



EARTH ENVIRONMENTAL
& GEOTECHNICAL

GeoEnvironmental Investigation

Brook Hey Drive, Kirkby

Knowsley

September 2020

On behalf of

Liverpool Community Homes PLC

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SITE INVESTIGATION

BROOK HEY DRIVE

KIRKBY, KNOWSLEY

Report Ref: A3677/20

SEPTEMBER 2020

Prepared on Behalf of:

LIVERPOOL COMMUNITY HOMES PLC

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1.0 EXECUTIVE SUMMARY

Appointment	A Site Investigation has been commissioned by Liverpool Community Homes PLC to examine ground conditions for a proposed residential development at a site located at Brook Hey Drive, Kirkby.
The Investigation	The investigation comprised window sample boreholes with associated sampling and in situ testing, laboratory geotechnical and contamination testing.
The Site	The site is located in Northwood, Kirkby, Northwest England approximately 1.47km northeast of Kirkby Town Centre. The approximate National Grid Reference for the centre of the site is SJ 42143 99510 (X: 342143, Y: 399510). The site is underlain by superficial deposits of the Shirdley Hill Sand Formation underlain by the Chester Sandstone Formation of Olenekian Age.
Site History	Historically, the site was agricultural land with a pathway crossing the northeast corner of the site and part of a road crossing the southern edge of the site. Two rows of residential terraced houses developed on the land in the 1962 which were demolished by 1984 and the site remains derelict.
Ground Conditions Encountered	The exploratory holes encountered Made Ground (up to 3.50m thick) overlying generally silty gravelly sand (to a maximum depth of 2.90m bgl) overlying generally firm to stiff sandy gravelly clay. Fibrous peat was encountered in half of the boreholes, ranging from 0.10m to 0.30m thick. A concrete layer was encountered in only WS02. Groundwater was not encountered during the fieldwork.
Geotechnical Assessment	Foundation options are conventional shallow strip/pad foundations at a minimum depth of 2.0m bgl. Due to the deeper Made Ground encountered in WS02, foundation options within the vicinity of Plot 3 are ground improvement or piles. Pavement Design – preliminary design value = 1% in Made Ground, 20% in natural sand. Design Sulphate Class = DS-1 ACEC Site Classification = AC-1s
Contamination Assessment	Risk from contamination to groundworkers during development – Low Risk from contamination to future site users – Low. Soil Waste Assessment: 5 samples tested all classified as Non-Hazardous. Asbestos Management Plan required as sample WS05 is Hazardous (0.274% Asbestos)
<i>This sheet is intended to provide a summary only of the report. It does not provide a definitive engineering analysis for the purposes of costing or construction and is subject to the limitation of the agreed brief.</i>	

2.0 INTRODUCTION

2.1 Background

A Site Investigation has been commissioned by Liverpool Community Homes PLC to examine ground conditions for ten proposed new residential properties with associated car parking and soft landscaping at a site in Kirkby, Knowsley.

2.2 Previous Investigations

2.2.1 Earth Environmental & Geotechnical Ltd, Phase I GeoEnvironmental Desk Study (A3677/20), dated September 2020

Historical archives show the site to have been first occupied by two rows of terraced residential houses in 1962. The buildings were subsequently demolished by 1984 and the site remains unoccupied. Currently the site is openly accessible to the public and is bound by Brook Hey Drive to the south and Gilescroft Avenue to the east. The site is surfaced in grass vegetation and a footpath crosses the eastern side of the site.

Potential sources of contamination were identified as Made Ground and asbestos containing materials from former structures. A potential off-site source of contamination in the electricity substation located 42m to the west of the site.

The risk from soil contamination to residential end users was considered to be **LOW**. The risk to controlled waters was concluded to be **LOW**. The risk from ground gas to end users was considered to be **LOW**. The risk of groundwater flooding was **MODERATE**.

An intrusive investigation was recommended to establish geotechnical parameters for the design of foundations, floor slabs and pavement construction. As part of the geotechnical investigation, it was recommended that samples are recovered for contamination testing and to confirm whether there are any potential risks.

2.3 Terms of Reference

Earth Environmental and Geotechnical Ltd (EEG) have been commissioned by the Client, to undertake a Site Investigation of the site in accordance with proposal A3677/20 dated 18th August 2020. The objectives of this investigation are as follows:

- *Provide factual information on the work undertaken including sampling location plan, borehole logs, geotechnical and chemical testing.*
- *Tier 1 (semi-quantitative) risk assessment will be undertaken. This will compare the concentrations of soil contaminants identified against current and appropriate published guidelines, in relation to identified receptors, e.g. existing/ future end users and site neighbours.*
- *Classification of soil for offsite disposal.*
- *Assessment of ground conditions for foundation design.*

2.4 Report Scope

This report presents full factual records of the site work carried out, the ground conditions encountered in the exploratory holes, the in situ and laboratory test results. All information collected has been used to provide an interpretation of the ground conditions, with recommendations on geotechnical design and potential ground contamination risks for the proposed development.

2.5 Limitations of the Study

The report is written in the context of an agreed scope of work and budget and should not be used in a different context. New information, improved practices or changes in legislation may require a reinterpretation of the report in whole or in part. EEG reserve the right to amend either conclusions or recommendations in light of any further information that may become available. The report is provided for the sole use by the client and is confidential to them.

Recommendations within this report are also based on exploratory records and examination of samples and, where applicable, laboratory tests. No liability can be accepted for conditions not revealed by the boreholes particularly at intervening locations. Whilst every effort is made to ensure accuracy of data supplied, all opinions expressed as to the spatial distribution of strata between sampling locations is for guidance only and no responsibility is accepted as to its accuracy.

3.0 SITE LOCATION & DESCRIPTION

The site is located in Northwood, Kirkby, Northwest England approximately 1.4km northeast of Kirkby Town Centre. The approximate National Grid Reference for the centre of the site is SJ 42143 99510 (X: 342143, Y: 399510) with the closest postcode being L33 6UW.

The site is an L shaped parcel of land currently accessible via both Brook Hey Drive and Gilescoft Avenue. The site is currently openly accessed by the public, with a well-trodden walkway crosscutting the eastern corner of the area. The area of the site is 0.29ha with a generally flat and level topography, with the southern boundary sloping down towards Brook Hey Drive.

The general surrounding area comprises predominantly of residential dwellings with pre-existing terraced dwellings lying immediately north of the plot. St. Marie's Catholic Primary School is located 250m to the south of the site, and an old abandoned church is located directly to the west of the site.

The site location is shown in the aerial photograph presented as Figure 1, below.

Figure 1: Aerial Photograph Showing Site Location



Access is from Brook Hey Drive to the south of the site and Gilescoft Avenue to the east of the site.

General site photographs are presented in Figure 2 below.

Figure 2: General Site Photographs

Photograph taken looking across site looking east



Photograph taken across site during the ground investigation looking south



3.1 Proposed Development

It is understood that the Client intends to build 10no. semi-detached residential properties on site with associated soft landscaping and parking. Access will be provided via Gilescroft Avenue.

The proposed development layout details are shown in Figure 3 below.

Figure 3: Proposed Development Plan



4.0 SITE INVESTIGATION

4.1 Exploratory Fieldwork

The fieldwork was carried out by EEG on 28th August 2020 and comprised:

- Six window sample boreholes (designated WS01 to WS06 inclusive) were each sunk to a depth of 5.00m to 6.00m below existing ground level. Window sampler boring is carried out with a small, track-mounted rig, which uses a chain-driven trip hammer to drive sampling tubes or penetrometers into the ground. These tools are coupled to the anvil of the hammer by solid drill rods. Sampling tubes comprise “windowless samplers”, which are plain sampler tubes in which a continuous disturbed sample is recovered within a semi-rigid plastic liner. In order to reduce friction within the borehole, sampling tubes of progressively smaller diameter are used as the borehole depth increases. Sampler diameters generally range from between approximately 90mm to 50mm. Standard Penetration Tests (SPTs) were undertaken in the boreholes in accordance with BS EN ISO 22476-3. Groundwater observations were noted where possible. These observations relate to the time of the investigation only, and do not necessarily reflect seasonal fluctuations. Exploratory hole logs are included in Appendix 1.

Exploratory hole locations were selected on-site by an EEG engineer based on the proposed development layout and avoiding known services. Each exploratory location was scanned using a Cable Avoidance Tool (CAT) in order to locate unrecorded underground services, and the exploratory locations were repositioned if necessary.

On completion, samples recovered from the site were taken to specialist laboratories for chemical and geotechnical testing.

All site investigation work was supervised full time by a representative of EEG. The logging of soils and rocks has been carried out in accordance with BS5930⁽²⁰¹⁵⁾ except where superseded by the soil and rock description methodology in BS EN14688-1⁽²⁰⁰²⁾, BS EN 14688-2⁽²⁰⁰⁴⁾ and BS EN 14689-1⁽²⁰⁰³⁾.

An Exploratory Hole Location Plan is presented as Figure 4, overleaf.

Figure 4: Exploratory Hole Location Plan



A summary of exploratory holes undertaken during the investigation are presented in Table 1 below.

Table 1: Summary of Exploratory Holes Undertaken

Hole	Type*	Depth (m)	Date Started	Date Finished	Easting (m)	Northing (m)	Backfill Details**
WS01	WS	6.00	28/08/2020	28/08/2020	342106	399527	A
WS02	WS	5.00	28/08/2020	28/08/2020	342123	399514	A
WS03	WS	5.00	28/08/2020	28/08/2020	342147	399514	A
WS04	WS	5.00	28/08/2020	28/08/2020	342165	399502	A
WS05	WS	6.00	28/08/2020	28/08/2020	342187	399501	A
WS06	WS	5.00	28/08/2020	28/08/2020	342191	399521	A
*WS = Window Sample Borehole							
**A=Arising							

4.2 Laboratory Testing

4.2.1 Geotechnical Testing

A programme of laboratory testing was carried out on samples taken from the various strata to assist in classification and determine the engineering properties of the materials underlying the site. The tests were scheduled by EEG and carried out by Murray Rix. The test procedures used were generally in accordance with the methods described in BS1377:1990. Details of the specific tests used in each case are given in Table 2, overleaf.

Table 2: Summary of Laboratory Geotechnical Tests Undertaken

TEST	STANDARD	No.
Moisture Content	BS1377:1990 Part 2, Clause 3.2	4
Liquid Limit, Plastic Limit, Plasticity Index	BS1377:1990 Part 2, Clause 4/5	4
Particle size distribution (wet)	BS1377:1990 Part 2, Clause 9.2	4
Sulphate content of 2:1 soil:water extract	BS1377:1990 Part 3, Clause 5	4
pH value	BS1377:1990 Part 3, Clause 9	4

The results of the laboratory geotechnical tests are discussed in Section 6 and included in Appendix 2.

4.2.2 Environmental Testing

The environmental chemistry of the ground was investigated by specialist chemical analysis of selected samples, scheduled by EEG and carried out by DETS.

Chemical analyses were carried out on five soil samples and were submitted for the following suite of determinants:

Asbestos Screen, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc, Cyanide, Phenol, Sulphate (SO₄), Sulphide, pH, Soil Organic Matter, Extractable Petroleum Hydrocarbons (EPH), Total Petroleum Hydrocarbon (TPH) and Speciated Polyaromatic Hydrocarbons (PAH).

The results of the laboratory contamination tests are discussed in Section 8 and included in Appendix 3.

5.0 GROUND CONDITIONS ENCOUNTERED

5.1 Soil Profile Encountered

BGS digital mapping shows the site is underlain by superficial deposits of the Shirdley Hill Sand Formation, comprising sand. The solid geology beneath the site is the Chester Sandstone Formation, comprising sandstone. The sequence of strata encountered beneath the site was as follows:

- **Made Ground** – Variable Made Ground was encountered in all the exploratory holes, comprising:
 - Silty gravelly SAND (containing gravel of red brick, concrete, pottery, glass, and sandstone).
 - Clayey silty gravelly SAND (containing gravel of concrete and red brick).
 - Silty SAND and GRAVEL (gravel of concrete).
 - CONCRETE slab layer.

- **Superficial Deposits** –

Sand was encountered in WS01, WS03, WS06 comprising:

- Silty gravelly SAND (containing gravel of sandstone and mudstone).
- Silty SAND.
- Clayey silty Sand.

Peat was encountered in WS01, WS03, WS06 comprising:

- Fibrous PEAT

Clay was encountered in all the exploratory holes, comprising:

- Sandy gravelly CLAY (containing gravel of sandstone and mudstone).

The depths of the various materials encountered in the exploratory holes are summarised in Table 3 below.

Table 3: Summary of Ground Conditions Encountered

Hole	Depth to Stratum (m bgl)				GROUNDWATER (m bgl)
	MADE GROUND	SAND	PEAT	CLAY	
WS01	GL-1.30	1.30-1.95	1.95-2.05	2.05-6.00+	-
WS02	GL-3.50	-	-	3.50-5.00+	-
WS03	GL-1.20	1.20-1.90 2.00-2.30 3.00-4.70	1.90-2.00	2.30-3.00 4.70-5.00+	-
WS04	GL-1.50	-	-	1.50-5.00+	-
WS05	GL-1.50	-	-	1.50-6.00+	-
WS06	GL-0.80	0.80-2.40 2.70-2.90	2.40-2.70	2.90-5.00+	-

5.2 Observable Indications of Contamination

Rubbish and gravel of clinker were encountered within the Made Ground of WS01.

5.3 Obstructions

A concrete slab was encountered in WS02 at 0.30-0.60m depth which was subsequently removed. Man Made obstructions were not encountered in any of the other exploratory hole locations.

5.4 Groundwater

No groundwater was encountered in any of the boreholes or excavations carried out during the fieldwork.

6.0 ENGINEERING PROPERTIES OF SOILS ENCOUNTERED

6.1 General

The following sections discuss the engineering properties of the strata encountered, based on results of in situ testing and laboratory testing obtained during this investigation.

The results of laboratory geotechnical testing are summarised in the following table.

Table 4: Summary of Laboratory Geotechnical Test Results

Location	Depth (m)	Strata*	CLASSIFICATION										STRENGTH		CHEMICAL	
			Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	PSD Cobbles (%)	PSD Gravel (%)	PSD Sand (%)	PSD Silt (%)	PSD Clay (%)	Bulk Density Mg/m ³	Dry Density (Mg/m ³)	Shear Strength (kN/m ²)	pH Value	Water Soluble Sulphate SO ₄ (mg/l)
WS01	3.00	Clay	13	27	12	15	-	4	49	33	14	-	-	-	7.0	130
WS03	3.00	Clay	9.3	26	10	16	-	34	32	25	9	-	-	-	7.1	200
WS05	2.80	Clay	12	29	12	17	-	6	45	40	9	-	-	-	7.0	180
WS06	3.50	Clay	12	27	10	17	-	5	51	36	8	-	-	-	7.0	170
*NP – Non-Plastic																

6.2 Made Ground

Made Ground was encountered in all exploratory hole locations between ground level and 3.50m below ground level (WS02) and varied from exploratory hole location.

SPT tests carried out in the deeper Made Ground resulted in **SPT N values** of between 6 and 18, as shown on the SPT v Depth Plot, in Figure 8 (overleaf).

Made Ground is not typically considered to be a suitable founding material, and as such, no further geotechnical testing was carried out on the material.

6.3 Superficial Deposits

As discussed in Section 5, soils interpreted to represent the Shirdley Hill Sand Formation were encountered as a silty gravelly SAND, silty SAND, clayey silty SAND and small layers of fibrous PEAT. However, a sandy gravelly CLAY was also encountered in all the exploratory hole locations.

6.3.1 Clay

A sandy gravelly clay was encountered in all exploratory hole locations between 1.90 and 6.00m below ground level.

Laboratory testing has given a value of **water-soluble sulphate** in the range 130mg/l to 200mg/l, together with **pH Values** in the range 7.0 to 7.1.

SPT tests carried out in the clay resulted in **SPT N values** of between 11 and 50, as shown on the SPT v Depth Plot in Figure 5 (overleaf). The results suggest the clay is firm to very stiff.

In-situ **hand penetrometer** (HP) tests have given results of shear strength in the range 48kN/m² to 192kN/m², also suggesting the clay is firm to very stiff.

Figure 6, overleaf, shows the **shear strength** of the clay soils based on in-situ hand penetrometer tests alongside equivalent shear strength from SPT N values based on correlations by Stroud and Butler ⁽¹⁹⁷⁵⁾.

Recommended N values and derived design values for the cohesive soils are summarised in Table 5, below.

Table 5: Summary of Design Parameters (Clay)

Depth	SPT N Value Range	Average N Value	Design N Value*	Equivalent Shear Strength** (kN/m ²)	Coefficient of Volume Compressibility** (mv)
2.0	11 - 13	12	12	52	0.14
3.0	15 - 18	17	16	71	0.10
4.0	26 - 38	31	27	122	0.06
5.0	19 - 50	40	36	162	0.05
6.0	41 - 50	46	43	195	0.04
*Based on lower quartile N value and correlations by Peck Hanson and Thornburn ⁽¹⁹⁷⁴⁾					
**Based on correlation by Stroud & Butler ⁽¹⁹⁷⁵⁾					

It is recommended that for assessing ultimate bearing capacities, where the lower values are critical, the lower quartile value of N values is used. Based on the N Values in the above table, the equivalent shear strength values were in the range of 52 - 195kN/m².

For design purposes, the following strength profile is recommended:

- At 2.0m depth $c_u = 52\text{kN/m}^2$, increasing linearly to $c_u = 71\text{kN/m}^2$ at 3.0m depth.
- At 3.0m depth $c_u = 71\text{kN/m}^2$, increasing linearly to $c_u = 195\text{kN/m}^2$ at 6.0m depth

Figure 5: SPT v Depth Plot

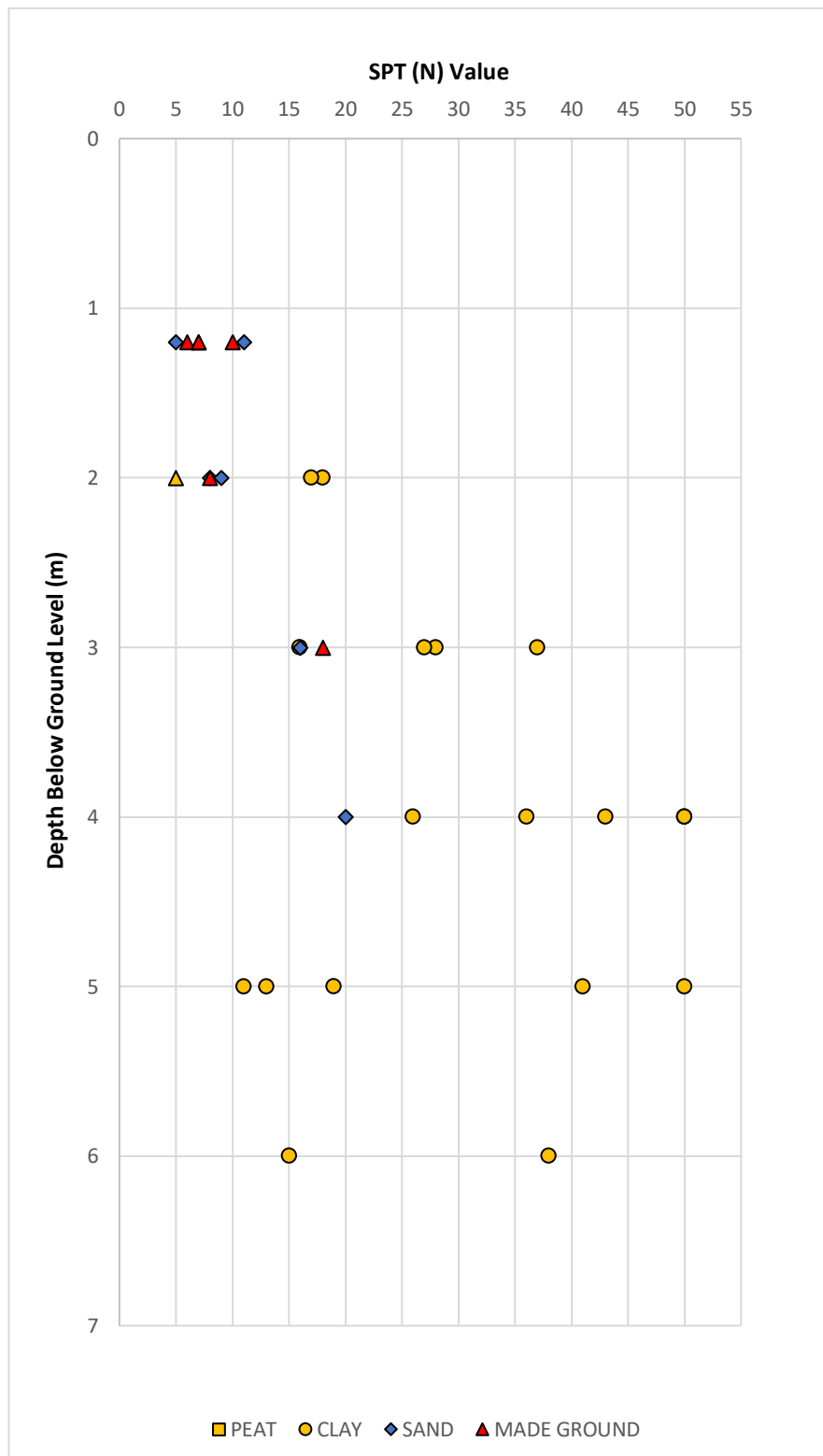
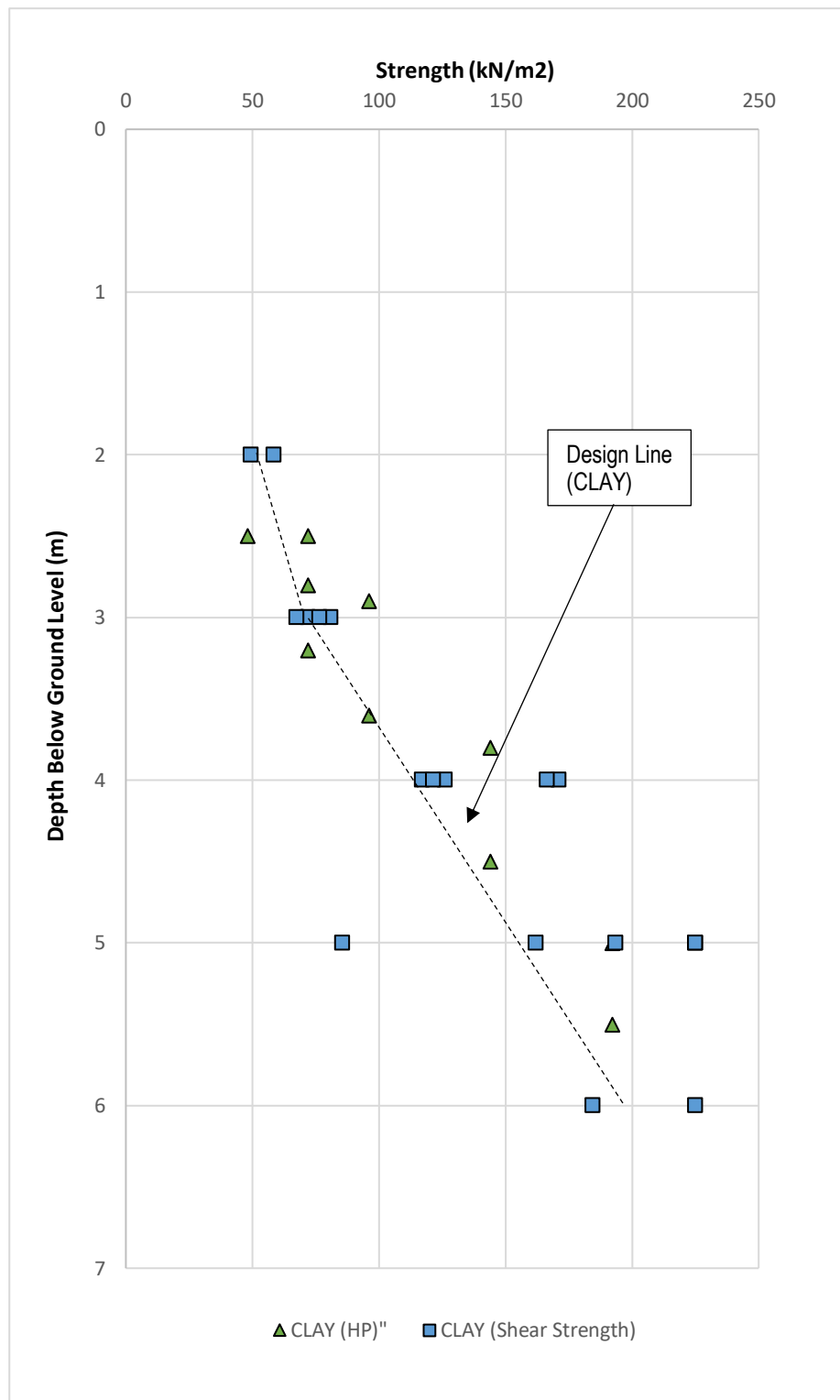
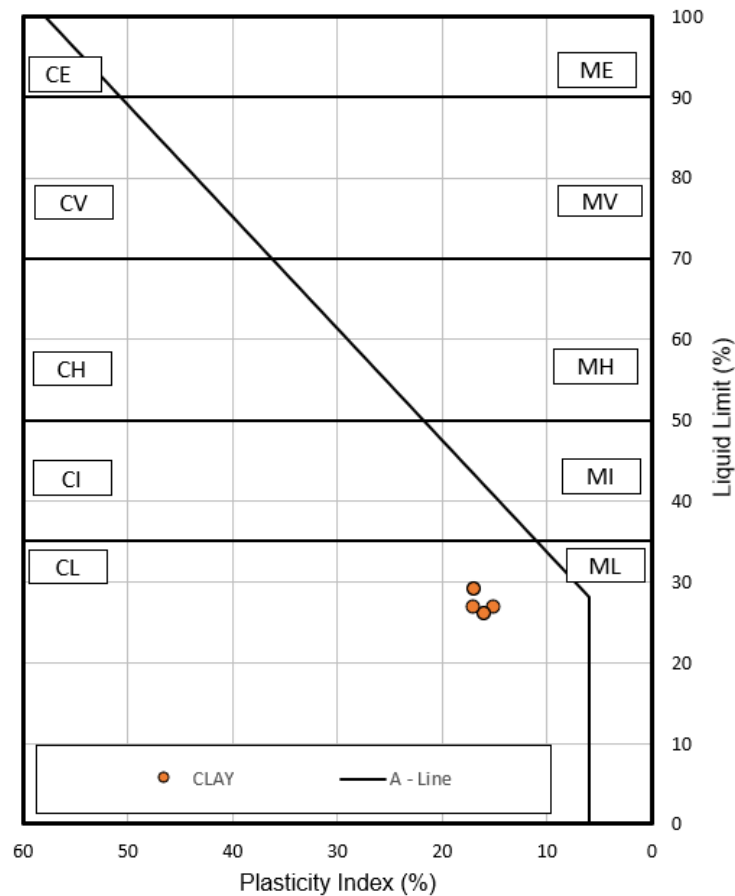


Figure 6: Strength v Depth Plot (Clay)



Atterberg Limit tests were carried out on four samples of the clay. Results of the test reported **liquid limit** values in the range 26% to 29% and **plastic limit** values in the range 10% to 12%, resulting in values of **plasticity index** in the range 15% to 17%. These results suggest the samples of clay tested are of **low plasticity** as shown on the Plasticity Chart in Figure 7, below.

Figure 7 Plasticity Chart



For design purposes, a value of plasticity index = 17% is recommended, based on the upper quartile of the results.

The **coefficient of volume compressibility (mv)** has been estimated using the following correlation by Stroud and Butler ⁽¹⁹⁷⁵⁾: for a clay with a plasticity index of 17%, $mv = 1 / (0.6 \times N \text{ value})$. This correlation gives values of coefficient of volume compressibility in the range 0.04m²/MN to 0.14m²/MN, as shown in Table 5, above. The results suggest the clay has a **very low to medium compressibility**.

6.3.2 Sand

Sand was encountered in exploratory hole locations WS01, WS03 and WS06 at depths between 0.80m and 4.70m below ground level.

SPT tests carried out in the sand resulted in **SPT N values** of between 5 and 20, as shown on the SPT v Depth Plot in Figure 5 (above). The results suggest suggests the sand is loose to medium dense.

Recommended N values and derived design values for the granular soils are summarised in Table 6, overleaf.

Table 6: Summary of Design Parameters (Sand)

Depth	SPT N Value Range	Average N Value	Design N Value*	Equivalent Soil Density	Angle of Internal Friction (degrees°)**
1.2	5-11	8	7	Loose	29
2.0	8-9	9	8	Loose	29
3.0	16	16	16	Medium Dense	32
4.0	20	20	20	Medium Dense	33
*Based on lower quartile N value					
**Based on the correlation by Peck, Hanson and Thornburn ⁽¹⁹⁷⁴⁾					

It is recommended that for assessing ultimate bearing capacities, where the lower values are critical, the lower quartile value of N values is used. For design purposes, a value of 8 seems reasonable based on the SPT N values encountered at 2.0m depth.

Based on the correlation by Peck, Hanson and Thornburn⁽¹⁹⁷⁴⁾, this gives an **angle of shearing resistance** of $\phi=29$.

For assessing settlements average ground conditions will give a more realistic value of settlements, and the average of N values should be used.

7.0 GEOTECHNICAL ASSESSMENT

7.1 Proposed Development

It is understood that the Client intends to build 10no. semi-detached residential properties on site with associated soft landscaping and parking. Access will be provided via Giles Croft Avenue. Detailed information regarding structural loadings and proposed foundation type was not available, however, we anticipate the loadings to be similar to those of a typical two-storey house (50kN/m² to 75kN/m²).

7.2 Ground Conditions Encountered

The exploratory holes generally encountered Made Ground to a maximum depth of 3.50m bgl (WS02). Underlying the Made Ground in WS01, WS03 and WS05 was the Shirdley Hill Sand Formation comprising loose to medium dense silty gravelly sand, silty sand and clayey silty sand to a maximum depth of 4.70m bgl. Small layers of fibrous peat were also encountered. A firm to very stiff sandy gravelly clay was encountered in all exploratory hole locations to a maximum depth of 6.0m bgl.

Groundwater was not encountered during the fieldwork.

7.3 Foundation Considerations

Based on the ground conditions encountered, conventional shallow strip/pad foundations are considered suitable for most of the plots, bearing into the superficial deposits, providing the anticipated structural loadings are relatively low and subject to tolerance of structure to settlement. Should the allowable bearing pressure and settlement prove unfavourable, then alternative foundations options will need to be considered, such as ground improvement and piles.

It should however be noted WS02 which is located within the building footprint of Plot 3, Made Ground was encountered to a depth of 3.5m. Therefore, alternative ground improvement, and pile foundations should be considered in this area of the site.

The shallow strip/pad foundations are discussed below in 7.3.1.

7.3.1 Conventional Shallow Depth Strip/Pad Foundations

Strip/Pad foundations should be taken down below any Made Ground and placed in the superficial deposits beneath at a minimum depth of 2.0m. If any Made Ground, particularly loose or soft material, is encountered at foundation level this should be excavated and replaced with suitable granular fill or the foundation extended at least 150mm into suitable natural strata.

Foundations should be placed in materials of similar bearing and consolidation characteristics to avoid potential differential settlement occurring. Should foundations cross from cohesive to granular soils, nominal reinforcement should be incorporated to avoid the effects of differential settlement.

Table 7 overleaf summarises anticipated allowable bearing pressures for strip/pad foundations placed in the superficial deposits. The bearing capacities are calculated based on Hansen's ⁽¹⁹⁷⁸⁾ method and assuming a factor of safety against bearing capacity failure of 3. Due to the variable

water level encountered in the monitoring wells, for the purpose of the calculation, groundwater has been assumed to be at foundation level.

Table 7: Summary of Allowable Bearing Pressures

Foundation Strata	Design Value (Section 6)	Foundation Depth (m bgl)	Foundation Type	Foundation Size (m)	Allowable Bearing Pressure (kN/m ²)
CLAY	$c_u=52\text{kN/m}^2$	2.0	Strip	0.4	144
				0.9	136
			Pad	1.0 x 1.0	159
				2.0 x 2.0	145
	$c_u=62\text{kN/m}^2$	2.5	Strip	0.4	173
				0.9	165
			Pad	1.0 x 1.0	194
				2.0 x 2.0	179
SAND	$\phi = 29^\circ$	2.0	Strip	0.4	134
				0.9	137
			Pad	1.0 x 1.0	196
				2.0 x 2.0	193
	$\phi = 31^\circ$	2.5	Strip	0.4	207
				0.9	213
			Pad	1.0 x 1.0	316
				2.0 x 2.0	312

Table 8 below summarises anticipated settlements of the above foundations in clay based on design values discussed in Section 6. Settlement in cohesive soils typically comprises a small amount of immediate settlement as loads are applied and a larger proportion of consolidation settlement, which will occur over a longer period of time. For the purposes of the calculations the strata over the depth of influence of the foundation is assumed as the same type and the foundation loading assumed as equal to the above bearing pressures to give a worse-case scenario.

Table 8: Summary of Anticipated Settlement

Foundation Depth (m bgl)	Foundation Strata	Foundation Type	Foundation Size (m)	Pad Foundation Loading (kN/m²)	Settlement (mm)		
					At Centre	At Corner	Average
2.0	CLAY	Strip	0.4	144	-	-	5-10
			0.9	136	-	-	10-15
		Pad	1.0 x 1.0	159	22	6	15-20
			2.0 x 2.0	145	29	7	20-25
2.5		Strip	0.4	173	-	-	10-15
			0.9	165	-	-	15-20
		Pad	1.0 x 1.0	194	27	7	20-25
			2.0 x 2.0	179	36	9	25-30
2.0	SAND	Strip	0.4	134	-	-	40-45
			0.9	137	-	-	75-80
		Pad	1.0 x 1.0	196	-	-	75-80
			2.0 x 2.0	193	-	-	115-120
2.5		Strip	0.4	207	-	-	30-35
			0.9	213	-	-	60-65
		Pad	1.0 x 1.0	316	-	-	65-70
			2.0 x 2.0	312	-	-	100-105

Floor slabs should be designed as suspended if Made Ground of 600mm thickness or greater is present. Made ground is not considered an appropriate bearing stratum due to its variable nature. Floor slabs may be designed as ground bearing where Made Ground is excavated and replaced with suitable granular fill.

The presence of trees within site boundaries indicates that foundations could be within their influence zone. In order to avoid possible excessive settlement due to water removal by trees during dry periods or ground heave due to tree removal, the recommendations of the National House Building Council Practice Standard "Building Near Trees", although not strictly applicable, should be closely followed. In this context clays near surface should be considered as having low volume change potential.

All foundation excavations should be inspected by a suitable qualified engineer to prove that the founding strata is suitable and uniform along the length of the foundation, and capable of taking the anticipated structural loadings. If foundations cross from granular to cohesive soils, nominal reinforcement should be incorporated.

7.3.2 Ground Improvement

Ground treatment (e.g. vibro displacement) may be an option, subject to environmental and noise/vibration constraints.

For example, vibro stone columns are often used to solve a wide range of static, dynamic and seismic foundation problems by using powerful depth vibrators to densify soils of form stone columns that compact or reinforce soils in situ. Vibro systems can be used to treat granular deposits, fills, made ground and soft clays/silts.

Soils treated by vibro could offer an allowable bearing pressure in the range 100kN/m² to 200kN/m², depending on column spacings and ground encountered.

Once the treatment has been carried out, spread foundations may be adopted across the site, and designed to the loadings given above. Providing that any imported fill material between the tops of the columns and the underside of the floor slab is placed in a controlled manner, floor slabs may be ground bearing. Positive assurances should be sought from an experienced specialist contractor that the proprietary system proposed is capable of providing the required working loads in the ground conditions encountered, with a guarantee on maximum settlement for both footings and floor slabs.

7.3.3 Piled Foundations

The proposed building may be founded on piles taken down to depth to a suitable founding stratum, such as the firm to very stiff sandy gravelly clay, encountered in all exploratory locations.

A variety of pile types may be used, including bored and continuous flight auger (CFA) piles. Driven piles may be suitable, subject to environmental and noise/vibration constraints.

Because of the various advantages and limitations of each pile type, and the cost implications, advice should be sought from specialist piling contractors to determine the most suitable and cost-effective type. They should also be able to give recommended pile diameters and depths and likely pile capacities, with guaranteed performance. It is recommended a pile test be carried out to confirm pile capacities. In assessing the pile capacities, contractors should make an allowance for the effects of negative skin friction, particularly in the made ground and soft clays.

There may be differential settlement between piled structures and the surrounding ground level. Provision should, therefore, be made to make up ground levels at threshold positions, loading bays, vehicle access doorways, etc. Alternatively, these materials should be removed and replaced in a controlled manner by suitable existing materials or imported engineered fill.

It is essential the advice of a specialist piling contractor is sought and that positive assurances are provided by the piling contractor that their proprietary system is capable of providing the required working loads in the ground conditions encountered.

7.4 Pavement Design

The ground investigation identified the soil type at the subgrade level to typically be Made Ground. However, a clayey silty sand was encountered at a subgrade level of 1200mm in WS06.

A conservative design CBR value of 1% should be adopted in areas where Made Ground is encountered at subgrade level.

Based on the recommendations for design CBR values provided in Interim advice note 73/06, Revision 1 (2009), a CBR value for the natural sand would be 20%.

Consideration should be given to the potential differing ground conditions near surface, which could cause pavements to be constructed on variable made ground. In this context a flexible pavement design may be required.

Consideration should also be given to the use of geotextiles to allow reduction of capping thickness. For examples biaxial geogrids such as Tensar SSLA20 and SSLA30 are often used to reduce capping thickness. The advice of a suitable contractor should be sought as to the most appropriate type of geotextile to use in the ground conditions encountered at this site. For guidance, the following table gives a comparison of granular layer thickness with and without the use of a geotextile, in accordance with the requirement of HA25/94 Part 2.

It should be noted the type of construction will depend on proposed finished pavement levels across the site and it is recommended the pavement design is reviewed once these levels are known. In this context, it is essential further in situ CBR testing is carried out once formation levels are known to confirm design CBR values.

Table 9: Comparison of Capping Thickness with and without Geotextile

CBR	Unreinforced			Reinforced with Tensar Geogrid				
	Sub-base	Capping	Total	Sub-base	Capping	No. of grids	Total	Thickness saving
0.5%	Design not suitable			200mm	400mm	2	600mm	-
1.0%	150mm	600mm	750mm	400mm	0	1	400mm	350mm
1.5%	150mm	600mm	750mm	310mm	0	1	310mm	440mm
2.0%	150mm	600mm	750mm	260mm	0	1	260mm	490mm
3.0%	150mm	350mm	500mm	210mm	0	1	210mm	290mm
4.0%	150mm	300mm	450mm	175mm	0	1	175mm	275mm
5.0%	150mm	250mm	400mm	160mm	0	1	160mm	240mm
These figures are suitable for light access roads and car parks, based on 1000 standard axles. For heavier loaded pavements the advice of specialist contractor should be sought.								

All formation excavations should be examined by a suitably experienced engineer or inspector to check for soft or unsuitable material, which should be removed and replaced with compacted granular fill. Also, to ensure good compaction and remove unevenness, the formation should be

compacted with equipment suitable for use in the ground conditions encountered. Careful inspection of this work will also help identify any soft spots at or just below formation level.

7.5 Chemical Attack on Buried Concrete

Chemical tests (see Appendices) show low levels of water-soluble sulphates and near neutral conditions. Based on these conditions, it is recommended that for concrete placed in natural strata the Design Sulphate Class for the site, as defined in BRE Special Digest 1⁽²⁰⁰⁵⁾, be taken as DS-1, and the Aggressive Chemical Environment for Concrete (ACEC) site classification be taken as AC-1s. The recommendations of BRE Special Digest 1 should be followed for concrete foundations and ground bearing floor slabs.

7.6 Suitability of Excavated Materials

Acceptability criteria and testing, and methods of compaction/placement will depend on the type of contract and specification used for the construction of the proposed development and it is recommended that earthworks specifications are reviewed by a suitably qualified engineer, once these have been prepared by the relevant parties.

Near surface soft natural clays are unlikely to be suitable as structural fill and should be used for landscaping purposes only, providing they are not contaminated.

Granular Made Ground and natural sand/gravel could be suitable for re-use as structural fill, providing it is not contaminated and does not contain excessive amounts of clay and providing moisture contents are controlled during placement. The control of moisture contents will be important as the cohesive content of this stratum is likely to be sensitive to moisture content changes.

7.7 Temporary Works

Formations will be susceptible to damage both by weather and trafficking, and should be protected immediately on exposure, particularly in areas where construction plant will access the site.

Excavations in Made Ground are likely to be unstable and should be battered back to an angle of 1 in 2, or a system of close sheeting and shoring adopted to ensure stability, and in particular where personnel are required to enter excavations. All excavations should be adequately supported where personnel are required to enter.

Groundwater seepages could be encountered near surface within excavations, particularly during the wetter months of the year. Pumping of excavations from a suitable located sump is likely to be required to keep excavations dry.

All-natural materials on site should be capable of being excavated using conventional excavating machinery.

8.0 SOIL CONTAMINATION RISK ASSESSMENT

8.1 Tier I Human Health Soil Risk Assessment – Groundworkers During Development

To assess the risk of soil contamination to construction and ground workers during development, guidelines from the HSE Document 'Protection of workers and the general public during development of contaminated land'⁽¹⁹⁹¹⁾ are used. The document assesses soil contamination test results and classifies the site as being uncontaminated or contaminated with varying degrees of contamination from 'slight' to 'unusually heavy'. The guideline values and laboratory test results are summarised in the following table:

Table 10: Summary of Guideline Values for Protection of Workers and the General Public During Development of Contaminated Land

Contaminant	Typical Values* for:					Test Results	Class
	Uncontaminated Soils	Slight Contamination	Contaminated	Heavy Contamination	Unusually Heavy Contamination		
	Class A	Class B	Class C	Class D	Class E		
pH (alkaline)	7 - 8	8 - 9	9 - 10	10 - 12	12	7.9 - 8.1	A - B
Arsenic	0 - 30	30 - 50	50 - 100	100 - 500	500	<2 - 8	A
Cadmium	0 - 1	1 - 3	3 - 10	10 - 50	50	< 0.2 - 0.3	A
Chromium	0 - 100	100 - 200	200 - 500	500 - 2500	2500	5 - 11	A
Copper	0 - 100	100 - 200	200 - 500	500 - 2500	2500	13 - 33	A
Lead	0 - 500	500 - 1000	1000 - 2000	2000 - 1%	1.0%	11 - 29	A
Mercury	0 - 1	1 - 3	3 - 10	10 - 50	50	< 1	A
Nickel	0 - 20	20 - 50	50 - 200	200 - 1000	1000	4 - 8	A
Zinc	0 - 250	250 - 500	500 - 1000	1000 - 5000	5000	23 - 219	A
Boron	0 - 2	2 - 5	5 - 50	50 - 250	250	< 1	A
Selenium	0 - 1	1 - 3	3 - 10	10 - 50	50	< 3	A
Barium	0-500	500-1000	1000-2000	2000-1.0%	1.0%	25 - 321	A
Beryllium	0 - 5	5 - 10	10 - 20	20 - 50	50	< 0.5	A
Vanadium	0 - 100	100 - 200	200 - 500	500 - 2500	2500	4 - 12	A
Sulphate	0 - 2000	2000 - 5000	5000 - 1%	1% - 5%	5.05%	<200 - 5637	A - C
Sulphide	0 - 10	10 - 20	20 - 100	100 - 500	500	< 5	A
Cyanide (free)	0 - 1	1 - 5	5 - 50	50 - 100	100	< 2	A
Phenol	0 - 2	2 - 5	5 - 50	50 - 250	250	< 2	A

Based on the above results it is considered there is a low potential risk from soil contamination to construction workers, ground workers and members of the public during construction. Appropriate measures, such as PPE, site health plans, and appropriate disposal of material arisings will be required to mitigate any risk.

8.2 Tier I Human Health Soil Risk Assessment – Future Site Users

The following section provides a Human Health Soil Assessment for future site users. Based on the proposed development type, the following section compares the results of contamination analyses to residential types of end development as specified by Defra/LQM/CIEH. As part of the contamination assessment, the chemical results obtained by EEG have been screened against accepted compliance criteria, namely:

- Defra C4SL Health Criteria Values (March 2014), where available; and
- Tier 1 assessment values - based on LQM/CIEH Suitable 4 Use Levels⁽²⁰¹⁵⁾ (S4ULs).

The soil chemical testing results are summarised in Table 11, below.

Table 11: Soil Results Comparison with C4SL/S4UL Values

Determinand	C4SL/S4UL Levels Residential (mg/kg)	WS01 0.45m	WS02 2.00m	WS03 1.00m	WS05 0.85m	WS06 0.50m	No of Exceedances
Metals							
Arsenic	37	8	5	5	5	< 2	0
Beryllium	1.7	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0
Boron	290	< 1	< 1	< 1	< 1	< 1	0
Cadmium	22	< 0.2	< 0.2	0.2	0.3	< 0.2	0
Chromium	910	10	9	6	11	5	0
Chromium VI	21	< 2	< 2	< 2	< 2	< 2	0
Copper	2400	15	15	16	33	13	0
Lead	200	29	17	20	28	11	0
Mercury	1.2	< 1	< 1	< 1	< 1	< 1	0
Nickel	180	6	8	5	7	4	0
Selenium	250	< 3	< 3	< 3	< 3	< 3	0
Vanadium	410	12	10	7	7	4	0
Zinc	3700	219	25	58	58	23	0
Polycyclic Aromatic Hydrocarbons							
Naphthalene	2.3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Acenaphthylene	210	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Acenaphthene	170	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Fluorene	170	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Phenanthrene	95	< 0.1	< 0.1	< 0.1	0.13	< 0.1	0
Anthracene	2400	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Fluoranthene	280	0.21	< 0.1	0.17	0.2	0.12	0
Pyrene	620	0.22	< 0.1	0.19	0.19	0.13	0
Benzo(a)anthracene	7.2	0.17	< 0.1	< 0.1	< 0.1	< 0.1	0
Chrysene	15	0.13	< 0.1	< 0.1	< 0.1	< 0.1	0
Benzo(a)pyrene	5	0.34	< 0.1	< 0.1	< 0.1	< 0.1	0
Benzo(b)fluoranthene	2.6	0.33	< 0.1	< 0.1	< 0.1	< 0.1	0
Benzo(k)fluoranthene	77	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Indeno(1,2,3-cd)pyrene	27	0.19	< 0.1	< 0.1	< 0.1	< 0.1	0
Dibenz(a,h)anthracene	0.24	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0
Benzo(ghi)perylene	320	0.21	< 0.1	< 0.1	< 0.1	< 0.1	0
Phenols							
Phenol	280	< 2	< 2	< 2	< 2	< 2	0
Concentrations in red are above the assessment criteria based on Residential End Use with Plant Uptake.							

Based on the above table, none of the samples collected exceeded the screening criteria relevant to a Residential End Use with Plant Uptake.

Asbestos was however identified in one sample, the details of which are summarised in Table 12 below.

Table 12: Summary of Asbestos Encountered

Location	Depth	Sample Matrix	Asbestos Type	Asbestos Quantification
WS05	0.85m	Bundles of fibres	Amosite	0.274

8.3 Soil Waste Assessment

An assessment of the disposal characteristics of the soil in accordance with Environment Agency guidance WM3.1, edition of June 2018, "Guidance on the classification and assessment of waste" has been carried out on soils recovered from the site, using HazWasteOnline.

The results are summarised in Table 13 below and presented in full in Appendix 4.

Table 13: Waste Classification of Soils

Location	Depth (m bgl)	WM3.1 Classification	Comments
WS01	0.45	Non-Hazardous	-
WS02	2.00	Non-Hazardous	-
WS03	1.00	Non-Hazardous	-
WS05	0.85	Non-Hazardous	0.274% Asbestos changes classification to Hazardous
WS06	0.50	Non-Hazardous	-

Table 13, above shows that the five soils samples collected from the window sample boreholes were classified as **Non-Hazardous** in accordance with WM3.1.

Further Waste Acceptance Criteria (WAC) testing may prove that this material is acceptable as inert waste.

However, asbestos can affect the waste classification of soil, if the concentration is greater than 0.1%, the soil will automatically be classified as Hazardous waste. The asbestos concentration in WS05 was 0.274%, therefore the soil is now classified as Hazardous Waste.

9.0 CONCLUSIONS & RECOMMENDATIONS

9.1 Soil Contamination

There is a low potential risk from soil contamination to construction workers and ground workers during development, and appropriate measures such as PPE, site health plans, appropriate disposal of material arisings will be required to mitigate this risk. The groundworks contractor must provide a soil management plan including methods of dealing with unanticipated soil contamination encountered during groundworks.

Based on the results of the chemical testing, no exceedances in contaminants were observed in the soil samples analysed.

9.2 Foundations

Shallow strip/pad foundation placed in the superficial deposits at a minimum depth of approximately 2.0m bgl are considered appropriate for most of the plots on-site.

However, due to the depth of the Made Ground encountered within the vicinity of Plot 3, alternative foundations such as ground improvement, controlled modulus columns or piles should be considered.

9.3 Asbestos

Asbestos fibres were detected as bundles of amosite in the soil sample collected from 0.85m in WS05.

Further Asbestos Quantification testing detected a concentration of 0.274% in WS05. Therefore, an Asbestos Management Plan is required for the site.

Additional sampling is recommended in the vicinity of WS05 in order to delineate the asbestos contamination.

9.4 Soil Disposal

Soils should be disposed of at a suitable site, registered to take the levels of contamination encountered. The soils collected from all borehole locations have been classified as Non-Hazardous (See Table 11) for the purpose of off-site disposal in accordance with Environment Agency guidance WM3.1.

9.5 Risk to Buried (Water) Services

It is considered that, due to the absence of any significant hydrocarbon, VOC and BTEX contamination, standard materials should be acceptable for new water pipes. Further advice should be sought from the local water company.

Previous guidance on buried water pipes was contained in Water Regulations Advisory Scheme (WRAS) Guidance Note No. 9-04-03⁽²⁰⁰²⁾, however this has been superseded by the UK Water Industry Research Report 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' Ref 10/WM/03/21 (January 2011).

9.6 Site Personnel

As with all construction sites, personnel working on the site during the construction period should be encouraged to maintain a high standard of personal hygiene and on-site washing facilities should be available.

9.8 Other Matters

Due diligence is required during the construction period, and should any further evidence of contamination be found, appropriate investigation and / or action should be taken. The significance of any contamination not discovered by this investigation is outside the scope of this report.

APPENDIX 1

EXPLORATORY HOLE LOGS

APPENDIX 2

GEOTECHNICAL TESTING RESULTS

APPENDIX 3

CHEMICAL TESTING RESULTS



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DETS Report No: 20-10086

Site Reference: Brook Hey Drive

Project / Job Ref: A3677

Order No: A3677

Sample Receipt Date: 03/09/2020

Sample Scheduled Date: 03/09/2020

Report Issue Number: 1

Reporting Date: 11/09/2020

Authorised by:

A handwritten signature in black ink, appearing to read "Kevin Old".

Kevin Old
General Manager

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

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



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Soil Analysis Certificate						
DETS Report No: 20-10086	Date Sampled	28/08/20	28/08/20	28/08/20	28/08/20	28/08/20
Earth Environmental & Geotechnical Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Brook Hey Drive	TP / BH No	WS01	WS02	WS03	WS05	WS06
Project / Job Ref: A3677	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: A3677	Depth (m)	0.45	2.00	1.00	0.85	0.50
Reporting Date: 11/09/2020	DETS Sample No	496286	496287	496288	496289	496290

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Detected	Not Detected
Sample Matrix ^(S)	Material Type	N/a	NONE				bundles of Amosite fibres	
Asbestos Type ^(S)	PLM Result	N/a	ISO17025				Amosite	
pH	pH Units	N/a	MCERTS	8.1	7.9	7.9	8.0	7.9
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Complex Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Free Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Total Sulphate as SO ₄	mg/kg	< 200	NONE	5637	593	664	425	< 200
Total Sulphate as SO ₄	%	< 0.02	NONE	0.56	0.06	0.07	0.04	0.02
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	1510	84	31	51	11
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	1.51	0.08	0.03	0.05	0.01
Sulphide	mg/kg	< 5	NONE	< 5	< 5	< 5	< 5	< 5
Organic Matter	%	< 0.1	MCERTS	0.8	2.6	1	2.3	1.6
Arsenic (As)	mg/kg	< 2	MCERTS	8	5	5	5	< 2
Barium (Ba)	mg/kg	< 2.5	MCERTS	321	59	38	57	25
Beryllium (Be)	mg/kg	< 0.5	MCERTS	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
W/S Boron	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2	< 0.2	0.2	0.3	< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS	10	9	6	11	5
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	15	15	16	33	13
Lead (Pb)	mg/kg	< 3	MCERTS	29	17	20	28	11
Mercury (Hg)	mg/kg	< 1	MCERTS	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	6	8	5	7	4
Selenium (Se)	mg/kg	< 2	MCERTS	< 3	< 3	< 3	< 3	< 3
Vanadium (V)	mg/kg	< 1	MCERTS	12	10	7	7	4
Zinc (Zn)	mg/kg	< 3	MCERTS	219	25	58	58	23
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
EPH (C10 - C40)	mg/kg	< 6	MCERTS	85	12	7	17	17

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



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Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 20-10086	Date Sampled	28/08/20	28/08/20	28/08/20	28/08/20	28/08/20
Earth Environmental & Geotechnical Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Brook Hey Drive	TP / BH No	WS01	WS02	WS03	WS05	WS06
Project / Job Ref: A3677	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: A3677	Depth (m)	0.45	2.00	1.00	0.85	0.50
Reporting Date: 11/09/2020	DETS Sample No	496286	496287	496288	496289	496290

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	0.13	< 0.1
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	0.21	< 0.1	0.17	0.20	0.12
Pyrene	mg/kg	< 0.1	MCERTS	0.22	< 0.1	0.19	0.19	0.13
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	0.17	< 0.1	< 0.1	< 0.1	< 0.1
Chrysene	mg/kg	< 0.1	MCERTS	0.13	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.33	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	0.34	< 0.1	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	0.19	< 0.1	< 0.1	< 0.1	< 0.1
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	0.21	< 0.1	< 0.1	< 0.1	< 0.1
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	1.8	< 1.6	< 1.6	< 1.6	< 1.6



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Maidstone
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Soil Analysis Certificate - Sample Descriptions

DETS Report No: 20-10086	
Earth Environmental & Geotechnical Ltd	
Site Reference: Brook Hey Drive	
Project / Job Ref: A3677	
Order No: A3677	
Reporting Date: 11/09/2020	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
496286	WS01	None Supplied	0.45	10.1	Brown sandy gravel with stones and concrete
496287	WS02	None Supplied	2.00	11.4	Black loamy sand with stones
496288	WS03	None Supplied	1.00	9.8	Black loamy sand with stones
496289	WS05	None Supplied	0.85	9.2	Black loamy sand with stones
496290	WS06	None Supplied	0.50	8.6	Black loamy sand

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

Insufficient Sample ^{u/s}

Unsuitable Sample ^{u/s}



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-10086

Earth Environmental & Geotechnical Ltd

Site Reference: Brook Hey Drive

Project / Job Ref: A3677

Order No: A3677

Reporting Date: 11/09/2020

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

D Dried
AR As Received



Shauna McLoughlin
Earth Environmental & Geotechnical Ltd
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t: 01622 850410

DETS Report No: 20-10847

Site Reference: Brook Hey Drive

Project / Job Ref: A3677 DETS Ref: 20-10086

Order No: A3677/SM

Sample Receipt Date: 18/09/2020

Sample Scheduled Date: 18/09/2020

Report Issue Number: 1

Reporting Date: 24/09/2020

Authorised by:

Kevin Old
General Manager

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

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



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Soil Analysis Certificate						
DETS Report No: 20-10847	Date Sampled	28/08/20				
Earth Environmental & Geotechnical Ltd	Time Sampled	None Supplied				
Site Reference: Brook Hey Drive	TP / BH No	WS05				
Project / Job Ref: A3677 DETS Ref: 20-10086	Additional Refs	None Supplied				
Order No: A3677/SM	Depth (m)	0.85				
Reporting Date: 24/09/2020	DETS Sample No	499715				

Determinand	Unit	RL	Accreditation				
Asbestos Quantification ^(S)	%	< 0.001	ISO17025	0.274			

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



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-10847

Earth Environmental & Geotechnical Ltd

Site Reference: Brook Hey Drive

Project / Job Ref: A3677 DETS Ref: 20-10086

Order No: A3677/SM

Reporting Date: 24/09/2020

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
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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

APPENDIX 4

SOIL WASTE ASSESSMENT

APPENDIX 5

REPORT LIMITATIONS

REPORT LIMITATIONS

This contract was completed by Earth Environmental & Geotechnical Ltd on the basis of a defined programme and scope of works and terms and conditions agreed with the client. This report was compiled with all reasonable skill, and care, bearing in mind the project objectives, the agreed scope of works, the prevailing site conditions, the budget and staff resources allocated to the project.

Other than that, expressly contained in the above paragraph, Earth Environmental & Geotechnical Ltd provides no other representation or warranty whether express or implied, is made in relation to the services. Unless otherwise agreed this report has been prepared exclusively for the use and reliance of the client in accordance with generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon, or transferred to, by any other party without the written agreement of a Director of Earth Environmental & Geotechnical Ltd.

If a third party relies on this report, it does so wholly at its own and sole risk and Earth Environmental & Geotechnical Ltd disclaims any liability to such parties.

It is Earth Environmental & Geotechnical Ltd understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was an important factor in determining the scope and level of the services. Should the purpose for which the report is used, or the proposed use of the site change, this report will no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without Earth Environmental & Geotechnical Ltd review and advice shall be at the client's sole and own risk.

The report was written in 2020 and should be read in light of any subsequent changes in legislation, statutory requirements and industry best practices. Ground conditions can also change over time and further investigations or assessment should be made if there is any significant delay in acting on the findings of this report. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of Earth Environmental & Geotechnical Ltd. In the absence of such written advice of Earth Environmental & Geotechnical Ltd, reliance on the report in the future shall be at the client's own and sole risk. Should Earth Environmental & Geotechnical Ltd be requested to review the report in the future, Earth Environmental & Geotechnical Ltd shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between Earth Environmental & Geotechnical Ltd and the client.

The observations and conclusions described in this report are based solely upon the services that were provided pursuant to the agreement between the client and Earth Environmental & Geotechnical Ltd. Earth Environmental & Geotechnical Ltd has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report.

Earth Environmental & Geotechnical Ltd is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, Earth Environmental & Geotechnical Ltd did not seek to evaluate the presence on or off the site of electromagnetic fields, lead paint, radon gas or other radioactive materials.

The services are based upon Earth Environmental & Geotechnical Ltd observations of existing physical conditions at the site gained from a walkover survey of the site together with Earth Environmental & Geotechnical Ltd interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst Earth Environmental & Geotechnical Ltd have no reason to doubt the accuracy and that it has been provided in full from those it was requested from, the items relied on have not been verified.

No responsibility can be accepted for errors within third party items presented in this report. Further Earth Environmental & Geotechnical Ltd was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the services. Earth Environmental & Geotechnical Ltd is not liable for any inaccurate information, misrepresentation of data or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to Earth Environmental & Geotechnical Ltd and including the doing of any independent investigation of the information provided to Earth Environmental & Geotechnical Ltd save as otherwise provided in the terms of the contract between the client and Earth Environmental & Geotechnical Ltd.

Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions can also be variable and as investigation excavations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this report. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and Earth Environmental & Geotechnical Ltd] based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

The groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The normal speed of investigation usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions and higher groundwater levels may occur at other times of the year than were recorded during this investigation.

Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site.