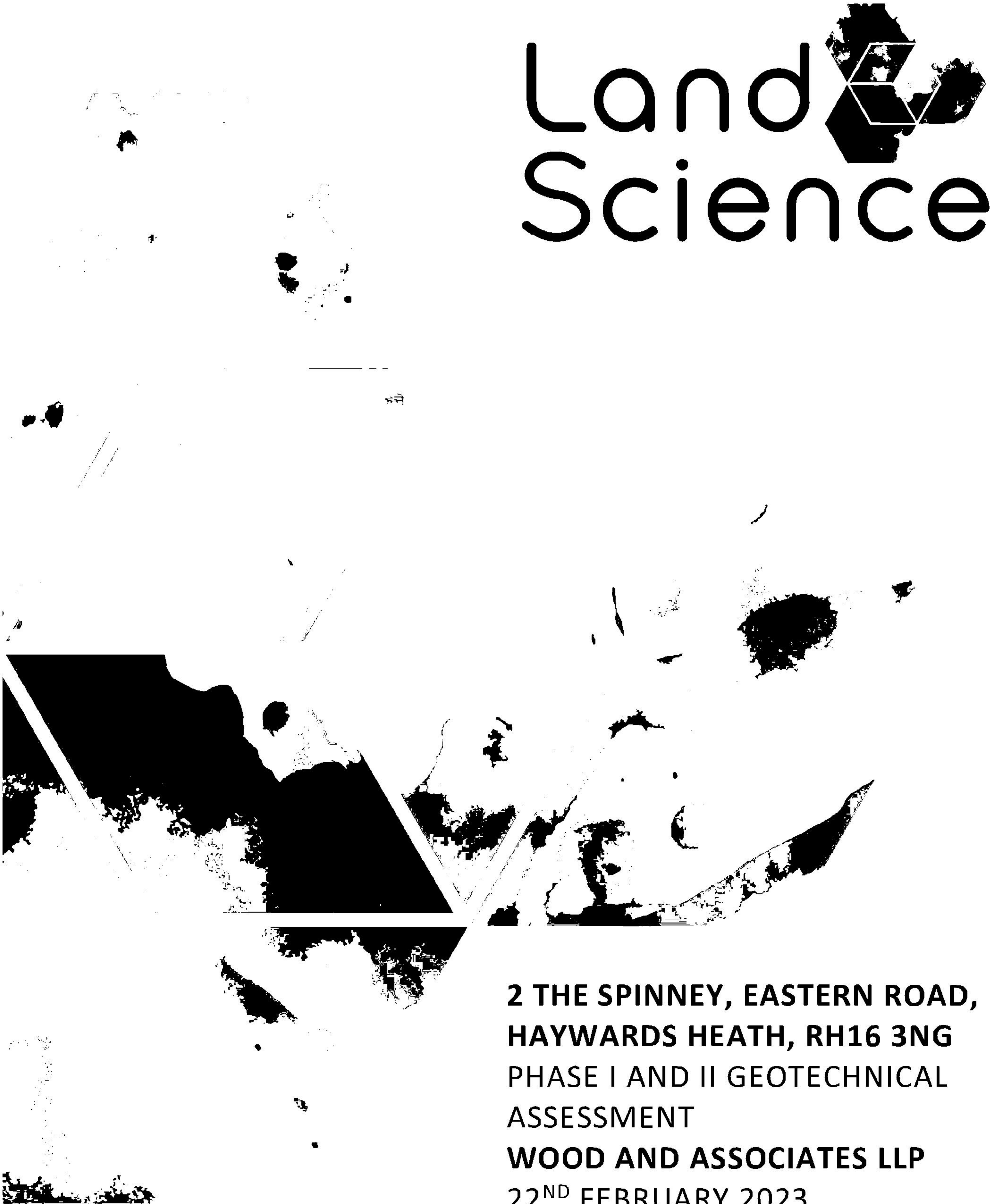
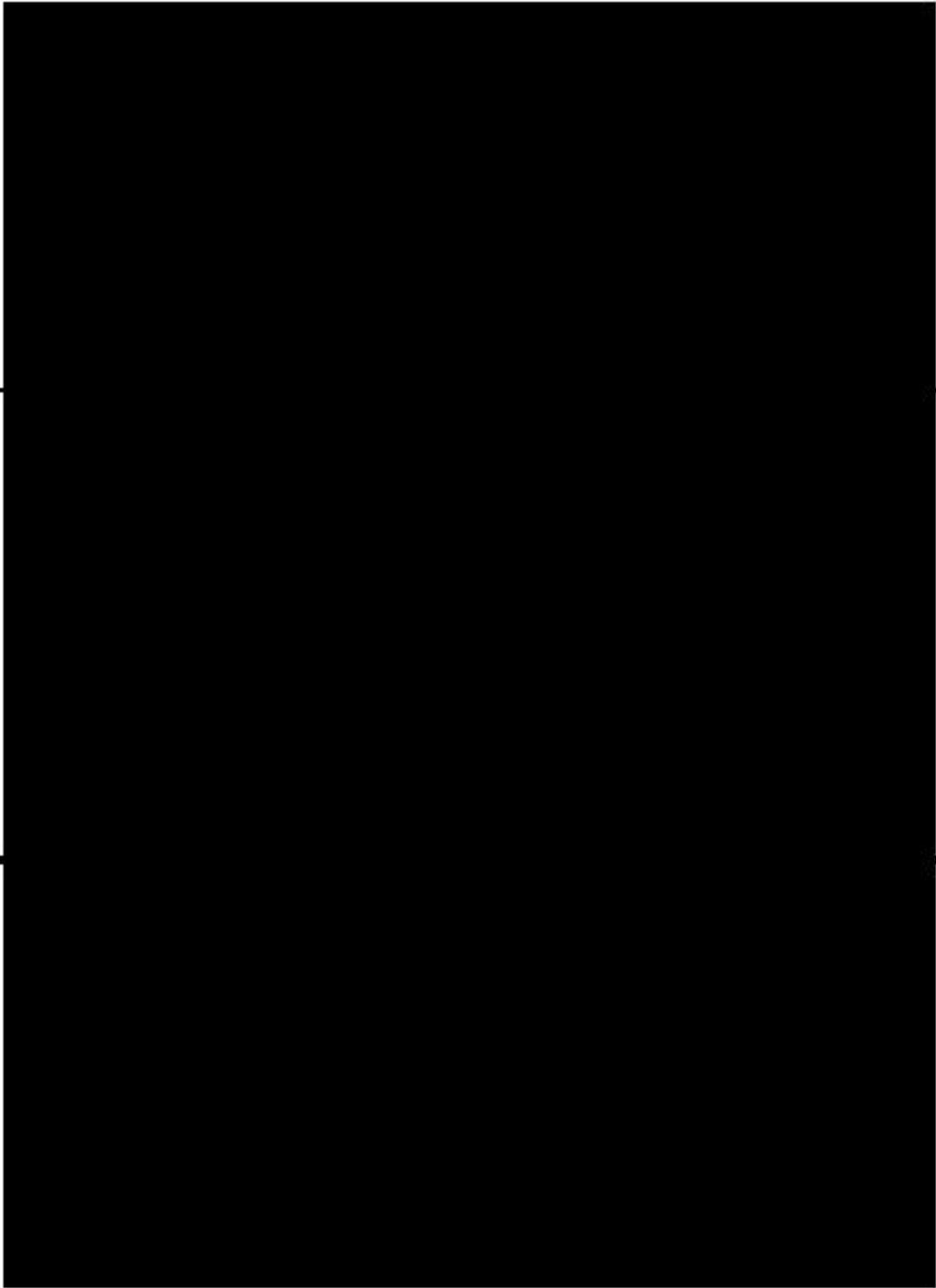




Land Science

**2 THE SPINNEY, EASTERN ROAD,
HAYWARDS HEATH, RH16 3NG
PHASE I AND II GEOTECHNICAL
ASSESSMENT
WOOD AND ASSOCIATES LLP
22ND FEBRUARY 2023
LS6737**

Site:	2 THE SPINNEY, EASTERN ROAD, HAYWARDS HEATH, RH16 3NG		
Title:	PHASE I AND II GEOTECHNICAL ASSESSMENT		
Project:	RESIDENTIAL DEVELOPMENT		
Client:	WOOD AND ASSOCIATES LLP		
Date:	22 ND FEBRUARY 2023		
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CONTENTS

1.0 EXECUTIVE SUMMARY.....4
2.0 INTRODUCTION5
3.0 DESK STUDY7
4.0 INTRUSIVE INVESTIGATION10
5.0 GROUND CONDITIONS11
6.0 FIELD TESTING13
7.0 GEOTECHNICAL LABORATORY TESTING14
8.0 GEOTECHNICAL ASSESSMENT18
9.0 CONTAMINATION LABORATORY TESTING22
10.0 PRELIMINARY CONTAMINATION ASSESSMENT.....23
11.0 PRELIMINARY WASTE ASSESSMENT24
REFERENCES26
REPORT CONDITIONS27
GLOSSARY OF TERMS28

FIGURES

FIGURE 1: Site Location Plan
FIGURE 2: Existing Layout / Investigation Layout
FIGURE 3: Proposed Layout / Investigation Layout

APPENDICES

APPENDIX A: Site Walkover
APPENDIX B: Site Photographs
APPENDIX C: Field Logs and Testing
APPENDIX D: Geotechnical Laboratory Testing
APPENDIX E: Contamination Laboratory Testing
APPENDIX F: Desk Study
APPENDIX G: Radon Report

1.0 EXECUTIVE SUMMARY

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.

The existing site comprised part of a garden to an existing residential property. The development comprised the construction of two adjoined chalet bungalows. The intrusive investigation included 3no trial holes.

Topsoil	0.20-0.25	Dark brown, slightly gravelly, silty, CLAY. Gravels are of flint, and rare charcoal, plastic, and glass.
Upper Tunbridge Wells Sand	1.75+	Light brown and orange, soft, silty, CLAY. The positions refused on SILTSTONE.

No groundwater encountered within 1.75m depth.

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 low volume change potential.

Excavations are generally likely to remain stable. Excavations below the water table may become highly unstable.

A CBR value of 4.5% is recommended for the Upper Tunbridge Wells Sand, which is classified as being frost susceptible.

Buried structural concrete may be designed to DS-1 and AC-1 in accordance with BS8500. Water supply pipe work will not require protection from aggressive soil contaminants.

Soakage testing identified an extremely poor rate of infiltration and it is unlikely that soakaways will perform satisfactorily on site.

No Radon Protection Measures (RPM) are required for new dwellings and extensions at this location.

Preliminary soil testing has not identified elevated levels of contamination.

Chemical results on Topsoil corresponded to Non-Hazardous Waste classification. Natural soils are anticipated to generally be Inert Waste.

No immediate requirements for further ground investigation have been identified. This report should be submitted to relevant authorities etc in good time for consideration and approval.

2.0 INTRODUCTION

2.1 General

Land Science was instructed to undertake a Combined Phase I and Phase II Geotechnical Assessment in relation to the proposed redevelopment at 2 The Spinney, Eastern Road, Haywards Heath, RH16 3NG. The location is shown on Figure 1, which is centred at grid reference TQ 33853 23484.

2.2 Client

The Client for this appointment was Wood and Associates LLP. This report may only be used by this named client and their project team for the purposes set out and subject to the report conditions. It was understood that the Client already owned the property, and that this investigation was not a pre-purchase appraisal.

2.3 Area Under Investigation

The area under investigation comprised part of a garden to an existing property, it had been recently cleared of overgrown vegetation and was now laid to lawn. The layout is indicated on Figure 2, and a walkover survey is presented in section 3.0. The area was approximately 0.05 hectares.

2.4 Proposed Development

The proposed development was understood to comprise the construction of two adjoined chalet bungalows with associated soft landscaping and driveway area. No information regarding planning was available at the time of writing the report. Figure 3 illustrates the layout of the proposed redevelopment. The findings of this report may be not valid if the proposed development is altered.

2.5 Previous Investigations

Land Science was not aware of any previous desk studies or ground investigation(s) for this project.

2.6 Scope of Work

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

- A phase I assessment desk study.
- An intrusive investigation comprising dynamic trial pits and soakage testing.
- Preliminary geotechnical testing of selected soil samples in the laboratory.
- Preliminary chemical testing of selected soil in the laboratory.

The fieldwork was conducted on the 31st of January 2023, under the supervision of Land Science.

2.7 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, excavations and waste classification.

2.8 Standards

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

- 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.

3.0 DESK STUDY

3.1 General

A desk study was carried out to inform the preliminary conceptual understanding of the site and its setting, and to identify potential aspects of concern, in the context of the stated report objectives.

3.2 Walkover Survey

A walkover survey was carried out, as recorded in Appendix A, with photographs from the site in Appendix B. In summary, the area under investigation comprised a roughly rectangular shaped parcel of land which was laid to lawn, and currently formed part of a garden to an existing property.

The site sloped relatively uniformly from the southeast to the northwest, with a change in elevation across the site of ~1.50-2.00m and angle of slope of ~4°.

Saplings were noted to have been recently planted along the north-western boundary, whilst an evergreen hedge was noted on part of the northeast boundary. A tall mature deciduous tree was noted off site in the garden of the existing property, this was ~20-30m to the southwest of the site boundary.

With the exception of the trees, the walkover survey did not identify any areas of particular concern regarding the geotechnical condition of the site. No significant evidence of underground structures, ground instability, subsidence, wet areas, significant earthworks, etc, were noted.

The walkover survey did not identify any areas of particular concern regarding the geo-environmental condition of the site. No significant evidence of tanks, chemical storage, staining or sheens, built up ground, contaminative land uses etc, were noted.

3.3 Historical Land Use Data

Various historical records were reviewed in order to assess potential historical land uses and activities that may impact on ground conditions at the site.

Free historic maps were reviewed online. The following key features were noted:

- The earliest map dated 1885-1900 showed the site comprised a portion of open field or marshland.
- The 1888-1900 map showed the site comprised an area of woodland.
- On the 1937-1961 map, the site was shown to comprise an area of open land to the rear of a row of houses, this could have corresponded to garden space.
- The 1944-1971 map showed the site to comprise a garden area to an adjacent property located to the east. This map suggested that the site was in a similar layout to the present day from this time.
- Off site, the map dated 1885-1900 showed the site was surrounded by open field and marshland, a priory was marked ~50m to the east of the site. The following map dated 1888-1913 showed the site to be surrounded by woodland with various tracks marked running in a N-S direction.
- The 1937-1961 map showed the site to be surrounded by other residential dwellings and roadways.

Recent aerial photography covering the site was examined using Google Earth Pro. The imagery identified that the site was covered by some large mature trees to the northern and southern extents from the imagery dated December 2001, up until the majority of the trees appeared to have been cleared in the imagery dated December 2005. The 2012 imagery showed the existing extension to have been added to the dwelling on the adjacent site to the south. The site appeared to become heavily overgrown from 2015 up until 2020 when it was partially cleared, areas of bare ground were visible on site from the clearing. The 2021 imagery showed the site to be in a similar layout to the present day, covered with grass.

A brief internet search was carried out, which did not immediately reveal any relevant land use information.

3.4 Ground Conditions

A preliminary ground model was derived for the site by based on a combination of various sources including published maps, borehole records, previous investigations, and the site history. In summary, the following potential ground model was identified:

Topsoil	<0.50m	No Made Ground is anticipated on site; however, topsoil may be present due to the growth of vegetation on the site and subsequent decay to form organic matter.
Upper Tunbridge Wells Sand – sandstone and siltstone	To depth	Complex succession of interbedded silty mudstones, siltstones, silty sandstones and fine-grained sandstones. Sandstones commonly weather to a pale yellowish grey or brown colour.

No relevant nearby borehole records were identified; however, groundwater may be present within the Upper Tunbridge Wells Sand and may be present as perched water in more granular beds of this strata.

The desk study included searches of geological hazards. None of the hazards were rated as moderate or above, considered the screening threshold for further investigation.

A search of various databases for coal mining, mining, brine compensation, and natural cavities was carried-out. No relevant features were identified.

3.5 Environmental Setting

The site lies in the following groundwater setting:

- Superficial aquifer: None - No superficial strata were classified.
- Bedrock aquifer: The Upper Tunbridge Wells Sand was classified as a Secondary A - Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
- Source protection zone: None - no groundwater Source Protection Zones were identified on site or in the vicinity.

- Flooding from Rivers and Sea: Zone 1 Low Probability - Land having a less than 1 in 1,000 annual probability of river or sea flooding.
- Surface water flooding on site: Very low risk - each year this area has a chance of flooding of less than 0.1%. Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding.

3.6 Radon Gas

The requirement for Radon Protection Measures (RPM) has been assessed in accordance with BRE 211:2015. Public Health England and the BGS estimate the potential for radon and the requirement for Radon Protection Measures on site as follows:

- Radon probability: Not at risk - less than 1% of homes are estimated by PHE to exceed the threshold for Radon gas in residential dwellings.
- Radon Protection Measures (RPM): No Radon protection is required for new dwellings or extensions constructed at this location.

4.0 INTRUSIVE INVESTIGATION

4.1 Investigation Strategy

Based on the geotechnical objectives, the intrusive investigation was based on the following strategy:

- Trial pits were dug across the site to inspect and sample the underlying soils. The positions were located to give broad coverage across the site and also within the footprint of the proposed dwellings.
- Soakage testing was carried out in TP01 and TP03 to BRE365 to help determine a soil infiltration rate.

TP01	2.50m or refusal	East of site	Front gardens / driveway	BRE365, HP
TP02		Centre of site	Building footprint	HP
TP03		West of site	Rear garden	BRE365, HP

4.2 Trial Pits (TP)

Trial pits are open excavations using a mechanical excavator to inspect a larger volume of soils and in turn provide a better understanding of variability water ingress, instability, etc.

4.3 Hand Penetrometer (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.

4.4 Full Scale Soakage Testing (BRE365)

Full scale soakage tests were undertaken in accordance with BRE365. The test was carried out in open holes in one day with only one repeat test possible in the time available.

4.5 Soil Sampling

Soil samples were recovered from the exploratory holes during the ground investigation and stored/transported in containers appropriate for the laboratory testing undertaken. Sample types and depths are recorded on the relevant exploratory hole records.

5.0 GROUND CONDITIONS

5.1 General

The expected ground conditions were anticipated to comprise Topsoil over Tunbridge Wells Sand to depth. The investigation confirmed the anticipated ground conditions. A summary of the encountered conditions is presented below.

Topsoil	0.20	0.25	0.25
Upper Tunbridge Wells Sand - Clay	1.50	1.40	1.75+
Upper Tunbridge Wells Sand - Siltstone	1.65+	1.50+	-

The naming of geological strata is tentative and should be used as a guide. Interpolation between or below investigation points should be treated with caution. The description of soils and rocks was in accordance with BS5930. Topsoil can be distinguished from Made Ground, even though these may have been disturbed through human activity and may contain materials such as brick, pottery, or charcoal etc.

5.2 Topsoil

Topsoil was encountered to depths of between 0.20m and 0.25m and in summary comprised a dark brown, slightly gravelly, silty, CLAY. Gravels are rare, fine to medium, subangular to subrounded flint, and rare charcoal, plastic, and glass.

5.3 Upper Tunbridge Wells Sand

Upper Tunbridge Wells Sand was encountered to depth and initially comprised a light brown and orange, soft, silty, CLAY which became slightly sandy beyond depths of 1.00m. At depths of 1.20-1.40m gravels were encountered which were of fine to medium subangular to subrounded siltstone fragments. The positions refused at depths of between 1.50m and 1.75m on SILTSTONE.

5.4 Roots and Rootlets

A summary of roots and rootlets encountered is given below.

TP01	0.00-0.20m; rare roots	0.00-0.20m; abundant rootlets 0.20-0.50m; rare rootlets
TP02	0.00-0.25m; rare roots	0.00-0.25m; abundant rootlets 0.25-0.90m; rare rootlets
TP03	0.00-0.25; rare roots	0.00-0.25; abundant rootlets 0.25-0.60; rare rootlets

5.5 Field Evidence of Contamination

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

5.6 Groundwater

Groundwater was not encountered during excavation of any of the investigative positions.

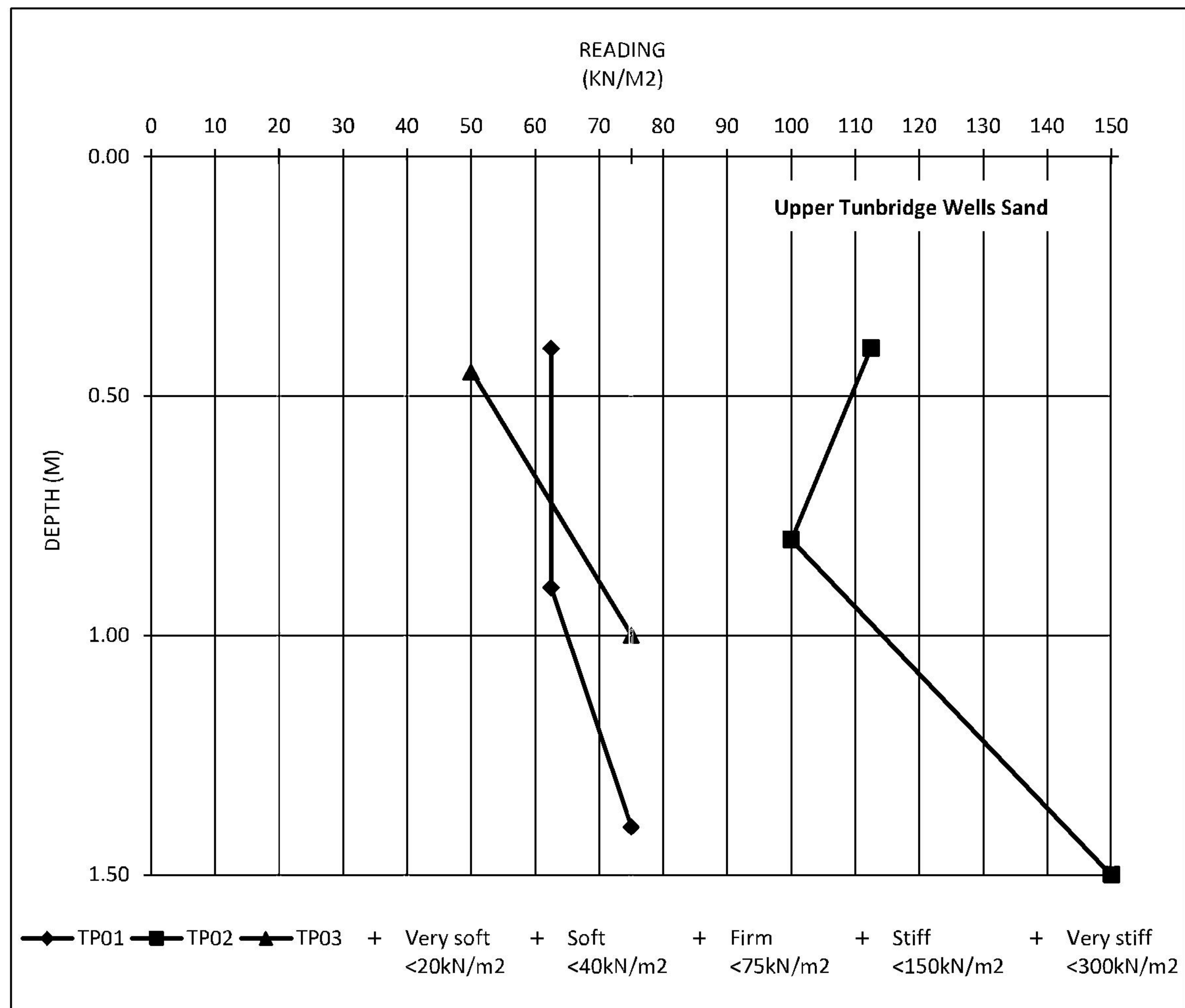
5.7 Stability and Casing

Positions remained stable throughout the intrusive investigation.

6.0 FIELD TESTING

6.1 Hand Penetrometers (HP)

The results in the Upper Tunbridge Wells Sand generally showed a trend of increasing results with depth. Results in TP01 and TP03 corresponded to that of firm clays, whilst the results in TP02 showed the presence of stiff clays.



6.2 Full Scale Soakage Testing (BRE365)

Full scale soakage tests were undertaken in trial pits TP01 and TP03 in accordance with BRE365. The tests were carried out in open holes in one day with only one repeat test possible in the time available.

The test in TP01 failed within the first 24 hours, not reaching the 75% full criteria within this period. The test in TP03 was very slow and did not complete within the time allowed; however, the water level did fall below the 75% full criteria within the first 24 hours and therefore the test was considered in progress. Extrapolation of the data gave an infiltration rate on the order of 8.8×10^{-7} m/s.

7.0 GEOTECHNICAL LABORATORY TESTING

7.1 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 (Plasticity Index) tests (PI).
- Moisture content (MC) determinations were carried out in association with the Atterberg limit tests.
- For general classification purposes, representative samples of granular soils were selected for Particle Size Distribution by wet sieving (PSD).
- Given the fine-grained nature of the soils, the particle size distribution was supplemented by Hydrometer analysis on the silt and clay fractions (HYD).
- 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:

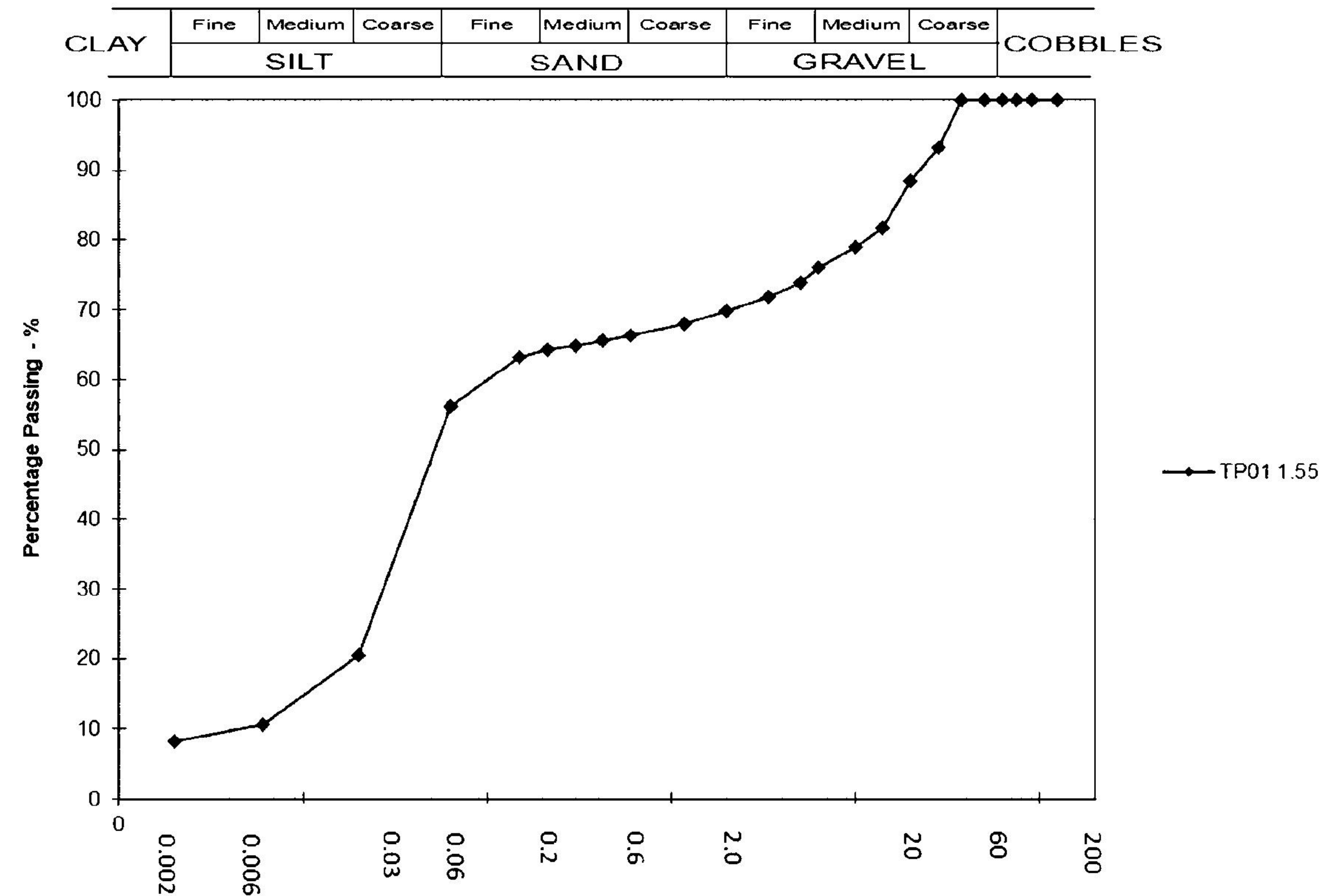
TP01, 0.90m	Upper Tunbridge Wells Sand					✓
TP01, 1.55m		✓	✓	✓	✓	
TP02, 0.80m		✓	✓			
TP02, 1.30m						✓
TP02, 1.50m		✓	✓			
TP03, 1.00m		✓	✓			

The results are discussed in the relevant sections.

7.2 Particle Size Distribution

Particle Size Distribution analysis was performed on a representative sample of more granular material as summarised below.

Upper Tunbridge Wells Sand	1	56.1	13.7	30.2	-



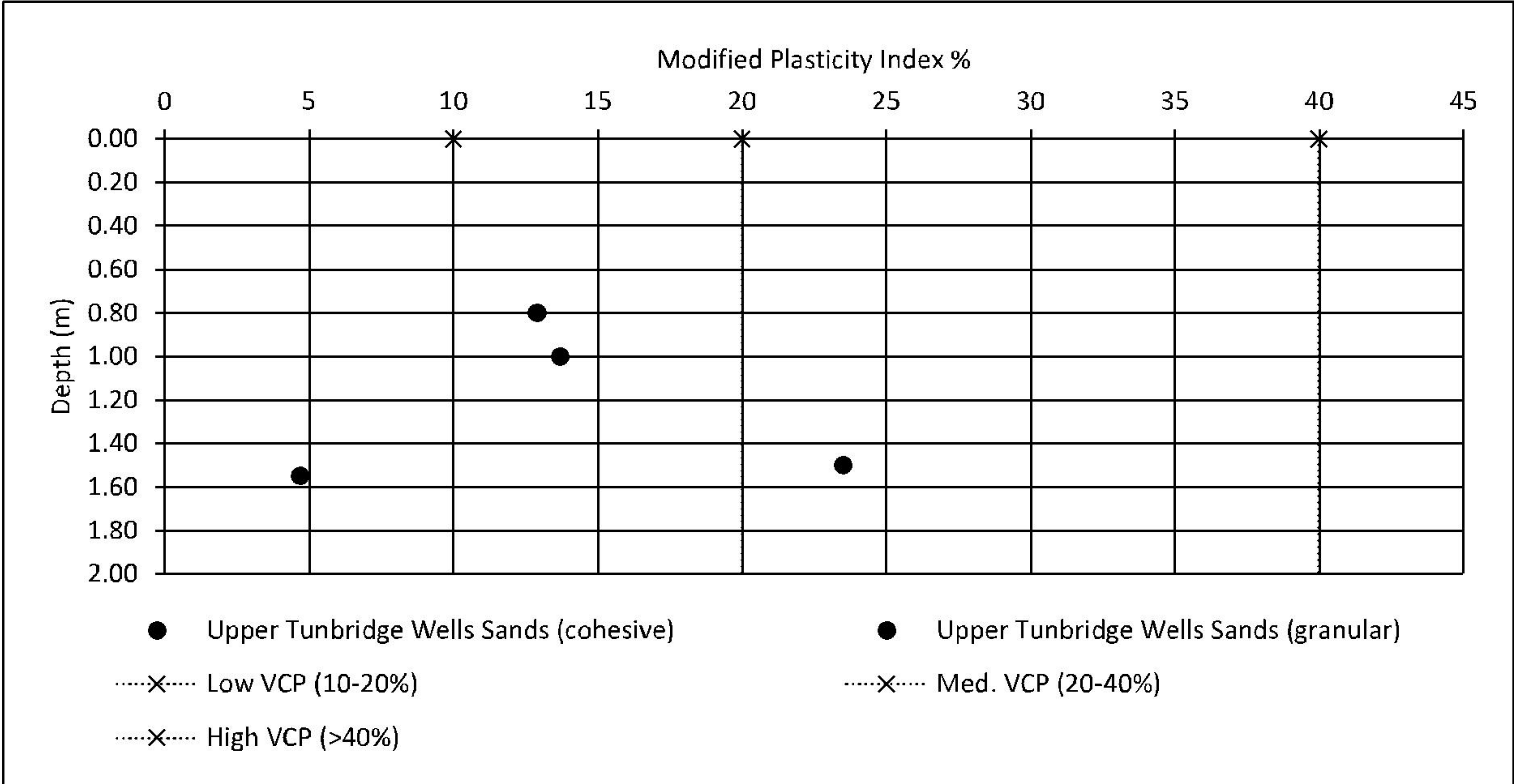
7.3 Plasticity Indexes (Atterberg Limits)

Atterberg Limit tests were undertaken on selected samples of cohesive soils, as summarised below.

Upper Tunbridge Wells Sands (cohesive)	3	13.5	24.1	17.6
Upper Tunbridge Wells Sands (granular)	1	6.8	6.8	6.8

A modified plasticity index (PI') was calculated following the NHBC methodology, to account for any non-shrinkable percentage not passing the 425µm sieve:

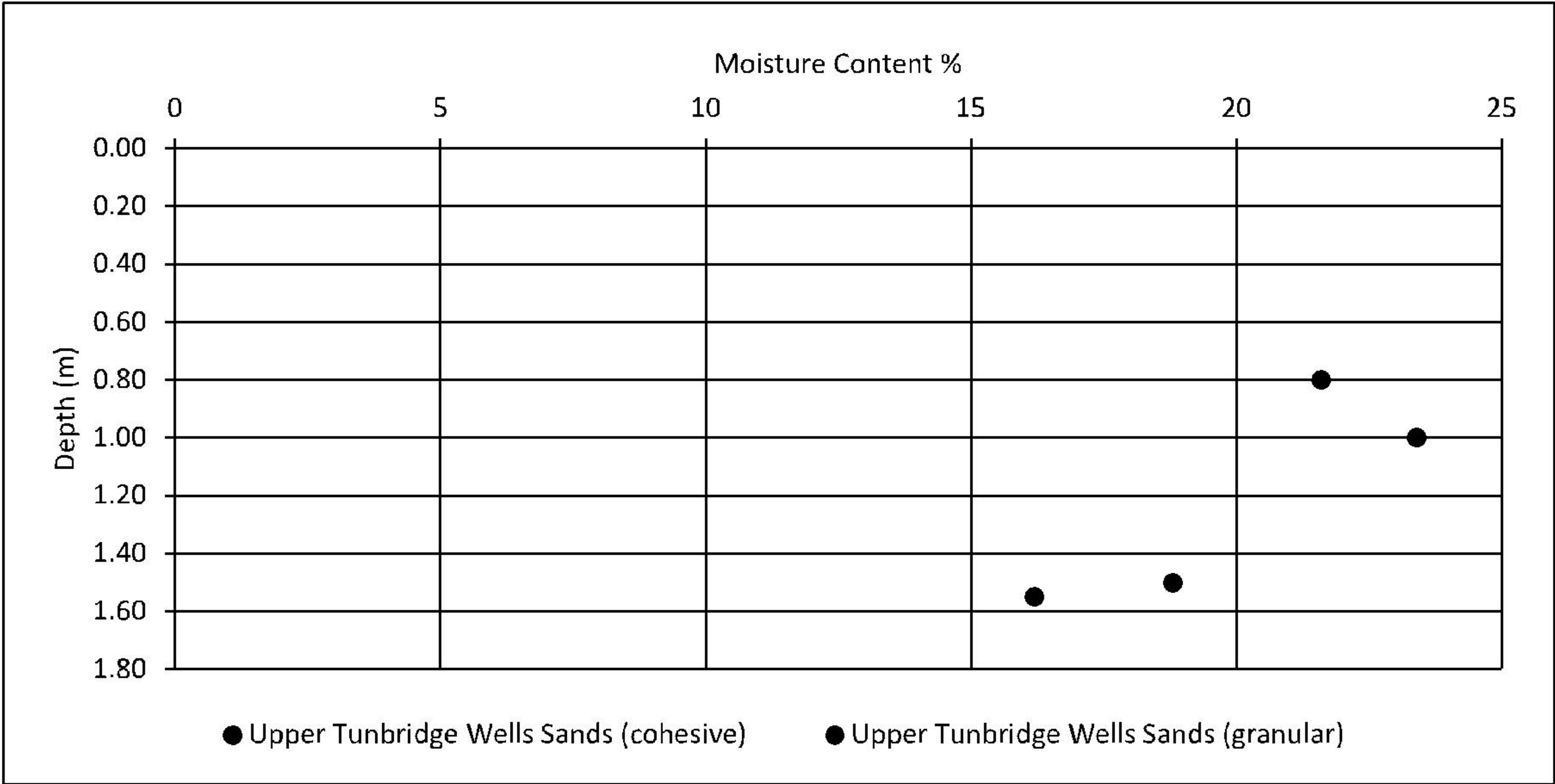
Upper Tunbridge Wells Sands (cohesive)	3	12.9	23.5	16.7
Upper Tunbridge Wells Sands (granular)	1	4.7	4.7	4.7



7.4 Water Content

Water content determinations (formerly known as *moisture content*) were undertaken in combination with various classification tests, and the results are summarised below.

Upper Tunbridge Wells Sands	4	16.2	23.4	20.0



7.5 pH and Sulphate

Geochemical testing for water soluble Sulphate and pH were undertaken, and the results are summarised on the following table.

Topsoil	1	0.0082	7.2
Upper Tunbridge Wells Sand	2	0.013	7.3-7.7

8.0 GEOTECHNICAL ASSESSMENT

8.1 General

The proposed development was understood to comprise the construction of two adjoined chalet bungalows with associated soft landscaping and driveway area.

Groundwater was not encountered within the Trial Pits. It should be noted that the maximum depth of investigation was 1.75mbgl, and water may occur below this depth or may vary seasonally. 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.

Cohesive soils were identified, which are susceptible to heave and shrinkage through changes in moisture content, such as seasonally or trees. The BGS do not designate the site as being at risk of shrinking or swelling clays. Whilst young recently planted trees were noted along the north-western boundary of the site, and a tall mature hedgerow was noted along the north-eastern boundary, however these were not considered significant in terms of the location of the proposed building footprint.

Based on the ground and groundwater conditions encountered, it is considered that traditional strip foundations would be appropriate for the proposed development. It is recommended that these are taken down onto the intact siltstone at 1.50-1.75mbgl. Further heave precautions are unlikely to be required.

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

8.2 Volume Change Potential

Reference may be given to the NHBC standards or similar guidance for 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.

Upper Tunbridge Wells Sands	10-20%	Low volume change potential
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Specifications for heave precautions 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.

Minimum depth for traditional foundations outside zone of influence of trees (m) *		0.75m
No tree planting zone required for minimum depth foundations above (m)		0.2 x mature tree height
Minimum depth for traditional foundations but allowing for restricted new planting (m) *		1.00m
Minimum void dimension	Against side of traditional foundations and ground beams etc.	0mm
	Beneath ground beam and suspended in-situ concrete ground floors etc.	50mm
	Beneath suspended precast concrete or timber floors etc.	200mm

Minimum allowance for potential ground movement for new drains	50mm
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All foundations should extend below any major root zones or desiccated soil encountered, and trenches should be carefully inspected accordingly.

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, desiccated materials and all weathered silts and sands, and taken wholly into or onto the intact SILTSTONE of the Upper Tunbridge Wells Sand formation at 1.50-1.75mbgl.

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 250 kN/m².

This assessment includes an appropriate factor of safety against shear failure, and settlements should remain within appropriate limits. This figure should be ample for the type of construction proposed.

The Upper Tunbridge Wells Sands will soften rapidly when exposed to free water. The final 50mm of any foundation trench should not be excavated until immediately before concreting, unless blinded or otherwise protected immediately after excavation.

8.4 Ground Floor Slabs

Given the presence of soils susceptible to volume change potential (i.e. shrinkable), it is recommended that all ground floor slabs should be fully suspended, with a suitable minimum void space.

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.

Topsoil	Generally unstable. May be battered back to a safe angle. Deeper excavations may require trench support.
Upper Tunbridge Wells Sand	Generally stable in the short to medium term.

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

It is considered that normal-rated plant and machinery will be sufficient for undertaking excavations. Suitably rated plant with ripper and breaker may be needed to progress any great depth into the Upper Tunbridge Wells Sands. Care should be taken so as not to undermine existing structures, services, or adjacent property.

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:

Topsoil	0.20-0.25m	Not suitable for trafficable pavements. All topsoil should be removed and replaced.
Upper Tunbridge Wells Sands	To depth	These materials are generally a suitable formation level. The formation may be frost susceptible and a minimum pavement of 450mm should be considered. TRRL 1132 suggests a CBR of around 4.5%, assuming average construction conditions and a low water table. Cohesive formations will degrade rapidly if exposed to standing water and should be protected.

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. All engineering fill should be granular and non-frost susceptible (i.e. <10% fine material passing 425µm sieve).

8.7 Building Materials

All sub surface concrete should be designed and specified in accordance with BS8500-1:2015+A1:2016. The results of the Sulphate and pH analyses fell into Class DS-1 and an ACEC class AC-1 is appropriate.

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

One of the full scale BRE 365 soakage tests failed, the other gave a very low infiltration rate of 8.8×10^{-7} m/s. It is unlikely that soakaways will perform satisfactorily in these materials given the low infiltration rate. Consideration should be given to an alternative drainage solution, such as permeable paving, SUDs, and possible discharge to the surface water sewer.