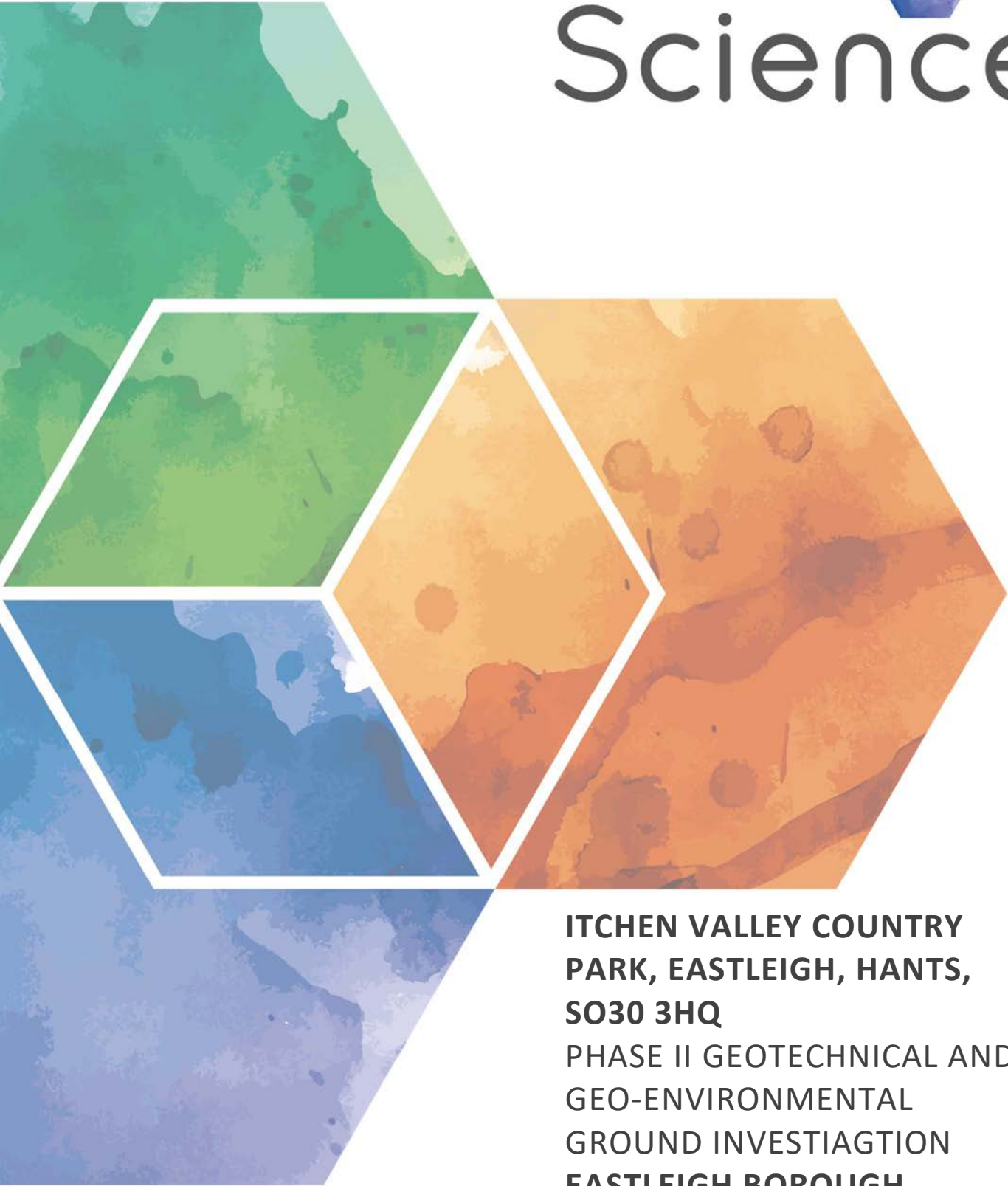




Land Science

**ITCHEN VALLEY COUNTRY
PARK, EASTLEIGH, HANTS,
SO30 3HQ**

**PHASE II GEOTECHNICAL AND
GEO-ENVIRONMENTAL
GROUND INVESTIGATION
EASTLEIGH BOROUGH
COUNCIL**

19TH MAY 2022

LS6195

Site:	ITCHEN VALLEY COUNTRY PARK, EASTLEIGH, HANTS, SO30 3HQ	
Title:	PHASE II GEOTECHNICAL AND GEO-ENVIRONMENTAL GROUND INVESTIGATION	
Project:	COMMERCIAL / PARK ALTERATIONS AND NEW MODULAR BUILDINGS	
Client:	EASTLEIGH BOROUGH COUNCIL	
Contact:	WHITBY WOOD (ENGINEER)	
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1.0 INTRODUCTION

1.1 General

Land Science was instructed to undertake a Phase II Geotechnical and Geo-Environmental Ground Investigation in relation to the proposed redevelopment at Itchen Valley Country Park, Eastleigh, Hants, SO30 3HQ. The location is shown on Figure 1, which is centred at grid reference SU4615 16196.

1.2 Client

The Client for this appointment was Eastleigh Borough Council, represented by Whitby Wood Engineers. This report may only be used by this named client and their directly appointed project team for the purposes set out in the report conditions. It was understood that the Client already owned the property, and that this investigation was not a pre-purchase appraisal.

1.3 Area Under Investigation

The area under investigation was within Itchen Valley Country Park and comprised a mix of parkland intersected by a densely forested area. The investigation focused on a number of different specific areas within the park. The first area in the north (*High Hill Site*) was primarily a car park with a children's play area and open fields. The second area to the south (main site) primarily open park land, children's play area to the north (*the Barns*), an access road up the eastern extent, and a car park to the east (*Youth Learning Centre*). The layout is indicated on Figure 2, and a walkover survey is presented in section 3.0. The area was approximately 0.9 hectares (North) and 2.07 hectares (South).

1.4 Form of Development

The proposed development was understood to comprise the following: -

- The addition of two new modular, single storey buildings - at the *High Hill site* and *The Youth Learning Centre*,
- A temporary lightweight tensile structure near the *Barns* and play area,
- Adjustment of levels and layout changes,
- The reconfiguration of below ground drainage system (inc. new cesspit and soakaways),
- Additional car parking spaces, and modifications to road layout.

The proposed development was covered under planning application number F/22/92889. Figure 3 illustrates the layout of the proposed redevelopment. The findings of this report may be not valid if the proposed development is altered.

1.4.1 Previous Investigations

The following previous investigations relevant to the site were made available:

- Phase I Desk Study, A-Squared Studio, January 2022, Report Reference 2123.

The phase II ground investigation has been carried out in accordance with the recommendations of the previous report. This report must be read in conjunction with the previous Phase I assessment.

1.5 Scope of Work

The work carried out is described in detail in following sections but in summary included:

- An intrusive investigation comprising 7no. Dynamic Sampler boreholes with associated Dynamic Probing and installation of monitoring wells
- 7no. trial pits with full scale BRE:365 Soakage tests
- 7no. Plate Load Tests obtaining CBR values
- Preliminary geotechnical testing of selected soil in the field and laboratory
- Preliminary chemical testing of selected soil in the field and laboratory

The fieldwork was conducted between 26th and 28th April 2022, under the supervision of Land Science. The one return monitoring visits were conducted on 05th May 2022.

1.6 Geo-Environmental Objectives

The phase I assessment identified no unacceptable risks except for the potential for 'sulphate attack' on new below ground concrete. A discovery strategy was recommended dealing with unidentified contamination during ground works. No contamination specific ground investigation was recommended.

1.7 Geotechnical Objectives

An interpretive Ground Investigation Report (GIR) was required in order to provide an assessment of ground conditions with respect to proposed foundations, pavements, soakaways, concrete specification, and excavation.

2.0 STANDARDS AND REFERENCES

2.1 Standards

Where practicable, the investigation was undertaken in accordance with the following primary standards and guidance:

- Land Contamination Risk Management (LCRM) Environment Agency 2020
- BS10175:2011+A1:2013, Investigation of Potentially Contaminated Sites.
- National Planning Policy Framework, July 2018.
- Building Regulations Approved Document C: Site preparation and resistance to contaminants and moisture, HM Government, July 2013.
- NHBC Standards Chapter 4.1: Land Quality - Managing Ground Conditions, 2019.
- BS 5930:2015 Code of Practice for Site Investigations
- BS 1377:2018 Soils for Civil Engineering Purposes
- BS 8004:2015 Code of Practice for Foundations
- BS EN 1997-2:2007. Eurocode 7: Geotechnical Design – Part 2: Ground Investigation and testing.

Other technical sources have been cited in respect of specific aspects of the investigation, as referenced throughout the text.

2.2 References

A number of technical references have been referred to in the preparation of this document, including:

- Smith, I. (2014) Smith's Elements of Soil Mechanics. Chichester. Wiley Blackwell. 9th Edition.
- Highways England 2009. Interim Advice Note 73/06 revision 1: Design Guidance for Road Pavement foundations (draft HD25)
- BRE Design Guide 365. Soakaway design ("DG365")
- Groundwater protection: Principles and practice (GP3) August 2013 Version 1.1
- Revised EU Waste Framework Directive 2008 2008/98/EC [transposed into English law under The Waste (England and Wales) Regulations 2011]
- European Community (EC) Directive 1999/31/EC [transposed into English law under the Landfill (England and Wales) Regulations 2002]
- Defining Waste Recovery - Permanent Deposit of Waste on Land, EPR13 v1.0, EA 2010
- The definition of waste: Development Industry Code of Practice, v2, CL:AIRE 2011
- Guidance on the classification and assessment of waste Technical Guidance WM3 ("WM3") EA publication (1st edition 2015)

3.0 INTRUSIVE INVESTIGATION

3.1 Investigation Strategy

The layout of the investigation was specified by Whitby Wood, reference P450815-P01.

- Dynamic Sampler boreholes (DS01-07) were used to minimise disruption to the site and to enable monitoring wells to be installed. The positions were located to give broad coverage across the footprints of the proposed developments.
- 1no. Dynamic Sampler borehole (DS08) was added to the investigation layout, as instructed by the engineer, as a result of abandoning DS06 and DS07 as a suspected reservoir pipe was indicated by a park manager.
- Monitoring wells were installed in all Dynamic Sampler positions (exc. DS06 and DS07). The installation was sealed through Topsoil/Made Ground, with the response zone in Wittering Formation.
- 7no. Trial Pits (TP01 to 07) were excavated to carry-out BRE soakage testing in natural strata, with 3 repeat soaks in each pit, allowing an infiltration rate to be calculated.
- 7no. in-situ CBR determinations using the plate load (CBR1-7) methodology. These tests were undertaken beneath the Topsoil/Made Ground.

Position	Targets			Testing, installations
	Provisional Depth / strata	Existing Location	Proposed Location	
DS01 to DS03	5.00mbgl or refusal	Soft landscaping (<i>High Hill</i>)	Footprint of modular building (<i>High Hill</i>)	MW, SPT, HP
DS04 and DS05		Soft landscaping	Footprint of temporary Tensile structure (<i>Barns</i>)	
DS06 and DS07 (Abandoned/ not drilled)	Abandoned/ not drilled	Car Park (East) Youth Learning Centre	Footprint of new modular building (<i>Youth Learning Centre</i>)	-
DS08	5.00mbgl or refusal	Soft landscaping (<i>Barns</i>)	Proposed Play area (<i>Barns</i>)	MW, SPT, HP
TP01	Into natural strata	Possible Soakaways		BRE
TP02 and TP03				
TP04 and TP05				
TP06 and TP07				
CBR1	Into natural strata	Possible car parking refurbishment/ extension		PLT
CBR2 and CBR3				
CBR4 and CBR5				
CBR6 and CBR7				

3.2 Dynamic (Windowless) Sampling (DS)

Dynamic Sampling entails 1m long hollow tubes with liners driven into the ground and retracted in order to obtain samples. The process is repeated sequentially to the target depth, unless impenetrable strata or borehole instability prevent further progress. The liners are split, logged, tested, and subsampled as required.

3.3 Trial Pits (TP)

Trial pits are open excavations using a mechanical excavator in order to inspect a larger volume of soils and in turn provide a better understanding of variability water ingress, instability, etc. However, samples recovered can be highly disturbed and n-situ testing is limited.

3.4 Plate Load Test (PLT)

The Plate Bearing Test is carried out in accordance with BS 1377 Part 9: 1990. The test consists of loading a steel plate of known diameter and recording the settlements corresponding to each load increment. The test load is gradually increased till the plate starts to settle at a rapid rate. The results can in turn be used to estimate a CBR value.

3.5 Monitoring Wells (MW)

Monitoring wells are installations within boreholes that enable return monitoring to be carried out. The pipework was 50mm diameter HDPE, with cased section sealed with bentonite, and the slotted response zone packed with a shingle filter pack.

4.0 GROUND CONDITIONS

4.1 General

The expected ground conditions were anticipated to comprise Topsoil over Whittering Formation over London Clay to depth. The investigation confirmed the anticipated ground conditions. A thin capping of topsoil and/or Made Ground was encountered at surface. A summary of the encountered conditions is presented below.

Position	Strata				
	Topsoil	Subsoil	Made Ground	Whittering Formation	London Clay Formation
DS01	0.35	-	-	3.80	5.00+
DS02	0.30	-	-	4.80	5.00+
DS03	0.25	-	-	3.60	5.00+
DS04	0.35	-	-	3.25	5.00+
DS05	0.40	-	-	3.90	5.00+
DS06	0.50	-	-	1.60+	-
DS07	Not drilled due to services				
DS08	0.50	-	-	3.60	5.00+
TP01	0.20	0.35	-	1.55+	-
TP02	0.25	-	-	1.45+	-
TP03	0.35	-	-	2.30+	-
TP04	0.30	-	-	1.60+	-
TP05	0.30	-	-	2.30+	-
TP06	0.20	0.30	-	1.40+	-
TP07	-	-	1.10	1.55+	-

The identification of materials encountered as specific geological strata is tentative and should be used as a guide, and interpolation between or below investigation points should be treated with caution.

4.2 Topsoil

A thin cover of topsoil was encountered at surface to depths of between 0.20 to 0.50m and generally described as brown gravelly sandy silty CLAY / clayey SILT with abundant rootlets. Gravels comprised flints and rare brick and concrete fragments. These materials are identified separately from Made Ground, even though they may have been disturbed through human activity and may contain recent entrained materials such as fragments of brick and concrete.

4.3 Subsoil

A thin layer of subsoil was encountered below the topsoil two of the trial pits (TP01 and TP06) to base depths of 0.30 to 0.35m and generally described as orange-brown gravelly sandy Clay with rootlets and rare flint gravel.

4.4 Made Ground

Made Ground was only encountered at one position TP07 to depths of 1.10m and generally comprised sandy, gravelly CLAY. Gravels included brick, concrete and glass fragments. This Trial pit

was noted to have been undertaken in a slightly raised bund of material and not at the original ground level as per the other locations.

4.5 Wittering Formation

The Wittering Formation was encountered below the Topsoil / Subsoil to base depths of between 3.25 and 4.80mbgl and generally comprised a light brown mottled light grey / orange / yellow / green / purple slightly gravelly CLAY with lenses of dark brown sandy silt / sand. The clay was noted to be slightly friable / shaley with increasing depth.

4.6 London Clay Formation

Below the Wittering Formation, the London Clay Formation was proven to a depth of 5.00m. The London Clay Formation was described as a dark grey silty CLAY.

4.7 Roots and Rootlets

No roots were identified, however abundant rootlets were noted within the Topsoil across the site.

4.8 Field Evidence of Contamination

No evidence of possible soil contamination (such as staining, malodours, or brightly coloured soils) was identified in the field.

Made Ground was identified in TP07 from 0.00m to 1.10m, and such materials may be imported from an unknown source or mixed with hazardous materials, and as such may contain a wide range of potential contaminants. All such materials should be treated as suspect unless proven otherwise. Preliminary testing has been carried out, as described in section 7.1.

4.9 Groundwater

Groundwater was only struck within two positions during the fieldwork as detailed in the following table no water strikes were noted in the other locations.

Position	Strike	Rest level (after 20 minutes)
DS01	2.00m bgl	2.00m bgl
DS02	1.80m bgl	1.95m bgl
TP05	2.25m bgl	2.25m bgl

The level of water in a borehole can be affected by the drilling process and speed of infiltration; short-term rest levels should be used with caution.

Groundwater levels may vary seasonally and with variations in rainfall. Water may also become perched upon cohesive strata or around features such as foundations, and may also occur from leaking drains and water mains etc.

4.10 Stability and Casing

Borehole collapsing was noted in DS02. DS02 was completed to target depth however collapsed to 3.00mbgl. No evidence of any instability was noted in any other positions.

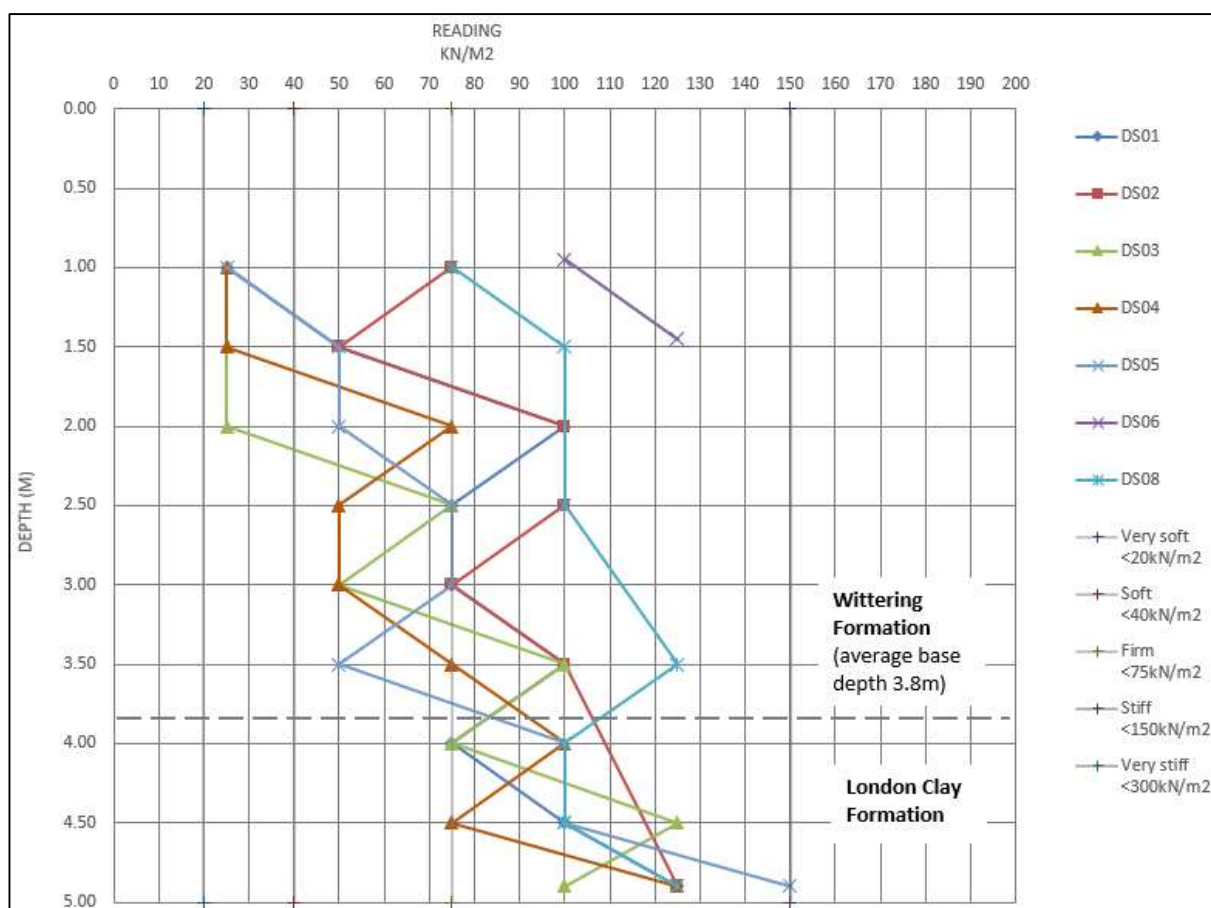
5.0 FIELD TESTING

5.1 Hand Penetrometers (HP)

Hand penetrometer tests were performed on samples of cohesive materials recovered within the boreholes. The test is used to approximate undrained shear strength and in turn has been used to give an indication of consistency as defined in BS5930.

The results are detailed in the table and graph below. There was an overall consistent trend of increasing results with depth.

Strata	Base Depth Range	Typical Results (kN/m ²)
Wittering Formation	3.25m to 4.80m	25kN/m ² – 125kN/m ²
London Clay Formation	5.00m+	75kN/m ² - 150kN/m ²

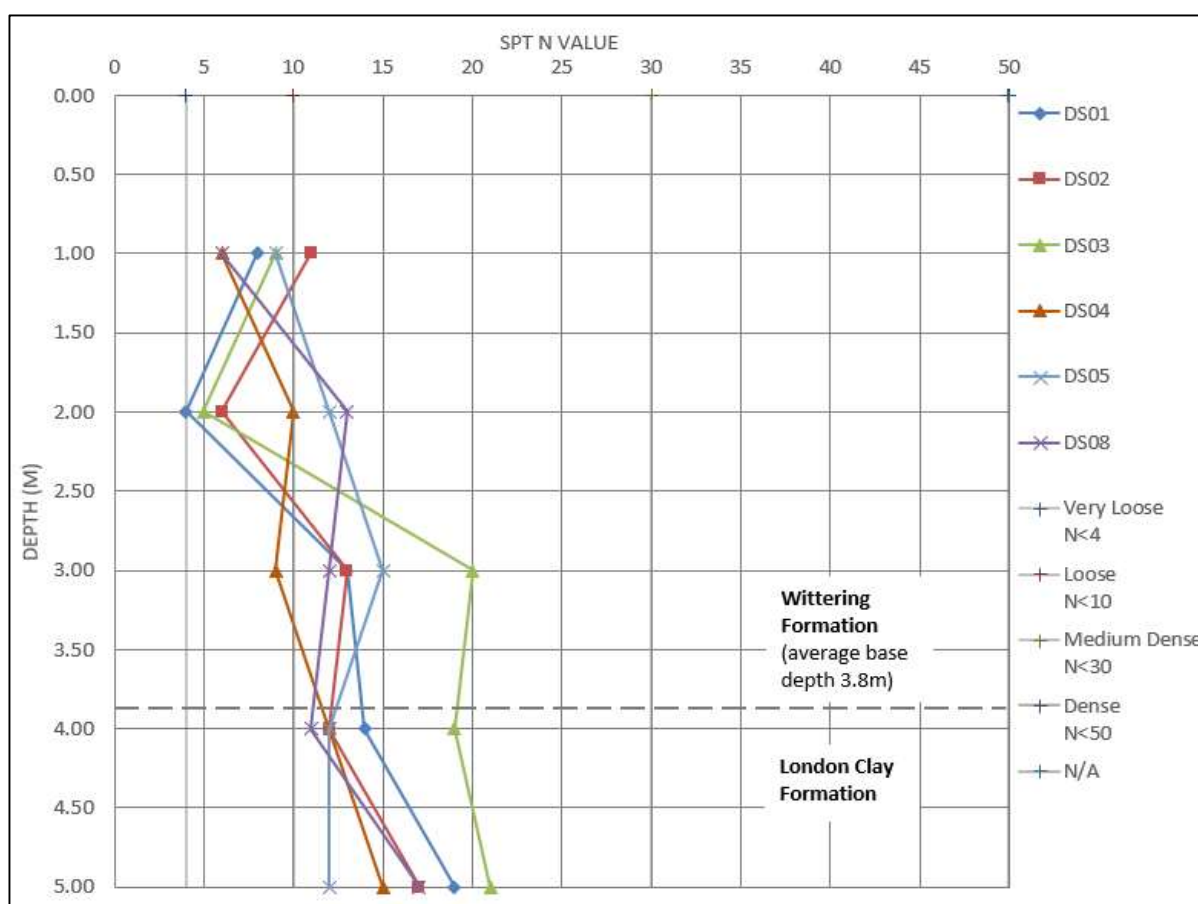


5.2 Standard Penetration Test (SPT)

The Standard Penetration Test involved driving a cone (SPT(C)) or split spoon sampler (SPT(S)) with a percussive hammer weight and recording the number of blows to penetrate six consecutive intervals of 75mm; the first two are discarded as 'seating blows', while the final four are added together to calculate an N-Value. The procedure is defined under numerous international standards including BS5930.

The results are detailed within the table and graph below. There was an overall consistent trend of increasing results with depth

Strata	Base Depth Range	Typical Results (SHDP N)
Wittering Formation	3.25m to 4.80m	N=4 to N=20
London Clay Formation	5.00m+	N=12 to N=21



Values are uncorrected to N60. Any use of this data must be in conjunction with the accompanying report. Grid lines for density, cohesion and strata boundaries (if any) shown are indicative only.

5.3 Full Scale Soakage Testing (BRE365)

Full scale soakage tests were undertaken in trial pit TP01 to TP07 in accordance with BRE365. The tests were carried out in open holes in one day.

Position	Recordings
TP01 Soak 1	0.75m fall in 5.5 hours
TP01 Soak 2	0.43m fall in 20 hours
TP02	0.11m fall in 19.5 hours
TP03	0.11m fall in 4 hours
TP04	0.20m fall in 14.6 hours
TP05	0.07m fall in 24 hours
TP06	0.17m fall in 19.5hours
TP07	0.00m fall in 3 hours

5.4 Plate Load Test (PLT)

The Plate Bearing Test is carried out in accordance with BS 1377 Part 9: 1990. The test consists of loading a steel plate of known diameter and recording the settlements corresponding to each load increment. The test load is gradually increased till the plate starts to settle at a rapid rate. The results can in turn be used to estimate a CBR value.

The in-situ CBR tests results are summarised below:

Strata	Position	Depth	Results (%)	Water Content (%)	Description
Wittering Formation	CBR1	0.30m	6.4%	15.2%	Brown Slightly Gravelly CLAY with Occasional Rootlets
	CBR2	0.30m	4.8%	20.0%	
	CBR3	0.30m	6.9%	14.7%	
	CBR4	0.30m	5.9%	20.7%	
	CBR5	0.30m	3.8%	25.7%	
	CBR6	0.30m	4.7%	21.3%	
	CBR7	0.30m	5.4%	32.8%	

6.0 MONITORING DATA

6.1 Groundwater Monitoring

Groundwater was recorded in the single return monitoring visit, standing at the following depths (m bgl).

Measurement	DS01	DS02	DS03	DS04	DS05	DS08
Water level	1.43m	1.43m	1.48m	2.90m	2.05m	1.50m

6.2 Ground Gas Monitoring

The results of the ground gas monitoring are summarised on the following table. Depending on the parameter with the maximum (peak) or minimum readings are reported, as stated.

Measurement		DS01	DS02	DS03	DS04	DS05	DS08
Carbon Dioxide %	Maximum	1.0	1.2	0.9	3.0	2.1	2.1
Methane %	Maximum	0.0	0.0	0.0	0.0	0.0	0.0
Oxygen %	Minimum	19.8	19.9	19.8	16.7	19.3	19.3
VOCs ppm	Maximum	0.0	0.0	0.0	0.0	0.0	0.0
Flow rate l/hr	Full range	0.0	0.0	0.0	0.0	0.0	0.0

Below is a summary of the atmospheric pressure conditions during the monitoring visits:

Visit	Pressure (recorded on site)	Published pressure trend
05/05/2022	1018mB	Rising high

7.0 LABORATORY TESTING

7.1 Geochemical Laboratory Analysis

Based on the scope issued by Whitby Wood, shallow samples from each borehole were selected for geochemical (contamination) analysis, based on the following rationale:

- Topsoil was encountered in each of the completed dynamic sampler boreholes. Selected samples of this material were taken from each position and were tested for a routine screening suite (LS1) and screened for Asbestos to confirm the potential re-use of the material.
- In addition, the samples of Topsoil were also tested for a Waste Acceptance Criteria test (LS2) to provide a preliminary assessment if the material was to be excavated and disposed of to a landfill site.

The scope and extent of testing was considered appropriate and in accordance with the Conceptual Site Model and preliminary risk assessment.

Sample	Strata	Suite		
		LS1	Asbestos	LS2
DS01 0.20m	Topsoil	X	X	X
DS02 0.20m		X	X	X
DS03 0.20m		X	X	X
DS04 0.20m		X	X	X
DS05 0.20m		X	X	X
DS06 0.20m		X	X	X
DS08 0.20m		X	X	X

The relevant screening suites are defined below. Where duplicate analysis exists between suites, each test is performed only once:

Suite	Definition
LS1 (soil)	Screening suite: pH, fraction of organic carbon, Metals and Non Metals, water soluble Sulphate, Sulphide, total Cyanide, total Phenols, speciated PAH's.
Asbestos	Asbestos screen: Laboratory screening for fibres and Asbestos Containing Materials; identification where identified. Using polarising light and dispersion staining as described in HSG 248, HSE Contract Research Report No 83/1996 and in Davies et al, 1996.
LS2	Waste Acceptance Criteria: Total Organic Carbon, Loss on Ignition, BTEX, speciated PCB's, Mineral Oil (EC10 – EC40), pH, Acid Neutralisation Capacity, speciated PAH's, 10:1 leachable Metals and Non Metals.

The results are discussed in the relevant sections.

7.2 Geotechnical Laboratory Testing

Samples were selected for geotechnical testing, based on the following rationale:

- For general classification purposes, representative cohesive natural samples of soil were analysed for 1pt Atterberg Limit tests (otherwise known as plasticity indexes (PI)).
- Moisture content tests were carried out in association with the Atterberg
- Also for general classification purposes, representative samples of granular soils were selected for Particle Size Distribution by wet sieving (PSD).
- To determine the required concrete specification to resist chemical attack, samples were tested for pH and soil soluble sulphate. (pH/SO₄)

A summary of the testing scheduled is given below:

Sample	Strata	Test		
		PI	PSD	pH/SO ₄
DS01 0.45m	Wittering Formation	-	-	X
DS01 0.95m		X	-	-
DS02 0.45m		X	-	-
DS02 0.95m		-	-	X
DS02 2.45m		-	X	-
DS03 0.45m		-	-	X
DS03 0.95m		X	-	-
DS04 0.45m		-	-	X
DS04 0.95m		X	-	-
DS04 0.45m		X	-	-
DS04 0.95m		-	-	X
DS05 0.45m		X	-	-
DS05 0.95m		-	-	X
DS06 0.95m		X	-	-
DS06 1.45m		-	-	X
DS08 0.45m		X	-	-
DS08 0.95m		-	-	X
TP01 0.95m		X	-	-
TP02 0.50m		X	-	-
TP03 0.95m		X	-	-
TP05 0.70m		X	-	-
TP06 0.45m		X	-	-
TP07 0.50m	Made Ground	X	-	-

The results are discussed in the relevant sections.

8.0 GEOTECHNICAL ASSESSMENT

8.1 General

The proposed development was understood to comprise the following:

- The addition of two new modular, single storey buildings - at the *High Hill* site and the *Youth Learning Centre*,
- A temporary lightweight tensile structure near the *Barns* and play area,
- Adjustment of levels and layout changes,
- The reconfiguration of below ground drainage system (inc. new cesspit and soakaways),
- Additional car parking spaces, and modifications to road layout.

Shrinkable soils were identified, which may be susceptible to heave and shrinkage caused by changes in moisture content seasonally and through the action of tree roots. Numerous mature trees were noted around the southern edge of the High Hill section and also around the northern edge of the main site.

No evidence of desiccation was recorded. Whilst a low Moisture Content reading was recorded at DS03 0.95m (14%) the result reflects that the sample was very gravelly. Whilst some of the moisture contents were low compared to the liquid limits, these were marginal. The Hand Penetrometer results, field observations and groundwater monitoring did not support the potential for desiccation.

A shallow water standing between 1.43m and 2.90m bgl was encountered, which may be problematic for deeper excavations.

However, based on the ground and groundwater conditions encountered, it is considered that traditional shallow strip or pad type foundations would be appropriate for the proposed development.

The final foundation scheme will depend on other constraints and should be evolved in consultation with the design team.

8.2 Volume Change Potential

Although not strictly applicable to this form of development, reference may be given to the NHBC standards or similar guidance for measures that might be taken when designing and constructing foundations in the zone of influence of trees and hedgerows that currently exist, are to be planted, or have recently been felled.

Strata	% passing 425µm sieve	Modified Plasticity Index	Shrinkability classification
Wittering Formation	-	>40%	High volume change potential

Specifications for heave precautions on High volume change potential soils are summarised below. In addition to the depths marked *, localised deepening of foundations will be required in the

influence of trees; it will be necessary to evaluate tree species and height in relation to the proposed building footprints.

Volume Change Potential		High
Minimum depth for traditional foundations outside zone of influence of trees (m) *		1.00m
No tree planting zone required for minimum depth foundations above (m)		1.0 x mature tree height
Minimum depth for traditional foundations but allowing for restricted new planting (m) *		1.50m
Minimum void dimension	Against side of traditional foundations and ground beams etc.	35mm
	Beneath ground beam and suspended in-situ concrete ground floors etc.	150mm
	Beneath suspended precast concrete or timber floors etc.	300mm
Minimum allowance for potential ground movement for new drains		150mm

All foundations should extend below any major root zones or desiccated soil encountered, and trenches should be carefully inspected accordingly. Void former will be required for foundations deeper than 1.50m and within the influence of trees.

8.3 Traditional Shallow Foundations

The following recommendations are made where traditional foundations are to be used.

The primary design parameter for shallow foundations is maximum net allowable bearing pressure, which takes into account a tolerable degree of settlement, and is dependent not only on soil conditions but also the foundation dimensions, ground levels, sloping ground, and the symmetry of loading, amongst others.

All traditional shallow foundations should be taken through any Made Ground, soft or loose zones, disturbed soils, major root zones, or desiccated materials and taken wholly into or onto the Dense Gravelly Clay of the Whittering Formation.

A long narrow strip foundation, as described above, symmetrically loaded and up to a width of 1.00m, may be designed based on a maximum allowable net bearing pressure of 90 kN/m².

This assessment includes an appropriate factor of safety against shear failure, and settlements should remain within appropriate limits. This is a little low but should be sufficient for the type of construction proposed.

In general terms, settlement will be broadly proportional to loading. Under no circumstances should a safe bearing pressure be exceeded (at which point there is a risk of shear failure). Foundations should be subject to sensibly uniform loading, to minimise differential settlement.

8.4 Ground Floor Slabs

If ground bearing floor slabs are proposed, these would need to take into account potential heave. A bearing pressure of up to say 30kN/m² should easily be accommodated on the Whittering Formation. Alternatively, fully suspended floor slabs may be considered.

8.5 Excavations

The risks arising from excavation works should be properly assessed and appropriate safety precautions should be adopted. Reference may be made to various guidance including BS8000-1:1989, BS6031:2009 and CIRIA C97.

The likelihood of excavation instability through different strata has been assessed as summarised below. It should be noted that all open unsupported excavations have the potential to collapse.

Strata	Stability
Topsoil/Made Ground	Generally unstable. May be battered back to a safe angle. Deeper excavations may require trench support.
Wittering Formation	Generally stable in the short to medium term.

Excavations which are to remain open for prolonged periods will require trench support.

Water seepages may be encountered at shallow depth, particularly during wetter climatic conditions, and therefore some localised dewatering and trench support may be required.

It is considered that normal-rated plant and machinery will be sufficient for undertaking excavations.

Adjacent excavations should generally be tackled in order of depth with the deepest first. Vehicles and spoil heaps etc. should not surcharge excavations, and edge protection and fencing should be used as appropriate. Frozen materials should generally not be used as backfill.

8.6 Pavements

The design of pavements will depend on the performance requirements and specification, as well as the ground conditions and finished levels etc. The suitability of shallow soils encountered as a formation level for pavements is summarised as follows:

Strata	Base Depth	Suitability
Topsoil and subsoil	0.60-0.80m	Not suitable for trafficable pavements. All topsoil should be removed and replaced.
Made Ground	1.10m (TP07 only)	Only suitable for pavements with low performance requirements. A CBR value for these materials will not reflect the possible settlements that may occur. The materials will be frost susceptible so a minimum pavement thickness of 450mm will be required, and the formation will need to be adequately proof-rolled and treated
Wittering Formation (cohesive)	3.25m to 4.80m	These materials are generally a suitable formation level. Based on the Atterberg Limit test results, the formation materials should be considered as being non-frost susceptible for pavement design purposes.

The results of the in-situ CBR tests generally ranged between 4.7% and 6.9% on the Wittering Formation. Transport Road Research Laboratory Report suggests a CBR of 3.0% is appropriate, assuming average construction conditions and a deep groundwater table.

CBR design values can be derived from a combination of in-situ and laboratory testing, as summarised below:

Strata	In-situ tests	Lab tests	Published values	Design CBR Value	Frost susceptible?
Wittering Formation	4.7 to 6.9%	-	3.0%	4.0%	No

The formation level should be carefully inspected, and any soft or loose zones should be removed and replaced with engineering fill, well-compacted in layers to a suitable specification. Consideration might be given to installing geotextiles. Cohesive formations will degrade rapidly if exposed to standing water for even short periods. All engineering fill should be granular and non-frost susceptible (i.e. <10% fine material passing 425µm sieve).

Any hard spots in the formation level such as old foundations may induce reflective cracking in the pavement and allowance should be made for removing any slabs or other hard spots etc. that may be present.

8.7 Building Materials

Based on BS8500-1:2015+A1:2016, the results of the Sulphate and pH analyses fell into Class DS-1 and an ACEC class AC-1s is deemed appropriate. The advice of this publication should be taken for the design and specification of all sub surface concrete.

Buried plastics used for potable water supplies should not require any special specification in order to resist chemical contamination. No pipework should be laid where there is evidence of hydrocarbons.

8.8 Surface Water Drainage

Full scale BRE 365 soakage tests were undertaken within the seven trial pits across the site. However, the percolation was extremely poor and a soil infiltration rate could not be calculated.

Given the low permeability of shallow soils, it is unlikely that soakaways will perform satisfactorily at this site. Consideration might be given other means of disposal such as discharge to field drainage, surface water sewer or drainage ditch under license if present.

9.0 PRELIMINARY CONTAMINATION ASSESSMENT

Contaminated land risks are evaluated on following a source-pathway-receptor ('SPR') approach, in accordance with best practice.

Based on the findings of the desk study, no significant sources of potential contamination, natural or man-made, arising in soils, ground gases or groundwater phases, were suspected. The ground and groundwater conditions encountered in section 5.0 did not identify any potentially suspect ground condition. In the absence of any sources, no SPR linkages exist, and consequently no risk has been identified.

Made Ground was identified at TP07 in the form of a raised mound and testing at this location was outside the scope of works. It is anticipated that this material would be removed as part of the development and will not be present as part of the finished development. It is recommended that samples of this material be taken and tested for a preliminary waste assessment.

10.0 PRELIMINARY WASTE ASSESSMENT

10.1 General

Waste may be defined as any substance or object in Annex 1 of the Waste Framework Directive which the holder discards, intends to discard, or is required to discard. Subject to certain provisions, soils may either be handled as either:

- Non-Waste, and re-used (on or off-site), or
- Waste, and disposed of (to a waste management facility).

The waste producer has a legal duty of care to ensure that waste materials are handled properly and sent to the appropriate licenced facility. Further inspection, testing, segregation etc will be required on site, and the advice of a suitably qualified consultant sought wherever necessary. Substantial tax penalties and fines are being levied by the regulators. The advice contained in this section is preliminary only.

10.2 Non-Waste

Soils may potentially be handled as Non-Waste and re-used on site (or on other sites) in accordance with various protocols such as those published by the EA or CL:AIRE. Typical requirements include:

- That the re-use of material will not endanger human health, cause nuisance, or harm the wider environment (controlled waters, ecosystems, etc.)
- That there is there a clear Environmental benefit from the activity, and that the waste is being used as a substitute for non-waste material.
- The materials are suitable for use in terms of chemical and geotechnical parameters without further treatment.
- The holder is certain that the materials will be used in a safe manner, and only the necessary quantities of materials are being used.
- Where the activities do not require a waste management licence (e.g. landfilling).
- A Waste Recovery Plan (EA) or Materials Management Plan (CL:AIRE) are produced and followed, and audited in a Verification Plan.

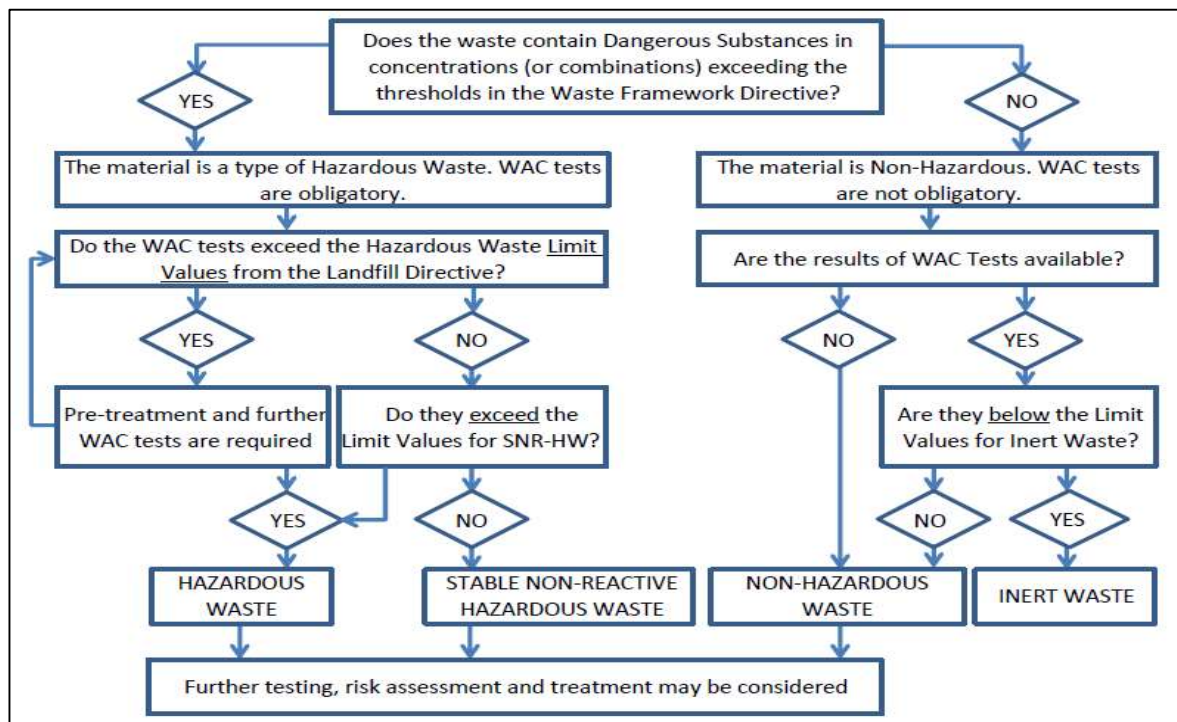
The Topsoil and Natural soils are considered to be potentially suitable for re-use on site. The chemical analysis suggests these materials may be suitable for use in soft landscaped areas (subject to landscaping specifications), or under hardstandings such as roads or slabs (subject to geotechnical considerations).

Soil	Suitability for re-use on site			Notes
	Landscaping	Hard cover	Not suitable	
Topsoil	X	X		No significant risks identified
Natural Soils				

10.3 Waste Disposal

Where materials are not re-used they must be handled as Waste, and must be sent to a licenced waste management facility. The classification of waste is prescribed under the Waste Framework

Directive and the Landfill Directive, as summarised below. Different waste management facilities may also have specific acceptance criteria, and their advice should be sought.



The results of the soil analysis have been classified as follows:

Soil	Hazardous		Non Hazardous		Details
	Hazardous	Stable Non-Reactive	Non-Hazardous	Inert	
Topsoil DS01 0.20m DS02 0.20m DS03 0.20m DS05 0.20m DS08 0.20m			X		The soil analysis was not identified as hazardous but the WAC test did not meet the requirements for Inert waste. Interpretation: Non Hazardous waste . The tests failing the criteria were: Total Organic Carbon (TOC) in all samples.
Topsoil DS04 0.20m DS06 0.20m				X	The soil analysis was not identified as hazardous and the WAC test met the requirements for Inert. Interpretation: Inert Waste .

The samples of topsoil that were classified as Non-Hazardous waste all failed on the criteria for Total Organic Carbon, it is recommended that the waste transfer companies / waste facilities are contacted to confirm whether they could accept it at a less onerous classification.

It is anticipated that the underlying natural soils would meet the Inert Waste Criteria.

Further WAC testing may be considered for soils identified as Non-Hazardous, as the tests may enable those materials to be re-classified as Inert and therefore represent a potential saving on disposal costs.

With reference to the current List of Wastes (formerly European Waste Catalogue), waste soils and stone derived from construction and demolition sites may be disposed of under either of the following codes as appropriate:

Waste	Code	Description
Hazardous	17 05 03*	soil and stones containing dangerous substances
Non-Hazardous	17 05 04	soil and stones other than those mentioned in 17 05 03

(Note, the asterix is a Mirror Entry, as defined in the List of Wastes, conferring the relationship with the non-hazardous code 17-05-04).

11.0 SUMMARY AND CONCLUSIONS

This summary is a brief precis of the main findings and conclusions of the investigation. For detailed information, the reader is referred to the main report.

11.1 General

The area under investigation comprised two irregular shaped parcels of open parkland intersected by a densely forested area. The proposed development was understood to comprise the addition of two new modular, single storey buildings - at the *High Hill site* and *The Youth Learning Centre*, a temporary lightweight tensile structure near the *Barns* and play area, adjustment of levels and layout changes, the reconfiguration of below ground drainage system (inc. new cesspit and soakaways), and additional car parking spaces, and modifications to road layout.

The work carried out included an intrusive investigation comprising 7no. Dynamic Sampler boreholes with associated Dynamic Probing and installation of monitoring wells, 7no. trial pits with full scale BRE:365 Soakage tests, 7no. Plate Load Tests obtaining CBR values and preliminary geotechnical and chemical testing of selected soil in the field and laboratory.

11.2 Soils Encountered

Strata	Depth	Summary
Topsoil	0.20 to 0.50m	Brown gravelly sandy silty CLAY / clayey SILT with rootlets. Gravels comprised flints and brick and concrete fragments.
Subsoil	0.30 to 0.35m	orange-brown gravelly sandy Clay with rootlets and rare flint gravel.
Made Ground	1.10m	Sandy, gravelly CLAY. Gravels included brick, concrete and glass fragments. ST07 only
Wittering Formation	3.25 to 4.80m	Light brown mottled light grey / orange / yellow / green / purple slightly gravelly CLAY with lenses of dark brown sandy silt / sand. The clay was noted to be slightly friable / shaley with increasing depth
London Clay Formation	5.00+	Dark grey silty CLAY.

11.3 Groundwater

Groundwater was recorded during the return monitoring standing at levels of between 1.43m and 2.90m.

11.4 Foundations

Traditional foundations are likely to be suitable to the ground and groundwater conditions, and suggested design parameters are given. The formation should be treated as being High volume change potential.

11.5 Excavations

Generally likely to be unstable. Excavations below the water table may become highly unstable. Risk assessments should be prepared and appropriate safety measures provided.

11.6 Pavements

CBR value of 4% recommended for the Wittering Formation, which is not classified as being frost susceptible.

11.7 Building Materials

DS1 and AC1s in accordance with BS8500. Water supply pipe work will not require protection from aggressive soil contaminants.

11.8 Soakaways

Soakage tests were undertaken within the seven trial pits across the site. However, the percolation was extremely poor and a soil infiltration rate could not be calculated. Given the low permeability of shallow soils, it is unlikely that soakaways will perform satisfactorily at this site. Consideration might be given other means of disposal such as discharge to field drainage, surface water sewer or drainage ditch under license if present

11.9 Soil Contamination

No issues with respect to soil or groundwater contamination have been identified.

11.10 Waste Disposal

The chemical results confirmed that the Topsoil at DS01, DS02, DS03, DS05 and DS08 should be handled as Non-Hazardous waste for disposal purposes with the Topsoil at DS04 and DS06 handled as Inert Waste. It is likely that natural soils could be handled as Inert Waste.

11.11 Further Action

No immediate requirements for further ground investigation have been identified.

This report should be submitted to relevant regulatory bodies and warranty providers in good time for approval.

REPORT CONDITIONS

The Client

This report may also be used only by the client named in section 1 and their appointed project team for the purpose of design, obtaining planning, building regulations approval, and in connection with finance. This report must not be used by any other persons or for other purposes without express written agreement of Land Science.

General

Land Science takes all reasonable professional care in preparation of this report, using current standards and industry practice. However, the evaluation of ground conditions depends on an interpretation and extrapolation of the conditions revealed by a limited data set. The level of risk is related to the extent of investigation and no site is ever free of risk. The client should understand their risks and liabilities. We accept no liability whatsoever in respect of:

- The scope, extent or design of an investigation.
- Any conditions not directly revealed by the investigation.
- Published standards or methodologies used or adopted in this report.
- The opinion of any other party including any regulator, authority or stakeholder.
- Any dispute, claim or consequential loss arising from any findings of this report.
- Third party information and data.

This report relates solely to ground-related matters as set out in the objectives and makes no representation on other matters such as ecology, arboriculture, invasive plant species, the condition of buildings and structures, hazardous building materials such as insulation or asbestos, the locations of boundaries, unexploded ordnance, and or planning constraints etc. Further reports should be commissioned in this respect as appropriate.

Regulators and Approvals

This (and any other) report should be submitted to relevant authorities for their own assessments and to provide their approval or comments accordingly. This should be in good time before commencing on site in case additional work is to be carried out.

Standards, technical guidance and regulatory positions change over time and which may therefore affect the findings and recommendations made in this report; this should be verified by the client prior to any critical project milestones. Where this information is used in design, the designer should verify that the information is appropriate and has been used correctly.

Variations with time

The report relates to conditions revealed at the time of the investigation and any monitoring visits. Some parameters may vary over time or seasonally; groundwater levels, ground gas compositions, or concentrations of contaminants are particularly variable in this respect. Further monitoring or verification should be considered as appropriate.

GLOSSARY OF TERMS

ACM	Asbestos Containing Material
BGS	British Geological Survey
BRE	Building Research Establishment
BS	British Standard
C4SL	Category 4 Screening Level
CBR	California Bearing Ratio
CDM	Construction Design and Management regulations
CIRIA	Construction Industry Research and Information Association
CL:AIRE	Contaminated Land: Applications in Real Environments
CLEA	Contaminated Land Exposure Assessment model
CSM	Conceptual Site Model
EA	Environment Agency
EQS	Environmental Quality Standards
FOC	Fraction of Organic Carbon
GAC	Generic Assessment Criterion
GQRA	Generic Quantitative Risk Assessment
mbgl	Meters Below Ground Level
NHBC	National House Building Council
mOD	Metres above Ordnance Datum
PAH's	Polycyclic Aromatic Hydrocarbons
PHE	Public Health England
PID	Photo-Ionisation Detector
PQRA	Preliminary Quantitative Risk Assessment
PSD	Particle Size Distribution Test
RMS	Remediation Method Statement
S4UL	Suitable for Use Level
SOM	Soil Organic Matter
SPZ	Source Protection Zone
SPT	Standard Penetration Test
SSSI	Sites of Special Scientific Interest
ST-WEL	Short Term Workplace Exposure Limit
SVOC's	Semi-Volatile Organic Compounds
TPH	Total Petroleum Hydrocarbons
TRRL / TRL	Transport Road Research Laboratory
TWA-WEL	Time Weighted Average Workplace Exposure Limit
UK HBF	United Kingdom House Building Federation
VOC's	Volatile Organic Compounds
WAC	Waste Acceptance Criteria