



Phase II Ground Investigation Report

at

Padnell Grange, Padnell Road, Cowplain, Hampshire PO8 8ED

for

Bellway Homes (Wessex)

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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.

Commission

Soils Limited was commissioned by Bellway Homes (Wessex) to undertake a Phase II Ground Investigation on land at Padnell Grange, Padnell Road, Cowplain, Hampshire PO8 8ED. The scope of the investigation was outlined in the Soils Limited quotation reference Q18869, dated 21st June 2017.

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

This Phase II report must be read in conjunction with the Phase I Desk Study undertaken on the above site by Soils Limited, Report ref: 16362/DS, dated August 2017.

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 14688-1:2002+A1:2013
- 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 Bellway Homes (Wessex) to undertake a Phase II Ground Investigation 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 Phase I Desk Study undertaken for the site by Soils Limited (Report ref: 16362/DS, August 2017) and/or the Revised Conceptual Site Model presented in Appendix C.1.

I.2 Location

The site was located at Padnell Grange, Padnell Road, Cowplain, Hampshire PO8 8ED and had an approximate O.S Land Ranger Grid Reference of SU 698 111. The site was situated to the west of the Waterlooville Golf Course and to the east of Cherry Tree Avenue.

The site location plan is given in Figure 1.

I.3 Site Description

The site comprised numerous two storeys pitched and flat roofed buildings that have been converted from historical brick and tile works for use as residential and office space.

The site topography had local undulations with a gentle slope down to the southeast in-line with the wider topography.

Numerous mature trees and areas of shrubs were located in patches onsite, particularly in the northwest. Mature trees and shrubs also comprised the site boundaries to all aspects. The site was bordered by housing to the south and west, golf course to the east and a small woodland area to the north.

An aerial photograph has been included in Figure 2.

1.4 Proposed Development

At the time of reporting, August 2017, the proposed development comprised demolition of the existing buildings and subsequent construction of eighty-four detached, semi-detached and terraced dwellings comprising of one to five bed houses and flats. The development included hard landscaping such as access roads, driveways and pavements, and soft landscaping such as public open spaces and private gardens.

In compiling this report reliance was placed on drawing number BELL170217/SKL-01, dated March 2017, prepared by Thrive Architects. 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 boundary of the bedrock formations of the Lambeth Group in the north of the site, and the London Clay Formation, which overlies the Lambeth Group, in the south of the site, with no recorded superficial deposits overlying.

1.5.1 London Clay Formation

The London Clay Formation in the Hampshire region comprises silty and sandy clay, clayey and sandy silt, silty sand; sporadic claystones and thin beds of flint pebbles. The formation includes the Whitecliff Sand, Durley Sand, Portsmouth Sand and Nursling Sand Members. Crystals of gypsum (Selenite) are often found within the weathered part of the London Clay, and precautions against sulphate attack to concrete are sometimes required.

The lowest part of the London Clay Formation rests on the Lambeth Group.

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 Phase II Ground Investigation Report relates to the site located at Padnell Grange, Padnell Road, Cowplain, Hampshire PO8 8ED and was prepared for the sole benefit of Bellway Homes (Wessex) (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 on 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 (Q18869, dated 21st June 2017), was therefore to comprise the following items:

- 1-day windowless sampler boreholes and super heavy dynamic probes;
- In-situ CBR Testing (DCP TRL);
- Well installation for long term groundwater level monitoring;
- Machine excavated trial pits;
- Infiltration testing to BRE365;
- Geotechnical laboratory testing;
- Chemical laboratory testing.

2.1.1 Actual Project Works

The actual project works were undertaken on 5th July 2017 and comprised:

- 5No. windowless sampler boreholes;
- 8No. super heavy dynamic probes;
- 4No. dual purpose groundwater and soil gas monitoring wells;
- 5No. DCP TRL probes;
- 5No. machine excavated trial pits;
- Infiltration testing to BRE365;
- Geotechnical laboratory testing;
- Chemical laboratory testing.

Four windowless sampler boreholes (WS1 – WS4) were backfilled with gravel and bentonite following the installation of monitoring wells. Comprising a 33mm OD slotted HDPE pipe to the base of the hole, a bentonite seal and a dual-purpose monitoring tap.

WSA was drilled in-place of TPA due to the area being inaccessible for the mechanical excavator.

Infiltration testing broadly in accordance with BRE 365:2016 was undertaken in two trial pits (SK1 and SK2). All trial pits were backfilled with arisings on completion of testing. Upon completion, each trial hole was backfilled with arisings and mounded over for future settlement.

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 5th July 2017, five windowless sampler boreholes (WS1 – WS4, WSA) were drilled, using a Premier compact 110 windowless sampler and dynamic probe rig, to depths ranging between 3.60 and 6.00m below ground level (bgl).

Eight super heavy dynamic probes, (DP1 – DP4, DPA – DPD) were driven prior and adjacent to their corresponding windowless sampler borehole/ trial pit locations to depths ranging between 3.60 and 8.00m bgl.

Four standpipes were installed within window sampler borehole locations (WS1 – WS4) to allow for continued monitoring of both groundwater and soil gas, where present.

Five trial pits (SK1 – SK2, TPB – TPD) were machine excavated to depths ranging between 2.60 and 3.50m bgl. WSA was drilled in-place of TPA due to the area being inaccessible for the mechanical excavator. Following excavation of SK1 and SK2, infiltration testing was carried out, broadly in accordance with the principles of BRE DG 365:2016. Infiltration testing was only carried out once within the trial pits due to slow observed infiltration. The infiltration tests comprised piping clean water via a water tanker into the open trial hole, the fall in water level (head) over time was then recorded to calculate an indicative infiltration rate.

In-situ CBR testing using TRL DCP probe was undertaken in five locations associated with the development of new access roads.

All trial pits were excavated at locations selected by Soils Limited using a development plan provided and approved by the client.

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)
WS1 ^w	6.00	DP3	3.80
WS2 ^w	3.60	DP4	4.00
WS3 ^w	4.00	DP-A	4.00
WS4 ^w	4.00	DP-B	4.00
WSA	3.70	DP-C	4.00
TP-B	3.50	DP-D	4.00
TP-C	3.30	DCP1	0.94
TP-D	2.60	DCP2	0.95
SK1	3.00	DCP3	0.95
SK2	3.00	DCP4	0.94
DPI	8.00	DCP5	0.95

Trial Hole	Depth (m bgl)	Trial Hole	Depth (m bgl)
DP2	3.60		
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:

Made Ground/Topsoil (MG/TS)
London Clay Formation (LCF) – Not Encountered
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	Recent	G.L	0.10–0.40	0.30	Brown slightly gravelly sandy SILT with frequent rootlets.
MG	Recent	G.L.	0.25–1.20	>1.00	Dark brown gravelly sandy SILT. Gravel is fine to coarse sub-angular brick and flint.
LMBE	Palaeocene	0.10–1.30	1.30–8.00 ¹	Not proven ²	Cohesive: Soft to firm brownish red mottled light grey slightly sandy silty CLAY.
		0.25–2.90	1.30-4.00 ¹	Not proven ²	Granular: Light orangish brown clayey to very clayey fine to medium SAND.
Note: ¹ Final depth of trial hole. ² Base of strata not encountered.					

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 Made Ground and Topsoil

Soils described as Made Ground were encountered in five out of the ten trial holes from ground level to depths ranging between 0.25m and 1.30m bgl. The Made Ground typically comprised dark brown gravelly sandy SILT. The gravel comprised fine to coarse sub-angular brick, flint, chalk and metal fragments. The depths of Made Ground have been included in Table 2.3.

Soils described as Topsoil were encountered in five out of the ten trial holes from ground level to depths ranging between 0.10m and 0.40m bgl. The Topsoil comprised brown slightly gravelly sandy SILT with frequent rootlets. Gravel was fine to medium sub-rounded clasts of flint. Sand was fine. The depth of Topsoil has been included in Table 2.3.

Table 2.3 Final Depth of Made Ground/Topsoil

Trial Hole	Strata	Depth (m bgl)
WS/DPI	MG	0.25
WS/DP 2	TS	0.40
WS/DP 3	TS	0.40
WS/DP 4	MG	0.90
WS/DP A	MG	0.35
SK 1	TS	0.30
SK 2	TS	0.30
TP/DP B	MG	1.20
TP/DP C	TS	0.10
TP/DP D	MG	1.30 ¹

Notes: ¹Infilled material

2.3.2 Lambeth Group

Soils described as Lambeth Group were encountered in all ten trial holes and were found in both cohesive and granular forms. The soils of the Lambeth group were encountered underlying the Made Ground/Topsoil and persisted to depth of 8.00m bgl, the full investigatory depth of DP1.

The soils of the Lambeth Group varied in composition across the site and layers of cohesive and granular material were found to be inconsistent in their order and thickness. Typically, where both cohesive and granular soils were encountered, the cohesive soils overlaid the granular soils. The exception is TP/DP D where the granular soils overlay the cohesive soils. Figure 4 identifies the different areas of different soil characteristics within the site.

The cohesive soils of the Lambeth Group were encountered in seven trial holes. The Cohesive soils of the Lambeth Group typically comprised soft to

firm brownish red mottled light grey slightly sandy CLAY. The sand was described as fine.

Granular soils of the Lambeth Group were encountered in nine trial holes underlying the Made Ground/Topsoil. The cohesive soils of the Lambeth Group persisted to a depth of 4.00m bgl (the final depth of WS/DP3, WS/DP4, TP/DPB and TP/DPC). The granular soils of Lambeth Group typically comprised light orangish brown clayey to very clayey fine to medium SAND.

The depth of Cohesive soils of the Lambeth Group has been included in Table 2.4 and the final depth of the granular soils of the Lambeth Group has been included in Table 2.5.

Table 2.4 Final Depth of Cohesive soils of the Lambeth Group

Trial Hole	Top Depth (m bgl)	Base Depth (m bgl)
WS/DP 1	0.25	6.00/8.00 ¹
WS/DP 2	0.40	1.90
WS/DP 3	0.40	1.80
WS/DP 4	0.90	1.30
WS/DP A	0.35	2.90
TP/DP B	Not present	
TP/DP C	0.10	2.20
TP/DP D ²	1.30	4.00 ¹
SK 1	Not present	
SK2	Not present	

Note: ¹ Final depth of trial hole. ²Cohesive soils overlaid by granular soils

Table 2.5 Final Depth of Granular soils of the Lambeth Group

Trial Hole	Top Depth (m bgl)	Base Depth (m bgl)
WS/DP 1	Not present	
WS/DP 2	1.90	3.60 ¹
WS/DP 3	1.80	4.00 ¹
WS/DP 4	1.30	4.00 ¹
WS/DP A	2.90	4.00 ¹
TP/DP B	1.20	4.00 ¹
TP/DP C	2.20	4.00 ¹
TP/DP D	Not present	
SK 1	0.30	3.00 ¹
SK2	0.30	3.00 ¹

Note: ¹ Final depth of trial hole.

2.4 Roots

Roots were encountered in all ten trial holes, present to depths ranging between 0.35 and 2.60m 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)
WS1	1.90
WS2	1.90
WS3	1.40
WS4	0.65
WSA	0.35
SK1	0.50
SK2	0.50
TPB	0.50
TPC	2.00
TPD	2.60

Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that may 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.

Several mature trees were noted onsite, particularly in the north of the site where WS1, TPC and TPD were located.

2.5 Groundwater

Groundwater was encountered within two trial holes and was struck at a depth of 2.98m bgl (SK2) and 3.00m bgl (TPB). Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in July (2017), when groundwater levels should be falling towards their annual minimum (lowest) elevation, which typically occurs around September.

The results of the ongoing groundwater level monitoring have been presented in Table 2.7.

Table 2.7 Groundwater Monitoring

Trial Hole	Depth to Water (m bgl)	
	11/07/2017	28/07/2017
WS1	Dry	G.L. ¹
WS2	Dry	Dry
WS3	Dry	Dry
WS4	Dry	Dry

Note: ¹Water standing at ground level.

The water recorded at ground level within WS1 on 28th July 2017 was unlikely to represent true groundwater level and was likely to result from localised surface water drainage and the low permeability cohesive soils of the Lambeth Group.

Monitoring of the groundwater and soil gas levels was ongoing at the time of reporting. The full results will be provided as an addendum once the gas monitoring regime has been completed.

2.6 Discussion of Onsite Geology

The Phase I Desk Study (Report number 16362/DS dated August 2017) identified a historical clay pit to the northwest of the site, located in the area of WS1 and TPD. Furthermore, Padnell Brick and Tile Works were located in the centre of the site and later extended to the east. It is considered that, over time, the site has undergone various cut and fill operations.

Trial pit logs have shown that the soils associated with the Lambeth Group varied in composition across the site and layers of cohesive and granular material were found to be inconsistent in their order and thickness. It is thought that these anomalies within the Lambeth Group are associated with the cut and fill operations.

Typically, where both cohesive and granular soils were encountered, the cohesive soils overlaid the granular soils – this is considered the natural order. The exception is TP/DP D where the granular soils overlay the cohesive soils and it is considered that the granular soils within this location have been infilled. The infilled granular material persists to a depth 1.30m bgl.

Figure 4 identifies the different areas of different soil characteristics within the site.

Section 3 Discussion of Geotechnical In-Situ and Laboratory Testing

3.1 Dynamic Probe Tests

Dynamic probing (DPSH) was undertaken at eight locations adjacent and prior to the construction of their corresponding trial hole depths ranging between 3.60m and 8.00m bgl. The results were converted to equivalent SPT “N” 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 B.1.2.

The cohesive soils of the Lambeth Group recorded equivalent SPT “N” values between 0 and 14, typically 3 and 9, showing general increase in strength with depth. Classifying the cohesive soils as extremely low to medium strength, typically low to medium, with inferred undrained cohesive strengths ranging between >10kPa and 70kPa and typical values of 15kPa to 45kPa.

The granular soils of the Lambeth Group recorded equivalent SPT “N” values between 3 and >50, typically 12 to 23. The granular soils were classified as ranging between loose to very dense relative density, typically medium dense.

It should be noted that SPT ‘N’ values used within Table B.2.1 are uncorrected. Whilst values within the foundation design, are corrected values in accordance with BS EN 22476 Part 3, to account for the rig efficiency, borehole depth, overburden factors etc. Further correction of the ‘N60’ values should therefore not be necessary. Raw field data is archived within the Soils Limited project file and can be provided on request.

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.

DCP testing was undertaken through the Made Ground/Topsoil and in to the cohesive soils of the Lambeth Group. The results from DCP testing indicated CBR values of between 4% and 20% 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 SK1 and SK2 within the granular soils of the 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 undertaken in SK1 and SK2. Neither test fully completed within the monitoring period due to insufficient infiltration. Results within SK2 have been extrapolated after 220minutes in order to calculate an infiltration rate.

BRE software BRESOAK was used to calculate the infiltration rates in SK2 and the results outlined in Table 3.1.

Table 3.1 Infiltration Rates

Trial Hole	Test No.	Infiltration Rate (m/s)	Notes
SK2	I	1.47×10^{-6}	Results have been extrapolated after 220minutes in order to calculate an estimated infiltration rate.

Infiltration testing within SK2 was undertaken directly into groundwater, which was encountered at 2.98m bgl. In accordance with BRE Digest DG365 and Environment Agency guidance, a soakaway system cannot discharge directly into groundwater. Therefore, the results from SK2 should not be used for the purpose of a surface water drainage system and the rate of 1.47×10^{-6} should only be taken for the preliminary design of a surface water drainage system.

3.4 Atterberg Limit Tests

Atterberg Limit tests were performed on six samples from the cohesive soils of the Lambeth Group. The results were classified in accordance with BRE Digest 240 and NHBC Standards Chapter 4.2.

The cohesive soils of the Lambeth Group were classified as medium 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 four samples from the Lambeth Group.

PSD classified the granular beds of the Lambeth Group as having a volume change potential in accordance BRE Digest 240 in three of four samples. The results from grading analysis confirmed that one of the four samples tested had a volume change potential in accordance with NHBC Standards Chapter 4.2. One sample (WS4:2.20) did not have a volume change potential. Further detailed assessment of the samples has

established that the soils are not plastic and therefore do not have 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

Three samples were taken from the Lambeth Group (WS1:1.40, WS3:2.10, WS4:1.70) 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 <10mg/kg and 112mg/l with pH values of 4.7 to 6.9.

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.

Consideration must be taken to the information provided within Phase I Desk Study (Report number 16362/DS dated August 2017). Where a historical clay pit to the northwest of the site, located in the area of WS1 and TPD has been identified. Furthermore, Padnell Brick and Tile Works were located in the centre of the site and later extended to the east. It is considered that, over time, the site has undergone various cut and fill operations.

Trial hole logs have shown that the soils associated with the Lambeth Group varied in composition across the site and layers of cohesive and granular material were found to be inconsistent in their order and thickness, it is thought that these anomalies with Lambeth Group are associated with the cut and fill operations. It is recommended that further work is carried out prior to the construction phase to confirm the thickness and composition of the underlying soils, especially in areas that were not covered during this investigation.

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 Made Ground were encountered in five out of the ten trial holes from ground level to depths ranging between 0.25m and 1.30m bgl. The Made Ground typically comprised dark brown gravelly sandy SILT. The gravel comprised fine to coarse sub-angular brick, flint, chalk and metal fragments. The depths of Made Ground have been included in Table 2.3.

Soils described as Topsoil were encountered in five out of the ten trial holes from ground level to depths ranging between 0.10m and 0.40m bgl. The Topsoil comprised brown slightly gravelly sandy SILT with frequent rootlets. Gravel was

fine to medium sub-rounded clasts of flint. Sand was fine. The depth of Topsoil has 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 Lambeth Group

Soils described as Lambeth Group was encountered in all twenty trial holes and were encountered in both cohesive and granular forms. The soils of the Lambeth group were encountered underlying the Made Ground/Topsoil and persisted to a depth of 8.00m bgl, the full investigatory depth of DP1.

The soils of the Lambeth Group varied in composition across the site and layers of cohesive and granular material were found to be inconsistent in their order and thickness across the site. Typically, where both cohesive and granular soils were encountered, the cohesive soils overlaid the granular soils. The exception is TP/DP D where the granular soils overlay the cohesive soils. Figure 4 identifies the different areas within the site.

The cohesive soils of the Lambeth Group were encountered in seven trial holes. The cohesive soils of the Lambeth Group typically comprised soft to firm brownish red mottled light grey slightly sandy CLAY. The sand was described as fine.

Granular soils of the Lambeth Group were encountered in nine trial holes underlying the Made Ground/Topsoil the cohesive soils of the Lambeth Group persisted to a depth of 4.00m bgl (the final depth of WS/DP3, WS/DP4, TP/DPB and TP/DPC). The granular soils of Lambeth Group typically comprised light orangish brown clayey to very clayey fine to medium SAND.

The results from DPSH testing inferred that the cohesive soils of the Lambeth Group were of an **extremely low to medium strength, typically low to medium**, with undrained cohesions of between **>10kPa and 70kPa**, typically ranging **15kPa to 45kPa**.

The granular soils of the Lambeth Group recorded equivalent SPT "N" values between **3 and >50, typically 12 to 23**. The granular soils were classified as ranging between **loose to very dense** relative density, **typically medium dense**.

The cohesive soils of the Lambeth Group were classified as **medium volume change potential** in accordance with both BRE Digest 240 and NHBC Standards Chapter 4.2.

PSD classified the granular beds of the Lambeth Group as having a volume change potential in accordance BRE Digest 240 in three of four samples. The results from grading analysis confirmed that one of the four samples tested had a volume change potential in accordance with NHBC Standards Chapter 4.2. One sample (WS4:2.20) did not have a volume change potential. Further detailed assessment of the samples has established that the soils are not plastic and therefore do not have volume change potential.

The soils of the Lambeth Group are overconsolidated and are expected to display moderate bearing capacities with moderate settlement characteristics. The soils of the Lambeth Group would be considered as a suitable bearing stratum for the proposed development

4.1.3 Roots

Roots were encountered in all ten trial holes, present to depths ranging between 0.35 and 2.60m bgl. Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that may have been removed both within the site and its close environs. Several mature trees were noted onsite, particularly in the north of the site where WS1, TPC and TPD were located.

4.1.4 Groundwater

Groundwater was encountered within two trial holes and was struck at a depth of 2.98 in SK2 and 3.00m bgl within SK1. Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in July (2017), when groundwater levels should be falling towards their annual minimum (lowest) elevation, which typically occurs around September.

Further groundwater monitoring recorded water at ground level in WS1 on one occasion, which was unlikely to represent groundwater level, rather localised / perched water or a drainage issue. Groundwater was not recorded in WS1 on the other occasion or within WS2 to WS4 during monitoring undertaken to date.

Groundwater monitoring was ongoing at the time of reporting and will be updated when complete.

4.2 Foundation Scheme General

At the time of reporting, August 2017, the proposed development comprised demolition of the existing buildings and subsequent construction of eighty-four detached, semi-detached and terraced dwellings comprising of one to five bed houses and flats. The development included hard landscaping such as access roads, driveways and pavements, and soft landscaping such as public open spaces and private gardens.

In compiling this report reliance was placed on drawing number BELL170217/SKL-01, dated March 2017, prepared by Thrive Architects. 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 cohesive soils of the Lambeth Group had **medium 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 cohesive Lambeth Group.

The results from PSD testing and further assessment showed that the granular soils of the Lambeth Group were not plastic and therefore did not have volume change potential.

Furthermore, in the area of TP/DP D, where the granular soils overlay the cohesive soils, it is considered that the granular soils have been infilled. Therefore, foundation footings must be taken beyond the granular soils and into the cohesive soils of the Lambeth Group in this location. Further intrusive investigation is required in order to establish the extent of the infilled area.

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 Made Ground/Topsoil due to the likely variability and potential for large load induced settlements both total and differential.

The Phase I Desk Study (Report number 16362/DS dated August 2017) identified a historical clay pit to the northwest of the site, located in the area of WS1 and TPD. Furthermore, Padnell Brick and Tile Works were located in the centre of the site and later extended to the east. It is considered that, over time, the site has undergone various cut and fill operations.

Trial hole logs have shown that the soils associated with the Lambeth Group varied in composition across the site and layers of cohesive and granular material were found to be inconsistent in their order and thickness, it is thought that these anomalies within the Lambeth Group are associated with the cut and fill operations.

Typically, where both cohesive and granular soils were encountered, the cohesive soils overlaid the granular soils – this is considered the natural order. The exception is TP/DP D where the granular soils overlay the cohesive soils and it is considered that the granular soils within this location have been infilled. The infilled granular material persists to a depth 1.30m bgl. Therefore, in the area of TP/DP D, foundation footings must be taken beyond the granular soils and into the cohesive soils of the Lambeth Group.

Figure 4 identifies the different areas of different soil characteristics within the site.

Roots were encountered in all ten trial holes to depths ranging between 0.35m bgl and 2.60m 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**. Several mature trees were noted onsite, particularly in the north of the site where WS1 TPC and TPD were located. 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 suitably qualified person prior to concrete being poured.

Considering the type of development, a shallow foundation solution was considered the most suitable. Where maximum root depth dictates a foundation depth greater than 2.50m bgl (TP D identified roots to 2.60m bgl), a deep foundation solution must be considered.

4.3.1 Shallow Foundations into the Cohesive Lambeth Group

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 for the soils of the cohesive Lambeth Group. Due to the presence of infilled ground overlying cohesive ground in TPD to a depth of 1.30m bgl, bearing capacities were calculated from 1.50m bgl.

Table 4.1 Allowable Bearing Capacities within the cohesive soils of the Lambeth Group

Depth (m bgl)	Size (m)	Bearing Capacity (kPa)	Anticipated Settlement (mm)
1.50	5.00 x 0.75	75	25
2.00		90	25
2.50		100	25

4.3.2 Shallow Foundations into the Granular soils of the Lambeth Group

Based on a 5.00 by 0.75m strip foundation, using commercial software Table 4.2 shows the calculated bearing values and anticipated settlement characteristics for the soils of the Lambeth Group. Bearing capacities were calculated from 1.50m bgl.

Table 4.2 Allowable Bearing Capacities within the granular soils of the Lambeth Group

Depth (m bgl)	Size (m)	Bearing Capacity (kPa)	Anticipated Settlement (mm)
1.50	5.00 x 0.75	150	25
2.00		200	25
2.50		260	25

The use of reinforced trench fill foundations is strongly recommended as it would simplify construction and reduce the possibility of differential settlement affecting the foundations, particularly given the variability in ground conditions observed on the site.

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.

4.3.3 Piled Foundations

If adopted the piled foundations must be taken through any Made Ground into suitable strength soils of the Lambeth Group.

The construction of a piled foundation is a specialist job with the actual pile working load depending on the particular type pile and installation method. Prior to finalising the foundation design the advice from a reputable contractor who is familiar with the ground and groundwater conditions present at the site should be sought.

Further investigation via cable percussive boreholes or CPTu probes would be required to inform the design of a deep foundation solution.

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-2z**. The pH of the soils tested ranged between 4.7 and 6.9. 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 Made Ground/Topsoil are likely to be marginally stable in the short term at best.

Excavations taken into the cohesive soils of the Lambeth Group are likely to be stable in the short term, depending on the thickness of overlying Made Ground/Topsoil and granular soils of the Lambeth Group. 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. Groundwater monitoring was ongoing at the time of reporting.

4.6 Pavements

The Transport Research Laboratory (TRL), Dynamic Cone Penetrometer (DCP) was undertaken at five locations (DCP1 – DCP5). DCP testing was undertaken through the

Made Ground/Topsoil and in to the cohesive soils of the Lambeth Group. The results from DCP testing indicated CBR values of between 4% and 20% for the soils encountered in the top 1.00m bgl

When removing the top ~400mm of either Made Ground or Topsoil, the worst case CBR value was 5%, which was considered suitable for design purposes for the proposed roadways. Any soft spots at formation level should be dug out and replaced with a suitable compacted granular fill. Prior to construction, the formation level should be proof rolled.

The cohesive soils of the Lambeth Group would be regarded as frost-susceptible as plasticity indexes were >20%. The non-cohesive soils of the Lambeth Group would be regarded as frost-susceptible as the soils consisted of >10% fines. In conclusion, all soils encountered will be frost susceptible.

4.7 Soakaways

Infiltration testing in accordance with BRE DG 365 was attempted in SK1 and SK2 within the Lambeth Group. Due to low observed infiltration, the tests did not complete within the monitoring period.

A single test was undertaken in SK1 and SK2. Infiltration rates within SK2 have been heavily extrapolated after 220minutes in order to calculate an infiltration rate. A rate of 1.47×10^{-6} was calculated. However, BRE Digest DG365 Soakaway design: 2016 states that 'Groundwater should not rise to the level of the base of the soakaway during annual variations in the water table'. Furthermore, the Environment Agency typically requires a minimum freeboard of 1.00m between the base of the soakaway and the phreatic zone (saturated ground).

Clarification to the maximum (highest) depth of groundwater must therefore be established prior to the commissioning of a soakaway installation. This will be achieved through the series of groundwater measurements associated with the gas monitoring. It is particularly important to gain information of the groundwater levels over the winter period. Alternatively, consideration could be given to a shallow soakaway system such as a herringbone system.

Section 5 Determination of Chemical Analysis

5.1 Site Characterisation and Revised Conceptual Site Model

The Phase I Desk Study undertaken by Soils Limited (report ref: 16362/DS dated August 2017) identified a low to moderate risk of ground contamination from previous usage of the site and offsite sources.

The Phase I Desk Study identified the area surrounding WS1 as being previously dominated by a clay pit and an onsite brickworks and kiln were noted near the centre of the site.

The Phase II Ground Investigation identified Made Ground to depths ranging between 0.25m and 1.20m bgl. The Made Ground typically comprised dark brown gravelly sandy SILT. The gravel comprised fine to coarse sub-angular brick, flint, chalk and metal fragments.

Shallow groundwater was encountered within the Lambeth Group. 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
WS1:0.60	Targeted – Area of historical clay pit	Rear garden of plot 2
WS2:0.40	Targeted – Area of historical brickworks and kiln – Made Ground	Boarder planting
WS3:0.30	Targeted – Area of historical brickworks and kiln	Rear garden of plot 44
WS4:0.50	Targeted – Area of historical clay mill	Rear garden of plot 81
WS4:0.75	Targeted – Area of historical clay mill	Rear garden of plot 81
WSA:0.20	Targeted – Made Ground	Rear garden of plot 32
WSA:0.50	Targeted – Directly below Made Ground	Rear garden of plot 32
TPD:0.50	Targeted – Area of historical clay pit	Rear garden of plot 24

5.3 Determination of Chemical Analysis

The driver for determination of the analysis suite was the information obtained from the Phase I Desk Study and Phase II intrusive investigation. Table 5.2 outlines the specification for each sample tested.

Table 5.2 Chemical Analysis Specification

Substance	Locations: Depths (m bgl)							
	WS1:0.60 ^s	WS2:0.40 ^s	WS3:0.30 ^s	WS4:0.50 ^s	WS4:0.75 ^s	WSA:0.20 ^s	WSA:0.50 ^s	TPD:0.50 ^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

At the time of reporting, August 2017, the proposed development comprised demolition of the existing buildings and subsequent construction of eighty-four detached, semi-detached and terraced dwellings comprising of one to five bed houses and flats. The development included hard landscaping such as access roads, driveways and pavements, and soft landscaping such as public open spaces and private gardens.

In compiling this report reliance was placed on drawing number BELL170217/SKL-01, dated March 2017, prepared by Thrive Architects. 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 residential with plant uptake 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
Benzo(b)fluoranthene	WSA:0.20 (5.89mg/kg against 4.00mg/kg)
Di-benzo(a,h)anthracene	WSA:0.20 (0.53mg/kg against 0.32mg/kg)

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 the 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 0.1% and 4.2%. For each soil sample tested, the Soil Organic Matter recorded was used to derive the appropriate guideline value for organic determinants.

In summary, one of the samples tested showed concentrations in excess of the relevant S4UL for a residential with plant uptake land-use scenario.

In WSA at 0.20m bgl Benzo (b)fluoranthene was recorded at a concentration of 5.89mg/kg against the residential with plant uptake end-use C4SL of 4.00mg/kg and Di-benzo(a,h)anthracene was recorded at 0.53mg/kg against a concentration of 0.32mg/kg. WSA is located on the boundary of the historical brick and tile works, It is thought that these exceedances are associated with these works.

None of the other substances tested recorded concentrations above the residential end-use screening values.

6.2.1 Asbestos

Asbestos Containing Material (ACM) was detected within the sample from WS4 at 0.50m bgl, an area previously occupied by a Kiln and small out buildings. The ACM was determined to comprise microscopic loose fibrous asbestos (Chrysotile) debris in soil. As asbestos containing material was identified in one of the samples tested 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 Risk to Groundwater

The risk to groundwater was not directly assessed as part of this investigation.

The Phase I Desk Study showed that the bedrock Lambeth Group, located in the northeast had a Secondary A Aquifer designation and the bedrock London Clay Formation, in the remainder of the site, had a Unproductive Strata designation. Furthermore, local topography dictates that any surface water and shallow ground water will flow down to the southeast – away from the Lambeth Group and the Secondary A Aquifer. Deep groundwater located within the Newhaven Chalk Formation is not at risk.

Groundwater was encountered within two trial holes and was struck at a depth of 3.00m bgl. Groundwater sampling was not included within the scope of this report. However, due to the level of contamination onsite it is considered that the residual risk to groundwater is negligible.

6.4 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.

6.4.1 Soils

One of the samples tested showed concentrations in excess of the relevant S4UL for a residential with plant uptake land-use scenario.

In WSA at 0.20m bgl Benzo (b)fluoranthene was recorded at a concentration of

5.89mg/kg against the residential end-use C4SL of 4.00mg/kg and Di-benzo(a,h)anthracene was recorded at 0.53mg/kg against a concentration of 0.32mg/kg.

Furthermore, Asbestos Containing Material (ACM) was detected (WS4:0.50m bgl) and determined to comprise Microscopic loose fibrous asbestos (Chrysotile) debris in soil.

The Tier 1 Quantitative risk assessment therefore established that there was **a risk to the human health receptors** of construction workers or future end-users.

6.4.2 Groundwater

The Groundwater Risk Assessment established that **there was no risk** to the deep groundwater receptor due to the insignificant level of contamination found within the soil, the underlying geology and local topography.

6.4.3 Soil Gas

The Phase I Desk Study identified a moderate risk of soil gas associated with an infilled clay pit onsite and a further four infilled clay pits to the north ranging from 24 to 165m from the site.

Monitoring of the wells installed within WS1 – WS4 has been undertaken on two occasions to date, including targeting periods of low and falling pressure. At the time of reporting, three more visits were scheduled and therefore the results of the soil gas risk assessment will be provided in an addendum once the regime is completed.

6.5 Remedial Objective

Soil chemical analysis recorded one sample with substance levels over their representative residential with plant uptake guideline values for two PAH's.

Therefore, there was a risk to the Human Health, Building Structures, which would require a remediation strategy.

The remedial objective for the site is to ensure site clean-up removes any unacceptable risk to the identified receptors of Human Health, Building Structures and Services and Groundwater receptor.

In essence, the remedial objective should sever any source-pathway-receptor pollutant linkages that have been established. Once this has been achieved, by whatever means, there can theoretically be no risk.

6.6 Development of Soil Remediation Strategy

Production of a remediation strategy report was not part of the brief for this Phase II

Intrusive Investigation. A number of examples remedial options are outlined below.

6.6.1 Asbestos

Asbestos Containing Material (ACM) was detected within the sample from WS4 at 0.50m bgl. The ACM was determined to comprise Microscopic loose fibrous asbestos (Chrysotile) debris in soil. In collaboration with a licensed asbestos removal contractor consultation must be made with the local authority to determine a remediation strategy. Asbestos-containing soils (ACSs) do not necessarily require removal or treatment, but would require a suitable capping layer to remain in-situ. All future works should have suitable health and safety procedures in place to protect workers from airborne asbestos fibres (for example, keeping soils damp during excavation in drier periods). If ACSs remain in-situ measures should be put in place to ensure the risk of exposures is not increased, such as exposing buried asbestos at the surface. Where ACSs have to be removed from site quantification of the asbestos would be required. Waste containing asbestos will be hazardous waste if it contains more than 0.1% by weight of asbestos, (CIRIA C733, Asbestos in soil and made ground: a guide to understanding and managing risks).

Asbestos quantification would be recommended on the soil sample where asbestos was identified, so an assessment can be carried out.

6.6.2 Further Chemical Testing and Human Health Risk Assessment

It is **recommended** that further testing is undertaken once the site strip has been completed. Soil contamination was found in the top 0.50m and it is considered that this will be removed during the site strip.

6.6.3 Adoption of Cover System in Soft Landscaped Areas

The BRE "*Cover Systems For Land Regeneration, Thickness Design of Cover Systems for Contaminated Land, BRE, March 2004*", allows for the design of cover systems to impacted soils where the concentration of substances within the ground does not exceed any of the respective SGV, C4SL or S4UL by more than six times. In such a situation, a maximum cover thickness of 600mm is given. However, the concentration of substances within the certified clean soil/topsoil, which comprises the cover system, determines the overall thickness of the system and can reduce the required thickness markedly below 600mm.

Where the concentration of substances within the ground does exceed any of the respective SGV, C4SL or S4UL by more than six then an engineered capping system would be required.

The concentrations of elevated contaminants outlined in Table 6.1 did not show any substances, which were greater than six times their respective guideline value.

6.6.4 Excavation of Impacted Soil

It could be proposed to excavate and stockpile the impacted material on the site in preparation for classification and subsequent disposal off-site to a suitable licensed

facility.

The initial excavations should be centred on the trial-holes with impacted soil and then extended in all directions, so that the impacted soils can be 'chased' out. Once excavation has been completed validation would be required to prove all impacted soil has been removed. Validation would involve taking a representative number of samples from the sides and base of any excavation and then sent off for appropriate chemical analysis.

The stockpiled soils must be placed on an impermeable liner with raised edges. During periods of rainfall, the stockpile must be covered over to minimise leaching and run-off into the underlying soils. Covering of the stockpile may be required to prevent fumes impacting receptors off-site.

The remedial works must be inspected and independently validated by a suitable person.

On completion of the development, a Validation and Closure Report must be supplied to both the Local Authority and the NHBC detailing the remediation works undertaken on the site.

Any voids resulting from the removal of impacted soil must be backfilled with a suitable certified clean granular soil.

The developer/groundworker must be made aware of the need to address the risk from asbestos identified in this report; former use of the site and for the potential for additional sources of contamination not identified in the Phase I Desk Study or the Phase II Intrusive Investigation to be found within the site both during demolition and the excavation of trenches for services and foundations.

6.6.5 Excavation of All Made Ground

Made Ground was encountered across the site to depths between 0.25m and 1.20m bgl. Given the nature of the site, this option is considered unnecessary.

6.6.6 Hard Landscape Entire Site

Hard landscaping the entire site could eliminate exposure pathways to contaminated soils for:

- Direct soil and dust ingestion,
- Consumption of home-grown produce,
- Dermal contact,
- Inhalation of dust (indoor and outdoor),
- Migration through permeable soils (direct precipitation, overland flow and through flow).

6.6.7 Engineering Capping System

If an engineering capping system was required it should comprise a geotextile and/or mesh underlying a 200mm thick layer of lightly compacted gap graded crushed concrete (5-75mm) or the like, with geotextile upper cover underlying 450mm thickness of clean certified Topsoil.

6.7 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.

6.8 Excavated Material

Excavated material must be classified with the Environment Agency for disposal at an appropriately licensed disposal facility. The requirements of Duty of Care and Health and Safety Guidance must be complied with.

Both Producers and Waste Management companies must ensure compliance with the new Waste Acceptance Criteria (WAC) prior to landfill in hazardous, stable non-reactive cells and inert sites. These regulations govern the operation of landfill in England and Wales. Basic characterisation is the responsibility of the waste producer and compliance checking is generally the responsibility of the landfill operator. Therefore, landfill operators will be unlikely to accept waste that does not meet the Waste Acceptance Criteria for their class of site.

There is an obligation to 'treat' all soils destined for landfill, including non-hazardous waste. This treatment must now be documented and presented to the landfill operator or waste may be refused entry. Note that all liquids are banned from landfill.

For the purposes of legal compliance, 'treatment' must comprise three things (the 'three-point test'):

1. It must be a physical, thermal, chemical or biological process.
2. It must change the characteristics of the waste.
3. It must do so in order to:
 - (a) reduce its volume, or
 - (b) reduce its hazardous nature, or
 - (c) facilitate its handling, or enhance its recovery.

WAC testing was not undertaken at this stage but may be necessary depending upon whether material is required to be taken off-site.

6.9 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.

6.10 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.

6.11 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 A Field Work

Appendix A.1 Engineers Logs

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Appendix B.1 Classification

Appendix B.2 Interpretation

Appendix B.3 Geotechnical In-Situ and Laboratory Results

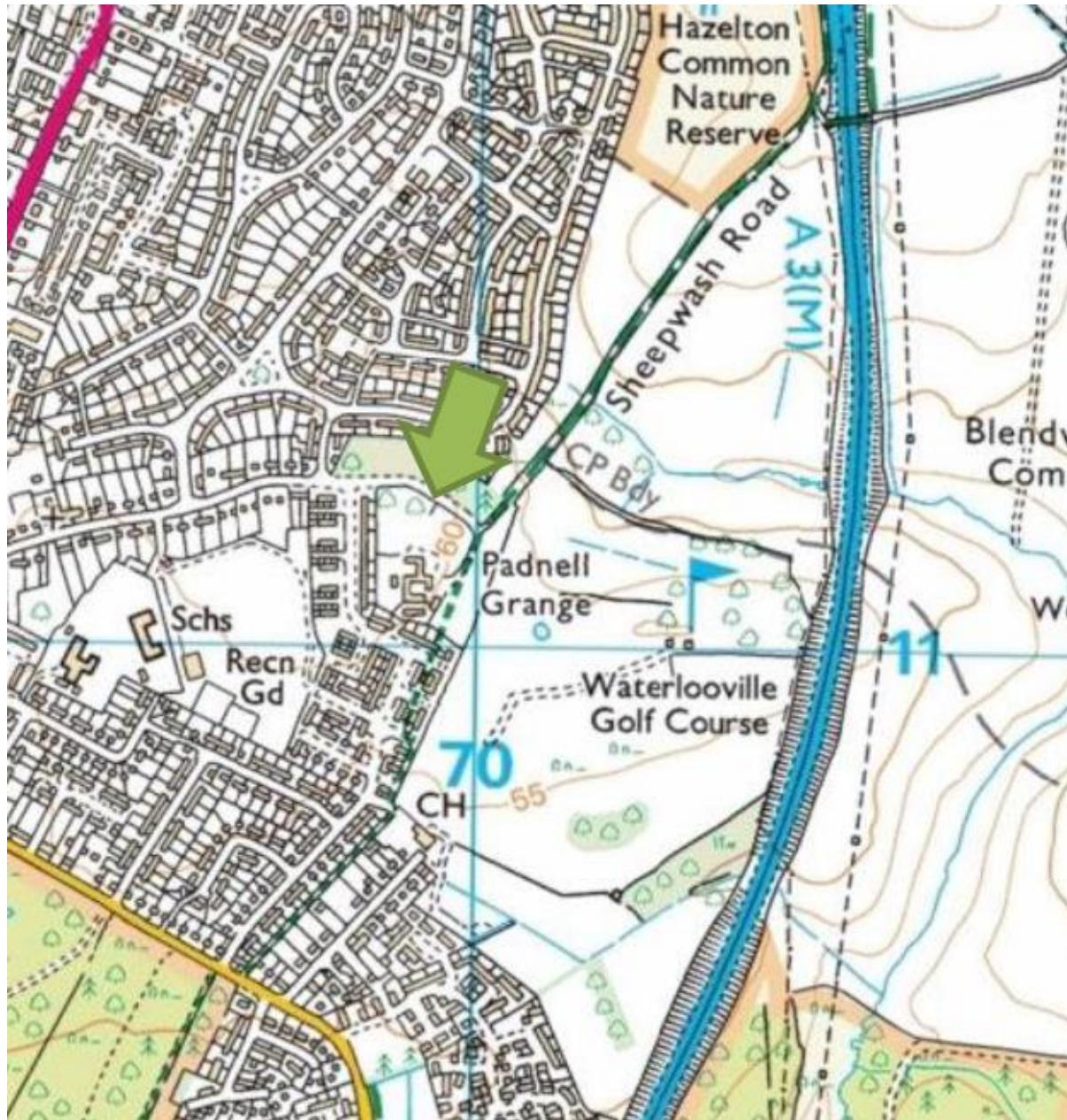
Appendix C Chemical Laboratory Testing

Appendix C.1 Conceptual Site Model

Appendix C.2 Chemical Laboratory Results

Appendix C.3 General Assessment Criteria

Appendix D Information Provided by the Client

Figure 1 – Site Location Map

Job Number
16362

Project
Padnell Grange, Padnell Road, Cowplain, Hampshire
PO8 8ED

Client
Bellway Homes (Wessex)

Date
August 2017

Figure 2 – Aerial Photograph



Project

Padnell Grange, Padnell Road,
Cowplain, Hampshire PO8 8ED

Client

Bellway Homes (Wessex)

Date

August 2017

Job Number

16362



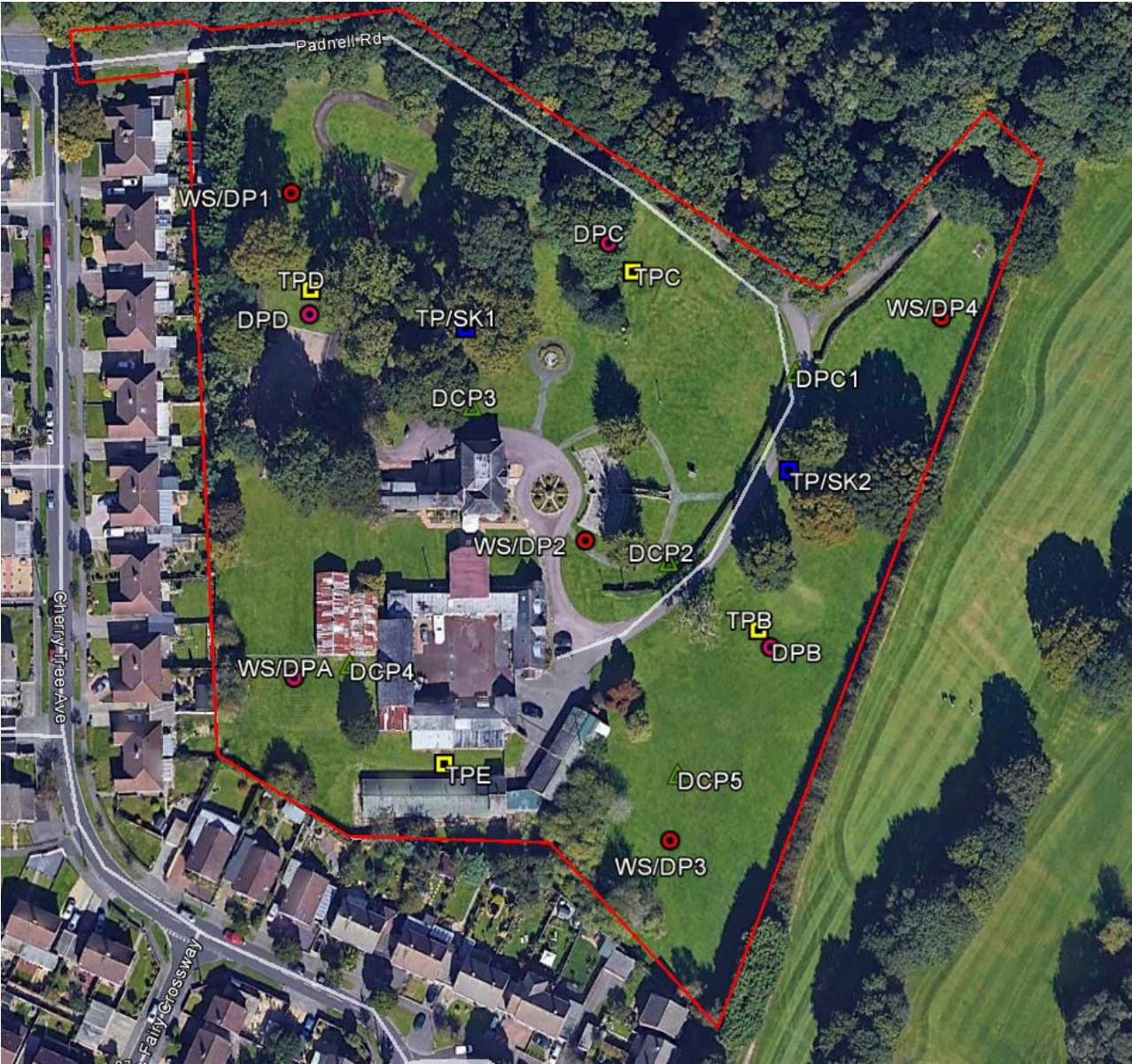


Figure 3 – Trial Hole Plan

Project
Padnell Grange, Padnell Road,
Cowplain, Hampshire PO8 8ED

Client
Bellway Homes (Wessex)

Date
August 2017

Job Number
16362





Padnell Grange, Padnell Road,
Cowplain, Hampshire PO8 8ED

Bellway Homes (Wessex)

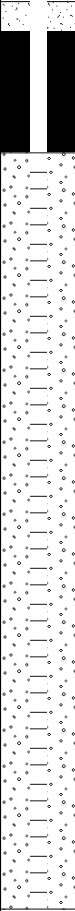
August 2017

16362

Appendix A Field Work

Appendix A.1 Engineers Logs

Project Name: Padnell Grange,	Project No.: 16362	Co-ords:	Hole Type WS
Location: Padnell Road, Cowplain, Hants PO8 8ED		Level:	Scale 1:50
Client: Bellway Homes (Wessex)		Dates: 05-07-2017	Logged By AE

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.25	D+J		0.25			Brown slightly gravelly sandy SILT. Sand is fine to coarse. Gravel is fine to medium sub-rounded brick and flint. Occasional ash. Frequent rootlets. MADE GROUND.	
		0.60 - 1.00	B+J		0.60			Soft to firm dark greyish brown silty sandy CLAY. Sand is fine to medium. Occasional fine roots and rootlets. LAMBETH GROUP.	
								Stiff to very stiff brownish red and light grey mottled sandy CLAY. Roots and rootlets present to 1.9m bgl. Rare evidence of decaying roots throughout. LAMBETH GROUP.	1
		1.40	D						
		1.90	D						2
		2.30	D						
		3.20	D					Occasional ferruginous staining 2.9 to 3.2m	3
		3.70	D						
		4.20	D						4
		4.70	D						
		5.20	D						5
		5.70	D						
					6.00			End of Borehole at 6.00m	6
									7
									8
									9
									10

General Remarks:

Roots observed to 1.90m bgl.

Groundwater Remarks:

No groundwater encountered.

Borehole Type

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

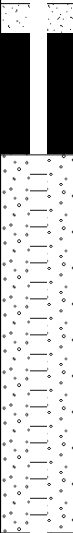
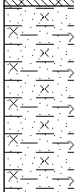
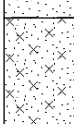
Sample Types

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

In-Situ Testing

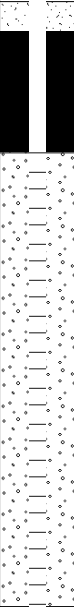
SPT: Split spoon - Standard Penetration Test
CPT: Cone - Standard Penetration Test

Project Name: Padnell Grange,	Project No.: 16362	Co-ords:	Hole Type WS
Location: Padnell Road, Cowplain, Hants PO8 8ED		Level:	Scale 1:50
Client: Bellway Homes (Wessex)		Dates: 05-07-2017	Logged By AE

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		0.25	D+J		0.40			Brown slightly gravelly sandy SILT. Sand is fine to coarse. Gravel is fine to medium sub-rounded flint. Frequent rootlets. TOPSOIL.			
		0.40 - 0.60	B+J					Soft to firm orange brown mottled grey slightly silty sandy CLAY. Sand is fine to medium. Occasional roots and rootlets. LAMBETH GROUP.			
		0.60 - 1.00	B+J								
		1.40	D		1.75				1		
		1.80	D								
		2.30	D					Stiff light grey mottled orangish slightly sandy CLAY. Sand fine to medium. Rare rootlets. LAMBETH GROUP.			
		2.70	D		2.80			Orange pinkish brown mottled light grey clayey fine to medium SAND. LAMBETH GROUP.	2		
		3.20	D					Yellowish orangish brown slightly silty fine to medium SAND. Occasional black staining. LAMBETH GROUP.			
							3.60			End of Borehole at 3.60m	3
											4
								5			
								6			
								7			
								8			
								9			
								10			

General Remarks: Roots observed to 1.90m bgl. Groundwater Remarks: No groundwater encountered.	Borehole Type CP: Cable Percussive WS: Windowless Sampler RC: Rotary Cored In-Situ Testing SPT: Split spoon - Standard Penetration Test CPT: Cone - Standard Penetration Test	Sample Types D: Disturbed B: Bulk J: Jar W: Water U: Undisturbed
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Project Name: Padnell Grange,	Project No.: 16362	Co-ords:	Hole Type WS
Location: Padnell Road, Cowplain, Hants PO8 8ED		Level:	Scale 1:50
Client: Bellway Homes (Wessex)		Dates: 05-07-2017	Logged By AE

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30	D+J		0.40			Dark brown slightly sandy slightly clayey slightly gravelly SILT. Sand is fine to medium. Gravel is medium to coarse sub-angular to sub-rounded flint and ash. Occasional rootlets. TOPSOIL.	
		0.80	D+J					Soft to firm light brown mottled reddish brown slightly silty sandy CLAY. Sand is medium to coarse. Rare fine gravel. Band of coarse sub-rounded flint gravel at 1.2m. Rare rootlets. LAMBETH GROUP.	1
		1.30	D		1.40			Stiff light grey mottled brown slightly sandy CLAY. Sand is fine. LAMBETH GROUP.	
		1.60	D		1.80			Light orangish brown silty becoming very silty fine SAND. Occasionally thickly laminated. LAMBETH GROUP.	2
		2.10	D		2.80			Light yellowish grey slightly silty fine to medium SAND. LAMBETH GROUP.	3
		2.60	D						
		3.10	D						
		3.60	D		4.00				
								End of Borehole at 4.00m	4
									5
									6
									7
									8
									9
									10

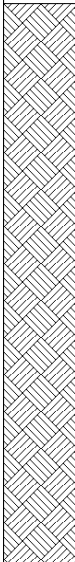
General Remarks: Rootlets to 1.40m bgl. Groundwater Remarks: No groundwater encountered.	Borehole Type CP: Cable Percussive WS: Windowless Sampler RC: Rotary Cored In-Situ Testing SPT: Split spoon - Standard Penetration Test CPT: Cone - Standard Penetration Test	Sample Types D: Disturbed B: Bulk J: Jar W: Water U: Undisturbed
---	---	--

Project Name: Padnell Grange,	Project No.: 16362	Co-ords:	Hole Type WS
Location: Padnell Road, Cowplain, Hants PO8 8ED		Level:	Scale 1:50
Client: Bellway Homes (Wessex)		Dates: 05-07-2017	Logged By

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.50	D+J		0.65			Dark brown sandy gravelly SILT. Sand is fine to coarse. Gravel is fine to coarse angular to sub-rounded flint and brick. Occasional rootlets. MADE GROUND.	
		0.75	D+J		0.90			Light brown, slightly gravelly sandy SILT. Sand is fine to coarse. Gravel is fine to coarse angular to sub-rounded brick. MADE GROUND.	
		1.20	D		1.30			Very soft mottled grey orange and reddish brown slightly silty CLAY. LAMBETH GROUP.	1
		1.70	D					Light grey mottled orange becoming light brown slightly clayey fine SAND. Band of very soft fine sandy clay at 1.45m BGL. Frequent thinly laminated black staining. LAMBETH GROUP.	
		2.20	D					Band of very soft fine sandy clay at 1.45m bgl	2
		2.70	D					Band of very soft fine sandy clay at 1.9m bgl	
		3.20	D						3
		3.70	D						
					4.00			End of Borehole at 4.00m	4
									5
									6
									7
									8
									9
									10

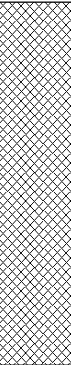
General Remarks: Rootlets to 0.65m bgl.	Borehole Type CP: Cable Percussive WS: Windowless Sampler RC: Rotary Cored	Sample Types D: Disturbed B: Bulk J: Jar W: Water U: Undisturbed
Groundwater Remarks: No groundwater encountered.	In-Situ Testing SPT: Split spoon - Standard Penetration Test CPT: Cone - Standard Penetration Test	

Project Name: Padnell Grange,	Project No.: 16362	Co-ords:	Hole Type WS
Location: Padnell Road, Cowplain, Hants PO8 8ED		Level:	Scale 1:50
Client: Bellway Homes (Wessex)		Dates: 05-07-2017	Logged By SCD

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D+J		0.35			Dark brown sandy clayey gravelly SILT. Sand is fine to coarse. Gravel is fine to coarse sub-angular to sub-rounded flint and other. Clay present as medium gravel sized lumps. Frequent rootlets. MADE GROUND. Soft light grey mottled orangish and red CLAY. LAMBETH GROUP.	1
		0.50	D+J						
		0.90	D+J						
		1.40	D		1.50			Stiff brown mottled grey CLAY. LAMBETH GROUP.	2
		1.90	D						
		2.60	D		2.40			Firm light brown mottled orange brown slightly sandy slightly silty CLAY. Rare bands of thinly laminated light grey clay. LAMBETH GROUP.	
		2.80	D						
		3.30	D		3.40			soft, light brown slightly sandy slightly silty CLAY. Sand is fine. LAMBETH GROUP.	3
		3.60	D						
							End of Borehole at 3.70m	4	
								5	
								6	
								7	
								8	
								9	
								10	

		Soils Limited Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk			Trial Pit Log		Trial Pit No. SK1 Sheet 1 of 1	
Project Name: Padnell Grange,				Project No.: 16362		Method: Mechanical Excavator		Hole Type TP
Location: Padnell Road, Cowplain, Hants PO8 8ED						Plant: JCB 3CX		
Client: Bellway Homes (Wessex)				Trial Pit Length: 1.60m		Trial Pit Width: 0.60m		Scale 1:25
Dates: 05-07-2017				Level:		Co-ords:		Logged By JO
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.25	D		0.30			Slightly sandy gravelly SILT. Gravel is fine to medium sub-rounded flint. Occasional roots and rootlets. TOPSOIL.	
	0.50	B					Grey mottled orange fine to medium SAND. LAMBETH GROUP.	
	0.75	D						
	1.00	D						
	1.50	D						
	2.00	D						
	2.50	D						
	3.00	D		3.00		End of Pit at 3.00m		
General Remarks: Roots observed to 0.50m bgl. No groundwater encountered.								Sample Type D: Disturbed B: Bulk J: Jar W: Water
Groundwater Remarks:								

		Soils Limited Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk			Trial Pit Log		Trial Pit No. SK2 Sheet 1 of 1	
Project Name: Padnell Grange,				Project No.: 16362		Method: Mechanical Excavator		Hole Type TP
Location: Padnell Road, Cowplain, Hants PO8 8ED						Plant: JCB 3CX		
Client: Bellway Homes (Wessex)				Trial Pit Length: 1.80m		Trial Pit Width: 0.60m		Scale 1:25
Dates: 05-07-2017				Level:		Co-ords:		Logged By JO
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.25	D		0.30			Slightly sandy gravelly SILT. Gravel is fine to medium sub-rounded flint. Occasional roots and rootlets. TOPSOIL.	
	0.50	B					Grey mottled orange fine to medium SAND. LAMBETH GROUP.	
	0.75	D						
	1.00	D						
	1.50	D						
	2.00	D						
	2.50	D						
	2.98	D		3.00			End of Pit at 3.00m	
	3.00							
	General Remarks: Roots observed to 0.50m bgl. Groundwater encountered at 2.98m bgl							
Groundwater Remarks:								

		Soils Limited Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk			Trial Pit Log		Trial Pit No. TPB Sheet 1 of 1	
Project Name: Padnell Grange,				Project No.: 16362		Method: Mechanical Excavator		Hole Type TP
Location: Padnell Road, Cowplain, Hants PO8 8ED						Plant: JCB 3CX		
Client: Bellway Homes (Wessex)				Trial Pit Length: m		Trial Pit Width: m		Scale 1:25
Dates: 05-07-2017				Level:		Co-ords:		Logged By JO
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.25	D		1.20			Slightly sandy gravelly SILT. Gravel is fine to medium sub-rounded flint, brick and chalk. Occasional metal and wood. Occasional roots and rootlets. MADE GROUND.	
	0.50	B						
	0.75	D						
	1.00	D						
	1.50	D		3.50			Grey mottled orange fine to medium SAND. LAMBETH GROUP.	
	2.00	D						
	2.50	D						
	3.00	D						
	3.50	D					End of Pit at 3.50m	
	3.50							
General Remarks:								Sample Type D: Disturbed B: Bulk J: Jar W: Water
Roots observed to 0.50m bgl. Groundwater encountered at 3.00m bgl								
Groundwater Remarks:								

		Soils Limited Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk			Trial Pit Log		Trial Pit No. TPC Sheet 1 of 1	
Project Name: Padnell Grange,				Project No.: 16362		Method: Mechanical Excavator		Hole Type TP
Location: Padnell Road, Cowplain, Hants PO8 8ED						Plant: JCB 3CX		
Client: Bellway Homes (Wessex)				Trial Pit Length: m		Trial Pit Width: m		Scale 1:25
Dates: 05-07-2017				Level:		Co-ords:		Logged By JO
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	D		0.10			Slightly sandy gravelly SILT. Gravel is fine to medium sub-rounded flint. Occasional roots and rootlets. TOPSOIL. Soft orange very sandy CLAY. Sand is fine to medium. LAMBETH GROUP.	
	0.50	B						
	1.00	D						
	1.50	D						
	2.00	D		2.20			Grey mottled orange fine to medium SAND. LAMBETH GROUP.	
	2.50	D						
	3.00	D						
	3.30	D		3.30				
						End of Pit at 3.30m		
General Remarks: Roots observed to 2.00m bgl. No groundwater encountered.								
Groundwater Remarks:								Sample Type D: Disturbed B: Bulk J: Jar W: Water

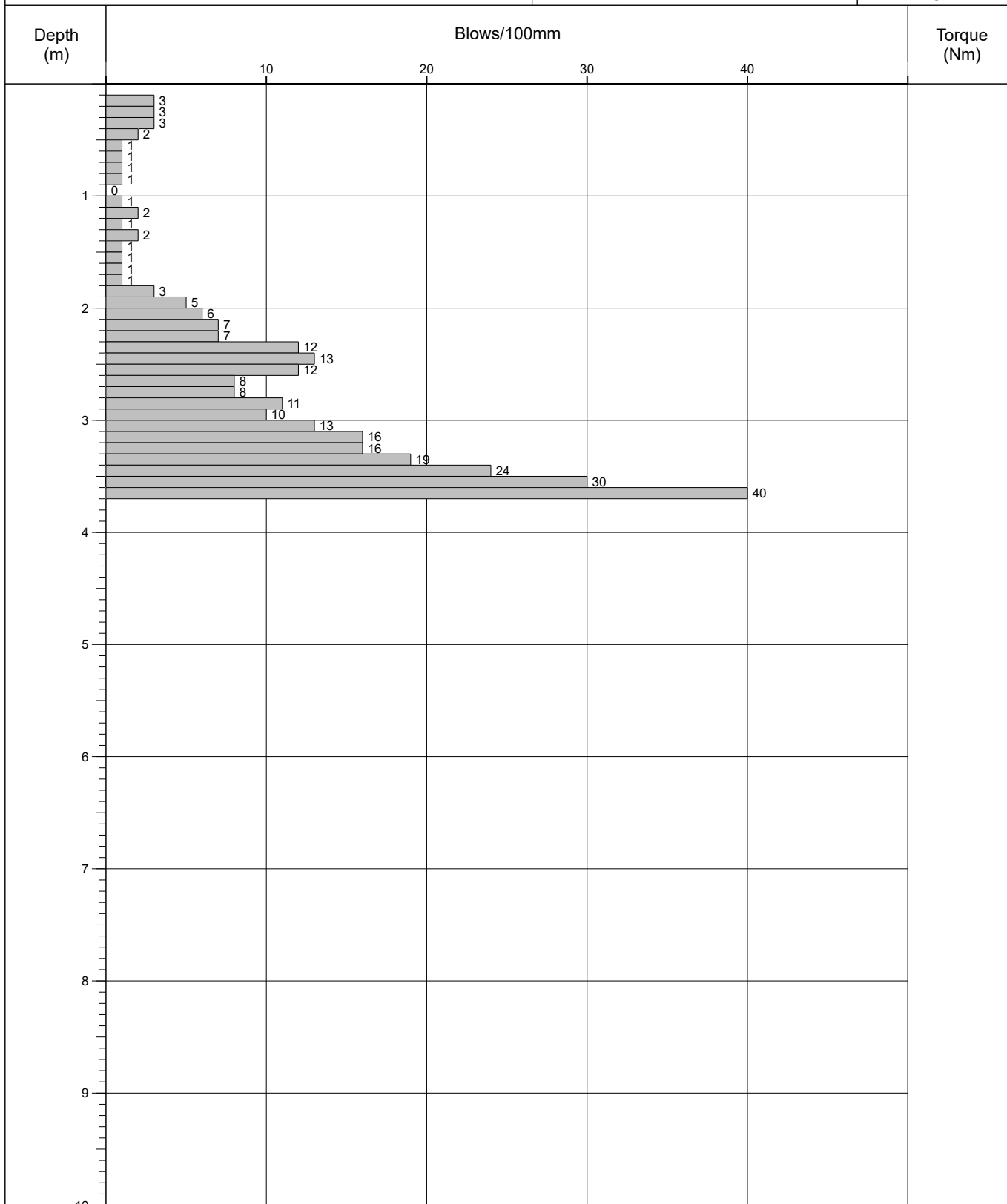
		Soils Limited Newton House, Cross Road, Tadworth KT20 5SR Tel: 01737 814221 Email: admin@soilslimited.co.uk			Trial Pit Log		Trial Pit No. TPD Sheet 1 of 1	
Project Name: Padnell Grange,				Project No.: 16362		Method: Mechanical Excavator		Hole Type TP
Location: Padnell Road, Cowplain, Hants PO8 8ED						Plant: JCB 3CX		
Client: Bellway Homes (Wessex)				Trial Pit Length: m		Trial Pit Width: m		Scale 1:25
Dates: 05-07-2017				Level:		Co-ords:		Logged By JO
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.10	D		0.25			Slightly sandy gravelly SILT. Gravel is fine to medium sub-rounded flint. Occasional roots and rootlets. TOPSOIL.	
							Grey mottled orange fine to medium SAND. LAMBETH GROUP.	
	0.50	B		1.30		Firm to stiff greyish brown mottled red CLAY . Occasional roots and rootlets. LAMBETH GROUP. <i>Ferruginous stained sand.</i>		
	1.00	D						
	1.50	D						
	2.00	D						
	2.50	D		2.60		End of Pit at 2.60m		
	3.00	D						
3.30	D							
General Remarks: Roots observed to 2.60m bgl. No groundwater encountered.								Sample Type D: Disturbed B: Bulk J: Jar W: Water
Groundwater Remarks:								

Project Name:	Padnell Grange,	Project No.	16362	Co-ords:		Hole Type	DP
Location:	Padnell Road, Cowplain, Hants PO8 8ED	Level:	m AOD			Scale	1:50
Client:	Bellway Homes (Wessex)	Dates:	05-07-2017			Logged By	SCD

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0					
0.1					
0.2					
0.3					
0.4					
0.5					
0.6					
0.7					
0.8					
0.9					
1.0					
1.1	2				
1.2	1				
1.3	2				
1.4	2				
1.5	3				
1.6	2				
1.7	2				
1.8	2				
1.9	2				
2.0	2				
2.1	2				
2.2	2				
2.3	2				
2.4	2				
2.5	2				
2.6	2				
2.7	2				
2.8	2				
2.9	2				
3.0	2				
3.1	4				
3.2	2				
3.3	2				
3.4	3				
3.5	2				
3.6	2				
3.7	2				
3.8	2				
3.9	2				
4.0	2				
4.1	2				
4.2	2				
4.3	2				
4.4	2				
4.5	2				
4.6	2				
4.7	2				
4.8	2				
4.9	2				
5.0	2				
5.1	2				
5.2	2				
5.3	2				
5.4	2				
5.5	2				
5.6	2				
5.7	2				
5.8	2				
5.9	2				
6.0	2				
6.1	2				
6.2	2				
6.3	2				
6.4	2				
6.5	2				
6.6	2				
6.7	2				
6.8	2				
6.9	2				
7.0	2				
7.1	2				
7.2	2				
7.3	2				
7.4	2				
7.5	2				
7.6	2				
7.7	2				
7.8	2				
7.9	2				
8.0	2				
8.1	2				
8.2	2				
8.3	2				
8.4	2				
8.5	2				
8.6	2				
8.7	2				
8.8	2				
8.9	2				
9.0	2				
9.1	2				
9.2	2				
9.3	2				
9.4	2				
9.5	2				
9.6	2				
9.7	2				
9.8	2				
9.9	2				
10.0	2				

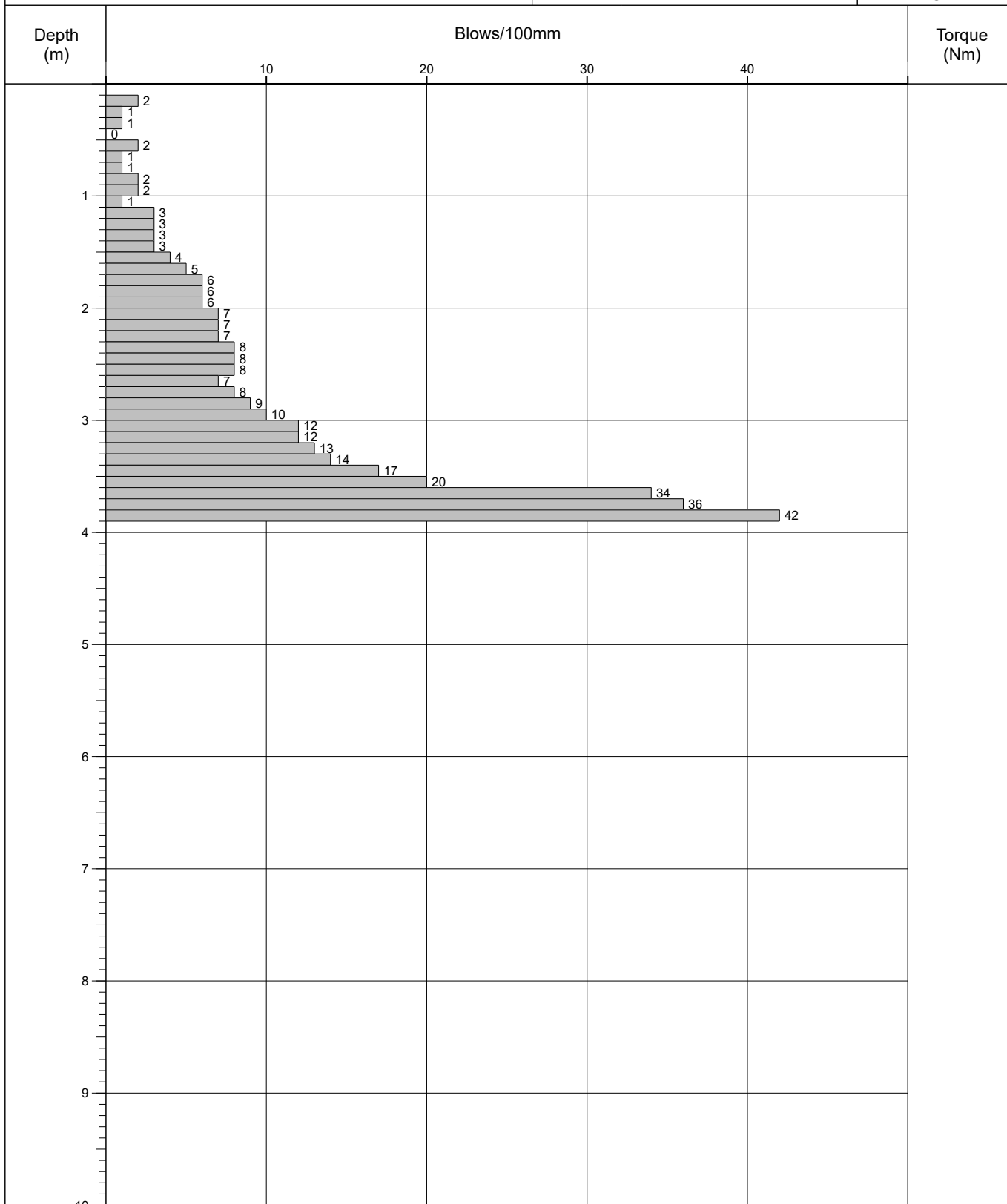
Remarks	Fall Height	750mm	Cone Base Diameter	51.5mm
	Hammer Weight	63.5kg	Final Depth	7.9m
	Probe Type	DPSH-B	Energy Ratio (Er)	61%

Project Name:	Padnell Grange,	Project No.	16362	Co-ords:		Hole Type	DP
Location:	Padnell Road, Cowplain, Hants PO8 8ED	Level:	m AOD			Scale	1:50
Client:	Bellway Homes (Wessex)	Dates:	05-07-2017			Logged By	SCD



Remarks	Fall Height	750mm	Cone Base Diameter	51.5mm
	Hammer Weight	63.5kg	Final Depth	3.6m
	Probe Type	DPSH-B	Energy Ratio (Er)	61%

Project Name:	Padnell Grange,	Project No.	16362	Co-ords:		Hole Type	DP
Location:	Padnell Road, Cowplain, Hants PO8 8ED	Level:	m AOD			Scale	1:50
Client:	Bellway Homes (Wessex)	Dates:	05-07-2017			Logged By	SCD

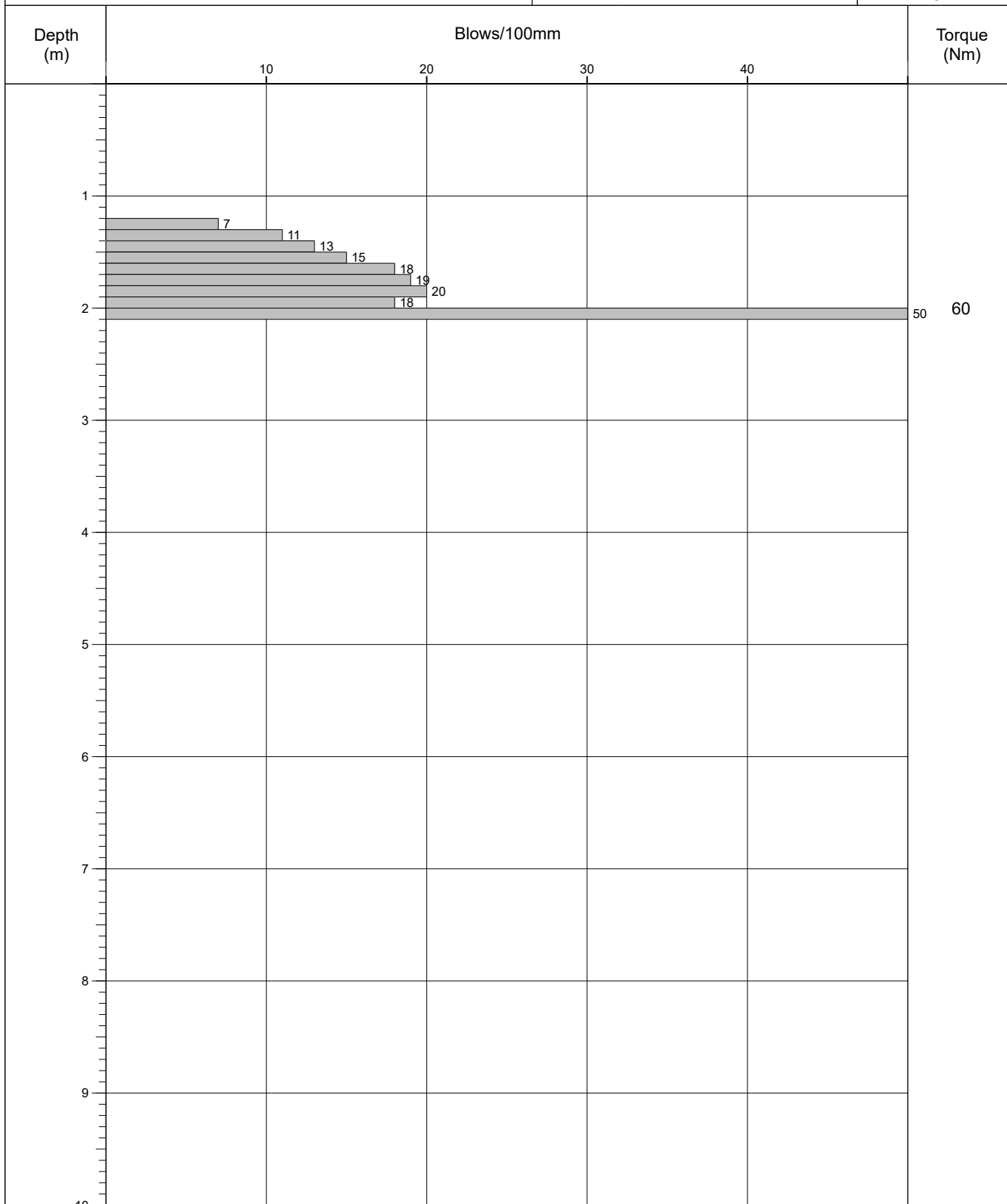


Remarks	Fall Height	750mm	Cone Base Diameter	51.5mm
	Hammer Weight	63.5kg	Final Depth	3.8m
	Probe Type	DPSH-B	Energy Ratio (Er)	61%

Project Name:	Padnell Grange,	Project No.	16362	Co-ords:		Hole Type	DP
Location:	Padnell Road, Cowplain, Hants PO8 8ED	Level:	m AOD			Scale	1:50
Client:	Bellway Homes (Wessex)	Dates:	05-07-2017			Logged By	SCD

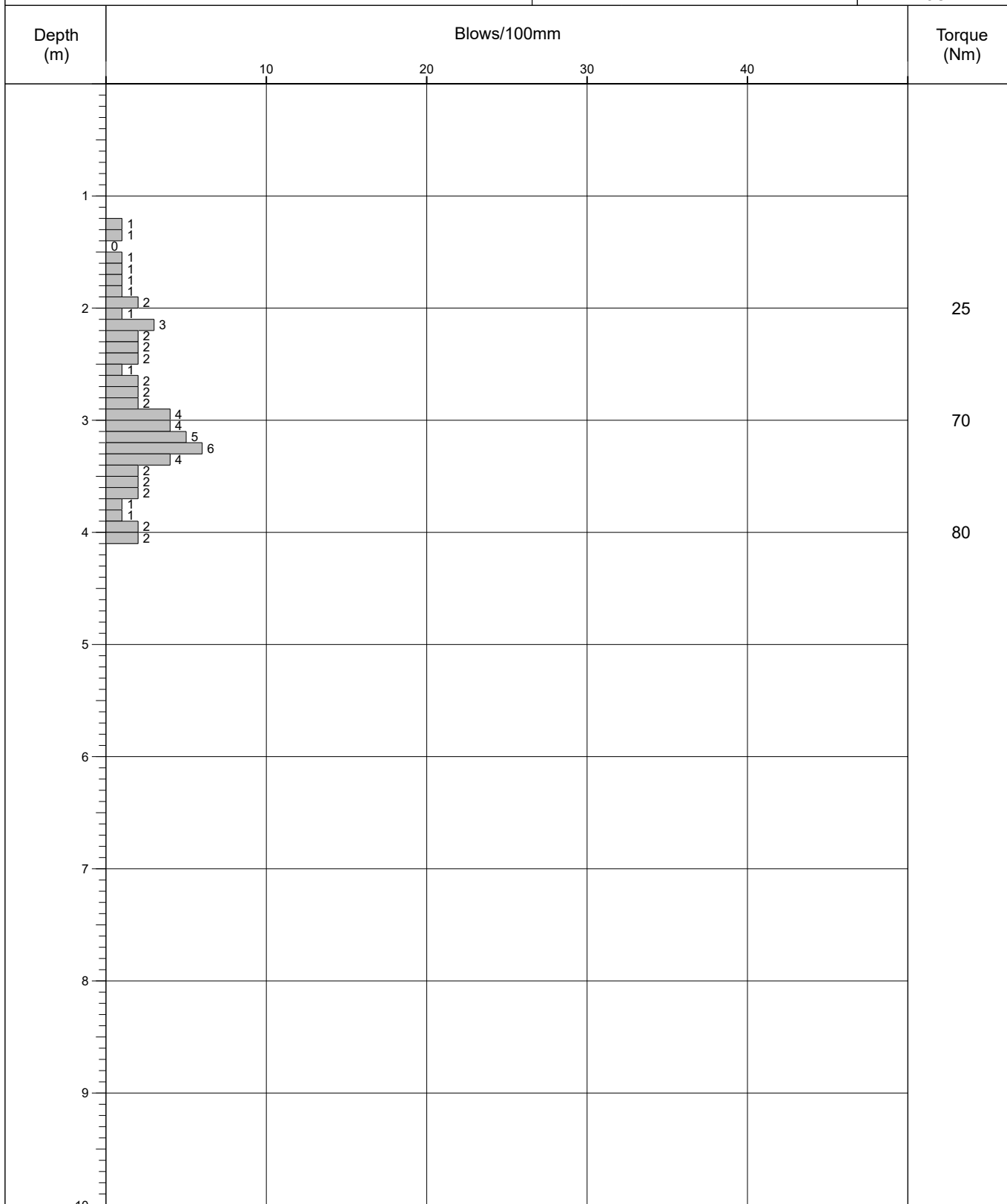
Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0	4				
0.1	5				
0.2	4				
0.3	3				
0.4	4				
0.5	4				
0.6	3				
0.7	1				
0.8	0				
0.9	1				
1	0				
1.1	0				
1.2	0				
1.3	5				
1.4	6				
1.5	6				
1.6	5				
1.7	5				
1.8	6				
1.9	4				
2	3				
2.1	6				
2.2	5				
2.3	4				
2.4	4				
2.5	5				
2.6	6				
2.7	4				
2.8	3				
2.9	2				
3	2				
3.1	2				
3.2	2				
3.3	2				
3.4	1				
3.5	2				
3.6	2				
3.7	3				
3.8	3				
4					
5					
6					
7					
8					
9					
10					
Remarks	Fall Height 750mm		Cone Base Diameter 51.5mm		
	Hammer Weight 63.5kg		Final Depth 3.9m		
	Probe Type DPSH-B		Energy Ratio (Er) 61%		

Project Name:	Padnell Grange,	Project No.	16362	Co-ords:		Hole Type	DP
Location:	Padnell Road, Cowplain, Hants PO8 8ED	Level:	m AOD			Scale	1:50
Client:	Bellway Homes (Wessex)	Dates:	05-07-2017			Logged By	SCD



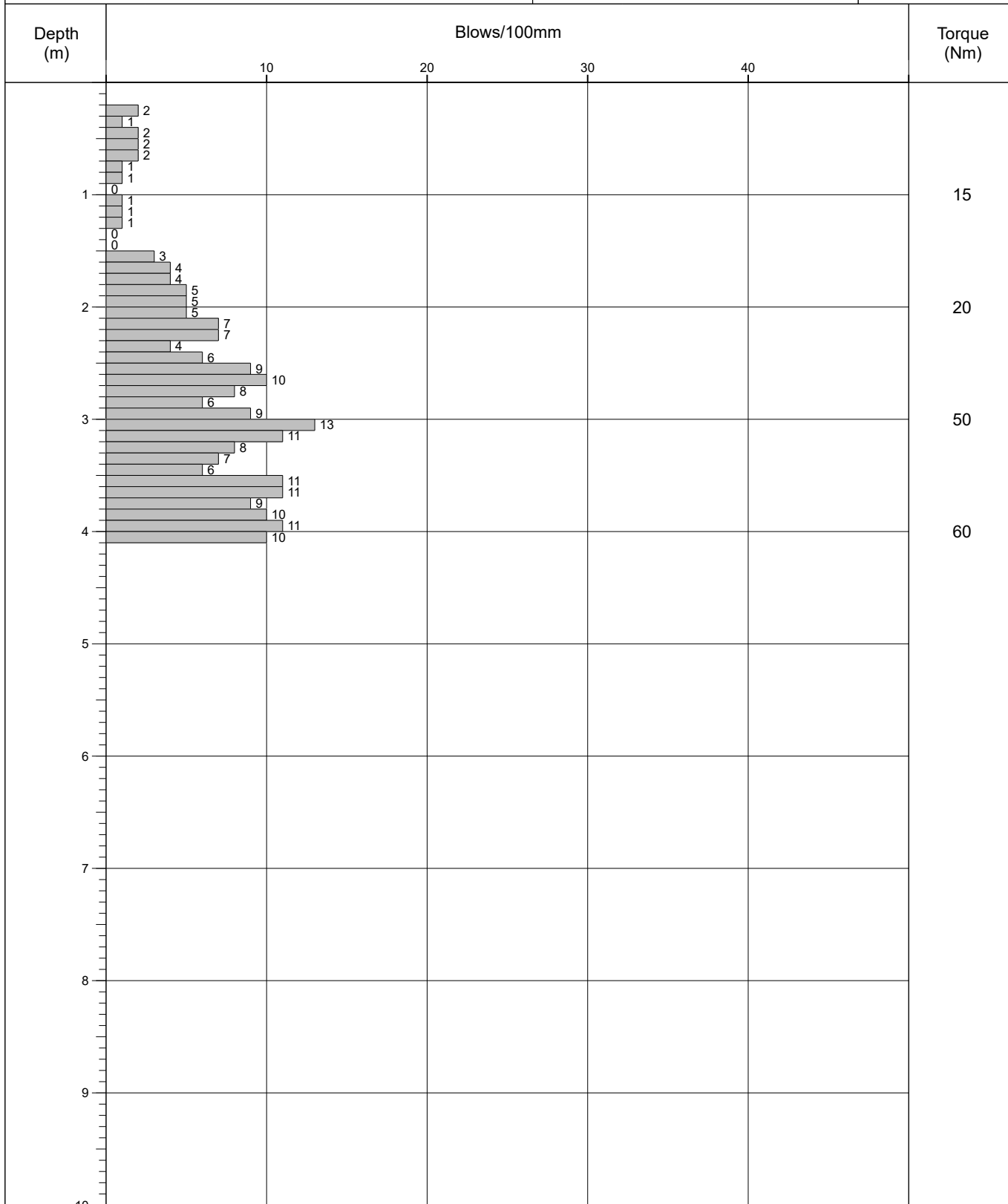
Remarks	Fall Height	750mm	Cone Base Diameter	51.5mm
	Hammer Weight	63.5kg	Final Depth	2m
	Probe Type	DPSH-B	Energy Ratio (Er)	61%

Project Name:	Padnell Grange,	Project No.	16362	Co-ords:		Hole Type	DP
Location:	Padnell Road, Cowplain, Hants PO8 8ED	Level:	m AOD			Scale	1:50
Client:	Bellway Homes (Wessex)	Dates:	05-07-2017			Logged By	JO



Remarks	Fall Height	750mm	Cone Base Diameter	51.5mm
	Hammer Weight	63.5kg	Final Depth	4m
	Probe Type	DPSH-B	Energy Ratio (Er)	80.98%

Project Name:	Padnell Grange,	Project No.	16362	Co-ords:		Hole Type	DP
Location:	Padnell Road, Cowplain, Hants PO8 8ED	Level:	m AOD			Scale	1:50
Client:	Bellway Homes (Wessex)	Dates:	05-07-2017			Logged By	JO



Remarks	Fall Height	750mm	Cone Base Diameter	51.5mm
	Hammer Weight	63.5kg	Final Depth	4m
	Probe Type	DPSH-B	Energy Ratio (Er)	80.98%

Project Name:	Padnell Grange,	Project No.	16362	Co-ords:		Hole Type	DP
Location:	Padnell Road, Cowplain, Hants PO8 8ED	Level:	m AOD			Scale	1:50
Client:	Bellway Homes (Wessex)	Dates:	05-07-2017			Logged By	JO

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0.0	2				10
0.1	2				
0.2	1				
0.3	2				
0.4	1				
0.5	1				
0.6	2				
0.7	1				
0.8	2				
0.9	1				
1.0	2				10
1.1	3				
1.2	2				
1.3	3				
1.4	2				
1.5	2				
1.6	3				
1.7	1				
1.8	2				
1.9	2				
2.0	2				50
2.1	2				
2.2	1				
2.3	2				
2.4	2				
2.5	1				
2.6	2				
2.7	7				
2.8	7				
2.9	16				
3.0	13				80
3.1	18				
3.2	23				
3.3	27				
3.4	24				
3.5	17				
3.6	14				
3.7	10				
3.8	16				
3.9					
4.0					
4.1					
4.2					
4.3					
4.4					
4.5					
4.6					
4.7					
4.8					
4.9					
5.0					
5.1					
5.2					
5.3					
5.4					
5.5					
5.6					
5.7					
5.8					
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 51.5mm		
	Hammer Weight 63.5kg		Final Depth 4m		
	Probe Type DPSH-B		Energy Ratio (Er) 80.98%		

Project Name:	Padnell Grange,	Project No.	16362	Co-ords:		Hole Type	DP
Location:	Padnell Road, Cowplain, Hants PO8 8ED	Level:	m AOD			Scale	1:50
Client:	Bellway Homes (Wessex)	Dates:	05-07-2017			Logged By	JO

Depth (m)	Blows/100mm				Torque (Nm)
	10	20	30	40	
0					10
1					
2					15
3					15
4					10
5					
6					
7					
8					
9					
10					

Remarks	Fall Height	750mm	Cone Base Diameter	51.5mm
	Hammer Weight	63.5kg	Final Depth	4m
	Probe Type	DPSH-B	Energy Ratio (Er)	80.98%

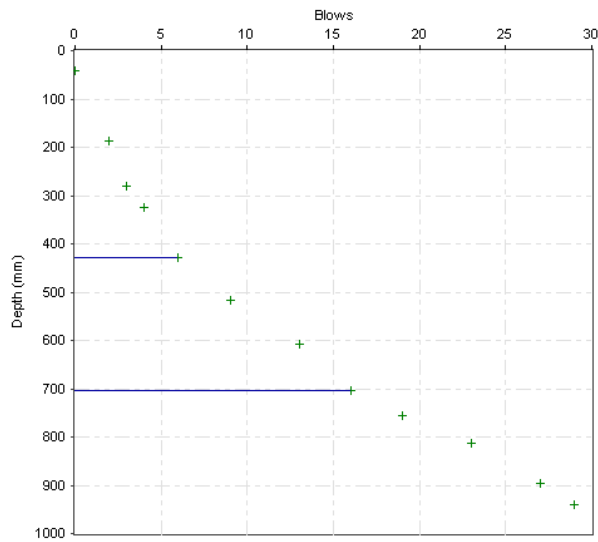
DCP Layer Strength Analysis Report

Project Name: 16362

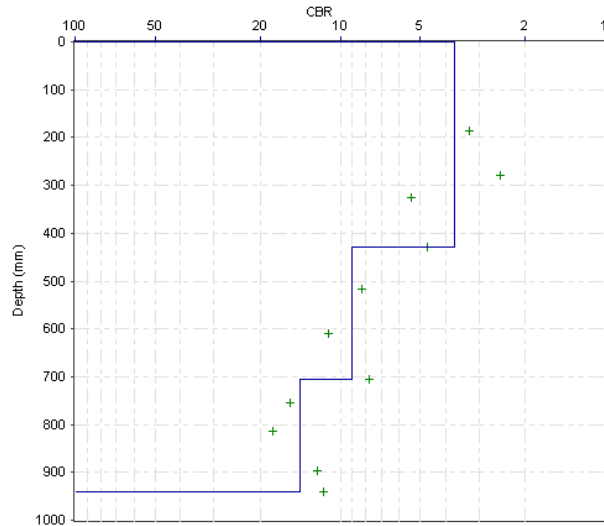
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 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 17/07/2017

Surface Type: Unpaved
 Thickness (mm): 0
 Base Type:
 Thickness (mm):
 Surface Moisture: Unknown
 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)
1	64.50	4	428	428
2	27.70	9	277	705
3	18.08	14	235	940

CBR Relationship:

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

Report produced by

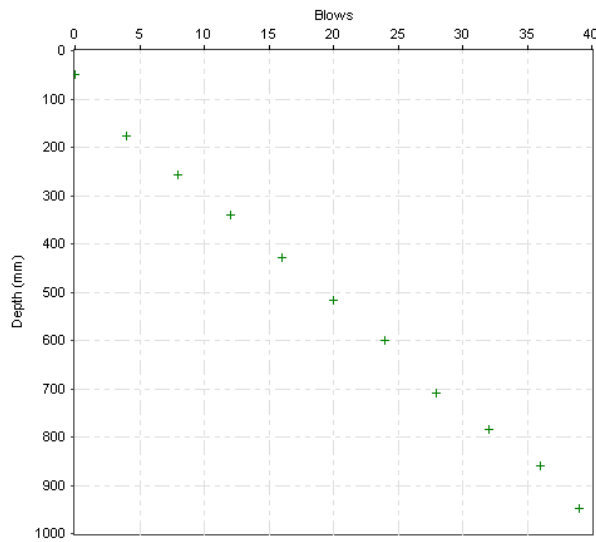
DCP Layer Strength Analysis Report

Project Name: 16362

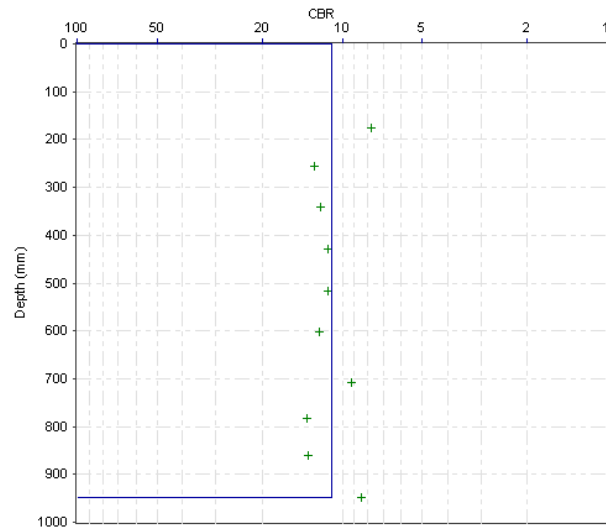
Chainage (km): 2.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 17/07/2017

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)
1	23.05	11	948	948

CBR Relationship:

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

Report produced by

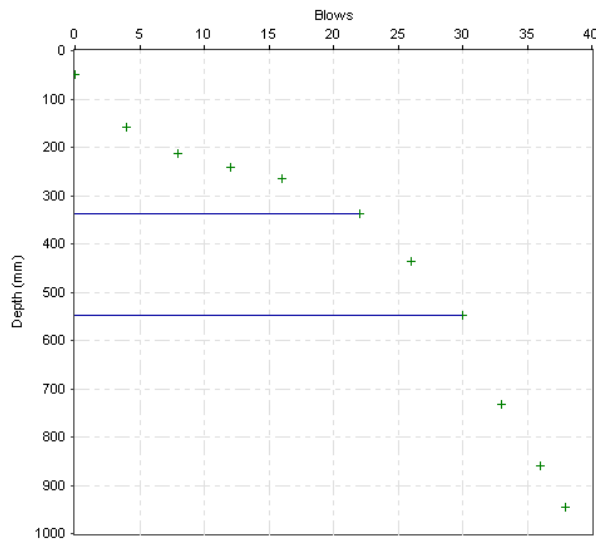
DCP Layer Strength Analysis Report

Project Name: 16362

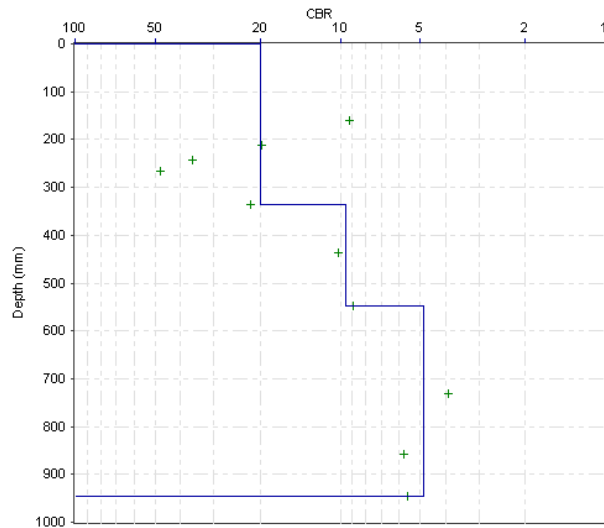
Chainage (km): 3.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 17/07/2017

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)
1	13.05	20	337	337
2	26.38	10	211	548
3	49.75	5	398	946

CBR Relationship:

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

Report produced by

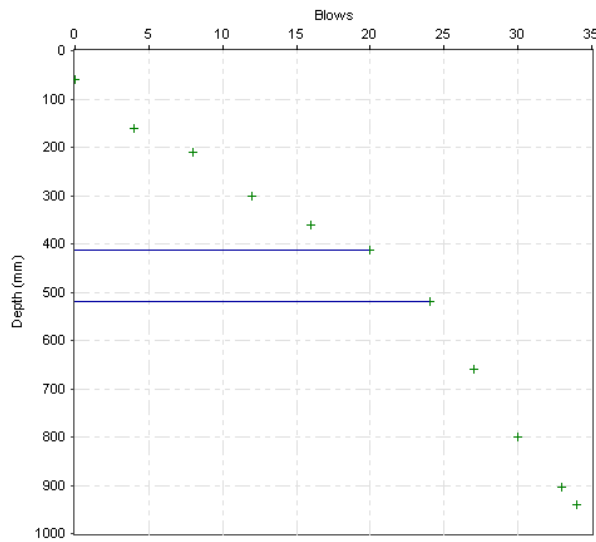
DCP Layer Strength Analysis Report

Project Name: 16362

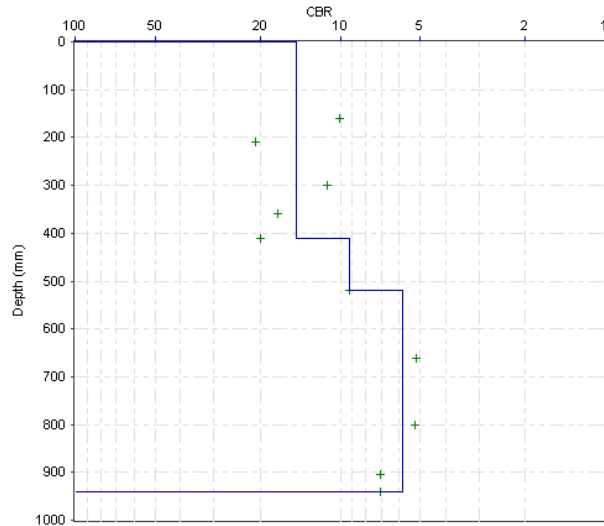
Chainage (km): 4.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 17/07/2017

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)
1	17.60	15	412	412
2	27.00	9	108	520
3	42.00	6	420	940

CBR Relationship:

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

Report produced by

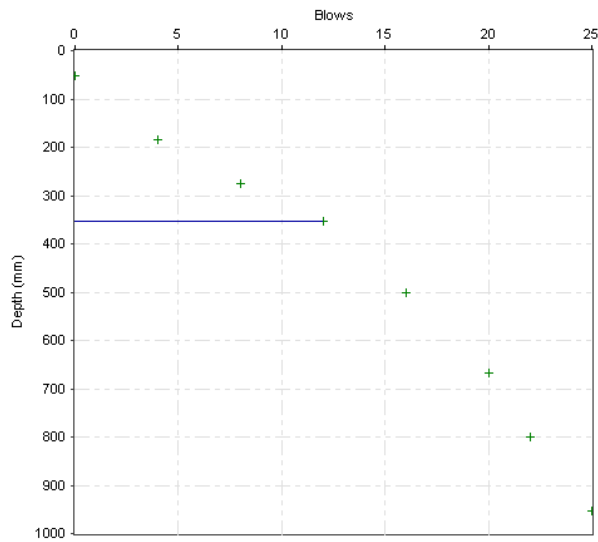
DCP Layer Strength Analysis Report

Project Name: 16362

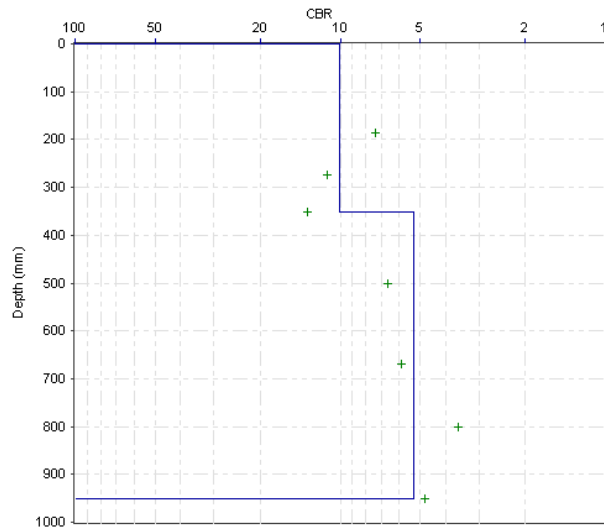
Chainage (km): 5.000
 Direction:
 Location/Offset: Carriageway
 Cone Angle: 60 degrees
 Zero Error (mm): 0
 Test Date: 17/07/2017

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)
1	25.08	10	352	352
2	46.15	5	600	952

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 N Blow Counts	Inferred Cohesive Strength/Granular Density
DPI	LCF 0.90 – 3.90 Sandy CLAY	3 – 6	Very low to low ($C_u = 15 - 30\text{kPa}$)
	LCF ¹ 3.90 – 7.00 Sandy CLAY	6 – 12	Low to medium ($C_u = 30 - 60\text{kPa}$)
	LCF ¹ 7.00 – 8.00 Sandy CLAY	12 – 14	Medium ($C_u = 60 - 70\text{kPa}$)
DP2	LCF 0.40 – 1.80 Sandy CLAY	3	Very low ($C_u = 15\text{kPa}$)
	LMBE 1.80 – 2.80 Clayey SAND	9 – 23	Loose to medium dense
	LCF 2.80 – 3.60 Clayey SAND	29 – >50	Dense to very dense
DP3	LCF 0.40 – 1.40 Sandy CLAY	3 – 9	Very low to medium ($C_u = 15 - 45\text{kPa}$)
	LMBE 1.40 – 3.70 Clayey SAND	12 – 23	Medium dense
	LMBE 3.70 – 3.40 Clayey SAND	17 – 49	Medium dense to dense
	LMBE 3.40 – 3.80 Clayey SAND	>50	Very dense
DP4	LCF 0.90 – 1.30 Sandy CLAY	0	Extremely low ($C_u = >10\text{kPa}$)
	LMBE 1.30 – 3.00 Clayey SAND	12 – 17	Medium dense
	LMBE 3.00 – 4.00 Clayey SAND	3 – 9	Loose
DP-A	LCF 1.10 – 2.80 Sandy CLAY	4 – 8	Low ($C_u = 20 - 40\text{kPa}$)
	LMBE 2.80 – 3.30 Clayey SAND	16 – 23	Medium dense

DP	Strata	Equivalent SPT N Blow Counts	Inferred Cohesive Strength/Granular Density
	LMBE ¹ 3.30 – 4.00 Sandy CLAY	4 – 8	Low (C _u = 20 – 40kPa)
DP-B	LMBE 1.40 – 3.40 Clayey SAND	16 – 31	High to very high (C _u = 80 – 155kPa)
	LMBE ¹ 3.40 – 4.00 Clayey SAND	35 – 43	Dense
DP-C	LCF 0.10 – 2.80 Sandy CLAY	4 – 8	Low (C _u = 20 – 40kPa)
	LMBE ¹ 3.40 – 4.00 Clayey SAND	23 – >50	Medium dense to very dense
DP-D	LCF 0.25 – 1.90 Sandy CLAY	4 – 8	Low (C _u = 20 – 40kPa)
	LMBE ¹ 1.90 – 4.00 Clayey SAND	8 – 12	Loose to medium dense

Note: ¹ Ground conditions inferred past the base of corresponding windowless sampler boreholes/trial pits

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
LCF	19 - 22	26 - 36	100	26 – 36	CI - CH	Medium	Medium

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	
WS2	2.30	Light brown sandy SILT/CLAY	Yes	Yes	36
WS3	2.60	Light brown very clayey fine to medium SAND	Yes	No	32

Location	Depth (m bgl)	Soil Description	Volume Change Potential		Passing 63µm Sieve (%)
			BRE	NHBC	
WS4	1.70	Light brown very clayey fine to medium SAND	Yes	No	18
WS4	2.20	Light brown slightly gravelly clayey fine to medium SAND	No	No	12

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: 36036

Client's Reference: **16362**

Report Date: **26-07-2017**

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

Contract Title: **Padnell Grange, Cowplain**
For the attention of: **John Hills**

Date Received: **20-07-2017**
Date Commenced: **20-07-2017**
Date Completed: **26-07-2017**

Test Description	Qty
Moisture Content 1377 : 1990 Part 2 : 3.2 - * UKAS	6
1 Point Liquid & Plastic Limit 1377 : 1990 Part 2 : 4.4 & 5.3 - * UKAS	6
PSD Wet Sieve method 1377 : 1990 Part 2 : 9.2 - * UKAS	4
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

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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/Quality Assistant)
Vaughan Edwards (Managing Director) - Wayne Honey (Administrative/Quality Assistant)



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

Contract Number

36036

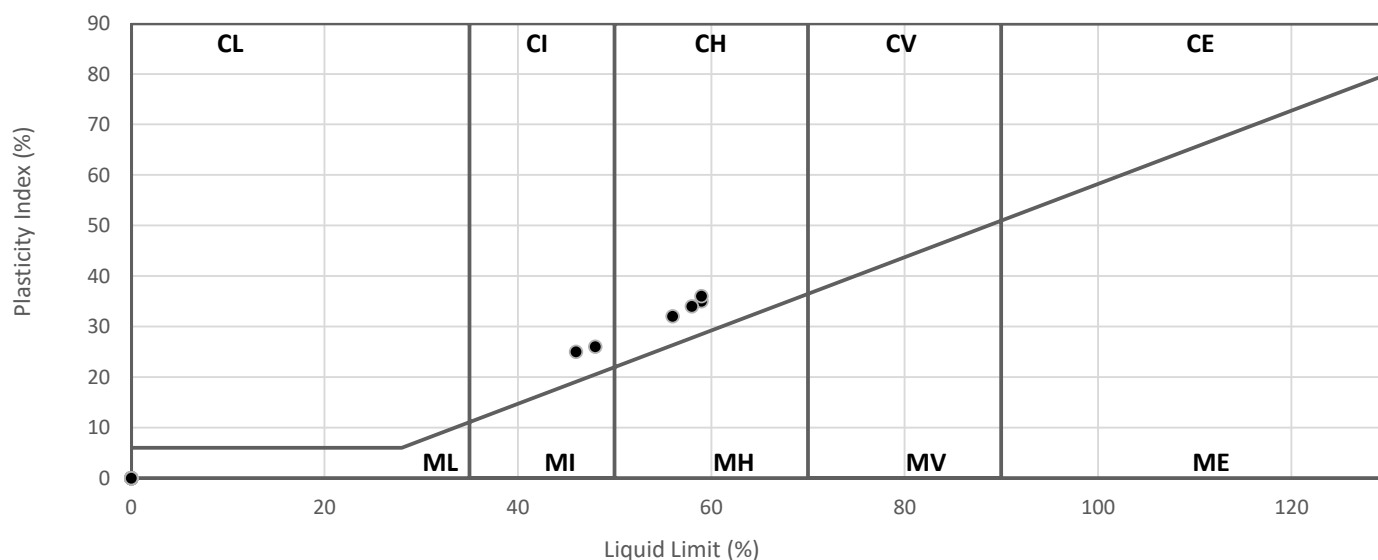
Site Name

Padnell Grange, Cowplain

[illegible]

Symbols: NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION



Operators	Checked	25/07/2017	Sean Penn	
DB	Approved	26/07/2017	Ben Sharp	



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

Contract Number

36036

Borehole/Pit No.

WS2

Site Name

Padnell Grange, Cowplain

Sample No.

Soil Description

Light brown silty clayey fine to medium SAND

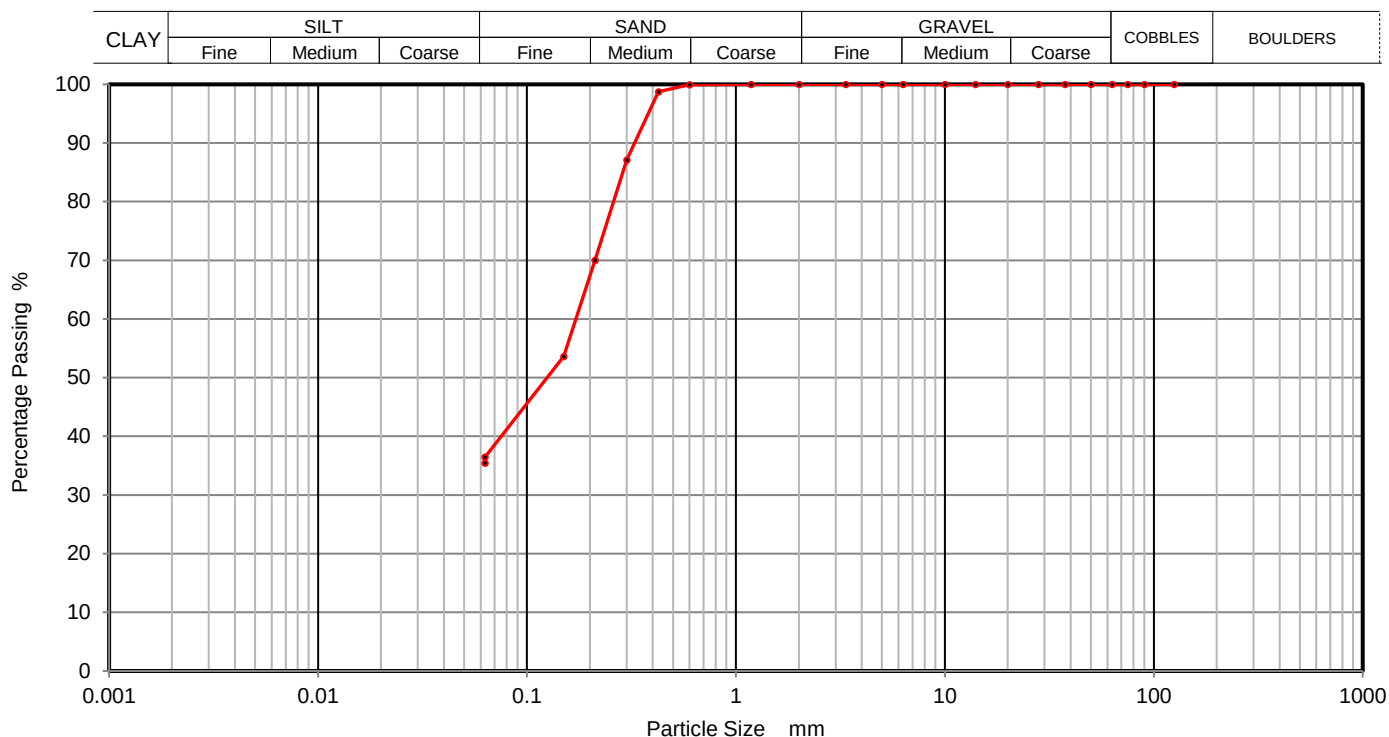
Depth Top

2.30

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	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	99		
0.3	87		
0.212	70		
0.15	54		
0.063	36		

Sample Proportions	% dry mass
Cobbles	0
Gravel	0
Sand	64
Silt and Clay	36

Grading Analysis	
Uniformity Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	25/07/2017	Sean Penn	
RO/MH	Approved	26/07/2017	Ben Sharp	





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

Contract Number

36036

Borehole/Pit No.

WS3

Site Name

Padnell Grange, Cowplain

Sample No.

Soil Description

Light brown silty clayey fine to medium SAND

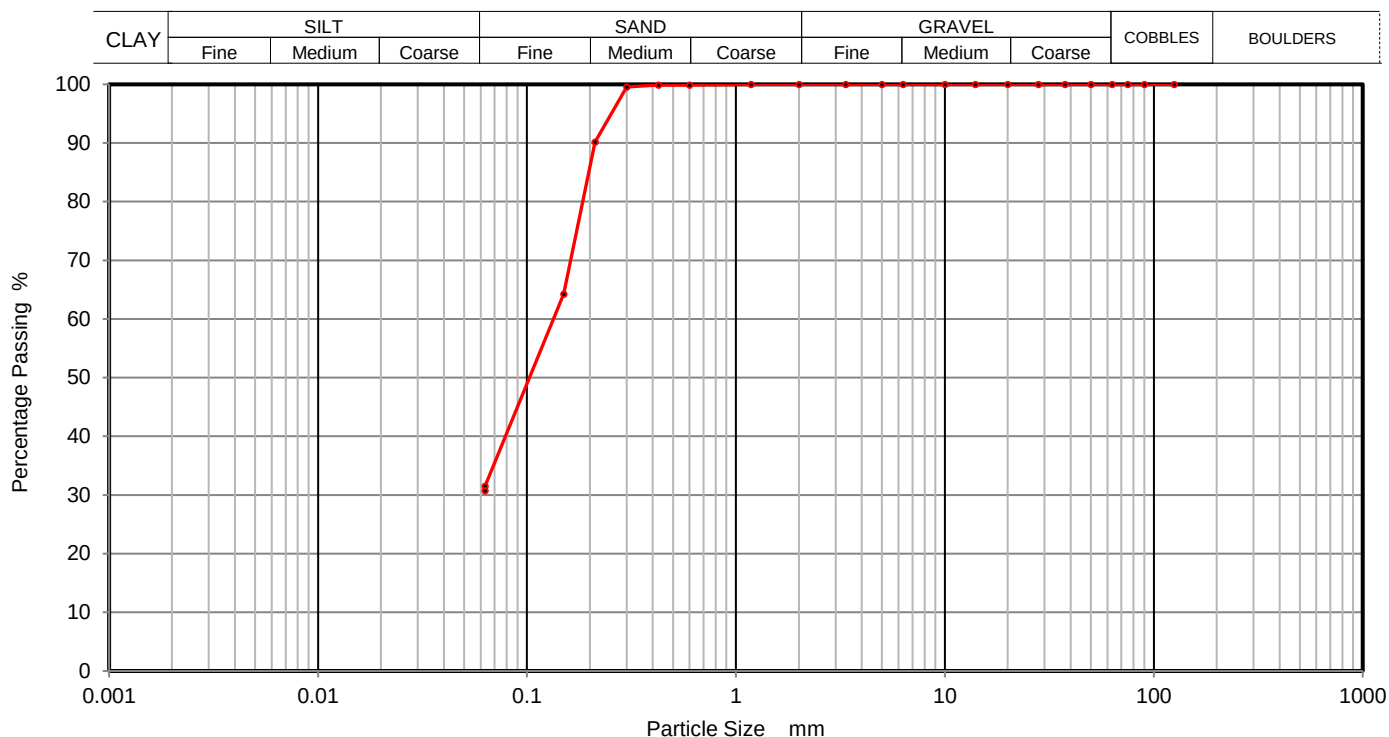
Depth Top

2.60

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	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	100		
0.3	100		
0.212	90		
0.15	64		
0.063	32		

Sample Proportions	% dry mass
Cobbles	0
Gravel	0
Sand	68
Silt and Clay	32

Grading Analysis	
Uniformity Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	25/07/2017	Sean Penn	
RO/MH	Approved	26/07/2017	Ben Sharp	





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

Contract Number

36036

Borehole/Pit No.

WS4

Site Name

Padnell Grange, Cowplain

Sample No.

Soil Description

Light brown silty clayey fine to medium SAND

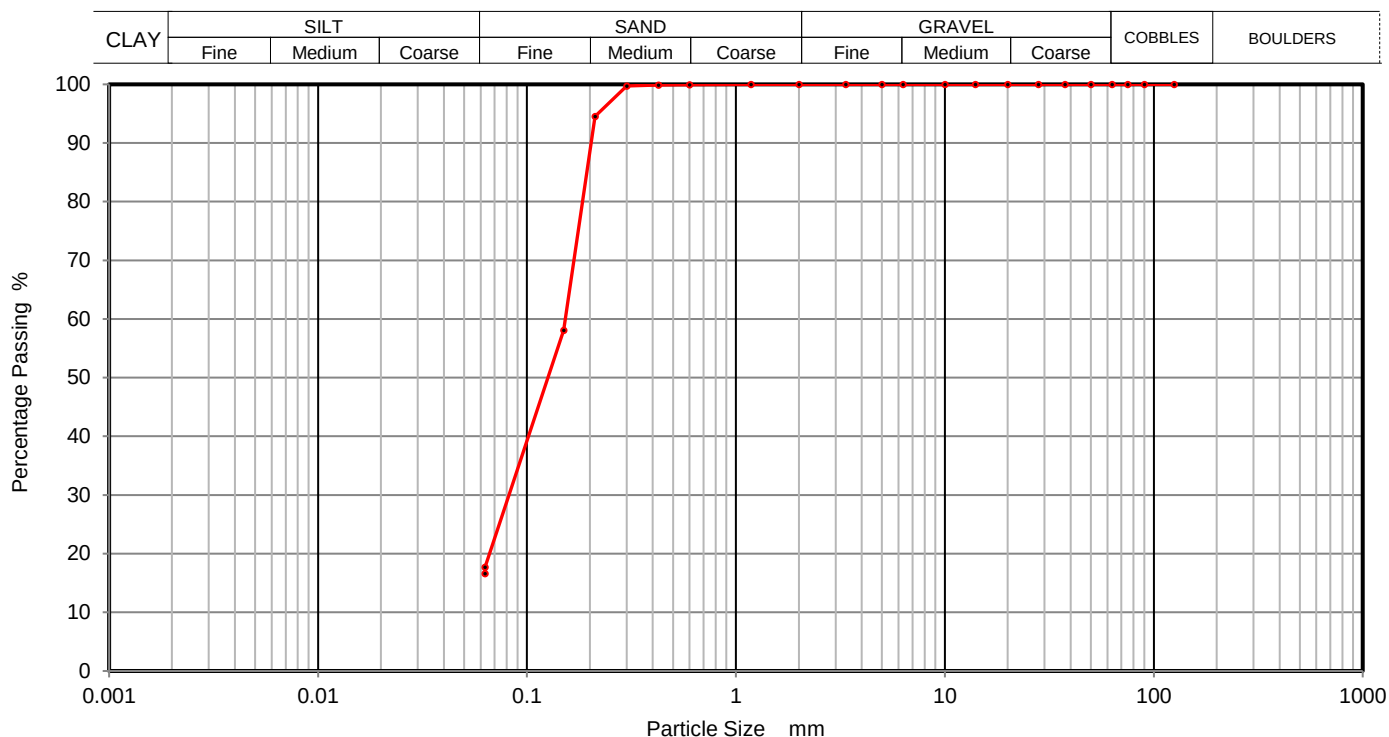
Depth Top

1.70

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	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	100		
0.3	100		
0.212	95		
0.15	58		
0.063	18		

Sample Proportions	% dry mass
Cobbles	0
Gravel	0
Sand	82
Silt and Clay	18

Grading Analysis	
Uniformity Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	25/07/2017	Sean Penn	
RO/MH	Approved	26/07/2017	Ben Sharp	





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

Contract Number

36036

Borehole/Pit No.

WS4

Site Name

Padnell Grange, Cowplain

Sample No.

Soil Description

Light brown slightly fine gravelly silty clayey fine to medium SAND

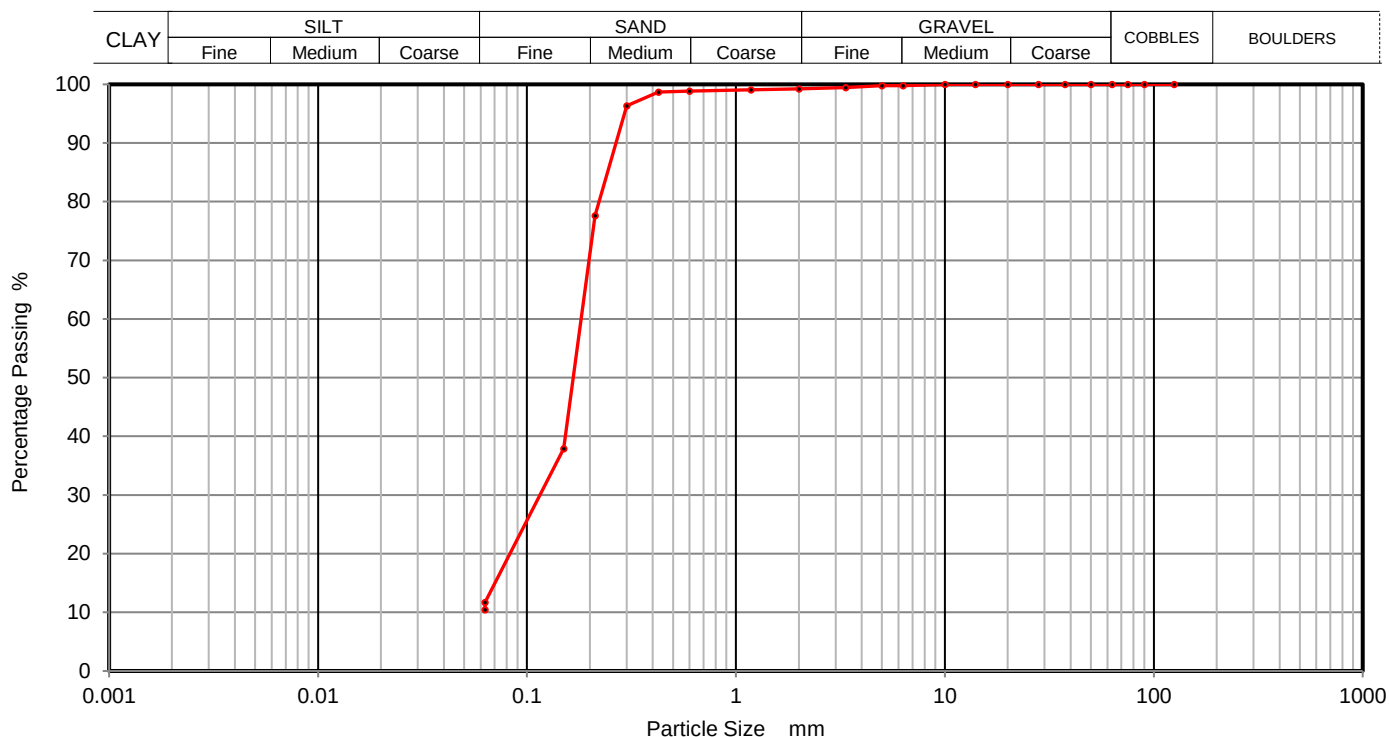
Depth Top

2.20

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	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	99		
2	99		
1.18	99		
0.6	99		
0.425	99		
0.3	96		
0.212	78		
0.15	38		
0.063	12		

Sample Proportions	% dry mass
Cobbles	0
Gravel	1
Sand	87
Silt and Clay	12

Grading Analysis	
Uniformity Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	25/07/2017	Sean Penn	
RO/MH	Approved	26/07/2017	Ben Sharp	





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russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 17-61885

Site Reference: Padnell Grange, Cowplain

Project / Job Ref: 16362

Order No: 16362

Sample Receipt Date: 20/07/2017

Sample Scheduled Date: 20/07/2017

Report Issue Number: 1

Reporting Date: 26/07/2017

Authorised by:

Kevin Old
Associate Director of Laboratory

Authorised by:

Russell Jarvis
Associate Director of Client Services

QTSE is the trading name of DETS Ltd, company registration number 03705645



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Soil Analysis Certificate						
QTS Environmental Report No: 17-61885	Date Sampled	None Supplied	None Supplied	None Supplied		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Padnell Grange, Cowplain	TP / BH No	WS1	WS3	WS4		
Project / Job Ref: 16362	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: 16362	Depth (m)	1.40	2.10	1.70		
Reporting Date: 26/07/2017	QTSE Sample No	280783	280784	280785		

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	5.8	4.7	6.9		
Total Sulphate as SO ₄	mg/kg	< 200	NONE	202	< 200	< 200		
Total Sulphate as SO ₄	%	< 0.02	NONE	0.02	< 0.02	< 0.02		
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	112	20	< 10		
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.11	0.02	< 0.01		
Total Sulphur	%	< 0.02	NONE	0.04	< 0.02	< 0.02		
Ammonium as NH ₄	mg/kg	< 0.5	NONE	7.4	2.9	1.7		
Ammonium as NH ₄	mg/l	< 0.05	NONE	0.74	0.29	0.17		
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	59	25	29		
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	29.4	12.5	14.4		
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	< 3	MCERTS	< 3	< 3	5		
Water Soluble Nitrate (2:1) as NO ₃	mg/l	< 1.5	MCERTS	< 1.5	< 1.5	2.4		
W/S Magnesium	mg/l	< 0.1	NONE	3.3	0.5	0.4		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis ^(S)



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Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 17-61885	
Soils Ltd	
Site Reference: Padnell Grange, Cowplain	
Project / Job Ref: 16362	
Order No: 16362	
Reporting Date: 26/07/2017	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
^ 280783	WS1	None Supplied	1.40	11.5	Red clay
^ 280784	WS3	None Supplied	2.10	10.1	Brown sandy clay
^ 280785	WS4	None Supplied	1.70	15.6	Blue sand

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

Insufficient Sample ^{1/5}

Unsuitable Sample ^{u/s}

^ no sampling date provided; unable to confirm if samples are within acceptable holding times



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Soil Analysis Certificate - Methodology & Miscellaneous Information	
QTS Environmental Report No: 17-61885	
Soils Ltd	
Site Reference: Padnell Grange, Cowplain	
Project / Job Ref: 16362	
Order No: 16362	
Reporting Date: 26/07/2017	

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 Chemical Laboratory Testing

Appendix C.1 Conceptual Site Model

Table C.1.1 CSM Revised Pre Testing

Potential Contaminants	Pathway	Receptor	Risk Assessment Methodology (plus anticipated quantitative risk assessment methods)	Site specific settings	Risk Classification: Based on Desk Study and Phase II Investigation	Pollutant Linkage & Action Required
P2, P3, P4	Uptake (root and stomata), ingestion, inhalation and dermal	Ecological features (i.e. Flora and Fauna)	Presence of SSSI, Nature reserves and others within 0- 250m to the site.	Wood noted to the north, development comprised private gardens	Low	Further investigation required. Targeted chemical analysis of soils
P2, P3, P4	Chemical attack	Building structures/services	BRE SD I 2005 for risk assessment. Water UK (2014) for pipes. Use Anglian Water trigger for services risk assessment	Residential development	Low	Further investigation required. Targeted chemical analysis of soils
P1, P2, P3, P4	Inhalation, ingestion and dermal contact	Human health Site residents	Use CLEA for human risk assessment	Residential development	Low to moderate	Further investigation required. Phase II Ground investigation required.
		Human Health Workers	Assessment not within the scope of this Desk study (responsibility of building contractor). Ground workers should follow regulations on health and safety during development (HSE, 1991)	Workers and the general public should follow regulation on health and safety during development (HSE, 1991)	Low	Follow HSE Procedures
P2, P3, P4	Leaching (direct precipitation, overland flow and through flow)	Surface Water / Shallow groundwater	Assess distance from watercourse and direction of flow – Consider use of R&D 20 publication and EA remediation target for risk assessment	Secondary A Aquifer in the bedrock of the Lambeth Group. Unproductive Strata in the London Clay Formation	Very Low	Further investigation required. Phase II Ground investigation required.
P2, P3, P4	Leaching (direct precipitation, overland flow, through and groundwater flow)	Deep groundwater	Undertake groundwater or leachate testing depending on site specific ground conditions. Consider use of R&D 20 publication and EA remediation target for risk assessment if contamination is identified.	Within the Newhaven Chalk Formation	None	No Further Action Required
P5	Through fissures, shafts, high permeability strata and inhalation	Human and Building Structures	Current or former Landfill sites within 0-250m to the site. Assess nature/age/size of site for Risk Assessment. Use CIRIA 149 & 665 to assess need for gas protection measures where necessary following ground gas testing	Multiple potentially backfilled clay pits, chalk pit and ponds	Moderate	Further investigation required. Phase II Ground investigation required.

Note: P1: Asbestos P2: Organic compounds (e.g. PAHs and TPHs) P3: Organic Solvents, P4: Metals and Semi-metals, P5: Soil gas: HSE = Health and Safety Executive

Table C.1.2 CSM Revised Post Testing

Potential Contaminants	Pathway	Receptor	Risk Assessment Methodology (plus anticipated quantitative risk assessment methods)	Site specific settings	Risk Classification: Based on Desk Study and Phase II Investigation	Pollutant Linkage & Action Required
PAH	Uptake (root and stomata), ingestion, inhalation and dermal	Ecological features (i.e. Flora and Fauna)	Presence of SSSI, Nature reserves and others within 0- 250m to the site.	Wood noted to the north	None	No further action required
PAH	Chemical attack	Building structures/services	BRE SD I 2005 for risk assessment. Water UK (2014) for pipes. Use Anglian Water trigger for services risk assessment	Residential development	Very Low	Proposed foundations and service pipes to be used
PAH, Asbestos	Inhalation, ingestion and dermal contact	Human health Site residents	Use CLEA for human risk assessment	development comprised private gardens	Low to moderate	Further Action Required. Remediation method statement required
		Human Health Workers	Assessment not within the scope of this Desk study (responsibility of building contractor). Ground workers should follow regulations on health and safety during development (HSE, 1991)	Workers and the general public should follow regulation on health and safety during development (HSE, 1991)	Low to moderate	Follow HSE Procedures
None	Leaching (direct precipitation, overland flow and through flow)	Shallow groundwater/ Surface Water	Assess distance from watercourse and direction of flow – Consider use of R&D 20 publication and EA remediation target for risk assessment	Secondary A Aquifer in the bedrock of the Lambeth Group. Unproductive Strata in the London Clay Formation	None	No further action required
None	Leaching (direct precipitation, overland flow, through and groundwater flow)	Deep groundwater	Undertake groundwater or leachate testing depending on site specific ground conditions. Consider use of R&D 20 publication and EA remediation target for risk assessment if contamination is identified.	Within the Newhaven Chalk Formation	None	No further action required
Soil Gas	Through fissures, shafts, high permeability strata and inhalation	Human and Building Structures	Current or former Landfill sites within 0-250m to the site. Assess nature/age/size of site for Risk Assessment. Use CIRIA 149 & 665 to assess need for gas protection measures where necessary following ground gas testing	Multiple potentially backfilled clay pits, chalk pit and ponds	Moderate	Further investigation required. SGRA and monitoring ongoing.

Note: HSE = Health and Safety Executive

Appendix C.2 Chemical Laboratory Results



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QTS Environmental Report No: 17-61881

Site Reference: Padnell Grange, Cowplain

Project / Job Ref: 16362

Order No: 16362

Sample Receipt Date: 20/07/2017

Sample Scheduled Date: 20/07/2017

Report Issue Number: 1

Reporting Date: 27/07/2017

Authorised by:

Kevin Old
Associate Director of Laboratory

Authorised by:

Russell Jarvis
Associate Director of Client Services

QTSE is the trading name of DETS Ltd, company registration number 03705645



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Soil Analysis Certificate						
QTS Environmental Report No: 17-61881	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Padnell Grange, Cowplain	TP / BH No	WS4	WS4	WSA	WSA	WS1
Project / Job Ref: 16362	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: 16362	Depth (m)	0.50	0.75	0.20	0.50	0.60
Reporting Date: 27/07/2017	QTSE Sample No	280767	280768	280769	280770	280771

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Detected	Not Detected	Not Detected	Not Detected	Not Detected
Sample Matrix ^(S)	Material Type	N/a	NONE	Microscopic loose fibrous asbestos debris in soil				
Asbestos Type ^(S)	PLM Result	N/a	ISO17025	Chrysotile				
pH	pH Units	N/a	MCERTS	7.8	8.1	7.3	7.6	5.6
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	13	14	11	35	153
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.01	0.01	0.01	0.04	0.15
Sulphide	mg/kg	< 5	NONE	< 5	< 5	< 5	< 5	< 5
Organic Matter	%	< 0.1	MCERTS	2.1	1	4.2	0.5	< 0.1
Total Organic Carbon (TOC)	%	< 0.1	MCERTS	1.2	0.6	2.4	0.3	< 0.1
Antimony (Sb)	mg/kg	< 1	NONE	1.6	< 1	< 1	< 1	< 1
Arsenic (As)	mg/kg	< 2	MCERTS	5	3	6	11	2
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	9	7	16	25	27
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	16	9	14	12	24
Lead (Pb)	mg/kg	< 3	MCERTS	149	61	67	19	9
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	5	< 3	7	8	7
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3	< 3	< 3
Vanadium (V)	mg/kg	< 2	NONE	19	15	27	43	49
Zinc (Zn)	mg/kg	< 3	MCERTS	108	44	165	32	20
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

Analysis carried out on the dried sample is corrected for the stone content

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

This report refers to samples as received, and QTS Environmental Ltd, takes no responsibility for the accuracy or competence of sampling by others.

The material description shall be regarded as tentative and is not included in our scope of UKAS Accreditation.

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.

Asbestos Analyst: Javeed Malik

RL: Reporting Limit

Pinch Test: Where pinch test is positive it is reported "Loose Fibres - PT" with type(s).

Subcontracted analysis ^(S)



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Soil Analysis Certificate						
QTS Environmental Report No: 17-61881	Date Sampled	None Supplied	None Supplied	None Supplied		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Padnell Grange, Cowplain	TP / BH No	WS2	WS3	TPD		
Project / Job Ref: 16362	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: 16362	Depth (m)	0.40	0.30	0.50		
Reporting Date: 27/07/2017	QTSE Sample No	280772	280773	280774		

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected		
Sample Matrix ^(S)	Material Type	N/a	NONE					
Asbestos Type ^(S)	PLM Result	N/a	ISO17025					
pH	pH Units	N/a	MCERTS	6.9	5.6	5.7		
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2		
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	15	12	131		
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.02	0.01	0.13		
Sulphide	mg/kg	< 5	NONE	< 5	< 5	< 5		
Organic Matter	%	< 0.1	MCERTS	0.7	2.7	1		
Total Organic Carbon (TOC)	%	< 0.1	MCERTS	0.4	1.6	0.6		
Antimony (Sb)	mg/kg	< 1	NONE	< 1	< 1	< 1		
Arsenic (As)	mg/kg	< 2	MCERTS	13	6	9		
Beryllium (Be)	mg/kg	< 0.5	NONE	0.8	< 0.5	0.5		
W/S Boron	mg/kg	< 1	NONE	< 1	< 1	< 1		
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2	< 0.2	< 0.2		
Chromium (Cr)	mg/kg	< 2	MCERTS	21	16	19		
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2		
Copper (Cu)	mg/kg	< 4	MCERTS	14	9	11		
Lead (Pb)	mg/kg	< 3	MCERTS	23	25	13		
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1		
Nickel (Ni)	mg/kg	< 3	MCERTS	16	6	9		
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3		
Vanadium (V)	mg/kg	< 2	NONE	40	32	35		
Zinc (Zn)	mg/kg	< 3	MCERTS	68	37	30		
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2		

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

Analysis carried out on the dried sample is corrected for the stone content

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

This report refers to samples as received, and QTS Environmental Ltd, takes no responsibility for the accuracy or competence of sampling by others.

The material description shall be regarded as tentative and is not included in our scope of UKAS Accreditation.

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.

Asbestos Analyst: Javeed Malik

RL: Reporting Limit

Pinch Test: Where pinch test is positive it is reported "Loose Fibres - PT" with type(s).

Subcontracted analysis ^(S)



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Soil Analysis Certificate - Speciated PAHs						
QTS Environmental Report No: 17-61881	Date Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Padnell Grange, Cowplain	TP / BH No	WS4	WS4	WSA	WSA	WS1
Project / Job Ref: 16362	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: 16362	Depth (m)	0.50	0.75	0.20	0.50	0.60
Reporting Date: 27/07/2017	QTSE Sample No	280767	280768	280769	280770	280771

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	0.18	< 0.1	0.42	< 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	0.40	< 0.1	1	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	MCERTS	0.39	< 0.1	0.94	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	3.32	1.28	9.48	0.20	< 0.1
Anthracene	mg/kg	< 0.1	MCERTS	0.47	0.19	1.57	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	3.56	2.72	15.20	0.21	< 0.1
Pyrene	mg/kg	< 0.1	MCERTS	2.96	2.45	12.70	0.18	< 0.1
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	1.22	1.04	5.34	< 0.1	< 0.1
Chrysene	mg/kg	< 0.1	MCERTS	1.23	1.06	5.25	< 0.1	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	1.25	1.21	5.89	< 0.1	< 0.1
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	0.46	0.50	2.08	< 0.1	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	1.04	1.06	4.99	< 0.1	< 0.1
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	0.66	0.66	2.99	< 0.1	< 0.1
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	0.11	< 0.1	0.53	< 0.1	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	0.58	0.67	2.69	< 0.1	< 0.1
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	17.8	12.8	71.1	< 1.6	< 1.6

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 - Speciated PAHs						
QTS Environmental Report No: 17-61881	Date Sampled	None Supplied	None Supplied	None Supplied		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Padnell Grange, Cowplain	TP / BH No	WS2	WS3	TPD		
Project / Job Ref: 16362	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: 16362	Depth (m)	0.40	0.30	0.50		
Reporting Date: 27/07/2017	QTSE Sample No	280772	280773	280774		

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



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Soil Analysis Certificate - TPH LQM Banded						
QTS Environmental Report No: 17-61881	Date Sampled	None Supplied	None Supplied	None Supplied		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Padnell Grange, Cowplain	TP / BH No	WS4	WSA	WS3		
Project / Job Ref: 16362	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: 16362	Depth (m)	0.50	0.20	0.30		
Reporting Date: 27/07/2017	QTSE Sample No	280767	280769	280773		

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01		
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05		
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3	< 3	< 3		
Aliphatic >C16 - C35	mg/kg	< 10	MCERTS	< 10	< 10	< 10		
Aliphatic >C35 - C44	mg/kg	< 10	NONE	< 10	< 10	< 10		
Aliphatic (C5 - C44)	mg/kg	< 30	NONE	< 30	< 30	< 30		
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01		
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05		
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	4	8	< 2		
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	14	50	< 3		
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	19	144	< 10		
Aromatic >C35 - C44	mg/kg	< 10	NONE	< 10	< 10	< 10		
Aromatic (>C5 - C44)	mg/kg	< 30	NONE	37	202	< 30		
Total >C5 - C44	mg/kg	< 60	NONE	< 60	202	< 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						
QTS Environmental Report No: 17-61881	Date Sampled	None Supplied	None Supplied	None Supplied		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Padnell Grange, Cowplain	TP / BH No	WS4	WSA	WS3		
Project / Job Ref: 16362	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: 16362	Depth (m)	0.50	0.20	0.30		
Reporting Date: 27/07/2017	QTSE Sample No	280767	280769	280773		

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
Toluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5		
Ethylbenzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
p & m-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
o-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
MTBE	ug/kg	< 5	MCERTS	< 5	< 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	
QTS Environmental Report No: 17-61881	
Soils Ltd	
Site Reference: Padnell Grange, Cowplain	
Project / Job Ref: 16362	
Order No: 16362	
Reporting Date: 27/07/2017	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
^ 280767	WS4	None Supplied	0.50	5.6	Brown sandy clay with stones and brick
^ 280768	WS4	None Supplied	0.75	10.7	Brown sandy clay with stones
^ 280769	WSA	None Supplied	0.20	10.9	Brown sandy clay with stones
^ 280770	WSA	None Supplied	0.50	18	Brown sandy clay
^ 280771	WS1	None Supplied	0.60	12.1	Red clay
^ 280772	WS2	None Supplied	0.40	13.8	Brown sandy clay
^ 280773	WS3	None Supplied	0.30	16.2	Brown sandy clay
^ 280774	TPD	None Supplied	0.50	15.9	Brown sandy clay

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

Insufficient Sample ^{1/5}

Unsuitable Sample ^{u/s}

^ no sampling date provided; unable to confirm if samples are within acceptable holding times



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Soil Analysis Certificate - Methodology & Miscellaneous Information				
QTS Environmental Report No: 17-61881				
Soils Ltd				
Site Reference: Padnell Grange, Cowplain				
Project / Job Ref: 16362				
Order No: 16362				
Reporting Date: 27/07/2017				

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 CL: AIRE 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 CL: AIRE 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 CLAIRE/CIEH published a joint report, *Guidance in comparing soil contamination data with a critical concentration* (CLAIRE/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						
			SOM	1.0	2.5	6	1	2.5																6
Type	Contaminants	Species	Year																					
Metals	Antimony		2010	550									7500									EIC/AGS/ CL:AIRE	EIC/AGS/ CL:AIRE	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
	Chromium		2014	26			149			4.9			410			220			880			C4SL	DEFRA	2014
		III	2015	910			910			18000			8600			1500			33000			S4UL	LQM/CIEH	2015
		VI	2014	21			21			170			49			23			250			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 >C5 - 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 >C5 - 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)									Name	Authority	Date	
			With home-grown produce			Without home-grown produce			Allotments			Commercial			Residential			Park						
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			
	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 (PAH's) (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	C4SL	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(ghi)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	4700	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
Explosives	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
	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-tetrenitro-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
Pesticides	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
	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
Chlorobenzenes	Gamma -Hexachlorocyclohexanes		2015	0.06	0.14	0.33	2.9	3.3	3.5	0.0092	0.023	0.054	67	69	70	8								

Land Use			Residential With or Without Plant Uptake									Public Open Space (POS)									Name	Authority	Date	
			With			Without			Allotments			Commercial			Residential			Park						
			SOM	1.0	2.5	6	1	2.5																6
Type	Contaminants	Species	Year																					
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,- Tetrachlobenzene		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,- Tetrachlobenzene		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
	Pentachlrobenzene		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 PCDDs, PCDFs 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 (CL:ARE), 2014)																						
3		2012: Soil Guideline Value (SGV) (Environment Agency, 2009)																						
4		2015: Suitable 4 Use Level (S4UL) (Nathanail <i>et al</i> , 2015)																						
For Generic Risk Assessment, the values in Bold have priority																								

Appendix D Information Provided by the Client



NOTES

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Contractors, Sub-contractors and suppliers are to check all relevant dimensions and levels of the site and building before commencing any shop drawings or building work. Any discrepancies should be recorded to the Architect.
Where applicable this drawing is to be read in conjunction with the Consultants' drawings.

REV	DESCRIPTION	DATE	AUTHOR	CHK'D

KEY

- Site Boundary
- Plot Number
- House Type
- Affordable Housing
- Shared Ownership
- Built Form
- Existing Tree
- Proposed Tree
- Existing Hedge
- Proposed Hedge
- Back Garden
- Front Garden
- NEAP/LEAP/LAP
- Public Open Space
- Attenuation Pond/Swale
- Road
- Pavement
- Shared Surface Mews
- Shared Surface Square
- Private Drive
- Parking Court

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PROJECT

Padnell Grange

Cowplain

For: Bellway Homes (Wessex)

DRAWING

Sketch Layout - 01

SCALE	DATE	AUTHOR	CHK'D
1:500 @ A1	16/03/17	PM/SWD	NC

JOB NO.	DRAWING NO.	REV
BELL170217	SKL-01	-

