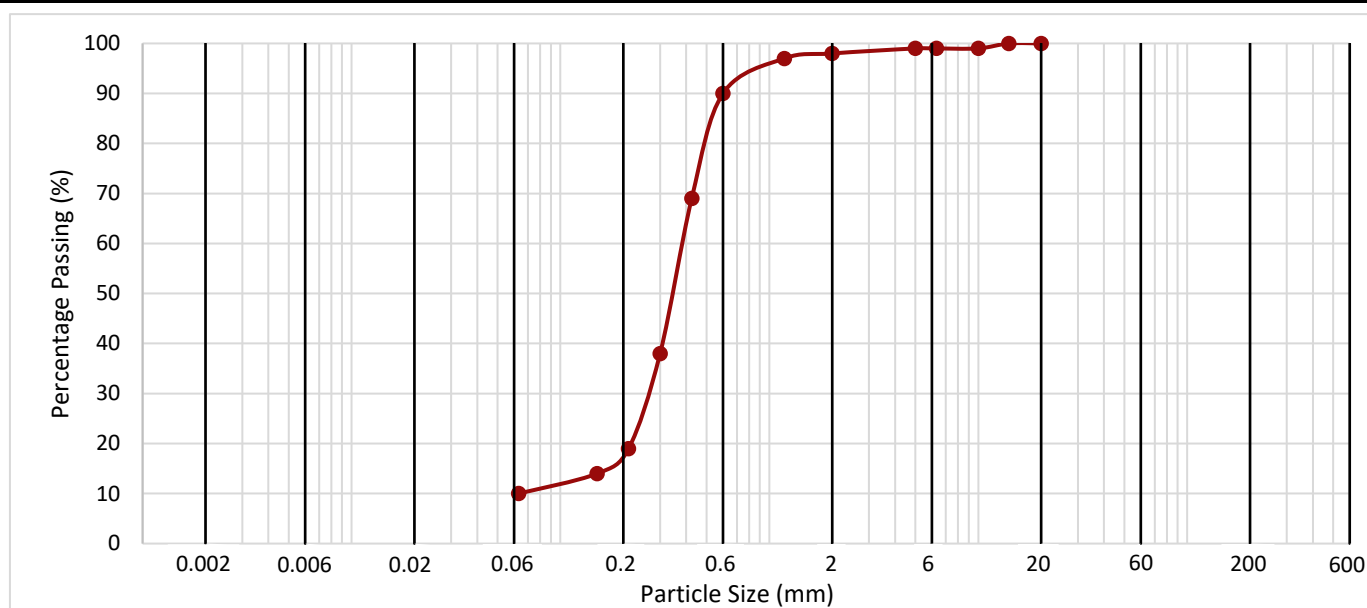
DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Pit No.	Depth (m)	Sample		Description	Remarks
		Type	Reference		
WS11	1.10	B	1	Orangish brown slightly gravelly silty SAND. Gravel is white, brown and black angular to subrounded chert	

Method of Test: Wet Sieve

Method of Pretreatment:

Not required



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

H y d r o m e t e r	Particle Size (mm)	Passing (%)	Silt by Dry Mass (%)
	0.075		
	0.15		
	0.3		
	0.6		
	1.2		
	2.5		
	5.0		
	Particle Size (mm)	Passing (%)	Clay by Dry Mass (%)
	0.075		
	0.15		
	0.3		
	0.6		
	1.2		
	2.5		
	5.0		

Sieve Size (mm)	Passing (%)	Sand By Dry Mass (%)
2.00	98	88
1.18	97	
0.600	90	
0.425	69	
0.300	38	
0.212	19	
0.150	14	
0.063	10	

Fines By Dry Mass (%)	
<0.063mm	10

Sieve Size (mm)	Passing (%)	2mm+ By Dry Mass (%)
300		2
125		
90		
63		
50		
37.5		
28		
20	100	
14	100	
10	99	
6.3	99	
5	99	

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