



Main Investigation Report

at

Land at Arundel Road, Fontwell, West Sussex BN18 0QP

for

Crayfern Homes

Reference: 16971/MIR

July 2018

Control Document

Project

Land at Arundel Road, Fontwell, West Sussex BN18 0QP

Document Type

Main Investigation Report

Document Reference

16971

Document Status

Final

Date

July 2018

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This is not a valid document for use in the design of the project unless it is titled Final in the document status box.

Current regulations and good practice were used in the preparation of this report. The recommendations given in this report must be reviewed by an appropriately qualified person at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.



Association of Geotechnical & Geoenvironmental Specialists



Commission

Soils Limited was commissioned by Crayfern Homes to undertake an intrusive investigation and to prepare a Main Investigation Report on land at Arundel Road, Fontwell, West Sussex BN18 0QP. The scope of the investigation was outlined in the Soils Limited quotation reference Q20042/REV1.01 dated 25th May 2018.

This document comprises the Main Investigation Report and incorporates the results, discussion and conclusions to this intrusive works.

This Main Investigation Report must be read in conjunction with the Preliminary Investigation Report undertaken on the above site by Soils Limited, Report ref: 16971/DS, dated July 2018.

Standards

The site works, soil descriptions and geotechnical testing was undertaken in accordance with the following standards:

- BS 5930:2015 and BS EN ISO 22476-2 2005+A1:2011
- BS EN 1997-1:2004+A1:2013 Eurocode 7.
- BS EN ISO 14688-2:2004+A1:2013
- BS 10175:2011+A1:2013

The geotechnical laboratory testing was performed by GEO Site & Testing Services Ltd (GSTL) in accordance with the methods given in BS 1377:1990 Parts 1 to 8 and their UKAS accredited test methods.

For the preparation of this report, the relevant BS code of practice was adopted for the geotechnical laboratory testing technical specifications, in the absence of the relevant Eurocode specifications (ref: ISO TS 17892).

The chemical analyses were undertaken by QTS Environmental Limited in accordance with their UKAS and MCERTS accredited test methods or their documented in-house testing procedures. This investigation did not comprise an environmental audit of the site or its environs.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sample borehole implies the specific technique used to produce a trial hole.

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Section I Introduction

I.1 Objective of Investigation

Soils Limited was commissioned by Crayfern Homes to undertake an intrusive investigation and to prepare a Main Investigation Report to supply the client and their designers with information regarding ground conditions, to assist in preparing a foundation scheme for development that was appropriate to the settings present on the site.

The investigation was to be undertaken to provide comment on appropriate foundation options for the proposed residential development. The investigation was to be made by means of in-situ testing and geotechnical laboratory testing undertaken on soil samples taken from the trial holes.

Soil samples were taken for chemical laboratory testing to enable recommendations for the safe redevelopment of the site and the protection of site workers, end-users and the public from any contamination identified as dictated by the Conceptual Site Model (CSM) in the Preliminary Investigation Report undertaken for the site by Soils Limited (Report ref: 16971/PIR July 2018) and/or the Revised Conceptual Site Model presented in Appendix C.1.

I.2 Location

The site was located at land at Arundel Road, Fontwell, West Sussex BN18 0QP and had an O.S Land Ranger Grid Reference of SU 960 068.

The site location plan is given in Figure 1.

I.3 Site Description

At the time of the intrusive investigation, no permeant structures or buildings were present on site. A small road towable caravan was located near the centre of the site. The majority of the site was covered in long grass, with areas of dense vegetation. The access track comprised concrete and brick rubble surfacing.

Mature trees and shrubs were located on all boundaries. Evidence of site clearance was noted across the site, with tree stumps, logs, chopped wood and evidence of burning and fires. The site had a very gradual slope down to the south in line with the wider topography.

An aerial photograph has been included in Figure 2.

I.4 Proposed Development

The proposed development comprised the erection of eight two-storey, three to five-

bedroom detached residential properties. The development included hard landscaping such as vehicular access roads, private driveways and pedestrian access routes. Soft landscaping included private gardens, border planting and areas of open grass.

In compiling this report reliance was placed on drawing SK03a, dated January 2018 and was prepared by Crayfern Homes Limited. Any change or deviation from the scheme outlined in the drawing could invalidate the recommendations presented within this report. Soils Limited must be notified about any such changes.

Development plans provided by the client are presented in Appendix D.

1.5 Anticipated Geology

The 1:50,000 BGS Geology map showed the site to be situated on the Lambeth Group with overlying superficial deposits of Head.

1.5.1 Head

Head deposit are drifts produced by solifluxion, the downslope movement of debris outwash during the periglacial period, and characteristically comprise poorly sorted sands gravels and chalk of local derivation.

1.5.2 Lambeth Group

The Lambeth Group, formerly known as the Woolwich and Reading Beds, occurs in the London and Hampshire Basins, where it directly overlies the Chalk or Thanet Sand Formation, and is succeeded by the Harwich and London Clay Formations. Although generally less than 50 metres thick, its lithological variability and position beneath much of London has concerned tunnelling engineers since the early 19th century.

The relationship between the different depositional environments is seen in central and south-east London, where deposits of fine-grained sand, flint gravel beds, mottled clay, shell beds and altered beds form a complex interdigitating sequence, which is divided into three formations and several informal lithological units.

1.6 Limitations and Disclaimers

This Main Investigation Report relates to the site located at land at Arundel Road, Fontwell, West Sussex BN18 0QP and was prepared for the sole benefit of Crayfern Homes (The "Client"). The report was prepared solely for the brief described in Section 1.1 of this report.

Soils Limited disclaims any responsibility to the Client and others in respect of any matters outside the scope of the above.

This report has been prepared by Soils Limited, with all reasonable skill, care and diligence within the terms of the Contract with the Client, incorporation of our General

Conditions of Contract of Business and taking into account the resources devoted to us by agreement with the Client.

The report is personal and confidential to the Client and Soils Limited accept no responsibility of whatever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report wholly at its own risk.

The Client may not assign the benefit of the report or any part to any third party without the written consent of Soils Limited.

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief. As such these do not necessarily address all aspects of ground behaviour at the site.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot by plot basis prior to the construction of foundations. Supplied site surveys may not include substantial shrubs or bushes and is also unlikely to have data or any trees, bushes or shrubs removed prior to or following the site survey.

Where trees are mentioned in the text this means existing trees, substantial bushes or shrubs, recently removed trees (approximately 20 years to full recovery on cohesive soils) and those planned as part of the site landscaping).

Ownership of land brings with it onerous legal liabilities in respect of harm to the environment. "Contaminated Land" is defined in Section 57 of the Environment Act 1995 as:

"Land which is in such a condition by reason of substances in, on or under the land that significant harm is being caused or that there is a significant possibility of such harm being caused or that pollution of controlled waters is being, or is likely to be caused".

The investigation, analysis or recommendations in respect of contamination are made solely in respect of the prevention of harm to vulnerable receptors, using where possible best practice at the date of preparation of the report. The investigation and report do not

address, define or make recommendations in respect of environmental liabilities. A separate environmental audit and liaison with statutory authorities is required to address these issues.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets remains with Soils Limited. License is for the sole use of the client and may not be assigned, transferred or given to a third party.

Section 2 Site Works

2.1 Proposed Project Works

The proposed intrusive investigation was designed to provide information on the ground conditions and to aid the design of foundations for the proposed residential development. The intended investigation, as outlined within the Soils Limited quotation Q20042/REV1.01 dated 25th May 2018) was therefore to comprise the following items:

- 1 day windowless sampler boreholes and dynamic probes
- TRL DCP probing for CBR values
- Well installation for groundwater monitoring
- Machine excavated trial holes
- Infiltration testing to BRE365
- Geotechnical laboratory testing
- Contamination laboratory testing.

2.1.1 Actual Project Works

The actual project works were undertaken on 31st May 2018 and comprised:

- 4No. windowless sampler boreholes and dynamic probes (WS/DP1 – WS/DP4)
- 4No. machine excavated trial holes (TP1 – TP4)
- 5No. TRL DCP probes (DCP1 – DCP5)
- Infiltration testing to BRE365
- Well installations for groundwater monitoring
- Geotechnical laboratory testing
- Contamination laboratory testing.

Two windowless sampler boreholes (WS1 and WS3) were backfilled with gravel and bentonite following the installation of 33mm ID monitoring wells.

Two windowless sampler boreholes (WS2 and WS4) were backfilled with gravel and bentonite.

Four machine excavated trial holes were backfilled with arisings.

All trial hole locations have been presented in Figure 3.

Following completion of site works, soil cores were logged and sub-sampled so that samples could be sent to the laboratory for both contamination and geotechnical testing.

2.2 Ground Conditions

On 31st May 2018 four windowless sampler boreholes (WS1 – WS4) were drilled, using an Archway Competitor windowless sampler and dynamic probe rig, to depths ranging

between 2.00 and 5.00m below ground level (bgl) at locations selected by Soils Limited using a development plan provided by the client.

Four super heavy dynamic probes, (DP1 – DP4) were driven prior and adjacent to their corresponding windowless sampler borehole to depths ranging between 3.00 and 7.00m bgl.

Two standpipes were installed within window sample borehole locations (WS1 and WS3) to allow for continued monitoring of groundwater, where present.

The maximum depths of trial holes have been included in Table 2.1.

All trial holes were scanned with a Cable Avoidance Tool (C.A.T.) and GENNY prior to excavation to ensure the health and safety of the operatives.

Table 2.1 Final Depth of Trial Holes

Trial Hole	Depth (m bgl)	Trial Hole	Depth (m bgl)
WS/DPI _w	5.00/6.00	TP1	3.50
WS/DP2	2.00/3.00	TP2	2.50
WS/DP3 _w	4.00/4.00	TP3	3.50
WS/DP4	3.00/7.00	TP4	1.00

Note: w - well installation

The approximate trial hole locations are shown on Figure 3.

The soil conditions encountered were recorded and soil sampling commensurate with the purposes of the investigation was carried out. The depths given on the trial hole logs and quoted in this report were measured from ground level.

The soils encountered from immediately below ground surface have been described in the following manner. Where the soil incorporated an organic content such as either decomposing leaf litter or roots, or has been identified as part of the in-situ weathering profile, it has been described as Topsoil both on the logs and within this report. Where man has clearly either placed the soil, or the composition altered, with say greater than an estimated 5% of a non-natural constituent, it has been referred to as Made Ground both on the log and within this report.

For more complete information about the soils encountered within the general area of the site reference should be made to the detailed records given within Appendix A, but for the purposes of discussion, the succession of conditions encountered in the trial holes in descending order can be summarised as:

Topsoil (TS)
Head (HEAD)
Lambeth Group (LMBE)

The ground conditions encountered in the trial holes are summarised in Table 2.2.

Table 2.2 Ground Conditions

Strata	Epoch	Depth Encountered (m bgl)		Typical Thickness (m)	Typical Description
		Top	Bottom		
TS	Anthropocene	G.L.	0.25 – 0.55	0.50	Dark orangish brown sandy gravelly SILT.
HEAD	Quaternary	0.25 – 0.55	1.00 ¹ – 4.90 ³	2.80	Dark orangish brown very clayey sandy fine to coarse sub-angular to angular flint GRAVEL.
LMBE	Thanetian	2.00 ¹ – 4.90 ³	3.00 ^{1,2,3} - 7.00 ^{1,2,3}	Not Proven	Orangish brown clayey fine to medium SAND with occasional bands of soft light grey sandy CLAY.

Note: ¹ Final depth of trial hole. ² Base of strata not encountered. ³ Inferred from DP logs

2.3 Ground Conditions Encountered in Trial Holes

The ground conditions encountered in trial holes have been described below in descending order. The engineering logs are presented in Appendix A.1.

2.3.1 Topsoil

Soils described as Topsoil were encountered in all eight trial holes (WS/DP1 to WS/DP4 and TP1 to TP4) from ground level to a range of depths from 0.25m bgl (TP4) to 0.55m bgl seen in WS1.

The Topsoil typically comprised dark orangish brown sandy gravelly SILT. Sand was fine. Gravel was fine to medium sub-rounded to sub-angular flint. Frequent roots were noted throughout.

The depth of Topsoil has been included in Table 2.3.

Table 2.3 Final Depth of Topsoil

Trial Hole	Depth (m bgl)	Trial Hole	Depth (m bgl)
WS/DP1	0.55	TP1	0.35
WS/DP2	0.40	TP2	0.40
WS/DP3	0.45	TP3	0.40
WS/DP4	0.50	TP4	0.25

2.3.2 Head

Soils of the Head deposits were encountered in all eight trial holes (WS/DP1 to WS/DP4 and TP1 to TP4) from directly beneath the Topsoil and persisted to depths ranging between 1.00m bgl (base of TP4) and 4.90m bgl (inferred from DP4).

The soils of the Head typically comprised dark orangish brown very clayey sandy fine to coarse sub-angular to angular flint GRAVEL. The sand was fine to coarse.

The depth of Head has been included in Table 2.4.

Table 2.4 Final Depth of Head

Trial Hole	Depth (m bgl)	Trial Hole	Depth (m bgl)
WS/DPI	2.70	TP1	3.50 ¹
WS/DP2	2.00 ¹ /2.80 ²	TP2	2.50 ¹
WS/DP3	2.65	TP3	2.60
WS/DP4	3.00 ¹ /4.90 ²	TP4	1.00 ¹

Notes: ¹Base of trial hole. ²Inferred from DP log

2.3.3 Lambeth Group

Soils of the Lambeth Group were encountered in five of the eight trial holes (WS/DP1 to WS/DP4 and TP3) from directly beneath the Head and persisted to depths of 3.00m bgl (base of DP2) and 7.00m bgl (inferred to the base of DP4).

The soils of the Lambeth Group typically comprised orangish brown clayey fine to medium SAND with occasional bands of light grey sandy CLAY.

The depth of Lambeth Group has been included in Table 2.5.

Table 2.5 Final Depth of Lambeth Group

Trial Hole	Depth (m bgl)	Trial Hole	Depth (m bgl)
WS/DPI	5.00 ¹ /6.00 ^{1,2}	TP1	Not encountered
DP2	3.00 ^{1,2}	TP2	Not encountered
WS/DP3	4.00 ¹ /4.00 ^{1,2}	TP3	3.90 ¹
WS/DP4	3.00 ¹ /7.00 ^{1,2}	TP4	Not encountered

Notes: ¹Base of trial hole. ²Inferred from DP log

2.4 Roots

Roots were encountered in all eight trial holes at depths ranging between 0.40 and 2.00m bgl.

The depths of root penetration have been included in Table 2.6.

Table 2.6 Depth of Root Penetration

Trial Hole	Depth (m bgl)	Trial Hole	Depth (m bgl)
WS1	0.55	TP1	1.50
WS2	0.40	TP2	1.50
WS3	0.45	TP3	2.00
WS4	0.50	TP4	1.00

It was noted during the intrusive investigation that the majority of the site was covered in long grass, with areas of dense vegetation. Mature trees and shrubs were located on all boundaries and evidence of site clearance was noted across the site, with tree stumps, logs, chopped wood and evidence of burning and fires. Furthermore, information from the Preliminary Investigation (16971/PIR, dated July 2018) indicated that the previous usage of the site was as a plantation.

Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs.

It must be emphasised that the probability of determining the maximum depth of roots from a narrow diameter borehole is low. Therefore, the direct observation from within a trial pit is a more reliable indication of the maximum root depth.

2.5 Groundwater

Groundwater was encountered within two trial holes (TP1 and TP3) and was struck at depths of 2.00m bgl and 3.50m bgl respectively. No change in water depth was noted after a 20minute period.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in May 2018, when groundwater levels should be falling from their annual maximum (highest) elevation, which typically occurs around March.

Ground water strike information has been included with Table 2.7.

Table 2.7 Groundwater Strikes

Trial Hole	Depth (m bgl)	Trial Hole	Depth (m bgl)
WS1	Not encountered	TP1	2.10
WS2	Not encountered	TP2	Not encountered
WS3	Not encountered	TP3	3.50
WS4	Not encountered	TP4	Not encountered

Groundwater equilibrium conditions may only be conclusively established, if a series of observations are made via groundwater monitoring wells. Monitoring wells were installed onsite with the intention of carrying out monitoring over the winter months.

Groundwater seepage may have been encountered within the boreholes, but at such a rate that no indication was noted.

Section 3 Discussion of Geotechnical In-Situ and Laboratory Testing

3.1 Dynamic Probe Tests

Dynamic probing (DPSH) was undertaken at four locations (DP1 to DP4) adjacent and prior to the drilling of WS1 and WS4 to depths ranging between 3.00 and 7.00m bgl. DP testing was limited to this depth due to very high torque readings in cohesive bands of the Lambeth Group. The results were converted to equivalent SPT “N60” values based on dynamic energy using commercial computer software (Geostru). The results were then interpreted based on the classifications outlined in Appendix B.1, Table B.1.1 to Table 1.2.

The SPT “N60” values presented have been corrected in accordance with BS EN 22476 Part 3, to account for the rig efficiency, borehole depth, overburden factors etc. Further correction of the ‘N’ values should therefore not be necessary. Raw field data is archived within the Soils Limited project file and can be provided on request.

The Head recorded equivalent SPT “N60” values between 15 and >50. Classifying, the predominantly granular soils, as medium dense to very dense relative density.

The Lambeth Group recorded equivalent SPT “N60” values between 4 to 22 within cohesive beds and 4 to >50 in granular beds. The cohesive beds were classified as low to high strength with an inferred undrained cohesive strength of 20 to 110kPa. The granular beds were classified as loose to very dense relative density.

A full interpretation of the DPSH tests are outlined in Appendix B.2, Table B.2.1.

3.2 Dynamic Cone Penetrometer Tests

The Transport Research Laboratory (TRL), Dynamic Cone Penetrometer (DCP) was undertaken at five locations (DCP1 – DCP5). The results were interpreted based on the classification outlined in Appendix B.1.

The results from DCP testing indicated CBR values of between 8% and 75% for the soils encountered in the top 1.00m bgl.

The DCP results are presented in Appendix B.3.

3.3 Infiltration Tests

Infiltration testing was undertaken in TP1 and TP2 within the Head and Lambeth Group following the principles of BRE Digest 365 Soakaway design: 2016. BRE 365 states that for an accurate infiltration rate to be obtained a soakage pit needs to be filled three times in quick succession. Each test can only be ended once 75% of the water present has drained away.

A single test was carried in TP1 ending once 75% of the water had drained away. Three full tests in accordance with BRE DG:365 2016 were carried out in TP2.

BRE software BRESOAK was used to calculate the infiltration rates in TP1 and TP2 and the results are outlined in Table 3.1.

Table 3.1 Infiltration Rates

Trial Hole	Test No.	Infiltration Rate (m/s)
TP1	1	6.78×10^{-05}
TP2	1	9.85×10^{-05}
	2	1.05×10^{-04}
	3	8.95×10^{-04}

3.4 Atterberg Limit Tests

Atterberg Limit tests were performed on four samples, three obtained from the Head and the remaining one from the Lambeth Group. The results were classified in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

The Head was classified as having none to medium volume change potential in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

The Lambeth Group was classified as having high volume change potential in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

A full interpretation of the Atterberg Limit tests are outlined in Table B.2.2, Appendix B.2 and the laboratory report in Appendix B.3.

3.5 Particle Size Distribution Tests

Particle Size Distribution (PSD) tests were performed on three samples from the Head.

PSD classified two of samples taken from the granular beds of the Head as having a volume change potential in accordance BRE Digest 240. The results from grading analysis identified that none of the three samples tested had a volume change potential in accordance with NHBC Standards Chapter 4.2.

A cohesive soil is only classified as having a volume change potential if it is also plastic. Atterberg Limit Tests have been undertaken on soils of the Head and as such they are considered to be plastic with a medium volume change potential.

A full interpretation of the PSD tests are outlined in Table B.2.3, Appendix B.2 and the laboratory report in Appendix B.3.

3.6 Sulphate and pH Tests

One sample was taken from the Head (WS2:1.30m bgl) and one from the Lambeth Group (WS3:2.30m bgl) for water soluble sulphate (2:1) and pH testing in accordance with Building Research Establishment Special Digest 1, 2005, 'Concrete in Aggressive Ground'.

The tests recorded water soluble sulphate between 11mg/l and 14mg/l with pH values of 6.5.

The significance of the sulphate and pH Test results are discussed in Section 4.4 and the laboratory report in Appendix B.3.

Section 4 Foundation Design

4.1 General

An engineering appraisal of the soil types encountered during the site investigation and likely to be encountered during the redevelopment of this site is presented. Soil descriptions are based on analysis of disturbed samples taken from the trial holes.

4.1.1 Made Ground and Topsoil

The terms *Fill* and *Made Ground* are used to describe material, which has been placed by man either for a particular purpose e.g. to form an embankment, or to dispose of unwanted material. For the former use, the Fill and/or Made Ground may well have been selected for the purpose and placed and compacted in a controlled manner. With the latter, great variations in material type, thickness and degree of compaction invariably occur and there can be deleterious or harmful matter, as well as potentially methanogenic organic material.

The BSI Code of Practice for Foundations, BS 8004:1986, Clause 2.2.2.3.5 Made Ground and Fill, includes the caveat that *'all Topsoil should be treated as suspect, because of the likelihood of extreme variability'*.

Soils described as Topsoil were encountered in all eight trial holes (WS/DP1 to WS/DP4 and TP1 to TP4) from ground level to a range of depths from 0.25m bgl (TP4) to 0.55m bgl (WS1).

The Topsoil typically comprised dark orangish brown sandy gravelly SILT. Sand was fine. Gravel was fine to medium sub-rounded to sub-angular flint. Frequent roots were noted throughout.

The depths of Topsoil have been included in Table 2.3.

A result of the inherent variability, particularly of uncontrolled Topsoil, Fill and/or Made Ground is that it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should, therefore, be taken through any Topsoil and/or Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

4.1.2 Head

Soils of the Head deposits were encountered in all eight trial holes (WS/DP1 to WS/DP4 and TP1 to TP4) from directly beneath the Topsoil and persisted to a range of depths from 1.00m bgl (base of TP4) to 4.90m bgl (inferred from DP4).

The soils of the Head typically comprised dark orangish brown very clayey sandy fine to coarse sub-angular to angular flint GRAVEL. Sand was fine to coarse.

The results from DPSH testing inferred equivalent SPT "N60" values between 15

and >50m, classifying the predominantly granular soils as medium dense to very dense.

The results from Atterberg Limits tests confirmed that the soils of the Head had **none to medium volume change potential** in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

PSD classified two of the granular beds of the Head as having a volume change potential in accordance BRE Digest 240. The results from grading analysis identified that none of the three samples tested had a volume change potential in accordance with NHBC Standards Chapter 4.2. Atterberg Limit Tests have been undertaken on soils of Head and as such are considered to be plastic with medium volume change potential.

Soils of Head are typically normally consolidated and are expected to display low to moderate bearing capacities with moderate to high settlement characteristics. The soils of Head were considered suitable for the proposed development, assuming sufficient bearing capacities and acceptable settlements could be achieved.

4.1.3 Lambeth Group

Soils of the Lambeth Group were encountered in five of the eight trial holes (WS/DP1 to WS/DP4 and TP3) from directly beneath the Head and persisted to depths of 3.00m bgl (base of DP2) and 7.00m bgl (inferred to the base of DP4).

The soils of the Lambeth Group typically comprised orangish brown clayey fine to medium SAND with occasional bands of soft light grey sandy CLAY.

The depth of Lambeth Group has been included in Table 2.5.

The results from the dynamic probing inferred that the Lambeth Group recorded equivalent SPT “N60” values between 4 to 22 within cohesive beds and 4 to >50 in granular beds. The cohesive beds were classified as low to high strength with an inferred undrained cohesive strength of 20 to 110kPa. The granular beds were classified as loose to very dense.

The cohesive beds of the Lambeth Group was classified as having high volume change potential in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

Soils of the Lambeth Group are overconsolidated and are expected to display low to moderate bearing capacities with moderate settlement characteristics. The soils of the Lambeth Group were considered suitable for the proposed development.

4.1.4 Roots

Roots were encountered in all eight trial holes at depths ranging between 0.40 and 2.00m bgl. It was noted during the intrusive investigation that the majority of the

site was covered in long grass, with areas of dense vegetation. Mature trees and shrubs were located on all boundaries and evidence of site clearance was noted across the site, with tree stumps, logs, chopped wood and evidence of burning and fires. Furthermore, information from the Preliminary Investigation (16971/PIR dated July 2018) indicated that the previous usage of the site was as a plantation.

Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs.

It must be emphasised that the probability of determining the maximum depth of roots from a narrow diameter borehole is low. Therefore, the direct observation from within a trial pit is a more reliable indication of the maximum root depth.

4.1.5 Groundwater

Groundwater was encountered within two trial holes (TP1 and TP3) and was struck at depths of 2.00m bgl and 3.50m bgl respectively. Groundwater seepage may have been encountered within the boreholes, but at such a rate that no indication was noted.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in May 2018, when groundwater levels should be falling from their annual maximum (highest) elevation, which typically occurs around March.

Groundwater equilibrium conditions may only be conclusively established, if a series of observations are made via groundwater monitoring wells. Monitoring wells were installed onsite with the intention of carrying out monitoring over the winter months.

4.2 Foundation Scheme General

The proposed development comprised the erection of eight two-storey, three to five-bedroom detached residential properties. The development included hard landscaping such as vehicular access roads, private driveways and pedestrian access routes. Soft land scaping included private gardens, border planting and areas of open grass.

In compiling this report reliance was placed on drawing SK03a, dated January 2018 and was prepared by Crayfern Homes Limited. Any change or deviation from the scheme outlined in the drawing could invalidate the recommendations presented within this report. Soils Limited must be notified about any such changes.

Development plans provided by the client are presented in Appendix D.

4.2.1 Guidance on Shrinkable Soils

The Building Research Establishment (BRE) Digests 240, 241 and 242 provide

guidance on 'best practice' for the design and construction of foundations on shrinkable soils.

The results from Atterberg Limits Tests showed that the Head had **none to medium volume change potential** in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

The Lambeth Group had a **high volume change potential** in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2

Medium volume change potential must therefore be adopted where foundations pass through the Head. Whilst **high volume change potential** must be adopted where foundations pass through / into the cohesive beds of the Lambeth Group.

The BRE Digest 241 states: *"An increasingly common, potentially damaging situation is where trees or hedges have been cut down prior to building. The subsequent long-term swelling of the zone of clay desiccated by the roots, as moisture slowly returns to the ground, can be substantial. The rate at which the ground recovers is very difficult to predict and if there is any doubt that recovery is complete then bored pile foundations with suspended beams and floors should be used"*.

The stated intention of the NHBC is to ensure that shrinkage and swelling of plastic soils does not adversely affect the structural integrity of foundations to such a degree that remedial works would be required to restore the serviceability of the building. It must be borne in mind that adherence to the NHBC tables and design recommendations may not, in all cases, totally prevent foundation movement and cracking of brickwork might occur.

The BRE Digest 240 suggests: *"Two courses of action are open:*

Estimate the potential for swelling or shrinkage and try to avoid large changes in the water content, for example by not planting trees near the foundations.

Accept that swelling or shrinkage will occur and take account of it. The foundations can be designed to resist resulting ground movements or the superstructure can be designed to accommodate movement without damage."

The design of foundations suitable to withstand movements is presented in BRE Digest 241 "Low-rise buildings on shrinkable clay soils: Part 2"

4.3 Foundation Scheme

Foundations **must not** be constructed within any Topsoil due to the likely variability and potential for large load induced settlements both total and differential.

Roots were encountered in all eight trial holes at depths ranging between 0.40 and 2.00m bgl. If roots are encountered during the construction phase foundations **must not be placed within any live root penetrated** or desiccated **cohesive soils or those with a volume change potential**. Should the foundation excavations reveal such materials, the excavations **must** be extended to greater depth in order to bypass these unsuitable soils. Excavations must be checked by a suitable person prior to concrete being poured.

It must be noted that not only trees but shrubs and general vegetation also desiccate cohesive soils and so in areas of dense vegetation must be recorded on the site survey and taken into account during the foundation depth calculations. In addition, recently removed trees (within about the last 20 years) are likely to result in desiccated soils and must again be taken into account when designing foundation depths.

Considering the type of development, a shallow foundation solution was considered the most suitable.

The proposed development is likely to be both light and brittle. It is therefore considered that foundation design is undertaken using NHBC Standards Chapter 4.2 'Building Near Trees'.

4.3.1 Shallow Foundations into the Head

Based on a 5.00 by 0.75m strip foundation, using commercial software Table 4.1 shows the calculated bearing values and anticipated settlement characteristics. The maximum encountered depth of Topsoil was 0.40m bgl. Roots were encountered from a depth of 0.40m bgl to 2.00m bgl. As such, bearing capacities were calculated below a depth of 1.00m bgl.

Table 4.1 Allowable Bearing Capacities within Head

Depth (m bgl)	Size (m)	Bearing Capacity (kPa)	Anticipated Settlement (mm)
1.20	5.00 x 0.75	100	20
1.50		125	25
2.00		125	25

The use of reinforced trench fill foundations is recommended as it would simplify construction and reduce the possibility of differential settlement affecting the foundations.

For the allowable bearing value given above, settlements should not exceed the presented values, provided that excavation bases are carefully bottomed out and blinded, or concreted as soon after excavation as possible and kept dry.

Foundations must not be constructed over former structures and other hard spots. The foundations design must be suitable for the conditions present at the site.

The anticipated settlement includes both elastic settlement and long-term drained settlement (in the case of cohesive soils).

Anticipated settlements may be taken as proportional to the bearing capacity adopted (for the same configuration of foundation), therefore if the bearing value is halved the anticipated settlement will halve.

All loose material and soft spots must be removed from the base of the excavations, these excavations then being either concreted or blinded as soon after excavation as possible. Failure to do so could result in increased settlements.

4.3.2 Ground Floor Slab

NHBC Standards 2018, Chapter 5.2, Suspended Ground Floors, states:

- *“Ground floors should be constructed as suspended floors where the depth of fill exceeds 600mm”.*
- *“Suspended slabs should be adopted where the foundation depth dictated by the NHBC Standards 2018, Chapter 4.2, Appendix 4.2-C would exceed 1.5m bgl.”*

Depending on the final foundation depth, ground bearing slabs could be adopted for the proposed redevelopment.

4.4 Subsurface Concrete

Sulphate concentration measured in 2:1 water/soil extracts fell into Class **DS-1** of the BRE Special Digest 1 2005, *‘Concrete in Aggressive Ground’*. Table C2 of the Digest indicated ACEC (Aggressive Chemical Environment for Concrete) site classifications of **AC-1**. The pH of the soils tested was 6.5. The classification given was determined using the mobile groundwater case, in view of groundwater being encountered. The laboratory results are presented in Appendix B.3.

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1 2005, *‘Concrete in Aggressive Ground’* taking into account any possible exposure of potentially pyrite bearing natural ground and the pH of the soils.

4.5 Excavations

Shallow excavations in the Topsoil and Head are likely to be marginally stable in the short term at best.

Deeper excavations taken into the Lambeth Group are likely to be unstable in the short term, depending on the thickness of overlying Head. Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported or battered back to a safe angle of repose before excavations are entered by

personnel.

Excavations beneath the groundwater table are likely to be unstable and dewatering of foundation trenches may be necessary.

4.6 Pavements

The Transport Research Laboratory (TRL) Dynamic Cone Penetrometer (DCP) was undertaken at five locations on site (DCP1 – DCP5). The results from dynamic cone penetrometer tests indicated **CBR values of between 8% and 75%** for the soils encountered in the top 1.00m bgl.

When removing 400mm of Topsoil the worst case CBR value was 8% which was considered suitable for design purposes for the majority of the road layout. During the interpretation no areas were highlighted as being potentially problematic

Any soft spots at formation level, should be dug out and replaced with a suitably compacted granular fill. Prior to construction the formation level should be proof rolled. The soils of the Head would be frost susceptible as plasticity indexes were less than 20%. Granular soils would also be frost susceptible due to a high proportion (>10%) of fines being greater than 75 microns.

4.7 Soakaways

Infiltration testing was undertaken in TP1 and TP2 within the Head and Lambeth Group following the principles of BRE Digest 365 Soakaway design: 2016. Given the observed infiltration over the test period, it is considered that area of TP1 and TP2 would be suitable for the adoption of a surface water soakaway system within the Head deposits and Lambeth Group. Design rates can be considered at 9.85×10^{-5} m/sec.

Section 5 Determination of Chemical Analysis

5.1 Site Characterisation and Revised Conceptual Site Model

The Preliminary Investigation Report undertaken by Soils Limited (report ref: 16971/PIR dated July 2018) identified a very low risk of ground contamination from previous usage of the site.

The Main Investigation Report did not identify any areas of Made Ground. Nor were any visual or olfactory signs of contamination noted.

Superficial deposits of Head were encountered underlying the Topsoil. Shallow groundwater was encountered within the Head. The conceptual site model was updated to take account of the shallow groundwater encountered at the site and presented in Appendix C.1.

5.2 Soil Sampling

A non-targeted sampling strategy is appropriate when there is:

- No adequate information available regarding the likely locations of contamination;
- No sensitive areas where there is a need for a high degree of confidence.

A targeted sampling strategy is appropriate when there is:

- Adequate information available regarding the likely locations of contamination
- Sensitive areas where there is a need for a high degree of confidence.

The CSM identified potential sources and a targeted sampling pattern was adopted as appropriate to these sources. Table 5.1 outlines the sampling undertaken.

Table 5.1 Sampling Strategy

Sample	Strategy	Proposed Use
WS1:0.50	Topsoil	Private rear garden
WS2:0.20	Topsoil	Private rear garden
WS3:0.20	Near area of burnt material	Private rear garden
WS3:0.50	Natural sub-soil near area of burnt material	Private rear garden
WS4:0.10	Topsoil	Private rear garden

5.3 Determination of Chemical Analysis

The driver for determination of the analysis suite was the information obtained from the Preliminary Investigation Report and Main Investigation Report intrusive investigation.

Table 5.2 outlines the specification for each sample tested.

Table 5.2 Chemical Analysis Specification

Substance	Locations: Depths (m bgl)				
	WS1:0.50 ^s	WS2:0.20 ^s	WS3:0.20 ^s	WS3:0.50 ^s	WS4:0.10 ^s
Asbestos Screen	✓	✓	✓	✓	✓
Total Phenols	✓	✓	✓	✓	✓
Total Cyanide	✓	✓	✓	✓	✓
Organic Matter	✓	✓	✓	✓	✓
pH	✓	✓	✓	✓	✓
Metals	✓	✓	✓	✓	✓
Metalloids	✓	✓	✓	✓	✓
Organics	✓	✓	✓	✓	✓
PAHs	✓	✓	✓	✓	✓
TPH-CWG	✓		✓		
BTEX	✓		✓		

Notes: **Metals:** Cd, Cr, Pb, Hg, Ni, Se, CN, S, Cu, Zn, Bo, V. **metalloids:** As. **organics:** USEPA 16 speciated PAH, TPH-CWG (speciated TPH), BTEX, **Asbestos screening** was undertaken in accordance with HSG 248. ^s = Soil sample.

Section 6 Qualitative Risk Assessment

6.1 Assessment Criteria

The assessment criteria used to determine risks to human health are derived and explained within Appendix C.3.

6.2 Representative Contamination Criteria - Soil

The proposed development comprised the erection of eight two-storey, three to five-bedroom detached residential properties. The development included hard landscaping such as vehicular access roads, private driveways and pedestrian access routes. Soft land scaping included private gardens, border planting and areas of open grass.

In compiling this report reliance was placed on drawing SK03a, dated January 2018 and was prepared by Crayfern Homes Limited. Any change or deviation from the scheme outlined in the drawing could invalidate the recommendations presented within this report. Soils Limited must be notified about any such changes.

The chemical laboratory results were compared against the representative contaminants concentration for human health receptor to Soil Guideline Values (SGV), Category 4 Screening Levels (C4SL's) or Suitable 4 Use Level (S4UL).

Table 6.1 outlines the samples that have exceeded their relevant assessment criteria. The full laboratory report is presented in Appendix C.2.

Table 6.1 Summary of Chemical Analysis of Soils Sample Exceedance

Substance	Sample locations where SGV, C4SL or S4UL adopted were exceeded for the 'Residential with plant uptake' land-use scenario
No exceedances identified	

The guideline values are assessed against the "Residential with plant uptake" land-use scenario, which was considered the most appropriate land-use scenario, given the type of proposed redevelopment.

To assess the potential toxicity to the human health receptor from the concentrations of organic compounds tested for, Soil Organic Matter (SOM) tests were undertaken on the samples submitted for chemical testing, which revealed SOM values of between 0.5% and 2.9%. For each soil sample tested, the Soil Organic Matter recorded was used to derive the appropriate guideline value for organic determinants.

In summary, none of the samples tested showed concentrations in excess of the relevant C4SL or S4UL for a residential with plant uptake land-use scenario.

6.2.1 Asbestos

Asbestos Containing Material (ACM) was not detected within any of the samples.

Although asbestos containing material was not identified, it is possible that asbestos is present in other areas of the site. If encountered, care must be taken to ensure any such material is separated and disposed of in an appropriate manner to a licensed waste facility.

6.3 Tier I Quantitative Risk Assessment

Quantitative risk assessments are undertaken for the soil, groundwater and soil gas. The CSM has been updated to take account of the assessments below and presented in Appendix C.1. The full laboratory chemical report is presented in Appendix D.2.

6.3.1 Soils

None of the samples tested showed concentrations in excess of the relevant C4SL or S4UL for a residential with plant uptake land-use scenario. Furthermore, Asbestos Containing Material (ACM) was not detected within any of the sample tested.

The Tier 1 Quantitative risk assessment therefore established that there was **no risk to the human health receptors** of construction workers or future end-users.

6.3.2 Groundwater

A groundwater risk assessment was not included within the scope of this project. However, considering that no Made Ground or soil contamination was identified during the investigation, the **risk to groundwater is negligible**.

6.3.3 Soil Gas

The Preliminary Investigation Report identified no risk of soil gas from on and offsite sources. Therefore, the **risk of soil gas is negligible**.

No sources of soil contamination have been identified from the Preliminary investigation nor the Main Investigation report. As such no remedial works will be required on the site.

6.4 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust is generated as a result of construction activities. The site should be securely fenced at all times to prevent unauthorised access.

Washing facilities should be provided and eating restricted to mess huts.

6.5 Excavated Material

Excavated material as waste must be defined or classified prior to any disposal, transport, recycling or re-use at or by an appropriately licensed or exempt carrier and/or off-site disposal facility. The requirements inherent in both Duty of Care and Health and Safety must also be complied with. In order to determine what is to happen, what is suitable, appropriate and most effective in the disposal of wastes, especially those subject to CDM waste management plan requirements, several factors must be considered and competent advice should always be sought.

The amount, type and nature of the material to be removed will in part determine the amount and type of analysis that may be required to comply with current waste guidance, and thereby allow a competent person to suitably classify the material. Often this data is uncertain or unavailable, especially in the early stages of a project, and therefore further investigation, testing and analysis may be required as additional information regarding the development becomes available.

Wastes must be classified and defined by their solid characteristics to comply with current waste guidance. Existing information and analysis derived for environmental purposes may therefore be suitable for use in this context. Waste Acceptance Criteria (WAC) report the leachability of materials and therefore cannot be used to classify, characterise or define wastes. The only purpose of a WAC analysis is to determine the suitability of a given material for acceptance at one of the three different types of available licenced landfills (inert, stable non-reactive hazardous or hazardous).

Other options are available that may lead to significant savings against disposal to landfill and expert advice should always be sought from a competent person to advise on their relative costs or benefits and advise on any additional analysis, sampling or investigation that may be required to reduce remaining uncertainties and comply with current guidance. Further consideration of results using HazWasteOnline™ can be undertaken on request to give an indication of potentially hazardous properties in the materials analysed.

6.6 Re-use of Excavated Material On-site

The re-use of on-site soils may be undertaken either under the Environmental Permitting Regulations 2007 (EPR), in which case soils other than uncontaminated soils are classed as waste, or under the CL:AIRE Voluntary Code of Practice (CoP) which was published in September 2008 and is accepted as an alternative regime to the EPR.

Under the EPR, material that is contaminated but otherwise suitable for re-use is also classified as waste and its re-use should be in accordance with the Environmental Permitting Regulations 2007 (EPR). Environmental Permit Exemptions (EPE) are for the re-use of non-hazardous or inert waste only; hazardous waste cannot be re-used under a

permit exemption. EPE apply only to imported inert waste materials; inert material arising on site and recovered on site is not classified as waste and does not require an exemption. It is possible that materials arising on-site will be classified as inert and would not need an exemption.

Environmental Permit Exemptions are only allowed for certain activities, placing controls on the quantities that can be stored and re-used. The re-use of waste shall be within areas and levels defined in planning applications and permissions for the development. An EPE requires a site-specific risk assessment for the receptor site to demonstrate that the materials are suitable for use, i.e. that they will not give rise to harm to human health or pollution of the environment.

Under the CL:AIRE voluntary code of practice (CoP) materials excavated on-site are not deemed contaminated if suitable for re-use at specified locations or generally within the site.

Material that may have been classified as hazardous waste under the EPR may be re-used. The CoP regime requires that a 'Qualified Person' as defined under the CoP reviews the development of the Materials Management Plan, including review of Risk Assessments and Remediation Strategy/Design Statement together with documentation relating to Planning and Regulatory issues, and signs a Declaration which is forwarded to the Environment Agency and which confirms compliance with the CoP.

Should it be necessary to import materials from another site where materials are excavated and which is not material from a quarry or produced under a WRAP protocol, then an EPE would be necessary for the imported material whether the work was managed under the CoP or the EPR.

6.7 Imported Material

Any soil, which is to be imported onto the site, must undergo chemical analysis to permit classification prior to its importation and placement in order to ascertain its status with specific regard to contamination, i.e. to prove that it is suitable for the purpose for which it is intended.

6.8 Discovery Strategy

There may be areas of contamination not identified during the course of the investigation. Such occurrences may also be discovered during the demolition and construction phases for the redevelopment of the site.

Care should be taken during excavation works especially to investigate any soils, which appear by eye (e.g. such as fibrous materials, large amounts of ash and unusual discolouration), odour (e.g. fuel, oil and chemical type odours or unusual odours such as sweet odours or fishy odours) or wellbeing (e.g. light headedness and/or nausea, burning of nasal passages and blistering or reddening of skin due to contact with soil) to

be contaminated or of unusual and/or different character to standard soils or those analysed.

In the event of any discovery of potentially contaminated soils or materials, this discovery should be quarantined and reported to the most senior member of site staff or the designated responsible person at the site for action. The location, type and quantity must be recorded and the Local Authority, and a competent and appropriate third party Engineer/Environmental consultant notified immediately. An approval from the Local authority must be sought prior to implementing any proposed mitigation action.

The discovery strategy must remain on site at all times and must demonstrate a clear allocation of responsibility for reporting and dealing with contamination. A copy of the strategy must be placed on the health and safety notice board and /or displayed in a prominent area where all site staff are able to take note of and consult the document at any time. Any member of the workforce entering the site to undertake any excavation must be made aware of the potential to discover contamination and the discovery strategy.

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Appendix C.1 Conceptual Site Model

Appendix C.2 Chemical Laboratory Results

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Appendix D Information Provided by the Client

Figure 1 – Site Location Map

Job Number
16971

Project
Land at Arundel Road, Fontwell, West Sussex BN18
0QP

Client
Crayfern Homes

Date
July 2018



Figure 2 – Aerial Photograph

Project

Land at Arundel Road, Fontwell,
West Sussex BN18 0QP

Client

Crayfern Homes

Date

July 2018

Job Number

16971





Figure 3 – Trial Hole Plan

Project
Land at Arundel Road, Fontwell,
West Sussex BN18 0QP

Client
Crayfern Homes

Date
July 2018

Job Number
16971



Appendix A Field Work

Appendix A.1 Engineers Logs

**Soils Limited**

Newton House, Cross Road, Tadworth KT20 5SR

Borehole Log

Borehole No.

WS1

Sheet 1 of 1

Project Name: Land at Arundel Road

Project No.: 16971

Co-ords:

Hole Type

WS

Location: Land at Arundel Road, Fontwell

Level:

Scale

1:50

Client: Crayfern Homes

Dates: 31/05/2018 - 11/06/2018

Logged By

AP

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	J+D		0.55		Dark brown sandy gravelly SILT. Sand is fine. Gravel is fine to coarse sub-rounded to angular flint. Frequent fine to medium roots and rootlets. TOPSOIL.		
		0.50	J+D						
		0.80	J+D						
		1.50	D	2.70			Stiff dark orangish brown sandy very gravelly CLAY and very clayey GRAVEL. Sand is fine to coarse. Gravel is fine to coarse sub-angular to angular flint. HEAD.		1
		2.30	D				2		
		2.80	D				3		
		3.30	D	3.60			Stiff light grey occasionally mottled orangish brown slightly silty CLAY. Frequent black ferruginous staining. Rare fine to medium rounded flint. LAMBETH GROUP.		3
		3.80	D				70% Recovery		
		4.50	D				5.00		
				50% Recovery					
		End of Borehole at 5.00m	5						
							6		
							7		
							8		
							9		
							10		

General Remarks:

Roots observed to 0.55m bgl. Installed to 3.40m bgl due to backfilling of borehole.

Groundwater Remarks:

No groundwater encountered.

Borehole TypeCP: Cable Percussive
WS: Windowless Sampler
RC: Rotary Cored**Sample Types**D: Disturbed
B: Bulk
J: Jar
W: Water
U: Undisturbed**In-Situ Testing**SPT: Split spoon - Standard Penetration Test
CPT: Cone - Standard Penetration Test

**Soils Limited**

Newton House, Cross Road, Tadworth KT20 5SR

Borehole Log

Borehole No.

WS2

Sheet 1 of 1

Project Name: Land at Arundel Road

Project No.: 16971

Co-ords:

Hole Type

WS

Location: Land at Arundel Road, Fontwell

Level:

Scale

1:50

Client: Crayfern Homes

Dates: 31/05/2018 - 11/06/2018

Logged By

AP

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (mAOD)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		0.20	J+D		0.40		Grass over dark brown sandy gravelly SILT. Sand is fine. Gravel is fine to coarse sub-angular flint. Frequent fine roots and rootlets. TOPSOIL.	1		
		0.50	J+D				Dark orangish brown very clayey sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse sub-angular to angular flint. HEAD.			
		0.80	J+D							
		1.30	D							
		1.80	D							
					2.00				End of Borehole at 2.00m	2
										3
										4
										5
										6
										7
										8
										9
										10

General Remarks:

Roots observed to 0.40m bgl.

Groundwater Remarks:

No groundwater encountered.

Borehole TypeCP: Cable Percussive
WS: Windowless Sampler
RC: Rotary Cored**Sample Types**D: Disturbed
B: Bulk
J: Jar
W: Water
U: Undisturbed**In-Situ Testing**SPT: Split spoon - Standard Penetration Test
CPT: Cone - Standard Penetration Test



Soils Limited
Newton House, Cross Road, Tadworth KT20 5SR

Borehole Log

Borehole No.

WS3

Sheet 1 of 1

Project Name: Land at Arundel Road

Project No.: 16971

Co-ords:

Hole Type
WS

Location: Land at Arundel Road, Fontwell

Level:

Scale
1:50

Client: Crayfern Homes

Dates: 31/05/2018 - 11/06/2018

Logged By
AP

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (mAOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	J+D		0.45		Dark orangish brown sandy gravelly SILT. Sand is fine. Gravel is fine to medium sub-rounded to sub-angular flint. Frequent fine roots and rootlets. TOPSOIL.	1	
		0.50	J+D						Stiff dark orangish brown sandy very gravelly CLAY and very clayey GRAVEL. Sand is fine to coarse. Gravel is fine to coarse sub-angular to angular flint. HEAD.
		0.80	J+D						
		1.50	D			Stiff light grey mottled orangish brown slightly silty sandy CLAY. Sand if fine. Frequent black ferruginous staining. LAMBETH GROUP.	2		
		2.30	D						
		2.80	D						
		3.30	D						
		3.80	D						
					3.40		Orangish brown clayey fine to medium SAND. Occasional bands of soft light grey sandy CLAY. LAMBETH GROUP.	3	
					3.70		Dark orange slightly gravelly fine to medium SAND. Gravel is fine to medium sub-angular to angular flint and shell fragments. LAMBETH GROUP.		
		4.00		Dark orange slightly gravelly fine to medium SAND. Gravel is fine to medium sub-angular to angular flint and shell fragments. LAMBETH GROUP.	4				
				End of Borehole at 4.00m					
								5	
								6	
								7	
								8	
								9	
								10	

General Remarks:

Roots observed to 0.45m bgl. Installed to 4.0m bgl.

Groundwater Remarks:

No groundwater encountered.

Borehole Type

CP: Cable Percussive
WS: Windowless Sampler
RC: Rotary Cored

Sample Types

D: Disturbed
B: Bulk
J: Jar
W: Water
U: Undisturbed

In-Situ Testing

SPT: Split spoon - Standard Penetration Test
CPT: Cone - Standard Penetration Test

**Soils Limited**

Newton House, Cross Road, Tadworth KT20 5SR

Borehole Log

Borehole No.

WS4

Sheet 1 of 1

Project Name: Land at Arundel Road

Project No.: 16971

Co-ords:

Hole Type

WS

Location: Land at Arundel Road, Fontwell

Level:

Scale

1:50

Client: Crayfern Homes

Dates: 31/05/2018 - 11/06/2018

Logged By

AP

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (mAOD)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		0.10	J+D		0.50		Very soft dark brown and light brown sandy gravelly silty CLAY. Sand is fine. Gravel is fine to medium sub-rounded to angular flint. Frequent fine to medium roots and rootlets. TOPSOIL.	1		
		0.45	J+D						Stiff dark orangish brown sandy very gravelly CLAY and very clayey GRAVEL. Sand is fine to coarse. Gravel is fine to coarse sub-angular to angular flint. HEAD.	2
		0.80	J+D							
		1.50	D		3.00				End of Borehole at 3.00m	3
		2.30	D							
		2.80	D							
										4
										5
										6
										7
										8
										9
										10

General Remarks:

Roots observed to 0.50m bgl.

Groundwater Remarks:

No groundwater encountered.

Borehole TypeCP: Cable Percussive
WS: Windowless Sampler
RC: Rotary Cored**Sample Types**D: Disturbed
B: Bulk
J: Jar
W: Water
U: Undisturbed**In-Situ Testing**SPT: Split spoon - Standard Penetration Test
CPT: Cone - Standard Penetration Test

Project Name:	Land at Arundel Road	Project No.	16971	Co-ords:		Hole Type	DP
Location:	Land at Arundel Road, Fontwell	Level:	m AOD			Scale	1:50
Client:	Crayfern Homes	Dates:	31/05/2018			Logged By	PI

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0.0	1				
0.1	4				
0.2	3				
0.3	3				
0.4	3				
0.5	2				
0.6	4				
0.7	11				5
0.8	9				
0.9	9				
1.0	7				
1.1	7				
1.2	8				
1.3	10				
1.4	15				
1.5	16				
1.6	12				10
1.7	10				
1.8	13				
1.9	10				
2.0	19				
2.1	11				
2.2	11				
2.3	8				
2.4	3				
2.5	2				
2.6	3				
2.7	2				
2.8	3				
2.9	2				
3.0	1				
3.1	3				
3.2	3				
3.3	2				
3.4	3				
3.5	5				
3.6	5				
3.7	5				
3.8	5				
3.9	7				
4.0	4				
4.1	4				
4.2	3				
4.3	4				
4.4	4				
4.5	5				
4.6	6				75
4.7	4				
4.8	3				
4.9	3				
5.0	3				
5.1	3				
5.2	3				
5.3	2				
5.4	2				
5.5	1				
5.6	1				
5.7	2				60
5.8	2				
5.9					
6.0					
6.1					
6.2					
6.3					
6.4					
6.5					
6.6					
6.7					
6.8					
6.9					
7.0					
7.1					
7.2					
7.3					
7.4					
7.5					
7.6					
7.7					
7.8					
7.9					
8.0					
8.1					
8.2					
8.3					
8.4					
8.5					
8.6					
8.7					
8.8					
8.9					
9.0					
9.1					
9.2					
9.3					
9.4					
9.5					
9.6					
9.7					
9.8					
9.9					
10.0					
Remarks	Fall Height 750mm		Cone Base Diameter 50.5mm		
	Hammer Weight 63.5kg		Final Depth 6m		
	Probe Type DPSH-B		Energy Ratio (Er) 78.23%		



Soils Limited

Newton House, Cross Road, Tadworth KT20 5SR

Probe Log

Probe No.

DP2

Sheet 1 of 1

Project Name:	Land at Arundel Road	Project No.	16971	Co-ords:		Hole Type	DP
Location:	Land at Arundel Road, Fontwell	Level:	m AOD			Scale	1:50
Client:	Crayfern Homes	Dates:	31/05/2018			Logged By	PI

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
1	1	2	3	4	5
2	6	9	10	12	115
3	10	13	15	18	210
4	12	14	13	12	
5	6	8	9	10	
6	14	5			
7					
8					
9					
10					
Remarks	Fall Height	750mm	Cone Base Diameter	50.5mm	
	Hammer Weight	63.5kg	Final Depth	3m	
	Probe Type	DPSH-B	Energy Ratio (Er)	78.23%	



Soils Limited

Newton House, Cross Road, Tadworth KT20 5SR

Probe Log

Probe No.

DP3

Sheet 1 of 1

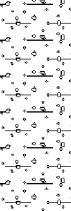
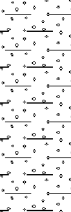
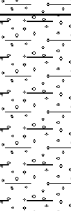
Project Name:	Land at Arundel Road	Project No.	16971	Co-ords:		Hole Type	DP
Location:	Land at Arundel Road, Fontwell	Level:	m AOD			Scale	1:50
Client:	Crayfern Homes	Dates:	31/05/2018			Logged By	PI

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0	1	1	2	4	0
1	9	9	11	21	
	8	8	11	12	
2	7	10			50
	7	9			
	7	7			
3	5	6			150
	5	8			
	9	10			
	11	11			
4	14	15			210
	15				
5					
6					
7					
8					
9					
10					
Remarks	Fall Height	750mm	Cone Base Diameter	50.5mm	
	Hammer Weight	63.5kg	Final Depth	4m	
	Probe Type	DPSH-B	Energy Ratio (Er)	78.23%	

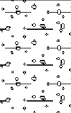
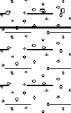
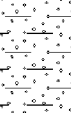
Project Name:	Land at Arundel Road	Project No.	16971	Co-ords:		Hole Type	DP
Location:	Land at Arundel Road, Fontwell	Level:	m AOD			Scale	1:50
Client:	Crayfern Homes	Dates:	31/05/2018			Logged By	PI

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0	1 1 2 1 1 4 6 9 12				0
20	8 9 10 8 10 11 12 14 14				20
100	11 11 13 15 14 11 19 17 20 14 14 14				100
40	9 10 8 8 11 13 17 16 20 20 19 19 21				40
50	5 11				50
75	2 3 3 2 3 3 3 3 3 4 5 6 6 7 8 7 10 12 12 16				75
210					210
8					
9					
10					
Remarks		Fall Height 750mm	Cone Base Diameter 50.5mm		
		Hammer Weight 63.5kg	Final Depth 7m		
		Probe Type DPSH-B	Energy Ratio (Er) 78.23%		

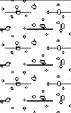
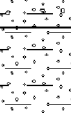
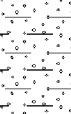
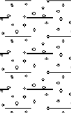
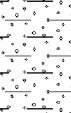
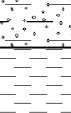
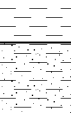
Project Name: Land at Arundel Road	Project No.: 16971	Method: Mechanical Excavator	Hole Type
Location: Land at Arundel Road, Fontwell		Plant: JCB 3CX	TP
Client: Crayfern Homes	Trial Pit Length: 1.30m	Support: None	Scale
Dates: 31/05/2018	Level:	Trial Pit Width: 0.50m	1:25
	Co-ords:		Logged By
			TR

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20	D		0.35			Dense vegetation over dark brown slightly gravelly slightly sandy SILT with frequent roots and rootlets. TOPSOIL	
	0.50	B		1.10			Light orangish brown sandy silty fine to medium subangular to angular flint GRAVEL. Sand is fine. HEAD.	1
	1.00	B		1.90			Orangish brown clayey fine to medium subangular to angular flint GRAVEL. HEAD.	
	1.50	B		2.80			Dark brown clayey fine to medium subangular to angular flint GRAVEL. HEAD.	2
	2.00	B		3.50			Light orangish brown very sandy fine to medium sub rounded to sub angular flint GRAVEL. Sand is fine to medium	3
	2.50	B						
	3.00	B						
	3.50	B					End of Pit at 3.50m	4
								5

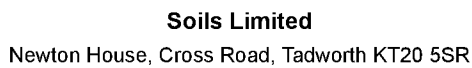
General Remarks:	Sample Type
Roots observed to 1.50m bgl.	D: Disturbed
	B: Bulk
	J: Jar
Groundwater Remarks: Groundwater encountered at 2.10m bgl.	W: Water

 Soils Limited Newton House, Cross Road, Tadworth KT20 5SR 				Trial Pit Log		Trial Pit No. TP2	
Project Name: Land at Arundel Road				Project No.: 16971		Method: Mechanical Excavator	
Location: Land at Arundel Road, Fontwell				Plant: JCB 3CX		Hole Type TP	
Client: Crayfern Homes				Trial Pit Length: 1.30m		Trial Pit Width: 0.50m	
Dates: 31/05/2018				Level:		Co-ords:	
Logged By TR							
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.20	D					Dense vegetation over dark brown slightly gravelly slightly sandy SILT with frequent roots and rootlets. TOPSOIL
	0.50	B		0.40			Light orangish brown sandy silty fine to medium subangular to angular flint GRAVEL. Sand is fine. HEAD.
	1.00	D		0.90			Orangish brown clayey fine to medium subangular to angular flint GRAVEL. HEAD.
	1.50	D					
	2.00	D		1.80			Dark brown clayey fine to medium subangular to angular flint GRAVEL. HEAD.
	2.50	D		2.50			End of Pit at 2.50m
1 2 3 4 5							
General Remarks: Roots observed to 1.50m bgl.							Sample Type D: Disturbed B: Bulk J: Jar W: Water
Groundwater Remarks: No groundwater encountered.							

Project Name: Land at Arundel Road		Project No.: 16971		Method: Mechanical Excavator		Hole Type TP
Location: Land at Arundel Road, Fontwell				Plant: JCB 3CX		
Client: Crayfern Homes		Trial Pit Length: m		Trial Pit Width: m		
Dates: 31/05/2018		Level:		Co-ords:		Scale 1:25
						Logged By TR

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20	D					Dense vegetation over dark brown slightly gravelly slightly sandy SILT with frequent roots and rootlets. TOPSOIL	
	0.50	B		0.40			Light orangish brown sandy silty fine to medium subangular to angular flint GRAVEL. Sand is fine. HEAD.	
	1.00	D		0.90			Orangish brown clayey fine to medium subangular to angular flint GRAVEL. HEAD.	1
	1.50	D						
	2.00	D						2
	2.50	D		2.60			Firm grey CLAY. LAMBETH GROUP.	
	3.00	D						3
	3.50	D		3.40			Light grey mottled orange very sandy CLAY. Sand is fine. LAMBETH GROUP.	
				3.90			End of Pit at 3.90m	4
								5

General Remarks: Roots observed to 2.00m bgl.		Sample Type D: Disturbed B: Bulk J: Jar W: Water
Groundwater Remarks: Groundwater encountered at 3.50m bgl.		



Trial Pit No.

Sheet 1 of 1

Project No.: 16971

Method:	Mechanical Excavator
---------	----------------------

Hole Type	Location	Depth (ft)	Flow Rate (gpm)	Water Level (ft)	Notes
1	...	...	...	...	...
2	...	...	...	...	...
3	...	...	...	...	...
4	...	...	...	...	...
5	...	...	...	...	...
6	...	...	...	...	...
7	...	...	...	...	...
8	...	...	...	...	...
9	...	...	...	...	...
10	...	...	...	...	...
11	...	...	...	...	...
12	...	...	...	...	...
13	...	...	...	...	...
14	...	...	...	...	...
15	...	...	...	...	...
16	...	...	...	...	...
17	...	...	...	...	...
18	...	...	...	...	...
19	...	...	...	...	...
20	...	...	...	...	...
21	...	...	...	...	...
22	...	...	...	...	...
23	...	...	...	...	...
24	...	...	...	...	...
25	...	...	...	...	...
26	...	...	...	...	...
27	...	...	...	...	...
28	...	...	...	...	...
29	...	...	...	...	...
30	...	...	...	...	...
31	...	...	...	...	...
32	...	...	...	...	...
33	...	...	...	...	...
34	...	...	...	...	...
35	...	...	...	...	...
36	...	...	...	...	...
37	...	...	...	...	...
38	...	...	...	...	...
39	...	...	...	...	...
40	...	...	...	...	...
41	...	...	...	...	...
42	...	...	...	...	...
43	...	...	...	...	...
44	...	...	...	...	...
45	...	...	...	...	...
46	...	...	...	...	...
47	...	...	...	...	...
48	...	...	...	...	...
49	...	...	...	...	...
50	...	...	...	...	...
51	...	...	...	...	...
52	...	...	...	...	...
53	...	...	...	...	...
54	...	...	...	...	...
55	...	...	...	...	...
56	...	...	...	...	...
57	...	...	...	...	...
58	...	...	...	...	...
59	...	...	...	...	...
60	...	...	...	...	...
61	...	...	...	...	...
62	...	...	...	...	...
63	...	...	...	...	...
64	...	...	...	...	...
65	...	...	...	...	...
66	...	...	...	...	...
67	...	...	...	...	...
68	...	...	...	...	...
69	...	...	...	...	...
70	...	...	...	...	...
71	...	...	...	...	...
72	...	...	...	...	...
73	...	...	...	...	...
74	...	...	...	...	...
75	...	...	...	...	...
76	...	...	...	...	...
77	...	...	...	...	...
78	...	...	...	...	...
79	...	...	...	...	...
80	...	...	...	...	...
81	...	...	...	...	...
82	...	...	...	...	...
83	...	...	...	...	...
84	...	...	...	...	...
85	...	...	...	...	...
86	...	...	...	...	...
87	...	...	...	...	...
88	...	...	...	...	...
89	...	...	...	...	...
90	...	...			

Location: Land at Arundel Road, Fontwell

Plant:	JCB 3CX
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Hole Type

Support:	None
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Scale

Client: Crayfern Homes

Trial Pit Length: m

Trial Pit Width: m

1:25

Dates: 31/05/2018

Level:

Co-ords:

Logged By

TR

General Remarks:	Sample Type D: Disturbed B: Bulk J: Jar W: Water
Roots observed to 1.00m bgl.	
Groundwater Remarks: No groundwater encountered.	

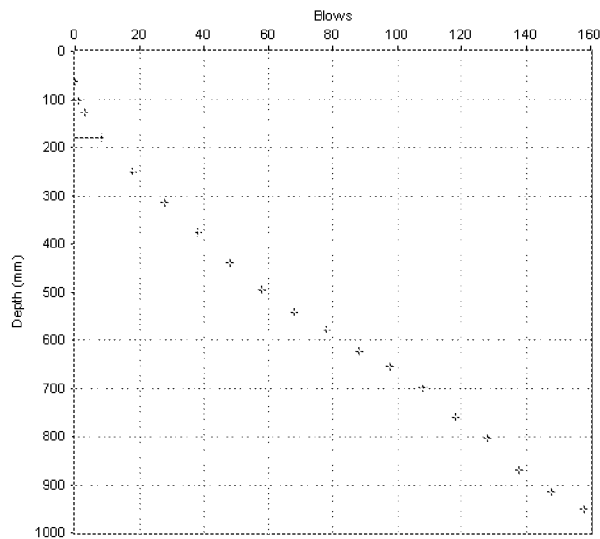
DCP Layer Strength Analysis Report

Project Name: 16971_DCP

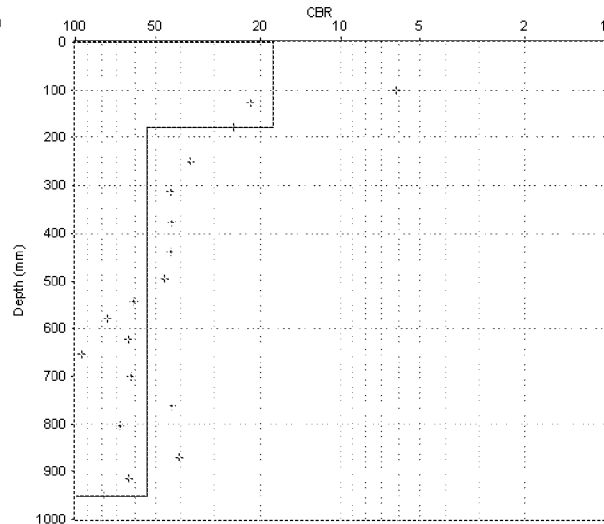
Chainage (km): 1.000
 Direction: 0
 Location/Offset: Lane 1
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 31/05/2018

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Wet
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 1.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	14.50	18	178	178	Base	0.05	0.32	0.32	0.32
2	5.15	53	772	950	Base	0.11	3.23	3.23	3.23

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	3.55	3.55	3.55
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	3.55	3.55	3.55

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

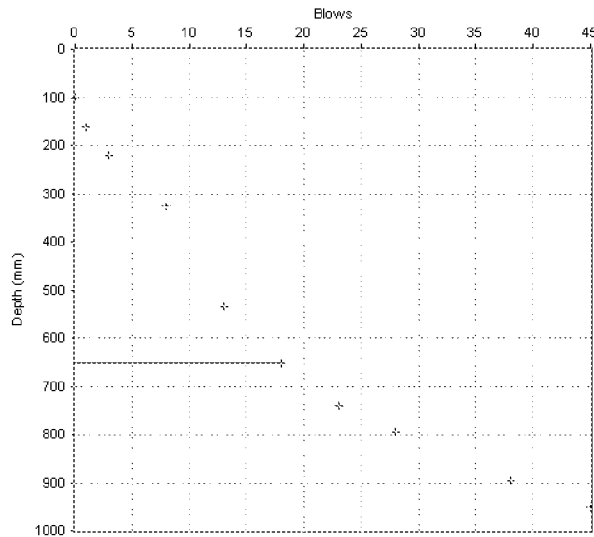
DCP Layer Strength Analysis Report

Project Name: 16971_DCP

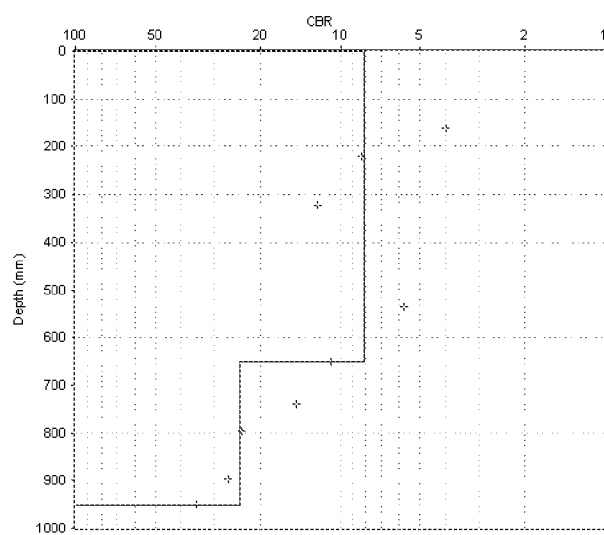
Chainage (km): 2.000
 Direction: 0
 Location/Offset: Lane 2
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 31/05/2018

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 2.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	30.67	8	652	652	Base	0.02	0.57	0.57	0.57
2	11.04	24	298	950	Base	0.06	0.69	0.69	0.69

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	1.26	1.26	1.26
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	1.26	1.26	1.26

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

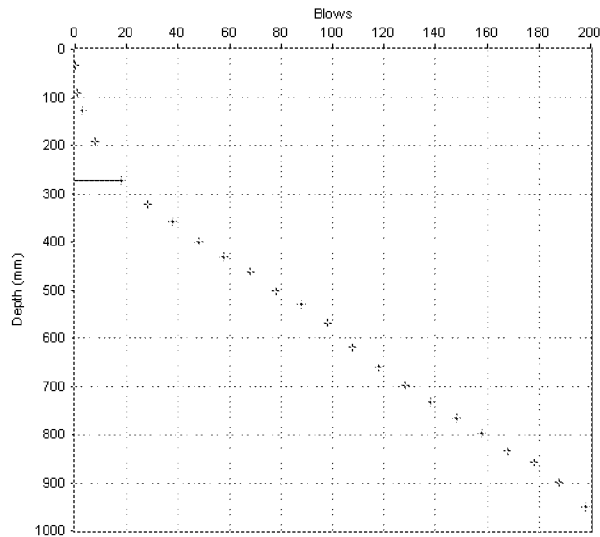
DCP Layer Strength Analysis Report

Project Name: 16971_DCP

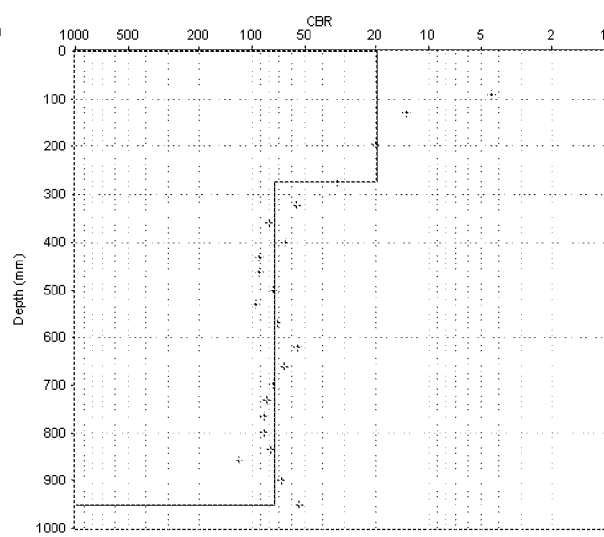
Chainage (km): 3.000
 Direction: 0
 Location/Offset: Lane 3
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 31/05/2018

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 3.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	13.28	20	274	274	Base	0.05	0.54	0.54	0.54
2	3.76	75	676	950	Base	0.13	3.35	3.35	3.35

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	3.89	3.89	3.89
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	3.89	3.89	3.89

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

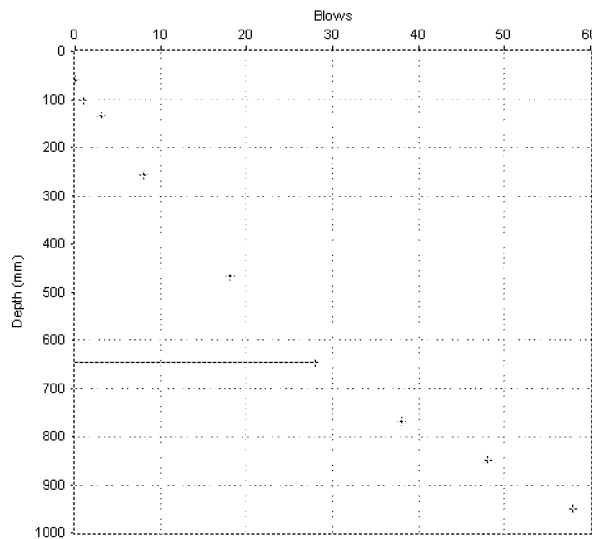
DCP Layer Strength Analysis Report

Project Name: 16971_DCP

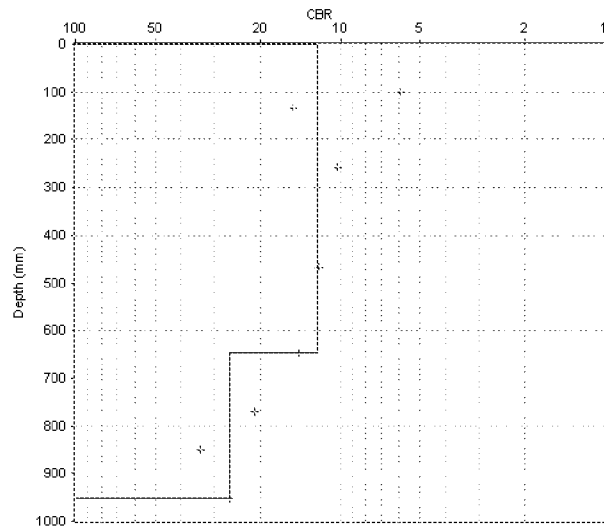
Chainage (km): 4.000
 Direction: 0
 Location/Offset: Lane 4
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 31/05/2018

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 4.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	20.93	12	646	646	Base	0.03	0.83	0.83	0.83
2	10.13	26	304	950	Base	0.06	0.76	0.76	0.76

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	1.59	1.59	1.59
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	1.59	1.59	1.59

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

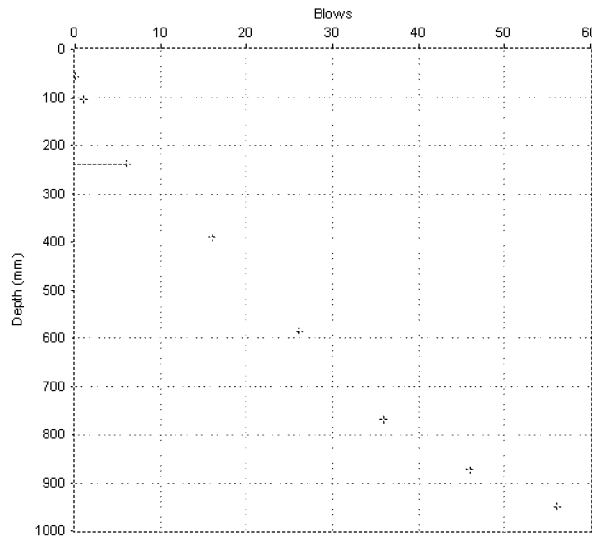
DCP Layer Strength Analysis Report

Project Name: 16971_DCP

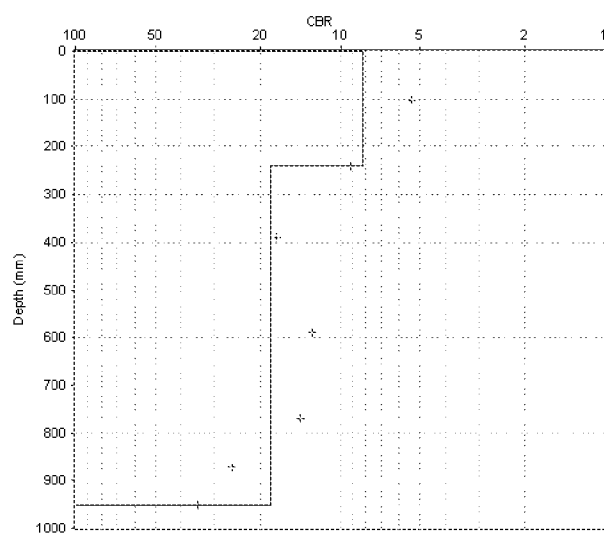
Chainage (km): 5.000
 Direction: 0
 Location/Offset: Lane 5
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 31/05/2018

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 Moisture adjustment factor: Not adjusted

Layer Boundaries: Chainage 5.000



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	Penetration Rate (mm/blow)	CBR (%)	Thickness (mm)	Depth to layer bottom (mm)	Position	Strength Coefficient	SN	SNC	SNP
1	30.33	8	240	240	Base	0.02	0.21	0.21	0.21
2	14.20	18	710	950	Base	0.05	1.31	1.31	1.31

Pavement Strength

Layer	Layer Contribution		
	SN	SNC	SNP
Surface	--	--	--
Base	1.53	1.53	1.53
Sub-Base	--	--	--
Subgrade	--	--	--
Pavement Strength	1.53	1.53	1.53

CBR Relationship:

TRL equation: $\log_{10}(\text{CBR}) = 2.48 - 1.057 \times \log_{10}(\text{Strength})$

Report produced by

Appendix B Geotechnical In-Situ and Laboratory Testing

Appendix B.1 Classification

Classification based on SPT “N” values:

The inferred undrained strength of the cohesive soils was based on the SPT “N” blow counts, derived from the relationship suggested by Stroud (1974) and classified using Table B.1.1. (Ref: Stroud, M. A. 1974, “The Standard Penetration Test – its application and interpretation”, Proc. ICE Conf. on Penetration Testing in the UK, Birmingham. Thomas Telford, London.).

Table B.1.1 SPT “N” Blow Count Cohesive Classification

Classification	Undrained Cohesive Strength C_u (kPa)
Extremely low	<10
Very low	10 – 20
Low	20 – 40
Medium	40 – 75
High	75 – 150
Very high	150 – 300
Extremely high	> 300

Note: (Ref: BS EN ISO 14688-2:2004+A1:2013 Clause 5.3.)

The relative density of granular soils was classified based of the relationship given in Table B.1.2.

The *UK National Annex to Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing, NA 3.7 SPT test, BS EN 1997-2:2007, Annex F* states “Relative density descriptions on borehole records should also be based on uncorrected SPT N values, unless significantly disturbed, using the density classification in BS 5930:2015, Table 7.

Table B.1.2 SPT “N” Blow Count Granular Classification

Classification	SPT “N” blow count (blows/300mm)
Very loose	0 to 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very dense	Greater than 50

Note: (Ref: The Standard Penetration Test (SPT): Methods and Use, CIRIA Report 143, 1995)

Classification of DCP results to CBR:

The DCP consists of a cone fixed to the bottom of a 575mm vertical rod. An 8kg weight is repeatedly lifted and dropped onto an anvil at the mid-height of the rod to deliver a 'blow'. A vertical scale alongside the rod is used to measure the depth of penetration of the cone. These measurements are then converted to CBR values using the following equation derived from the DTP Interim Advice Note 73/06 – Design Guidance for Road Pavement Foundations:

$$\text{Log}_{10}(\text{CBR}) = 2.48 - 1.057 \times \text{Log}_{10}(\text{mm/blow})$$

Appendix B.2 Interpretation

Table B.2.1 Interpretation of DPSH Blow Counts

DP	Strata	Equivalent SPT N60 Blow Counts	Inferred Cohesive Strength/Granular Density
DPI	HEAD 0.80 – 2.80 Very Clayey GRAVEL	15 - >50	Medium dense to very dense
	LMBE 2.80 – 3.60 Silty CLAY	4 – 7	Low $C_u = 20 - 35 \text{ kPa}$
	LMBE 3.60 – 5.00 Clayey SAND ¹	4 – 26	Loose to medium dense
DP2	HEAD 0.70 – 2.70 Clayey sandy GRAVEL	30 - >50	Dense to very Dense
	LMBE 2.70 – 3.00 Clayey SAND ¹	15 – 19	Medium Dense
DP3	HEAD 0.80 – 2.60 Very Clayey GRAVEL	15 - >50	Medium dense to very dense
	LMBE 2.60 – 3.20 Very sandy CLAY	11 – 22	Medium to high $C_u = 55 - 110 \text{ kPa}$
	LMBE 3.30 – 4.00 Very clayey SAND ¹	30 - >50	Dense to very Dense
DP4	HEAD 0.80 – 5.00 Very Clayey GRAVEL	19 - >50	Medium dense to very dense
	LMBE 5.00 – 6.40 Very clayey SAND ¹	7 – 26	Loose to Medium dense
	LMBE 6.40 – 7.00 Very clayey SAND ¹	30 - >50	Dense to very dense

Note: ¹ Ground conditions inferred past the base of windowless sampler borehole.

Table B.2.2 Interpretation of Atterberg Limit Tests

Stratum	Moisture Content (%)	Plasticity Index (%)	Passing 425µm Sieve (%)	Modified Plasticity Index (%)	Soil Classification	Volume Change Potential	
						BRE	NHBC
HEAD	15-17	28-32	26-65	7-21	CI	None to medium	None to Medium
LMBE	26	49	96	47	CV	High	High

Note: BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)

NHBC Volume Change Potential refers to NHBC Standards Chapter 4.2

Soils Classification based on British Soil Classification System

The most common use of the term clay is to describe a soil that contains enough clay-sized material or clay minerals to exhibit cohesive properties. The fraction of clay-sized material required varies, but can be as low as 15%. Unless stated otherwise, this is the sense used in Digest 240. The term can be used to denote the clay minerals. These are specific, naturally occurring chemical compounds, predominately silicates. The term is often used as a particle size descriptor. Soil particles that have a nominal diameter of less than 2 µm are normally considered to be of clay size, but they are not necessarily clay minerals. Some clay minerals are larger than 2 µm and some particles, 'rock flour' for example, can be finer than 2 µm but are not clay minerals.

(The Atterberg Limit Tests were undertaken in accordance with BS 1377:Part 2:1990 Clauses 3.2, 4.3 and 5)

Table B.2.3 Interpretation of PSD Tests

Location	Depth (m bgl)	Soil Description	Volume Change Potential		Passing 63µm Sieve (%)
			BRE	NHBC	
WS1	1.50	Brown silty clayey fine to coarse sandy fine to coarse GRAVEL.	Yes	No	22
WS2	1.80	Brown silty clayey fine to coarse sandy fine to coarse GRAVEL.	No	No	12
WS4	1.50	Brown clayey fine to coarse sandy silty fine to coarse GRAVEL.	Yes	No	22

Note: BRE 240 states that a soil has a volume change potential when the clay fraction **exceeds 15%**. Only the silt and clay combined fraction are determined by sieving therefore the volume change potential is estimated from the percentage passing the 63µm sieve. NHBC Standards Chapter 4.2 states that a soil is shrinkable if the percentage of silt and clay passing the 63µm sieve is greater than 35% and the Plasticity Index is greater than 10%.

(The Particle Size Distribution Tests were undertaken in accordance with BS 1377: Part 2: 1990 Clause 9)

Appendix B.3 Geotechnical In-Situ and Laboratory Results



Contract Number: 39644

Client Ref: **16971**

Report Date: **26-06-2018**

Client PO: **16971**

Client **Soils Limited**
Newton House
Cross Road
Tadworth
Surrey
KT20 5SR

Contract Title: **Arundel Road, Fontwell**
For the attention of: **John Hills**

Date Received: **15-06-2018**
Date Commenced: **15-06-2018**
Date Completed: **26-06-2018**

Test Description	Qty
Moisture Content BS 1377 : Part 2 : 3.2 - * UKAS	4
1 Point Liquid & Plastic Limit 1377 : 1990 Part 2 : 4.4 & 5.3 - * UKAS	4
PSD Wet Sieve method BS 1377 : 1990 Part 2 : 9.2 - * UKAS	3
PSD: Sedimentation by pipette carried out with Wet Sieve (Wet Sieve must also be selected) BS 1377 : 1990 Part 2 : 9.4 - * UKAS	2
Disposal of Samples on Project	1

Notes: **Observations and Interpretations are outside the UKAS Accreditation**
* - denotes test included in laboratory scope of accreditation
- denotes test carried out by approved contractor
@ - denotes non accredited tests

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.

Approved Signatories:

Alex Wynn (Associate Director) - Ben Sharp (Contracts Manager) - Emma Sharp (Office Manager)
Paul Evans (Quality/Technical Manager) - Richard John (Advanced Testing Manager) - Sean Penn (Administrative/Accounts Assistant)
Wayne Honey (Administrative/Quality Assistant)

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377 : Part 2 : 1990 Method 5)

DESCRIPTIONS

Contract Number

Site Name

Arundel Road, Fontwell

[illegible]

Operators	Checked	25-06-18	Emma Sharp
RO/MH	Approved	26-06-18	Paul Evans





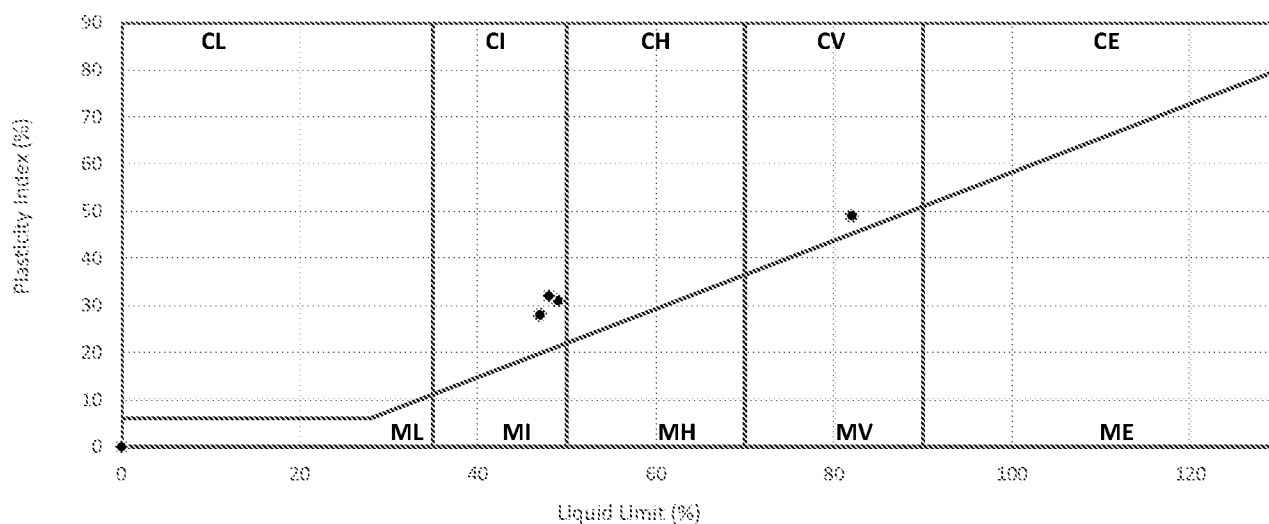
Site Name

Arundel Road, Fontwell

Symbols: NP : Non Plastic

: Liquid Limit and Plastic Limit Wet Sieved

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION



Operators	Checked	25-06-18	Emma Sharp
DB	Approved	26-06-18	Paul Evans





PARTICLE SIZE DISTRIBUTION
BS 1377 Part 2:1990
Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Contract Number **39644**

Borehole/Pit No. **WS1**

Site Name **Arundel Road, Fontwell**

Sample No.

Soil Description

Brown silty clayey fine to coarse sandy fine to coarse GRAVEL.

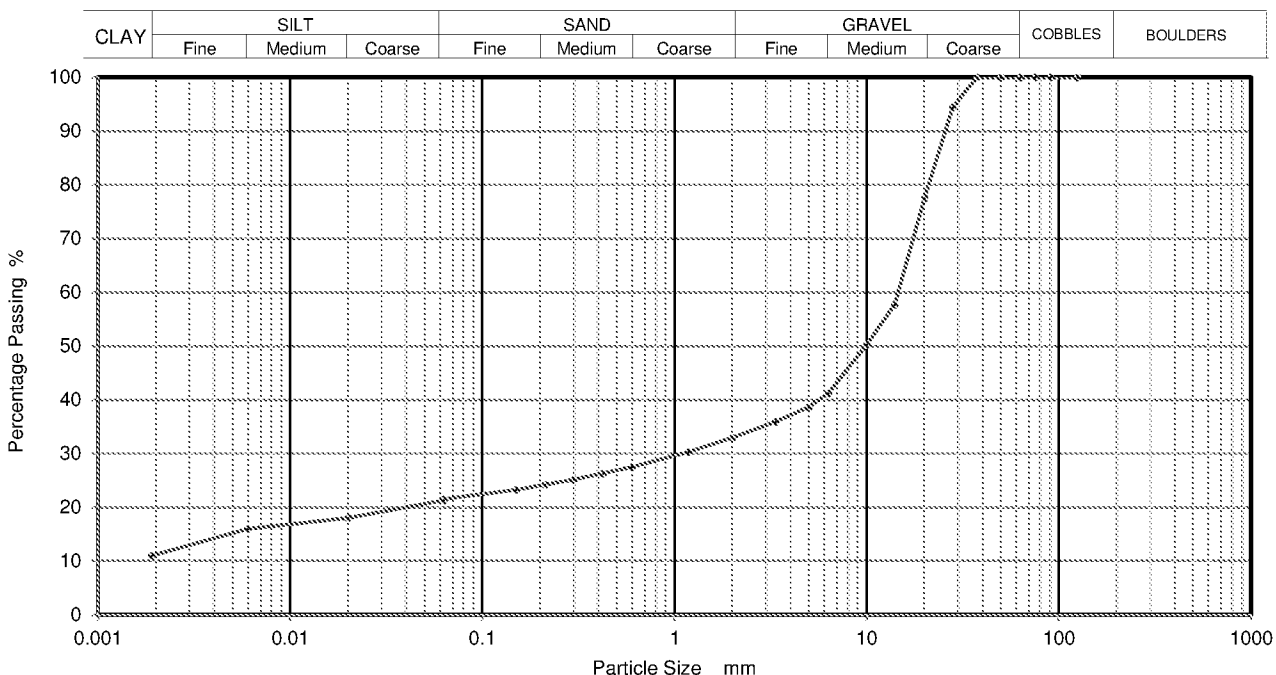
Depth Top

1.50

Depth Base

Sample Type

D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	18
90	100	0.0060	16
75	100	0.0019	11
63	100		
50	100		
37.5	100		
28	94		
20	78		
14	58		
10	50		
6.3	41		
5	39		
3.35	36		
2	33		
1.18	30		
0.6	27		
0.425	26		
0.3	25		
0.212	24		
0.15	23		
0.063	22		

Sample Proportions	% dry mass
Cobbles	0
Gravel	67
Sand	11
Silt	11
Clay	11

Grading Analysis	
Uniformity Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	25-06-18	Emma Sharp
RO/MH	Approved	26-06-18	Paul Evans





PARTICLE SIZE DISTRIBUTION
BS 1377 Part 2:1990
Wet Sieve, Clause 9.2

Contract Number

39644

Borehole/Pit No.

WS2

Site Name

Arundel Road, Fontwell

Sample No.

Soil Description

Brown silty clayey fine to coarse sandy fine to coarse GRAVEL.

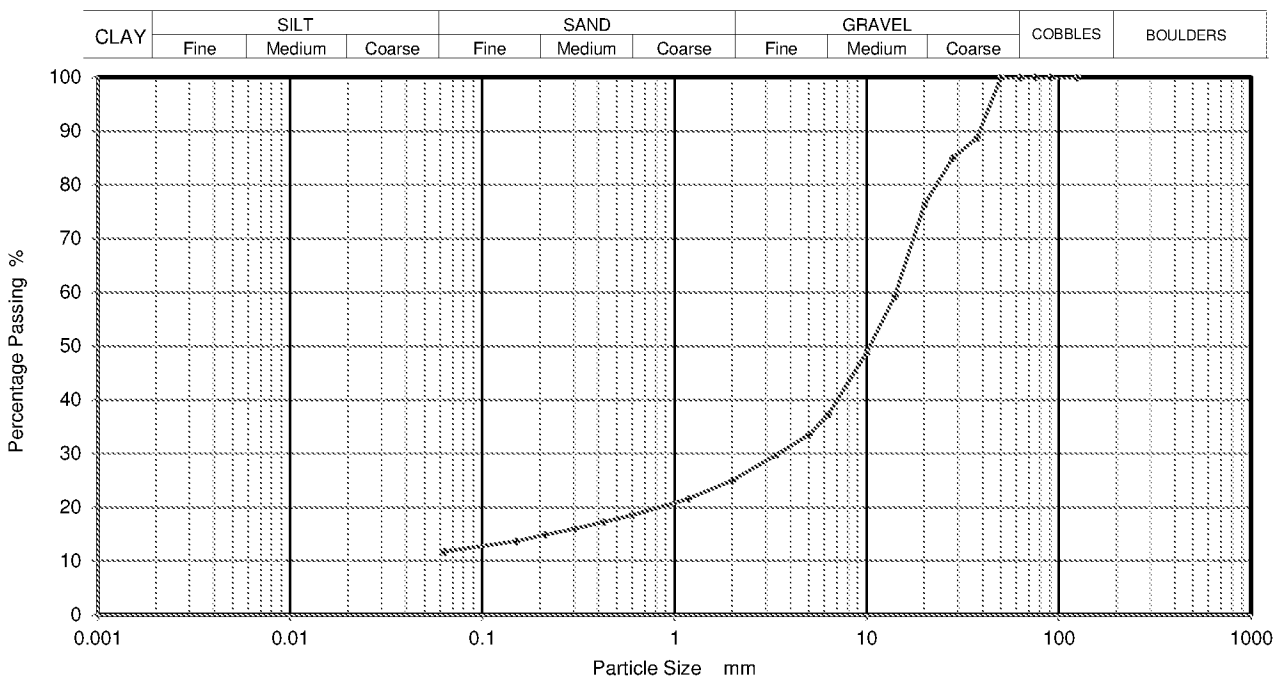
Depth Top

1.80

Depth Base

Sample Type

D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	
90	100	0.0060	
75	100	0.0019	
63	100		
50	100		
37.5	89		
28	85		
20	76		
14	59		
10	49		
6.3	37		
5	33		
3.35	30		
2	25		
1.18	22		
0.6	18		
0.425	17		
0.3	16		
0.212	15		
0.15	14		
0.063	12		

Sample Proportions

% dry mass

Cobbles	0
Gravel	75
Sand	13
Silt and Clay	12

Grading Analysis

Uniformity Coefficient

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	25-06-18	Emma Sharp
RO/MH	Approved	26-06-18	Paul Evans





PARTICLE SIZE DISTRIBUTION
BS 1377 Part 2:1990
Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Contract Number **39644**

Borehole/Pit No. **WS4**

Site Name **Arundel Road, Fontwell**

Sample No.

Soil Description

Brown clayey fine to coarse sandy silty fine to coarse GRAVEL.

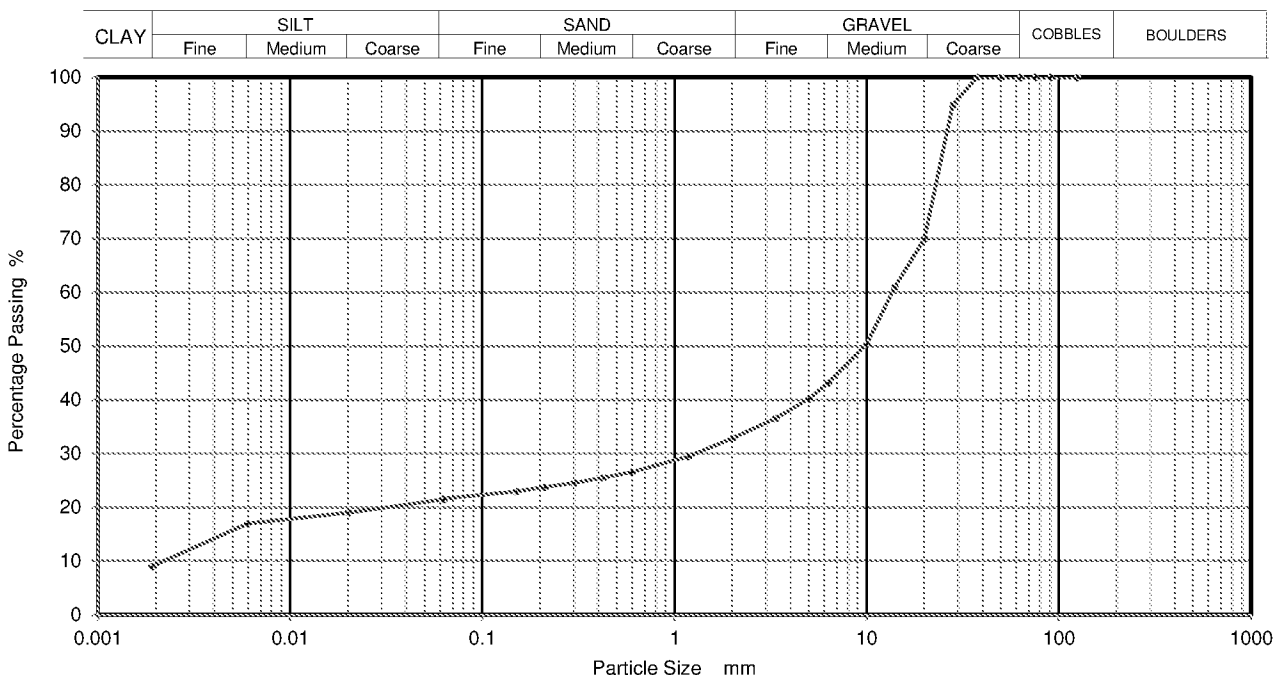
Depth Top

1.50

Depth Base

Sample Type

D



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	19
90	100	0.0060	17
75	100	0.0019	9
63	100		
50	100		
37.5	100		
28	95		
20	70		
14	61		
10	50		
6.3	43		
5	40		
3.35	37		
2	33		
1.18	29		
0.6	27		
0.425	26		
0.3	25		
0.212	24		
0.15	23		
0.063	22		

Sample Proportions	% dry mass
Cobbles	0
Gravel	67
Sand	11
Silt	13
Clay	9

Grading Analysis	
Uniformity Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	25-06-18	Emma Sharp
RO/MH	Approved	26-06-18	Paul Evans



Appendix C Chemical Laboratory Testing

Appendix C.1 Conceptual Site Model

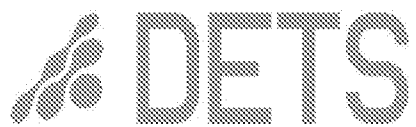
Table C.I.1 CSM Revised Pre Testing

Source	Potential Contaminant	Exposure Pathway	Receptor	Initial Assessment from Preliminary Investigation Report Information			Comments	Proposed Investigation
				Severity	Probability	Risk		
Onsite Source Evidence of burning and fires onsite	Organic Compounds	Inhalation of dust	Site Workers/Site Maintenance	Minor	Low	Very Low	Via private rear gardens	Further Works required. Chemical testing required
			End Users	Minor	Low	Very Low		
			Off-site Users	Minor	Low	Very Low		
	None	Inhalation of Vapour/gases (including Radon)	Site Workers/Site Maintenance	-	-	-	No source identified	
			End Users	-	-	-		
			Off-site Users	-	-	-		
	Organic Compounds	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	Minor	Low	Very Low	Via private rear gardens	
			End Users	Minor	Low	Very Low		
		Migration via surface runoff	Surface Water	Minor	Low	Very Low	Within the superficial Head	
		Migration in solution via groundwater	Surface Water	Minor	Low	Very Low		
			Shallow Aquifer	None	None	None	South of the site located in a SPZ111c associated with the underlying chalk	
			Deep Aquifer	None	None	None		
		Direct contact with construction material	Buried structures	Minor	Low	Very Low	Suitably graded concrete and services to be used	
			Buried Services	Minor	Low	Very Low		
		Migration of gases via permeable soils	Site Workers/Site Maintenance	-	-	-	No source identified	
			End Users	-	-	-		
			Off-site Users	-	-	-		
			Building and confined spaces	-	-	-		

Table C.I.2 CSM Revised Post Testing

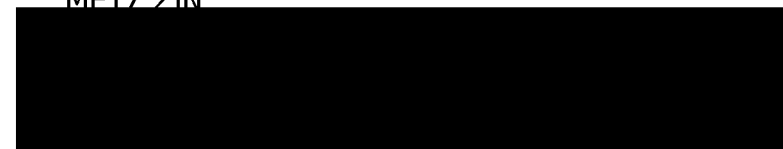
Potential Contaminant	Exposure Pathway	Receptor	Initial Assessment from Preliminary Investigation Report Information			Comments	Proposed Investigation
			Severity	Probability	Risk		
Non identified	Inhalation of dust	Site Workers/Site Maintenance	-	-	-	No source identified	No Further Works required.
		End Users	-	-	-		
		Off-site Users	-	-	-		
	Inhalation of Vapour/gases (including Radon)	Site Workers/Site Maintenance	-	-	-		
		End Users	-	-	-		
		Off-site Users	-	-	-		
	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	-	-	-		
		End Users	-	-	-		
	Migration via surface runoff	Surface Water	-	-	-		
	Migration in solution via groundwater	Surface Water	-	-	-		
		Shallow Aquifer	-	-	-		
		Deep Aquifer	-	-	-		
	Direct contact with construction material	Buried structures	-	-	-		
		Buried Services	-	-	-		
	Migration of gases via permeable soils	Site Workers/Site Maintenance	-	-	-		
		End Users	-	-	-		
		Off-site Users	-	-	-		
		Building and confined spaces	-	-	-		

Appendix C.2 Chemical Laboratory Results



John Hills
Soils Ltd
Thomas Telford House - Unit 11
Sun Valley Business Park
Winnall Close
Winchester
SO23 0LB

DETS Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 21N



DETS Report No: 18-76769

Site Reference: Arundel Road, Fontwell

Project / Job Ref: 16971

Order No: 16971/Contam

Sample Receipt Date: 14/06/2018

Sample Scheduled Date: 14/06/2018

Report Issue Number: 1

Reporting Date: 21/06/2018

Authorised by:



Associate Director of Client Services

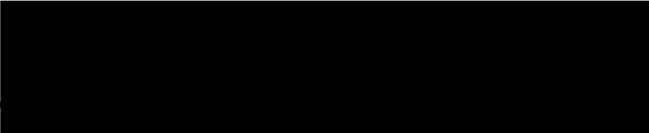
Authorised by:



Dave Ashworth
Deputy Quality Manager



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



Soil Analysis Certificate						
DETS Report No: 18-76769	Date Sampled	11/06/18	11/06/18	11/06/18	11/06/18	11/06/18
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Arundel Road, Fontwell	TP / BH No	WS1	WS2	WS3	WS3	WS4
Project / Job Ref: 16971	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: 16971/Contam	Depth (m)	0.50	0.20	0.20	0.50	0.10
Reporting Date: 21/06/2018	QTSE Sample No	340111	340112	340113	340114	340115

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
pH	pH Units	N/a	MCERTS	7.1	5.9	5.8	6.0	6.3
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	52	29	12	< 10	12
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.05	0.03	0.01	< 0.01	0.01
Sulphide	mg/kg	< 5	NONE	< 5	< 5	< 5	< 5	< 5
Organic Matter	%	< 0.1	MCERTS	1.2	2.8	1.2	0.5	2.9
Total Organic Carbon (TOC)	%	< 0.1	MCERTS	0.7	1.7	0.7	0.3	1.7
Antimony (Sb)	mg/kg	< 1	NONE	2.4	1.3	< 1	1	< 1
Arsenic (As)	mg/kg	< 2	MCERTS	6	7	4	8	6
Beryllium (Be)	mg/kg	< 0.5	NONE	< 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	< 0.2	< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS	16	14	19	20	15
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	10	6	6	7	7
Lead (Pb)	mg/kg	< 3	MCERTS	30	29	15	10	24
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	11	7	9	10	9
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3	< 3	< 3
Vanadium (V)	mg/kg	< 2	NONE	28	23	15	29	22
Zinc (Zn)	mg/kg	< 3	MCERTS	71	36	21	29	35
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C
Subcontracted analysis (S)



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



Soil Analysis Certificate - Speciated PAHs

DETS Report No: 18-76769	Date Sampled	11/06/18	11/06/18	11/06/18	11/06/18	11/06/18
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Arundel Road, Fontwell	TP / BH No	WS1	WS2	WS3	WS3	WS4
Project / Job Ref: 16971	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: 16971/Contam	Depth (m)	0.50	0.20	0.20	0.50	0.10
Reporting Date: 21/06/2018	QTSE Sample No	340111	340112	340113	340114	340115

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	0.15
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	0.13
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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



Soil Analysis Certificate - TPH LQM Banded

DETS Report No: 18-76769	Date Sampled	11/06/18	11/06/18			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Arundel Road, Fontwell	TP / BH No	WS1	WS3			
Project / Job Ref: 16971	Additional Refs	None Supplied	None Supplied			
Order No: 16971/Contam	Depth (m)	0.50	0.20			
Reporting Date: 21/06/2018	QTSE Sample No	340111	340113			

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

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - BTEX / MTBE						
DETS Report No: 18-76769	Date Sampled	11/06/18	11/06/18			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Arundel Road, Fontwell	TP / BH No	WS1	WS3			
Project / Job Ref: 16971	Additional Refs	None Supplied	None Supplied			
Order No: 16971/Contam	Depth (m)	0.50	0.20			
Reporting Date: 21/06/2018	QTSE Sample No	340111	340113			

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

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - Sample Descriptions	
DETS Report No: 18-76769	
Soils Ltd	
Site Reference: Arundel Road, Fontwell	
Project / Job Ref: 16971	
Order No: 16971/Contam	
Reporting Date: 21/06/2018	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
340111	WS1	None Supplied	0.50	13.2	Brown sandy clay
340112	WS2	None Supplied	0.20	13	Brown sandy clay with stones
340113	WS3	None Supplied	0.20	5.6	Brown sandy clay with stones
340114	WS3	None Supplied	0.50	9.7	Light brown sandy clay with stones and chalk
340115	WS4	None Supplied	0.10	20.4	Brown sandy clay with stones

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

Insufficient Sample ^{1/5}

Unsuitable Sample ^{U/5}



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 18-76769

Soils Ltd

Site Reference: Arundel Road, Fontwell

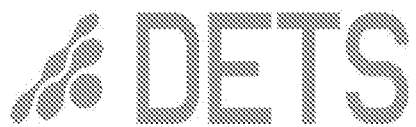
Project / Job Ref: 16971

Order No: 16971/Contam

Reporting Date: 21/06/2018

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received



John Hills
Soils Ltd
Thomas Telford House - Unit 11
Sun Valley Business Park
Winnall Close
Winchester
SO23 0LB

DETS Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN



DETS Report No: 18-76770

Site Reference: Arundel Road, Fontwell

Project / Job Ref: 16971

Order No: 16971/BRE

Sample Receipt Date: 14/06/2018

Sample Scheduled Date: 14/06/2018

Report Issue Number: 1

Reporting Date: 20/06/2018

Authorised by:



Russell Jarvis
Associate Director of Client Services

Authorised by:



Deputy Quality Manager



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



Soil Analysis Certificate						
DETS Report No: 18-76770	Date Sampled	11/06/18	11/06/18			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Arundel Road, Fontwell	TP / BH No	WS2	WS3			
Project / Job Ref: 16971	Additional Refs	None Supplied	None Supplied			
Order No: 16971/BRE	Depth (m)	1.30	2.30			
Reporting Date: 20/06/2018	QTSE Sample No	340116	340117			

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	6.5	6.5			
Total Sulphate as SO ₄	mg/kg	< 200	NONE	272	442			
Total Sulphate as SO ₄	%	< 0.02	NONE	0.03	0.04			
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	14	11			
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.01	0.01			
Total Sulphur	%	< 0.02	NONE	< 0.02	< 0.02			
Ammonium as NH ₄	mg/kg	< 0.5	NONE	< 0.5	< 0.5			
Ammonium as NH ₄	mg/l	< 0.05	NONE	< 0.05	< 0.05			
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	21	17			
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	10.4	8.3			
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	< 3	MCERTS	4	< 3			
Water Soluble Nitrate (2:1) as NO ₃	mg/l	< 1.5	MCERTS	1.9	< 1.5			
W/S Magnesium	mg/l	< 0.1	NONE	1	0.7			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C
Subcontracted analysis (S)



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Soil Analysis Certificate - Sample Descriptions	
DETS Report No: 18-76770	
Soils Ltd	
Site Reference: Arundel Road, Fontwell	
Project / Job Ref: 16971	
Order No: 16971/BRE	
Reporting Date: 20/06/2018	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
340116	WS2	None Supplied	1.30	8.6	Light brown sandy clay with stones
340117	WS3	None Supplied	2.30	11.5	Light brown sandy clay with stones

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

Insufficient Sample ^{1/5}

Unsuitable Sample ^{U/5}



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Soil Analysis Certificate - Methodology & Miscellaneous Information				
DETS Report No: 18-76770				
Soils Ltd				
Site Reference: Arundel Road, Fontwell				
Project / Job Ref: 16971				
Order No: 16971/BRE				
Reporting Date: 20/06/2018				

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

Appendix C.3 General Assessment Criteria

HUMAN HEALTH RISK ASSESSMENT

1.1 Introduction

Human Health Generic Quantitative Risk Assessment (GQRA) involves the comparison of contaminant concentrations measured in soil at the site with Generic Assessment Criteria (GAC).

GAC are conservative values adopted to ensure that they are applicable to the majority of possible contaminated site. These values may be published Contaminated Land Exposure Assessment Model (CLEA) derived GAC derived by a third party or the Environment Agency/ DEFRA. It is imperative to the risk assessor to understand the uncertainties and limitations associated with these GAC to ensure that they are used appropriately. Where the adoption of a GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses, then a Detailed Quantitative Risk Assessment (DQRA) may be undertaken to develop site specific values for relevant soil contaminants based on the site specific conditions.

1.2 General Assessment Criteria

The Contaminated Land Regime reflects the UK Government's stated objectives of achieving sustainable development through the 'suitable for use approach'.

1.2.1 Contaminated Land Exposure Assessment Model (CLEA)

Current United Kingdom risk assessment practice is based on the Contaminated Land Exposure Assessment Model (CLEA).

The CLEA Guidance comprises the following documents:

- EA Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil.
 - EA Science Report SC050021/SR3: Updated technical background to the CLEA model.
 - EA CLEA Bulletin (2009).
 - CLEA software version 1.04 (2009)
 - Toxicological reports and SGV technical notes.
-

The CLEA guidance and tools:

1. do not cover other types of risk to humans, such as fire, suffocation or explosion, or short-term and acute exposures.
 2. do not cover risks to the environment, such as groundwater, ecosystems or buildings.
 3. do not provide a definitive test for telling when human health risks are significant.
 4. are not a legal requirement in assessing land contamination risks. They are not part of the legal regime for Part 2A of the Environmental Protection Act 1990.
-

1.3 Soil Guideline Values (2009)

The EA are publishing a series of SGV reports for a selection of common contaminants relevant to the assessment of land contamination.

SGV's are generic assessment criteria based on CLEA standard land-uses and can be used to simplify the assessment of human health risks from long-term exposure to

chemical contamination in soil. They do not cover short-term exposure (i.e. construction and maintenance workers), acute exposure or other risks such as fire, suffocation or explosion, as might arise from an accumulation of gases such as methane and carbon dioxide, or either odour or aesthetic issues.

SGV's represent 'trigger values', indicators that soil concentrations above the SGV level may pose a possibility of *significant harm* to human health. The converse, where soil concentrations are less than the SGV, is that the long-term human health risks are considered to be tolerable or minimal.

The CLEA guidance derives soil concentrations of contaminants above which (in the opinion of the EA) there may be a concern that warrants further investigation. It does not provide a definitive test for establishing that the risk is significant.

1.4 Ongoing development of CLEA based guidance

The EA is involved in a programme of publishing SGV's and related toxicity data (the TOX reports). As at July 2009 ten SGV's and matching TOX reports had been published. Soil Assessment Criteria (SAC's) may be derived using toxicity data from the updated TOX reports, where these are published, or from the original TOX reports. SGV reports also take account of recent updates for plant uptake and other factors.

-
- GAC's developed by CLEA guidance and given in this report will need to be assessed against updated TOX reports and SGV's when these are published.
-
- SGV reports may give values that differ from the GAC's used in this report.
-
- These variations may materially alter the remediation requirement for the site, requiring either an increase or decrease in the extent, type and cost of remediation.
-

1.5 Phytotoxicity

CLEA guidance only addresses human health toxicity; assessment of plant toxicity (phytotoxicity) is based on threshold trigger values obtained from the following source:

ICRCL 70/90: *Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing.*

1.6 Other Generic Assessment Criteria

If an SGV is not available for a substance identified in the soil then the range of Generic Assessment Criteria published from a collaborative research by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health (CIEH) are used for example. In the case of Lead, Category 4 screening levels (C4SLs) have replaced the AtRisk Soil SSV.

1.6.1 EIC/AGS/CL: AIRE

The report represents the collaborative effort of risk assessors from 26 EIC and AGS member companies to produce generic assessment criteria (GAC) for soils for human health risk assessment. The project involved the collation and review of physico-chemical data, toxicological data and information on background

exposure for 44 contaminants sometimes encountered on land affected by contamination in the UK and the derivation of GAC for 351 of these using the CLEA model (v1.06). The GAC are intended to complement soil guideline values (SGV) produced by the Environment Agency of England and Wales and the 2nd edition GAC produced by LQM and CIEH (Nathanail *et al*, 2009). All three sets of assessment criteria have been derived in general accordance with the Environment Agency of England and Wales Contaminated Land Exposure Assessment (CLEA) guidance and thus the combined efforts of these three groups have resulted in a useful set of screening criteria for the assessment of risks to human health from soil contamination for more than 120 potentially contaminative substances.

1.6.2 Category 4 screening levels (C4SLs) (2014)

A new statutory DEFRA guidance recently (i.e. August 2014) published some GACs with a more pragmatic (but still strongly precautionary) approach in their derivation called the Category 4 screening levels (C4SLs). These values provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land. They are intended as generic screening values, (ii) they describe a level of risk that whilst above 'minimal' is still 'low' and (iii) they provide a 'higher simple test' for deciding that land is suitable for use and definitely not contaminated. These values were derived for four generic land uses: residential, commercial, allotments, and public open space.

1.6.3 LQM/CIEH Suitable 4 Use Level (S4UL) (2015)

The new S4UL's ((Nathanail *et al*, 2015), was developed for around 85 substances and are intended to enable a screening assessment of the risks posed by soil quality on development sites. The updated LQM/CIEH GAC publication was developed to accommodate recent developments in the understanding of chemical, toxicological and routine exposure to soil-based contaminants. The S4ULs were:

- based on Health Criteria Values, updated to reflect changes since 2009
- derived for the standard CLEA land uses and the two public open space scenarios developed by Defra SP1010
- developed for ca 85 substances (those previously covered by the LQM/CIEH GAC and the SGV substances);
- Compliant with SR2 and the long standing principle of 'suitable for use' and reflecting changes to exposure parameters produced by Defra SP1010.

For derivation of these Generic Assessment Criteria reference must be made to: Nathanail, P., McCaffrey, C., Ashmore, M., Cheng, Y., Gillet, A., Ogden, R., Scott, D. *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (3rd edition)*. **Land Quality Press**. 2015.

1.7 Standard Land-use Scenarios

The standard land-use scenarios used to develop conceptual exposure models are presented in the following sections:

1.7.1 Residential

Generic scenario assumes a typical two-storey house built on a ground bearing slab with a private garden having a lawn, flowerbeds and a small fruit and vegetable patch.

- | |
|--|
| • Critical receptor is a young female child (zero to six years old) |
| • Exposure duration is six years. |
| • Exposure pathways include direct soil and indoor dust ingestion, consumption of home-grown produce and any adhering soil, skin contact with soils and indoor dust and inhalation of indoor and outdoor dust and vapours. |
| • Building type is a two-storey small terraced house. |

A sub-set of this land-use is residential apartments with communal landscaped gardens where the consumption of home grown vegetables will not occur.

1.7.2 Allotments

Provision of open space (about 250sq.m) commonly made available to tenants by the local authority to grow fruit and vegetable for their own consumption. Typically, there are a number of plots to a site which may have a total area of up to 1 hectare. The tenants are assumed to be adults and that young children make occasional accompanied visits.

Although some allotment holders may choose to keep animals including rabbits, hens, and ducks, potential exposure to contaminated meat and eggs is not considered.

- | |
|--|
| • Critical receptor is a young female child (zero to six years old) |
| • Exposure duration is six years. |
| • Exposure pathways include direct soil ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and inhalation of outdoor dust and vapours. |
| • There is no building. |

1.7.3 Commercial/Industrial

The generic scenario assumes a typical commercial or light industrial property comprising a three-storey building at which employees spend most time indoors and are involved in office-based or relatively light physical work.

- | |
|--|
| • Critical receptor is a working female adult (aged 16 to 65 years old). |
| • Exposure duration is a working lifetime of 49 years. |
| • Exposure pathways include direct soil and indoor dust ingestion, skin contact with soils and dusts and inhalation of dust and vapours. |
| • Building type is a three-storey office (pre 1970). |

1.7.4 Public Open Space within Residential Area

The generic scenario refers to any grassed area 0.05 ha and that is close to Housing.

-
- Grassed area of up to 0.05 ha and a considerable proportion of this (up to 50%) may be bare soil
-
- Predominantly used by children for playing and may be used for activities such as a football kick about
-
- Sufficiently close proximity to home for tracking back of soil to occur, thus indoor exposure pathways apply
-
- older children as the critical receptor on basis that they will use site most frequently (Age class 4-9)
-
- ingestion rate 75 mg.day^{-1}
-

1.7.5 Public Open Space Park

This generic scenario refers to any public park that is more than 0.5ha in area:

-
- Public park (>0.5 ha), predominantly grassed and may also contain children's play equipment and border areas of soil containing flowers or shrubs (75% cover)
-
- Female child age classes 1-6
-
- Soil ingestion rate of 50 mg.day^{-1}
-
- Occupancy period outdoors = 2 hours.day^{-1}
-
- Exposure frequency of 170 days.year⁻¹ for age classes 2-18 and 85
-
- days.year⁻¹ for age class 1
-
- Outdoor exposure pathways only (no tracking back).
-

1.8 Detailed Quantitative Risk Assessments (DQRA)

Where the adoption of an SGV/GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses, then a DQRA may be undertaken to develop site specific values for relevant soil contaminants.

-
- Establishing the plausibility that generic exposure pathways exist in practice by measurement and observation.
-
- Developing more accurate parameters using site data.
-

1.9 Current Criteria

Table 1 presents the current Generic Assessment Criteria and reference should be made to the original publications if needed.

1.10 Statistical Tests

DEFRA R&D Publication CLR 7 (DOE 1994) and Category 4 screening levels (C4SLs) (2014) addressed the statistical treatment of test results and their comparison to Soil Guideline Values.

Consideration must be given to the appropriate area of land to be considered termed the critical averaging area.

For a communal open space or commercial land-use, the critical averaging area will depend on the proposed layout. For a residential use with private gardens the averaging area is the individual plot.

It may be appropriate to compare the upper 95th percentile concentration with the Soil Guideline Value, subject to applying a statistical test to establish that the range of concentrations are reasonably consistent and belonging to the same underlying distribution of data.

The DEFRA discussion paper Assessing risks from land contamination – a proportionate approach ('the way forward') (CLAN06/2006) aimed to increase understanding of the role that statistics can play in quantifying the uncertainty attached to the estimates of the mean concentration of contaminants in soil. In direct response CL:AIRE/CIEH published a joint report, *Guidance in comparing soil contamination data with a critical concentration* (CL:AIRE/CIEH 2008). A software implementation of the statistical techniques given in the report was published by ESI International (2008).

Treatment of Hot-Spots

- A statistical test is applied to establish whether the data is a part of a single set, or whether data outliers are present.
 - Provided that the data is based on random sampling and no distinct contamination source was present at the sampling location, the hot-spot(s) may be excluded and the mean of the remaining data assessed.
-

Land Use			Residential With or Without Plant Uptake									Public Open Space (POS)									Name	Authority	Date		
			With			Without			Allotments			Commercial			Residential			Park							
			home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce	home-grown produce					
Type	Contaminants	Species	Year	1.0	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6				
Metals	Antimony		2010						550						7500							EIC/AGS/CLAIRE	EIC/AGS/CLAIRE	2010	
	Arsenic		2014			37			40			49			640		79		168			C4SL	DEFRA	2014	
			2015			37			40			40			640		79		170			S4UL	LQM/CIEH	2015	
	Beryllium		2015			1.7			1.7			35			12		2.2		63			S4UL	LQM/CIEH	2015	
	Boron		2015			290			11000			45			240000		21000		46000			S4UL	LQM/CIEH	2015	
	Cadmium		2015			11			85			1.9			190		120		532			S4UL	LQM/CIEH	2015	
			2014			28			149			4.9			410		220		880			C4SL	DEFRA	2014	
	Chromium	III	2015			910			910			18000			8600		1500		33000			S4UL	LQM/CIEH	2015	
		V	2014			21			21			170			49		22		256			C4SL	DEFRA	2014	
		VI	2015			6			6			1.8			33		7.7		220			S4UL	LQM/CIEH	2015	
	Copper		2015			2400			7100			520			68000		12000		44000			S4UL	LQM/CIEH	2015	
	Lead					200			310			80			2330		630		1300			C4SL	DEFRA	2014	
	Mercury	Elemental	2012			1.0			1.0			26			26								SGV	DEFRA	2012
			2015			1.2			1.2			21			58		16		30			S4UL	LQM/CIEH	2015	
		Inorganic	2012			170			170			80			36000								SGV	DEFRA	2012
			2015			40			56			19			1100		120		240			S4UL	LQM/CIEH	2015	
		Methyl	2012			11			11			8			410								SGV	DEFRA	2012
			2015			11			15			6			320		40		68			S4UL	LQM/CIEH	2015	
	Nickel		2012			130			130			230			1800							SGV	DEFRA	2012	
			2015			130			180			53			980		230		800			S4UL	LQM/CIEH	2015	
	Selenium		2012			350			350			120			13000							SGV	DEFRA	2012	
			2015			250			430			88			12000		1100		1800			S4UL	LQM/CIEH	2015	
	Vanadium		2015			410			1200			91			9000		2000		5000			S4UL	LQM/CIEH	2015	
	Zinc		2015			3700			40000			620			730000		81000		170000			S4UL	LQM/CIEH	2015	
BTEX & MTBE	Benzene		2012			0.33			0.33			0.07			95							SGV	DEFRA	2012	
			2014			0.87			3.3			0.18			98		140		230			C4SL	DEFRA	2014	
			2015	0.087	0.17	0.37	0.38	0.7	1.4	0.017	0.034	0.075	27	47	90	72	72	73	90	100	110		S4UL	LQM/CIEH	2015
	Toluene		2012			610			610			120			4400							SGV	DEFRA	2012	
			2015	130	290	660	880	1900	3900	22	51	120	65000	110000	180000	56000	56000	56000	87000	95000	100000		S4UL	LQM/CIEH	2015
	Ethylbenzene		2012			350			350			90			2800							SGV	DEFRA	2012	
			2015	47	110	260	83	190	440	16	39	91	4700	13000	27000	24000	24000	25000	17000	22000	27000		S4UL	LQM/CIEH	2015
	Xylenes	o-xylene	2012			250			250			160			2600							SGV	DEFRA	2012	
			2015	60	140	330	88	210	480	28	67	160	6600	15000	33000	41000	42000	43000	17000	24000	33000		S4UL	LQM/CIEH	2015
		m-xylene	2012			240			240			180			3500							SGV	DEFRA	2012	
			2015	59	140	320	82	190	450	31	74	170	6200	14000	31000	41000	42000	43000	17000	24000	32000		S4UL	LQM/CIEH	2015
		p-xylene	2012			230			230			160			3200							SGV	DEFRA	2012	
			2015	56	130	310	79	180	310	29	69	160	5900	14000	30000	41000	42000	43000	17000	23000	31000		S4UL	LQM/CIEH	2015
Petroleum Hydrocarbons Fractions	Aliphatic >C3 - C6		2015	42	78	160	42	78	160	730	1700	3900	3200	5900	12000	570000	590000	600000	95000	130000	180000		S4UL	LQM/CIEH	2015
	Aliphatic >C6 - C8		2015	100	230	530	100	230	530	2300	5600	13000	7800	17000	40000	600000	610000	620000	150000	220000	320000		S4UL	LQM/CIEH	2015
	Aliphatic >C8 - C10		2015	27	65	150	27	65	150	320	770	1700	2000	4800	11000	13000	13000	13000	14000	18000	21000		S4UL	LQM/CIEH	2015
	Aliphatic >C10 - C12		2015	130	330	760	130	330	770	2200	4400	7300	9700	23000	47000	13000	13000	13000	21000	23000	24000		S4UL	LQM/CIEH	2015
	Aliphatic >C12 - C16		2015	1100	2400	4300	1100	2400	4400	11000	13000	13000	59000	82000	90000	13000	13000	13000	25000	25000	26000		S4UL	LQM/CIEH	2015
	Aliphatic >C16 - C35		2015	65000	92000	110000	65000	92000	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000		S4UL	LQM/CIEH	2015
	Aliphatic >C35 - C44		2015	65000	92000	140000	65000	92000	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000		S4UL	LQM/CIEH	2015
	Aromatic >C3 - C7		2015	70	140	300	370	690	1400	13	27	57	26000	46000	86000	56000	56000	56000	76000	84000	92000		S4UL	LQM/CIEH	2015
	Aromatic >C7 - C8		2015	130	290	660	860	1800	3900	22	51	120	56000	110000	180000	56000	56000	56000	87000	95000	100000		S4UL	LQM/CIEH	2015
	Aromatic >C8 - C10		2015	34	83	190	47	110	270	8.6	21	51	3500	8100	17000	5000	5000	5000	7200	8500	9300		S4UL	LQM/CIEH	2015
	Aromatic >C10 - C12		2015	74	180	380	250	590	1200	13	31	74	16000	28000	34000	5000	5000	5000	9200	9700	10000		S4UL	LQM/CIEH	2015
	Aromatic >C12 - C16		2015	140	330	660	1800	2300	2500	23	57	130	36000	37000	38000	5100	5100	5000	10000	10000	10000		S4UL	LQM/CIEH	2015
	Aromatic >C16 - C21		2015	260	540	930	1900	1900	1900	46	110	260	28000	28000	28000	3800	3800	3800	7600	7700	7800		S4UL	LQM/CIEH	2015

Land Use			Residential With or Without Plant Uptake									Public Open Space (POS)									Media	Authority	Date	
			Allotments						Commercial			Residential						Park						
			With home-grown produce			Without home-grown produce			1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6				
			SOM	1.0	2.5	6	1	2.5																6
Type	Contaminants	Species	Year																					
	Aromatic >C21 - C35		2015	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015
	Aromatic >C34 - C44		2015	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015
	Aliphatic + Aromatic >C44 - C70			1600	1800	1900	1900	1900	1900	1200	2100	3000	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)	Acenaphthene		2015	210	510	1100	3000	4700	6000	34	85	200	84000	97000	100000	15000	15000	15000	29000	30000	30000	S4UL	LQM/CIEH	2015
	Acenaphthylene		2015	170	420	920	2900	4600	6000	28	69	160	83000	97000	100000	15000	15000	15000	29000	30000	30000	S4UL	LQM/CIEH	2015
	Anthracene		2015	2400	5400	11000	31000	35000	37000	380	950	2200	520000	54000	540000	74000	74000	74000	150000	150000	150000	S4UL	LQM/CIEH	2015
	Benzo(a)anthracene		2015	7.2	11	13	11	14	15	2.9	6.5	13	170	170	180	29	29	29	49	56	62	S4UL	LQM/CIEH	2015
	Benzo(a)pyrene		2014			5			5.3			5.7			76			10		21	CASL	DEFRA	2014	
			2015	2.2	2.7	3	3.2	3.2	3.2	0.97	2	3.5	35	35	36	5.7	5.7	5.7	11	12	13	S4UL	LQM/CIEH	2015
	Benzo(b)fluoranthene		2015	2.6	3.3	3.7	3.9	4.0	4.0	0.99	2.1	3.9	44	44	45	7.1	7.2	7.2	13	15	16	S4UL	LQM/CIEH	2015
	Benzo(g,h)perylene		2015	320	340	250	360	360	360	290	470	640	3900	4000	4000	640	640	640	1400	1500	1600	S4UL	LQM/CIEH	2015
	Benzo(k)fluoranthene		2015	77	93	100	110	110	110	37	75	130	1200	1200	1200	190	190	190	370	410	440	S4UL	LQM/CIEH	2015
	Chrysene		2015	15	22	27	30	31	32	4.1	9.4	19	350	350	350	57	57	57	93	110	120	S4UL	LQM/CIEH	2015
	Dibenz(a,h)anthracene		2015	0.24	0.28	0.3	0.31	0.32	0.32	0.14	0.27	0.43	3.5	3.6	3.6	0.57	0.57	0.58	1.1	1.3	1.4	S4UL	LQM/CIEH	2015
	Fluoranthene		2015	280	560	890	1500	1600	1600	52	130	290	23000	23000	23000	3100	3100	3100	6300	6300	6400	S4UL	LQM/CIEH	2015
	Fluorene		2015	170	400	860	2800	3800	4500	27	67	160	63000	68000	71000	9900	9900	9900	20000	20000	20000	S4UL	LQM/CIEH	2015
	Indeno(1,2,3-cd)pyrene		2015	27	36	41	45	46	46	9.5	21	39	500	510	510	82	82	82	150	170	180	S4UL	LQM/CIEH	2015
	Naphthalene		2015	2.3	5.6	13	2.3	5.6	13	4.1	10	24	190	460	1100	4900	4900	4900	1200	1900	3000	S4UL	LQM/CIEH	2015
	Phenanthrene		2015	95	220	440	1300	1500	1500	15	38	90	22000	22000	23000	3100	3100	3100	6200	6200	6300	S4UL	LQM/CIEH	2015
	Pyrene		2015	620	1200	2000	3700	3800	3800	110	270	620	54000	54000	54000	7400	7400	7400	15000	15000	15000	S4UL	LQM/CIEH	2015
	Coal Tar(Bap as surrogate matter)		2015	0.79	0.98	1.1	1.2	1.2	1.2	0.32	0.67	1.2	15	15	15	2.2	2.2	2.2	4.4	4.7	4.8	S4UL	LQM/CIEH	2015
Chloroalkanes & alkenes	1,2 Dichloroethane		2015	0.0071	0.011	0.019	0.0092	0.013	0.023	0.0046	0.0083	0.016	0.67	0.97	1.7	29	29	29	21	24	28	S4UL	LQM/CIEH	2015
	1,1,1 Trichloroethane		2015	8.8	18	39	9	18	40	48	110	240	660	1300	3000	140000	140000	140000	57000	76000	100000	S4UL	LQM/CIEH	2015
	1,1,2,2 Tetrachloroethane		2015	1.6	3.4	7.5	3.9	8	17	0.41	0.89	2	270	550	1100	1400	1400	1400	1800	2100	2300	S4UL	LQM/CIEH	2015
	1,1,1,2 Tetrachloroethane		2015	1.2	2.8	6.4	1.5	3.5	8.2	0.79	1.9	4.4	110	250	560	1400	1400	1400	1500	1800	2100	S4UL	LQM/CIEH	2015
	Tetrachloroethene		2015	0.18	0.39	0.9	0.18	0.4	0.92	0.65	1.5	3.6	19	42	95	1400	1400	1400	810	1100	1500	S4UL	LQM/CIEH	2015
	Tetrachloromethane (Carbon Tetrachloride)		2015	0.026	0.056	0.13	0.026	0.056	0.13	0.45	1	2.4	2.9	6.3	14	890	920	950	190	270	400	S4UL	LQM/CIEH	2015
	Trichloroethene		2015	0.016	0.034	0.075	0.017	0.036	0.08	0.041	0.091	0.21	1.2	2.6	5.7	120	120	120	70	91	120	S4UL	LQM/CIEH	2015
	Trichloromethane		2015	0.91	1.7	3.4	1.2	2.1	4.2	0.42	0.83	1.7	99	170	350	2500	2500	2500	2600	2800	3100	S4UL	LQM/CIEH	2015
	Vinyl Chloride (chloroethene)		2015	0.00064	0.00087	0.0014	0.00077	0.001	0.0015	0.00055	0.001	0.0018	0.059	0.077	0.12	3.5	3.5	3.5	4.8	5	5.4	S4UL	LQM/CIEH	2015
	2,4,6 Trinitrotoluene		2015	1.6	3.7	8.1	65	66	66	0.24	0.58	1.4	1000	1000	1000	130	130	130	260	270	270	S4UL	LQM/CIEH	2015
Explosives	RDX (Hexogen/Cyclonite/1,3,5-trinitro-1,3,5-triazacyclohexane)		2015	120	250	540	13000	13000	13000	17	38	85	210000	210000	210000	26000	26000	27000	49000	51000	53000	S4UL	LQM/CIEH	2015
	HMX (Octogen/1,3,5,7-tetranitro-1,3,5,7-tetrazacyclo-octane)		2015	5.7	13	26	6700	6700	6700	0.86	1.9	3.9	110000	110000	110000	13000	13000	13000	23000	23000	24000	S4UL	LQM/CIEH	2015
	Aldrin		2015	5.7	6.6	7.1	7.3	7.4	7.5	3.2	6.1	9.6	170	170	170	18	18	18	30	31	31	S4UL	LQM/CIEH	2015
Pesticides	Dieldrin		2015	0.97	2	3.5	7	7.3	7.4	0.17	0.41	0.96	170	170	170	18	18	18	30	30	31	S4UL	LQM/CIEH	2015
	Atrazine		2015	3.3	7.6	17.4	610	620	620	0.5	1.2	2.7	9300	9400	9400	1200	1200	1200	2300	2400	2400	S4UL	LQM/CIEH	2015
	Dichlorvos		2015	0.032	0.066	0.14	6.4	6.5	6.6	0.0049	0.01	0.022	140	140	140	16	16	16	26	26	27	S4UL	LQM/CIEH	2015
	Alpha - Endosulfan		2015	7.4	18	41	160	280	410	1.2	2.9	6.8	5600	7400	8400	1200	1200	1200	2400	2400	2500	S4UL	LQM/CIEH	2015
	Beta - Endosulfan		2015	7	17	39	190	320	440	1.1	2.7	6.4	6300	7800	8700	1200	1200	1200	2400	2400	2500	S4UL	LQM/CIEH	2015
	Alpha -Hexachlorocyclohexanes		2015	0.23	0.55	1.2	6.9	9.2	11	0.035	0.087	0.21	170	180	180	24	24	24	47	48	48	S4UL	LQM/CIEH	2015
	Beta -Hexachlorocyclohexanes		2015	0.085	0.2	0.46	3.7	3.8	3.8	0.013	0.032	0.077	65	65	65	8.1	8.1	8.1	15	15	16	S4UL	LQM/CIEH	2015
	Gamma -Hexachlorocyclohexanes		2015	0.06	0.14																			

Land Use			Residential With or Without Plant Uptake									Public Open Space (POS)									Media	Authority	Date		
			Allotments						Commercial			Residential						Park							
			With home-grown produce			Without home-grown produce																			
Type	Contaminants	Species	SoM	1.0	2.5	8	1	2.5	8	1	2.5	8	1	2.5	8	1	2.5	8	1	2.5	8				
Phenols & Chlorophenols	1,2,3,4,-Tetrachlorobenzene		2015	15	36	78	24	56	120	4.4	11	26	1700	3080	4400	830	830	830	1500	1600	1600	S4UL	LQM/CIEH	2015	
	1,2,3,5,-Tetrachlorobenzene		2015	0.66	1.6	3.7	0.75	1.9	4.3	0.38	0.9	2.2	49	120	240	78	79	79	110	120	130	S4UL	LQM/CIEH	2015	
	1,2,4, 5,-Tetrachlorobenzene		2015	0.33	0.77	1.6	0.73	1.7	3.5	0.06	0.16	0.37	42	72	96	13	13	13	25	26	26	S4UL	LQM/CIEH	2015	
	Pentachlorobenzene		2015	5.8	12	22	19	30	38	1.2	3.1	7	640	770	830	100	100	100	190	190	190	S4UL	LQM/CIEH	2015	
	Hexachlorobenzene		2015	1.8	3.3	4.9	4.1	5.7	6.7	0.47	1.1	2.5	110	120	120	16	16	16	30	30	30	S4UL	LQM/CIEH	2015	
	Phenols		2012			420			420			280			3200							SGV	DEFRA	2012	
			2015	120	200	380	440	690	1200	23	42	83	440	690	1300	440	690	1300	440	690	1300	S4UL	LQM/CIEH	2015	
	Chlorophenols (4 Congeners)		2015	0.87	2	4.5	94	150	210	0.13	0.3	0.7	3500	4000	4300	620	620	620	1100	1100	1100	S4UL	LQM/CIEH	2015	
	Pentachlorophenols		2015	0.22	0.52	1.2	27	29	31	0.03	0.08	0.19	400	400	400	60	60	60	110	120	120	S4UL	LQM/CIEH	2015	
Others																									
	Carbon Disulphide		2015	0.14	0.29	0.62	0.14	0.29	0.62	4.8	10	23	11	22	47	11000	11000	12000	1300	1900	2700	S4UL	LQM/CIEH	2015	
	Hexachloro-1,3-Butadiene		2015	0.29	0.7	1.6	0.32	0.78	1.8	0.25	0.61	1.4	31	66	120	25	25	25	48	50	51	S4UL	LQM/CIEH	2015	
	Sum of PCDD's, PCDF's and dioxin-like PCB's.		2012			8			8			8			240							SGV	DEFRA	2012	

NOTE	
Priority	Guideline (mg kg ⁻¹)
1	Site Specific Assessment Criteria (SSAC) (Soils Limited)
2	2014: Category 4 Screening Level (C4SL) (Contaminated Land: Application in Real Environment (CLARE), 2014)
3	2012: Soil Guideline Value (SGV) (Environment Agency, 2009)
4	2015: Sutable 4 Use Level (S4UL) (Nathanail <i>et al</i> , 2015)
For Generic Risk Assessment, the values in Bold have priority	
Table reviewed February 2018	

Appendix D Information Provided by the Client

A 27

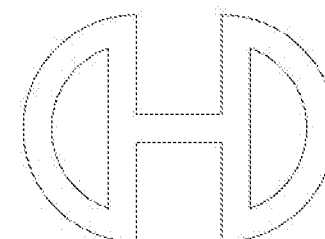
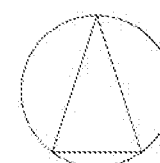
ARUNDEL ROAD

Foxwood
Cottage

Woodacre

Gracelands
Farm

N



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All dimensions are to be checked on site prior to commencement of work.
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PROPOSED SITE LAYOUT

DEVELOPMENT AT
LAND ADJACENT TO
WOODCROFT
WEST WALBERTON LANE

FOR
CRAYFERN HOMES LIMITED

SCALE: 1 : 500 DATE: JAN 18 DRAWING NO: SK03a

Soils Limited
Geotechnical & Environmental Consultants

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