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Geotechnical & Environmental Consultants

Phase II Ground Investigation Report

At

**251 Pagham Road, Bognor Regis,
West Sussex PO21 3QB**

For

Orchard Homes

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

REPORT 14011/GIR

Phase II Ground Investigation Report

Job Title: 251 Pagham Road, Bognor Regis, West Sussex, PO21 3QB

Client: Orchard Homes

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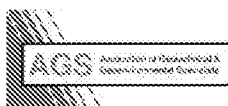
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Current regulations and good practice were used in the preparation of this report. The recommendations given in this report must be reviewed by an appropriately qualified person at the time of preparation of the scheme design to ensure that any recommendations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



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For

Orchard Homes

Commission

Soils Limited was commissioned by Orchard Homes to undertake a Phase II Ground Investigation on land at 251 Pagham Road, Bognor Regis, West Sussex, PO21 3QB. The scope of the investigation was outlined in the Soils Limited quotation reference Q14848 dated 28th October 2013.

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: 14011/DS, dated March 2014).

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- Appendix B: Geotechnical Laboratory Analysis;
- Appendix C: Chemical Laboratory Analysis;
- Appendix D: Soil Guideline Values and General Assessment Criteria;
- Appendix E: Information Provided by the Client.

Standards

The geotechnical laboratory testing was performed by K4 Soils Laboratories 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 Ltd 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.

Section 1 Introduction

1.1 Objective of Investigation

The overall objective was understood to be to supply the client and their designers with information regarding ground conditions, to assist them in preparing a foundation scheme for development that was appropriate to the conditions present on the site.

The investigation was to be undertaken to provide comment on appropriate foundation options for the proposed housing development. In addition infiltration testing undertaken to determine the suitability of the underlying soils for the adoption of a soakaway system. 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.

In addition, soil samples were recovered for chemical laboratory testing to enable recommendations for any possible remediation due to the presence of contaminants that may pose a risk to the proposed end-user.

1.2 Location

The site was located on 251 Pagham Road, Bognor Regis, West Sussex PO21 3QB and had an approximate site area of 1.39Ha. The centre of the site had an approximate Grid Reference of SZ 891 986.

The site location plan is given in Figure 1.

1.3 Proposed Development

The proposed redevelopment was understood to comprise the demolition of the existing structures on site and erection of forty three, two storey houses with associated hard and soft landscaping such as access roads and private gardens.

The proposed development layout as provided by the client is included within Appendix E.

1.4 Limitations and Disclaimers

This Phase II Ground Investigation Report relates to the site located at 251 Pagham Road, Bognor Regis, West Sussex PO21 3QB and was prepared for the sole benefit of Orchard Homes (The "Client"). The report was prepared solely for the brief described in Section 1.1 of this report.

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

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

The proposed intrusive investigation was designed to provide information on the ground conditions and to aid the design of foundations for the proposed housing development. The intended investigation, as outlined within the Soil Limited quotation (Ref: Q14848 Date: October 2013), was therefore to comprise the following items:

- 1 Day machine excavated trial holes;
- Infiltration testing within trial holes;
- 1 Day of driven sampler borehole sampling and dynamic probes driving;
- Geotechnical testing;
- Contamination testing.

2.1.1 Site Works Undertaken

The actual site works undertaken on 17th December 2013 comprised:

- 6No. Windowless sampler boreholes (WS1-6);
- 6No. Driven dynamic probes (DP1-6);
- 7No. Machine Excavated Trial Pits (TP1-6 & 8);
- Infiltration Testing within Trial Pits (TP1 & TP8);
- Logging and sampling of the ground conditions encountered in the trial holes;
- Geotechnical testing in accordance with the standards mentioned above;
- Chemical analysis of samples collected in the field in accordance with standards mentioned above.

All trial holes were backfilled with arisings upon completion.

The location of the trial holes has been included in Figure 2.

2.2 Ground Conditions

On 17th December 2013 six windowless sampler boreholes (WS1-6) were drilled, using a terrier type drilling rig, to depths of between 1.00 and 3.00m bgl at locations selected by the Soils Limited Engineer prior to arrival on site. 6No. dynamic probes (DP1-6) were driven, using DPSH, to depths of between 4.50 – 5.80m bgl prior and adjacent to the drilling of their corresponding windowless sampler borehole. One window sample, WS1, was drilled to a depth of 1.10m bgl as time restrictions did not allow the trial hole to be drilled to full depth.

Seven trial pits (TP1-6 & 8) were machine excavated, using a JCB 3CX, to depths of between 1.10 and 2.60m bgl at locations selected by the Soils Limited engineer prior to arrival on site. The western side of the site had been allocated for a trial pit (TP7) however due to obstructions the JCB was unable to access the area.

Infiltration testing was undertaken in two out of the seven trial pits at depths of between 1.10 (TP1) and 1.80m (TP8) bgl. The infiltration test comprised pumping water from a 10,000 litre bowser into trial holes and recording the drop in water level over a period of

time. Access for the water tanker was limited to the immediate area surrounding the site access and therefore it was not possible to carry out tests across the entire site.

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.

The depths of trial holes excavated are provided in Table 2.1.

Table 2.1 Final Depth of Trial Holes					
Trial Pit	Depth (m bgl)	Window Sample	Depth (m bgl)	Dynamic Probe	Depth (m bgl)
TP1(s)	1.10	WS1	3.00	DP1	4.50
TP2	1.10	WS2	3.00	DP2	4.70
TP3	1.10	WS3	3.00	DP3	5.50
TP4	2.50	WS4	3.00	DP4	5.80
TP5	2.60	WS5	1.00	DP5	5.80
TP6	1.10	WS6	3.00	DP6	4.70
TP8(s)	2.00				

Note: (s) - allocated for infiltration test.

The approximate trial hole locations are shown on Figure 2.

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 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:

Made Ground (MG)
River Terrace Deposits (RTD)
London Clay Formation (LCF)

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

Table 2.2 Ground Conditions					
Strata	Age	Depth Encountered (m bgl)		Typical Thickness (m)	Typical Description
		Top	Bottom		
MG	Recent	G.L	0.20 – 1.50	0.70	Turf over dark brown sandy gravelly SILT. Sand was fine to coarse, gravel was fine to coarse sub-angular to sub-rounded flints and brick fragments.
RTD	Quaternary	0.20 – 1.50	1.10 – 3.00 ¹	Not Proved*	Light orange brown sandy very gravelly CLAY over dark yellowish brown slightly gravelly fine to coarse SAND.
LCF	Paleogene	Not encountered within the windowless sampler boreholes			

Note - * The base of the strata was not encountered in any of the windowless sampler boreholes.

¹Recorded to the base of each of the windowless sampler boreholes

2.3 Ground Conditions Encountered in Trial Holes

The ground conditions encountered in trial holes have been described below in descending order.

2.3.1 Made Ground

Soils described as Made Ground were encountered in all of the trial holes from ground level to depths of between 0.20 and 1.50m bgl. The Made Ground typically consisted of turf over dark brown sandy gravelly silt. Sand was fine to coarse, gravel was fine to coarse sub-angular to sub-rounded flints and brick fragments.

Encountered within window samples were two layers of Made Ground, the first was encountered from ground level to depths of between 0.20 – 0.40m bgl and typically consisted dark brown sandy silt. Sand was fine to coarse, gravel was fine to medium sub-angular to sub-rounded flint and brick fragments. The second was encountered in all trial holes except WS2 from depths of between 0.20 and 0.40m bgl to depths of between 0.60 and 1.50m bgl. The second layer of Made Ground typically comprised soft dark orange brown sandy gravelly clay. Sand was fine to coarse; gravel was fine to medium sub-angular to sub-rounded flint and brick fragments.

The depths of Made Ground as encountered in the trial holes are given in Table 2.3.

Table 2.3 Depth of Made Ground			
Trial Hole	Depth (m bgl)	WS/DP	Depth (m bgl)
TP1	0.85	WS/DP1	1.00
TP2	0.25	WS/DP2	0.30
TP3	0.35	WS/DP3	0.60
TP4	0.30	WS/DP4	1.10
TP5	0.30	WS/DP5	1.00
TP6	0.25	WS/DP6	1.50
TP8	0.30		

2.3.2 River Terrace Deposits

Soils described as River Terrace Deposits were encountered in all but one trial hole (WS5) from depths of between 0.20 and 1.50m bgl and were encountered to the full depth of investigation in both trial pits (2.60m bgl) and window sample boreholes (3.00m bgl). The River Terrace Deposits typically comprised a cohesive layer immediately below the Made Ground overlying a granular layer.

The cohesive soil of the River Terrace Deposits typically comprised soft to firm, light orange brown slightly sandy clay with occasional fine to coarse gravel which persisted to depths ranging between 0.30m bgl and 2.60m bgl. Table 2.4 shows the maximum depths of the cohesive soils of the River Terrace Deposits at each location.

Table 2.4 Depth of Cohesive River Terrace Deposits			
Trial Hole	Depth (m bgl)	WS/DP	Depth (m bgl)
TP1	1.10*	WS/DP1	1.90
TP2	1.10*	WS/DP2	2.00
TP3	1.10*	WS/DP3	1.70
TP4	2.50*	WS/DP4	2.00
TP5	2.60*	WS/DP6	2.00
TP6	1.10*		
TP8	2.00*		

Note: *Final depth of trial hole

Beneath the cohesive soil the granular soils of the River Terrace Deposits were encountered comprising dark yellowish brown slightly gravelly fine to coarse sand. Gravel was fine to coarse sub-angular to sub-rounded flints. The granular soils were only encountered within a number of windowless sampler boreholes (WS1-4 & 6). Table 2.5 shows the maximum depths of the cohesive soils of the River Terrace Deposits at each location.

Table 2.5 Depth of Granular River Terrace Deposits	
Window Sample / Dynamic Probe	Depth (m bgl)
WS/DP1	3.00*
WS/DP2	3.00*
WS/DP3	3.00*
WS/DP4	3.00*
WS/DP6	3.00*

Note: *Recorded to the base of each of the windowless sampler borehole

2.3.3 London Clay Formation

The London Clay Formation was not encountered within any of the windowless sampler boreholes but was inferred from depths of below 4.10m bgl in DP2 and 5.50m in DP3 bgl and was inferred to the full depth of investigation within dynamic

probes 5.80m bgl (DP3). Table 2.6 shows the maximum inferred depths of the London Clay Formation.

Table 2.6 Depth of Granular River Terrace Deposits	
Dynamic Probe	Depth (m bgl)
DP1	4.50
DP2	4.70
DP3	5.80
DP4	5.80
DP5	5.00
DP6	5.00

Note: *Recorded to the base of each of the windowless sampler boreholes

2.4 Roots

Roots or rootlets were observed in eight of the thirteen trial holes to a maximum depth of 1.00m bgl.

Table 2.7 shows the observed depths of roots within each trial hole.

Table 2.7 Summary of Root Observations				
Trial Hole	Root Depth (m bgl)	Stratum	Description	Base Of Hole (m bgl)
WS1	1.00	Made Ground	Roots and Rootlets	3.00
WS2	1.00	River Terrace Deposits		3.00
WS3	None Observed			3.00
WS4				3.00
WS5				1.00
WS6				3.00
TP1	0.50	Made Ground	Roots and Rootlets	1.10
TP2	0.60			1.10
TP3	1.00	River Terrace Deposits		1.10
TP4	1.00			2.50
TP5	0.80			2.60
TP6	None Observed			1.10
TP8	0.60	River Terrace Deposits	Roots and Rootlets	2.00

Please note; mature trees and hedges were present on site, particularly within the eastern side of the site. Furthermore shrubs and hedges were present along site boundaries at the western area of the site.

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

2.5 Groundwater

Groundwater was encountered within three out (TP2, TP4 and TP5) of the thirteen trial holes

at a minimum depth of 1.10m bgl within TP2. Although the final depths of TP2 was 1.10m bgl trial holes close to the location of TP2 encountered a clay band to depths of between 1.70 and 2.00m bgl which suggests that groundwater could be perched within the more granular cohesive soils overlying. Groundwater was not encountered within window sample boreholes however the speed of drilling may have masked any water strikes encountered.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in December (2013), when groundwater levels should be rising from their typical annual minimum (lowest) elevation.

Groundwater equilibrium conditions may only be conclusively established by means of a series of measurements made in a standpipe, or piezometer installed in the ground after completion of the site works.

Section 3 Discussion of Geotechnical In-situ and Laboratory Testing

3.1 Dynamic Probe Tests

Dynamic probing (DPSH) was undertaken at six locations (DP1 to DP6) adjacent to and prior to the drilling of their respective windowless sampler boreholes to depths of between 4.50m bgl and 5.80m bgl.

Dynamic probing involves the driving of a metal cone into the ground via a series of steel rods. These rods are driven from the surface by a hammer system that lifts and drops a 63.5kg hammer onto the top of the rods through a set height, thus ensuring a consistent energy input. The number of hammer blows that are required to drive the cone down by each 100mm increment are recorded. These blow counts then provide a comparative assessment from which correlations have been published, based on dynamic energy, which permit engineering parameters to be generated.

The dynamic probe results were converted to equivalent SPT "N" values based on dynamic energy using in-house computer software (Geostru).

The inferred relative degree of compaction of the granular soils was based on the equivalent SPT "N" blow counts, derived from the relationship suggested by Stroud (1974). (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.).

Fine (cohesive) soils were classified using Table 3.1.

Table 3.1 Cohesive Soil Classification	
Classification	Undrained Cohesive Strength (kPa)
Extremely low	<10
Very low	10 – 20
Low	20 – 40
Medium	40 – 75
High	75 – 150
Very high	150 – 300
Extremely high	> 300

(Ref: EN ISO 14688-2:2004 Clause 5.3.)

Coarse (granular) soils were classified based on the relationship given in Table 3.2.

Table 3.2 S.P.T. "N" Blow Count Granular Classification	
Classification	S.P.T. "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

(BS EN ISO 22476-2:2005 Geotechnical investigation and testing Field testing Part 2: Dynamic probing)

Table 3.3 provides an interpretation of the equivalent SPT 'N' blow counts for the soils of the River Terrace Deposits (RTD) and the London Clay Formation (LCF) encountered in the windowless sampler boreholes and those inferred from the dynamic probe counts.

Made Ground has been excluded from this interpretation.

Table 3.3 Interpretation of Dynamic Probe Blow Counts				
Strata	Equivalent SPT "N" Blow Counts	Soil Type / Strength		DP
		Cohesive	Granular	
RTD Gravelly Clay 1.00 – 1.90m bgl	3 - 15	Very Low to High ($C_u = 15 - 75\text{kPa}$)		DP1
RTD Gravelly Sand 1.90 – 2.60m bgl	15 - 24		Medium Dense	
RTD Sandy Clay 2.60 – 3.00m bgl	24 - 27	High ($C_u = 120 - 135\text{kPa}$)		
*RTD 3.00 – 4.30m bgl	18 - 33	High to Very High ($C_u = 90 - 165\text{kPa}$)	Medium Dense to Dense	
*LCF *CLAY 4.30 – 4.50m bgl	45 - >50	Very High to Extremely High ($C_u = 225 - >300\text{kPa}$)		
RTD Soft Clay 0.30 – 1.00m bgl	<3	Extremely Low ($C_u < 10\text{kPa}$)		DP2
RTD Soft Clay 1.00 – 2.00m bgl	3 - 15	Very Low to Medium ($C_u = 15 - 45\text{kPa}$)		
RTD Sand 2.00 – 3.00m bgl	12 - 33		Medium Dense to Dense	
*RTD 3.00 – 4.10m bgl	21 - 33	High to Very High ($C_u = 105 - 165\text{kPa}$)	Medium Dense to Dense	
*LCF *CLAY 4.30 – 4.50m bgl	33 - >50	Very High to Extremely High ($C_u = 165 - >300\text{kPa}$)		
RTD Gravelly Clay 0.60 – 1.70m bgl	3 - 6	Very Low to Low ($C_u = 15 - 30\text{kPa}$)		DP3
RTD Sand 1.70 – 3.00m bgl	6 - 27		Loose to Medium Dense	
*RTD 3.00 – 5.50m bgl	6 - 18	Low to High (30 – 90kPa)	Loose to Medium Dense	
*LCF *CLAY 5.50 – 5.90m bgl	45 - >50	Very High to Extremely High ($C_u = 225 - >300\text{kPa}$)		
RTD Gravelly Clay 1.10 – 2.00m bgl	3 - 18	Very Low to High ($C_u = 15 - 90\text{kPa}$)		DP4
RTD Sand 2.00 – 3.00m bgl	0 - 30		Very Loose to Dense	

Table 3.3 Interpretation of Dynamic Probe Blow Counts				
Strata	Equivalent SPT "N" Blow Counts	Soil Type / Strength		DP
		Cohesive	Granular	
*RTD 3.00 – 5.10m bgl	6 - 12	Low to Medium ($C_u = 30 - 60\text{kPa}$)	Loose	
*LCF *CLAY 5.10 – 5.80m bgl	18 - >50	High to Extremely High ($C_u = 90 - >300\text{kPa}$)		
RTD 1.00 – 5.00m bgl	9 - 27	Medium To High ($C_u = 45 - 135\text{kPa}$)	Loose to Medium Dense	DP5
RTD Sand 1.50 – 1.80m bgl	3 - 6		Very Loose to Loose	DP6
RTD Clay 1.80 – 2.00m bgl	6	Low ($C_u = 30\text{kPa}$)		
RTD Sand 2.00 – 3.00m bgl	6 - 9		Loose	
*RTD 3.00 – 4.70m bgl	6 - 21	Low to High ($C_u = 30 - 105\text{kPa}$)	Loose to Medium Dense	
*LCF *CLAY 4.70 – 5.00m bgl	48 - >50	Very High to Extremely High ($C_u = 240 - >300\text{kPa}$)		

(BS EN ISO 22476-2:2005 Geotechnical investigation and testing Field testing Part 2: Dynamic probing)

* Ground conditions inferred below base of corresponding Windowless Sampler Borehole.

The strength of the cohesive soils of the River Terrace Deposits ranged from extremely low to extremely high, typically **low to medium** with inferred cohesive strengths of between <10 – 165kPa.

The strength of the granular soils of the River Terrace Deposits ranged from very loose to dense typically, **medium dense to dense**.

The strength of the London Clay Formation ranged from high to extremely high, typically **very high** with inferred cohesive strengths of between 90 - >300kPa.

The dynamic probe test results are presented within Appendix A.

3.2 Atterberg Limit Tests

Atterberg Limits Tests were performed on four cohesive samples of the River Terrace Deposits (RTD) (WS1:1.30m, WS1:2.80m, WS3:0.90m and WS4:1.50m). A précis of the results is given in Table 3.4.

Table 3.4 Atterberg Limit Test Interpretation							
Stratum	Moisture Content (%)	Plasticity Index (%)	Passing 425µm Sieve (%)	Modified Plasticity Index (%)	Soil Classification	Volume Change Potential	
						BRE	NHBC
RTD	19 - 38	10 - 32	62 - 94	9 - 30	CL - CH	Low to Medium	None to Medium

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

NB: BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)
 Soil Classification based on British Soil Classification System
 NHBC Volume Change Potential refers to NHBC Standards Chapter 4.2 Building near trees (based on Atterberg results)

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 results from the laboratory testing showed that the cohesive soils of the River Terrace Deposits expressed **low to medium** volume change potential in accordance with BRE Digest 240 and **none to medium** in accordance with NHBC Standards Chapter 4.2.

The test results are given in Appendix B.

3.3 Grading Analysis Tests

3No. samples from the River Terrace Deposits were submitted for grading analysis (particle size distribution tests). An interpretation of the results is provided in Table 3.5.

Table 3.5 Grading Analyses Interpretation					
Location	Depth (m bgl)	Soil Description	Volume Change Potential		Passing 63µm Sieve (%)
			BRE	NHBC	
WS6	1.20	Brown sandy CLAY with rare fine sub-angular gravel.	YES	YES	82
WS4	2.10	Brown slightly clayey SAND with rare fine and angular gravel	NO	NO	9
WS2	2.90	Pale brown slightly gravelly slightly clayey SAND. Gravel was fine to medium sub angular to sub rounded	NO	NO	8

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

NB Volume Change Potential refers to BRE Digest 240 (based on Grading test results).

Volume Change Potential – 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 results from grading analysis proved that the cohesive River Terrace Deposits from WS6 at 1.20m bgl possessed **volume change potential** in accordance with both BRE 240 and NHBC Standards Chapter 4.2.

The results from grading analysis proved that the granular soils of the River Terrace Deposits **did not possess volume change potential** in accordance with either BRE 240 or NHBC Standards Chapter 4.2.

The test results are given in Appendix B.

3.4 California Bearing Ratio (CBR) Tests

Two near surface samples from the River Terrace Deposits at a depth of 0.50m bgl were tested in the laboratory in order to provide an indication of likely California Bearing Ratio (CBR).

The results are summarised in Table 3.6.

Table 3.6 Summary of CBR Test Results				
Sample	Laboratory Description	Moisture Content	CBR Value (Top)	CBR Value (Base)
TP5: 0.50	Brown slightly gravelly fine sandy silty CLAY with occasional carbonaceous deposits and traces of rootlets. (gravel is fine to medium and sub-angular)	24	1	1
TP8: 0.50	Brown slightly gravelly sandy CLAY with occasional rootlets and carbonaceous deposits (gravel is fine to medium sub-angular to sub-rounded)	26	1	2

(Laboratory CBR Tests were performed in accordance with BS1377: Part 4: 1990: Clause 7.4)

The laboratory tests indicated **CBR values of between 1 and 2%** for the variable soils of the River Terrace Deposits at the moisture contents tested.

The full test results are given in Appendix B.

3.5 Sulphate and pH Tests

Three samples (WS1: 1.60m, WS2:2.50 and WS6: 1.90m) were taken from the River Terrace Deposits for water soluble sulphate (2:1) and pH testing in accordance with Building Research Establishment Special Digest 1, 2005, 'Concrete in Aggressive Ground'.

The significance of the sulphate and pH Test results are discussed in Section 4.4 in this report, however Table 3.7 summarises the results.

Table 3.7 Sulphate and pH Tests			
Trial Hole	Depth (m bgl)	pH	Sulphate (2:1) (mg/l)
WS1	1.60	8.0	80
WS2	2.50	7.9	30
WS6	1.90	8.1	40

(The Sulphate and pH Tests were undertaken in accordance with Building Research Establishment Special Digest 1, 2005, 'Concrete in Aggressive Ground')

The test results are given in Appendix B.

3.6 Indicative Soakage Tests

Two indicative soakage tests were performed during the investigation within TP1 at a depth of 1.10m bgl and TP8 at a depth of 1.80m bgl, the tests were conducted solely within the soils of the River Terrace Deposits and were performed in accordance with the principles of BRE Digest 365 Soakaway design: 1991.

BRE 365 states 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, in order to determine whether or not the underlying ground conditions may be suitable for surface water drainage. The tests were not refilled due to time restrictions as the water remained static.

Each test comprised introducing water into the open trial hole, the drop in water level over time was then recorded to give an indication of soakage potential. The results have been presented in Tables 3.8 to 3.9.

Table 3.8 Soakage Test: TP1	
Interval (mins)	Depth (m bgl)
0	0.50
23	0.50
51	0.50
80	0.50
132	0.50
162	0.50
196	0.50
226	0.50
249	0.50
Rate (f): Zero infiltration	

Note: Depth is from ground level to surface water level.

Table 3.9 Soakage Test: TP8	
Interval (mins)	Depth (m bgl)
0	0.70
23	0.70
51	0.70
72	0.70
124	0.70
154	0.70
178	0.70
196	0.70
211	0.70
Rate (f): Zero infiltration	

Note: Depth is from ground level to surface water level.

A discussion of the results of the indicative soakage tests is provided in Section 4.7.

Section 4 Foundation Design

4.1 General

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

4.1.1 Made Ground, Fill 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 all trial holes from ground level to depths of between 0.20 and 1.50m bgl. The Made Ground typically consisted of turf over dark brown sandy gravelly silt. Sand was fine to coarse, gravel was fine to coarse sub-angular to sub-rounded flints and brick fragments.

Encountered within window samples were two layers of Made Ground, the first was encountered from ground level to depths of between 0.20 – 0.40m bgl and typically consisted dark brown sandy silt. Sand was fine to coarse, gravel was fine to medium sub-angular to sub-rounded flint and brick fragments. The second was encountered in all trial holes except WS2 from depths of between 0.20 and 0.40m bgl to depths of between 0.60 and 1.50m bgl. The second layer of Made Ground typically comprised soft dark orange brown sandy gravelly clay. Sand was fine to coarse; gravel was fine to medium sub-angular to sub-rounded flint and brick fragments.

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 River Terrace Deposits

Soils described as River Terrace Deposits were encountered in all but one trial hole (WS5) from depths of between 0.20 and 1.50m bgl and were encountered to the full depth of investigation in both trial pits (2.60m bgl) and window sample boreholes (3.00m bgl). The River Terrace Deposits typically comprised a cohesive layer immediately below the Made Ground overlying a granular layer.

The cohesive soil of the River Terrace Deposits typically comprised soft to firm, light orange brown slightly sandy clay with occasional fine to coarse gravel which persisted to depths ranging between 0.30m bgl and 2.60m bgl.

Beneath the cohesive soil the granular soils of the River Terrace Deposits were encountered comprising dark yellowish brown slightly gravelly fine to coarse sand. Gravel was fine to coarse sub-angular to sub-rounded flints. The granular soils were only encountered within a number of windowless sampler boreholes (WS1-4 & 6).

The results from dynamic probing inferred that the strength of the cohesive soils of the River Terrace Deposits ranged from extremely low to extremely high, typically **low to medium** with inferred cohesive strengths of between <10 – 165kPa.

The results from dynamic probing inferred that the relative state of compaction (density) of the granular soils of the River Terrace Deposits ranged from very loose to dense typically, **medium dense to dense**.

The results from the laboratory testing showed that the **cohesive soils of the River Terrace Deposits** expressed **low to medium** volume change potential in accordance with BRE Digest 240 and **none to medium** in accordance with NHBC Standards Chapter 4.2.

The results from grading analysis proved that the cohesive River Terrace Deposits from WS6 at 1.20m bgl possessed ***volume change potential*** in accordance with both BRE 240 and NHBC Standards Chapter 4.2.

The results from grading analysis proved that the **granular soils of the River Terrace Deposits** ***did not possess volume change potential*** in accordance with either BRE 240 or NHBC Standards Chapter 4.2.

The laboratory tests indicated ***CBR values of between 1 and 2%*** for the variable soils of the River Terrace Deposits at the moisture contents tested. A higher moisture content resulted in a slightly higher CBR value.

The soils of the River Terrace Deposits are normally consolidated and would have low to moderate bearing capacities with moderate settlement characteristics, depending upon the fine content. The River Terrace Deposits have been considered suitable bearing stratum for the proposed development where foundations are taken through the cohesive soils and into/onto the granular soils.

4.1.3 London Clay Formation

The London Clay Formation was not encountered within any of the windowless sampler boreholes but was inferred at depths of below 4.10m bgl in DP2 and 5.50m in DP3 bgl and was inferred to the full depth of investigation within dynamic probes 5.80m bgl (DP3).

The strength of the London Clay Formation ranged from high to extremely high, typically **very high** with inferred cohesive strengths of between 90 - >300kPa.

The soils of the London Clay Formation are overconsolidated and would have high bearing capacities with low settlement characteristics depending upon its weathered state. Given the high to extremely high strength of the inferred soils of the London Clay Formation it was concluded that the unit was un-weathered. The London Clay Formation can be considered as suitable bearing stratum if a piled foundation scheme is adopted due to the inferred depths encountered across site.

4.1.4 Roots

Roots or rootlets were observed in two of the five trial holes to a maximum depth of 1.00m bgl.

Please note; mature trees and hedges were present on site, particularly within the eastern side of the site. Furthermore shrubs and hedges were present along site boundaries at the western area of the site.

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

4.1.5 Groundwater

Groundwater was encountered within three out of the thirteen trial holes at a minimum depth of 1.10m bgl within TP2. Although the final depths of TP2 was 1.10m bgl trial holes close to the location of TP2 encountered a clay band to depths of between 1.70 and 2.00m bgl which suggests that groundwater could be perched within the more granular cohesive soils overlying. Groundwater was not encountered within window samples however the drilling process may have masked any water strikes encountered.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was conducted in December (2013), when groundwater levels should be approaching their typical annual minimum (lowest) elevation. There has been significant rainfall during December 2013 and January 2014, and the groundwater levels may be higher than usually found during this time of year.

Groundwater equilibrium conditions may only be conclusively established by means of a series of measurements made in a standpipe, or piezometer installed in the ground after completion of the site works.

4.2 Foundation Scheme

The proposed redevelopment was understood to comprise the demolition of the existing structures on site and erection of forty three, two storey houses with associated hard and soft landscaping such as access roads and private gardens.

At the time of reporting, February 2014, anticipated foundation loads were not known to Soils Limited however the proposed development layout had been provided and a copy is presented in Appendix E.

4.2.1 Guidance on Shrinkable Soils

The Building Research Establishment (BRE) Digests 240, 241 and 242 and NHBC Standards Chapter 4.2 provide guidance on 'best practice' for the design and construction of foundations on shrinkable soils.

The results of Atterberg testing showed that the **cohesive soils of the River Terrace Deposits** possessed low to medium volume change potential as defined by the BRE Digest 240 and none to medium as defined by NHBC Standards Chapter 4.2 Building near trees.

Medium volume change potential (in accordance with NHBC Standards Chapter 4.2) must therefore be adopted for the proposed development where foundations pass through or are constructed on the cohesive soils of the River Terrace Deposits.

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 Conclusions and Recommendations

Foundations **must not** be constructed within any Made Ground or 'soft' cohesive soils of the River Terrace Deposits due to the likely variability and potential for large load induced settlements both total and differential.

Foundations **must not be placed within any live root penetrated** or desiccated cohesive soils. Should the foundation excavations reveal such materials, the excavations **must** be extended to greater depth in order to bypass these unsuitable soils. Excavations must be checked by a suitable person prior to concrete being poured.

Roots were encountered to depths of up to 1.00m bgl, furthermore mature trees and shrubs were present within the site perimeter and on site boundaries. Strip foundations can be considered across the site where suitable bearing values are achievable however **footings must not be placed within any live root penetrated** or desiccated cohesive soils.

The cohesive soils of the River Terrace Deposits were typically described as very soft to soft which corresponded to the inferred classifications of typically very low to medium from dynamic probes and therefore the cohesive soils were not considered as suitable bearing stratum. The granular soils of the River Terrace Deposits were typically medium dense to dense and were typically consistent in composition across the site which makes them a suitable bearing stratum.

The granular soils of the River Terrace Deposits were encountered at different depths in trial hole locations however the sands were typically encountered at depths of between 1.70 and 2.00m bgl. Allowable bearing values based on the **granular soils of the River Terrace Deposits** have been calculated based on a strip footing of 0.75m x 5.00m and the 'worst case' conditions encountered (DP3 & 6). An allowable bearing value of **140kPa** is considered suitable with settlements of <25mm where foundations bear onto the granular soils of the River Terrace Deposits.

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

The intrusive investigation was conducted during a period of heavy rainfall in December 2013 and it is likely that the groundwater table would have risen as a result. If groundwater is encountered during excavation dewatering of trenches would need to be adopted or consideration given to a piled foundation solution.

Any surface water ingress must be prevented from entering foundation trenches.

Considering the medium volume change potential associated with the cohesive upper bands of the River Terrace Deposits a suspended floor would be necessary for the proposed redevelopment.

Foundations must not be cast over foundations of former structures and other hard spots.

4.3.1 Piled Foundations

Considering the mature trees and shrubs that were present across there is potential for deep root penetrated soils, consideration may need to be given to a piled foundation solution if roots persist to depths greater than

encountered during the intrusive investigation.

The construction of a piled foundation is a specialist job, and the advice of a reputable contactor familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the foundation design.

The drilling of light cable percussion boreholes would be required on site to enable sampling and laboratory testing at depth for pile foundation design purposes.

4.4 Subsurface Concrete

Sulphate concentration measured in 2:1 water/soil extracts fell into Class **DS-1** of the BRE Special Digest 1 2005, '*Concrete in Aggressive Ground*'. Table C2 of the Digest indicated ACEC (Aggressive Chemical Environment for Concrete) site classifications of **AC-1**. The pH of the soils tested ranged between 7.9 and 8.1.

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 Pavements

The proposed redevelopment was to include access routes, car parking and pavement. The laboratory tests indicated **CBR values of 1-2%** for the soils of the River Terrace Deposits at moisture contents of between 24-26%.

As CBR values are highly variable due to changes in moisture content **in-situ testing must be undertaken** immediately prior to the installation of pavements/roads. Any soft spots at formation level should be dug out and replaced with a suitably compacted granular fill. Prior to construction the formation level should be proof rolled. The cohesive soils of the River Terrace Deposits would not be frost susceptible as plasticity indexes were >15%.

4.6 Excavations

Shallow excavations in the Made Ground and cohesive River Terrace Deposits are likely to be marginally stable in the short term.

Deeper excavations taken into the granular soils of the River Terrace Deposits are likely to become unstable very quickly. 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.

4.7 Surface Water Disposal

Two indicative soakage tests were performed during the investigation within TP1 at a depth of 1.10m bgl and TP8 at a depth of 1.80m bgl, the tests were conducted solely

within the soils of the River Terrace Deposits and were performed in accordance with the principles of BRE Digest 365 Soakaway design: 1991.

BRE 365 states 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, in order to determine whether or not the underlying ground conditions may be suitable for surface water drainage. The tests were not refilled due to time restrictions as the water remained static.

Access for the water tanker was limited to the immediate area surrounding the site access and therefore it was not possible to carry out tests across the entire site. Further testing is recommended when sufficient access for plant is available.

In conclusion it was considered that the cohesive soils of the River Terrace Deposits cannot be considered suitable for the adoption of a natural soakaway system, however further testing of the deeper granular soils of the River Terrace Deposits could be undertaken provided access for plant is available.

Consultation with the Environment Agency must be sought regarding any use which may have an impact on groundwater resources.

Section 5 Chemical Analysis of Soil Samples

5.1 Site Characterisation and Revised Conceptual Site Model

The Phase I Desk Study undertaken on the above site by Soils Limited (report ref: 14011/DS, dated March 2014) identified a low risk of contamination from on-site sources (Made Ground and Herbs & Pesticides from Nursery) but did not identify any off-site sources. The Phase II Ground Investigation did identify on-site sources in the form of Made Ground and therefore the CSM did not **require revision**. The updated CSM is presented in Table 5.

Table 5.1 Tabulated Conceptual Site Model				
Risk Rating	Source	Potential Migration Pathway	Potential Absorption Pathway	Receptor
ON SITE Low Risk	Made Ground Herbicides & Pesticides	Via contact with impacted soil	Ingestion of soil Dermal contact Inhalation of dust (indoor and outdoor) Location of service supply pipes in contaminated soils Via anthropogenic pathways (services trenches)	Human Health Future users of the site Visitors to the site Construction workers on site Service and maintenance workers Site neighbours and wide public
				Building Materials Future Potable Water Supply Construction materials
		Consumption of home-grown produce	Ingestion Dermal contact	Human Health Future users of the site Visitors to the site
		Migration downwards via natural granular soils		Controlled Water

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.

A targeted sampling strategy was adopted with sampling locations and sampling depths chosen to reflect both receptor and exposure scenarios of concern for the human health receptor (this being end users, ground workers, future maintenance workers), current and future buildings.

The sampling strategy has been presented in Table 5.2.

Table 5.2 Sampling Strategy		
Sample	Strategy	Proposed Use
WS1:0.50	Targeted: Made Ground beneath existing shed.	Soft Landscaped Area
WS3:0.10	Targeted: Made Ground	Soft Landscaped Area
WS4:0.20	Targeted: Made Ground	Soft Landscaped Area
WS5:0.20	Targeted: Made Ground	Soft Landscaped Area
TP2:0.20	Targeted: Made Ground beneath existing Greenhouse.	Soft Landscaped Area

5.3 Determination of Contaminants of Concern

The driver for the determination of the analysis suite was the information obtained from the Phase II intrusive investigation.

The analysis suite is presented in Table 5.3:

Table 5.3
Determination of Contaminants of Concern

Determinant	Locations:Depths (m bgl)				
	WS1:0.50	WS3:0.10	WS4:0.20	WS5:0.20	TP2:0.20
Asbestos Screen	✓	✓	✓	✓	
Total phenols	✓	✓	✓	✓	
Total Cyanide	✓	✓	✓	✓	
Organic Matter	✓	✓	✓	✓	
pH	✓	✓	✓	✓	
metals:	✓	✓	✓	✓	
metalloids	✓	✓	✓	✓	
organics	✓	✓	✓	✓	
PAHs	✓	✓	✓	✓	
TPH-CWG	✓		✓		
BTEX	✓		✓		
Organochlorine Pesticides					✓
Phenyl Urea Herbicides					✓

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** aims at identifying fibres or fibrous material, which are indicative of the presence of asbestos. Should fibres or fibrous material be detected the sample is characterised as "suspected" and is subsequently submitted for further analysis for confirmation and speciation if required.

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 D.

6.2 Representative Contamination Criteria

The proposed redevelopment was understood to comprise the demolition of the existing structures on site and erection of forty three, two storey houses with associated hard and soft landscaping such as access roads and private gardens.

The results of the comparison of the representative contaminants concentration for human health receptor to the Soil Guideline Values (SGV), Atkins ATRISK^{soil} SSV Guideline Values for Lead and General Assessment Criteria (GAC) are presented in Table 6.1.

The SGV and GAC are assessed against the "Residential" land-use scenario, which was considered the most appropriate land-use scenario, given the type of the proposed redevelopment (residential houses).

The assessment for lead was undertaken based on the ATRISK^{soil} Soil Screening Value (SSV) for the "Residential with plant uptake" land-use scenario.

Table 6.1 Summary of Chemical Analysis of Soil Samples	
Substance	Sample location where SGV, SSV or GAC adopted were exceeded for the 'Residential' land-use scenario
Arsenic	None
Beryllium	
w/s Boron	
Cadmium	
Chromium	
Copper	
Lead	
Mercury (inorganic)	
Nickel	
Selenium	
Vanadium	
Zinc	
Total Cyanide	
PAHs	
TPH-CWG (speciated)	
BTEX	
Organochlorine Pesticides	
Phenyl Urea Herbicides	
Asbestos Screen*	Not detected

* Asbestos screening was carried out by the sample preparers in sample reception at QTS Environmental Ltd's laboratory. They were trained to look for fibrous material though cannot actually determine whether it was asbestos. If they saw fibres, they report fibres as 'Detected'. The sample would then have to go to the laboratory for confirmation and speciation. If they do not see fibres, they report fibres as 'Not Detected'.

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 1.6 and 10.7%. For each soil sample tested, the Soil Organic Matter recorded was used to derive the appropriate GAC for organic determinants.

In summary, **none** of the samples tested showed concentrations in excess of the relevant DEFRA SGV, ATRISK^{soil} SSV or LQM CIEH GAC for a residential land-use scenario.

Note on Asbestos; whilst asbestos was not identified in any 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 Tier 1 Quantitative Risk Assessment

Whilst concentrations in excess of the laboratory instrument detection levels were recorded, none of the determinants was in excess of the relevant DEFRA SGV, ATRISK^{soil} SSV or LQM CIEH GAC for a residential scenario.

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

The results of the contamination testing are presented in Appendix C.

6.4 Risk to Groundwater

Made Ground and River Terrace Deposits (with soils of the London Clay Formation inferred at depth) were encountered across the site. Made Ground from five locations was tested in the laboratory for a range of common brownfield contaminants. Whilst groundwater samples were not recovered from the trial holes the results of the soils testing and ground investigation suggested it was **unlikely that any risk to groundwater was posed**, however further testing of groundwater could be undertaken to negate any possible risk.

6.5 Remedial Objective

No contaminants were found in excess of the relevant guideline values and no potential pathways such as ingestion, dermal contact, or inhalation could link the soils to the proposed end-users. Therefore **there was no requirement for remediation of the soils tested**.

Any imported Topsoil used on this site shall be as defined in the British Standard BS3882:2007 Specification for Topsoil.

In addition any imported topsoil must be fit for purpose and must either be supplied with traceable chemical laboratory test certificates or be tested, either prior to placing or after placing, to ensure that the human receptor cannot come into contact with any compounds that could be detrimental to human health.

In respect to the groundworkers and site operatives, it is understood that in order to minimise the effect of dust inhalation and dermal contact as exposure pathways, a good standard of personal hygiene must be adopted.

6.6 Soil-Gas Risk

No soil-gas risk was identified during the Phase I Desk Study and therefore a Soil-Gas Risk Assessment was not required.

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 were 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 or risk-based assessment 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 that have not been identified during the course of the intrusive investigation. For instance, there may have been underground storage tanks (UST's) not identified during Ground Investigation for which there is no historical or contemporary evidence. Such occurrences may be discovered during the construction phases for the development of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination, this may comprise visual indicators, such as fibrous materials within the soil, discolouration, or odours and emission. Upon discovery advice must be taken from a suitably

qualified person before proceeding, such that appropriate remedial measures and health and safety protection may be applied.

Should a new source of contamination be suspected or identified then the Local Authority and Soils Limited must be informed.

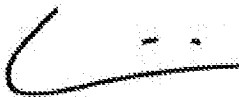
The following figures and appendices complete this report:

Figure 1 Site Location Map
Figure 2 Trial Hole Layout Plan

Appendix A Field Work;
Appendix B Geotechnical Laboratory Analysis;
Appendix C Chemical Laboratory Test Results;
Appendix D Soil Guideline Values and General Assessment Criteria;
Appendix E Information Provided by the Client.



R. West BEng. (Hons).
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Graduate Engineer



EurIng. R. B. Higginson B.Sc., PG. Dip., C.Eng., MICE., FGS.
Geotechnical Advisor



Trial Hole Location Plan

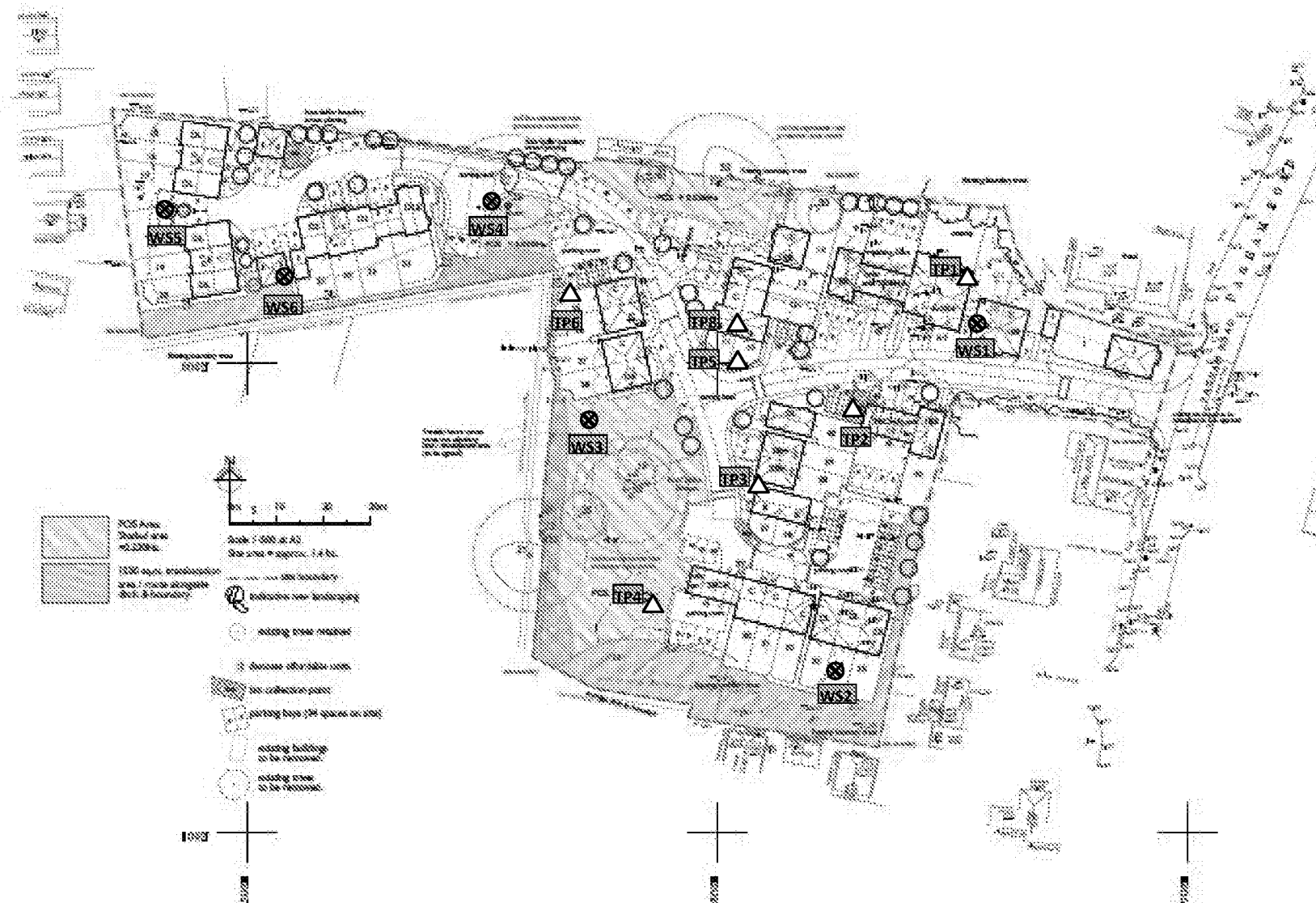
Key:

 Site Boundary

Figure	1
Job No.	14011
Project:	251 Pagham Road
Client:	Orchard Homes
Date:	Dec 2014

soils
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Statistical & Experimental Considerations



Trial Hole Location Plan

Key:

-  Window Sample Borehole/Dynamic Probe
-  Trial Pit

Figure	2
Job No.	14011
Project:	251 Pagham Road
Client:	Orchard Homes
Date:	Dec 2014

soils
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Geotechnical & Environmental Constants

Appendix A

Field Work

Soils Limited
Newton House
Cross Road
Tadworth
Surrey KT20 5SR
Tel: 01737 814221
Fax: 01737 812557



Record of Borehole WS 1

Sheet 1 of 1

Start Date: 17/12/2013
End Date: 17/12/2013
Logged By: CF

Ground Level: -
Easting: -
Northing: -

Site: 251 Pagham Road, Bognor Regis
Client: Orchard Homes & Developments Ltd
Project No: 14011

Boring Method: WS
Weather:
Driller: SC

Samples, In-situ Tests & Installations					Strata			
Depth	Type	Result	S/Pipe	Elev	Legend	Depth/(Thk)	Description	
0.10	J					0.20	Turf over dark brown sandy gravelly SILT. Sand is fine to coarse, gravel is fine to coarse sub-angular to sub-rounded made up of flint and brick. MADE GROUND	
0.45	J					0.80		
0.70	J					1.00		
1.30	D					0.90	Soft dark orangish brown sandy gravelly CLAY. Sand is fine to coarse, gravel is fine to coarse, sub-angular to sub-rounded made up of flint and brick with frequent rootlets and becoming less gravelly with depth. MADE GROUND	
1.60	D					1.90		
2.10	D					0.70	Light orangish brown sandy very gravelly CLAY. Sand is fine to coarse, gravel is fine to medium sub-angular to sub-rounded made up of flint. RIVER TERRACE DEPOSITS	
2.80	D					2.60		
						0.40	Dark orangish brown gravelly SAND. Gravel is fine to coarse, sub-angular to sub-rounded made up of flint. RIVER TERRACE DEPOSITS	
						3.00		
							Soft to firm dark reddish brown sandy CLAY with fine to coarse sand partings. Sand is fine to coarse. RIVER TERRACE DEPOSITS	
							End of Borehole at 3.00 m	

Daily Progress					Water Strikes							Chiselling			Hole Diameter		Casing Diameter	
Date	Time	Hole	Depth	Water Depth	Strike Depth	Casing Depth	Date	Time	Post Depth	Elapsed Minutes	Depth Sealed	Start Depth	End Depth	Hours	Depth	Diam. (mm)	Depth	Diam. (mm)

General Remarks:

Roots observed to 1.00m bgl

Soils Limited
Newton House
Cross Road
Tadworth
Surrey KT20 5SR
Tel: 01895 811221



Record of Borehole WS 2

Sheet 1 of 1

Start Date: 17/12/2013

End Date: 17/12/2013

Logged By: CF

Ground Level: -

Easting: -

Northing: -

Site: 251 Pagham Road, Bognor Regis
Client: Orchard Homes & Developments Ltd
Project No: 14011

Boring Method: WS

Weather:

Driller: SC

Samples, In-situ Tests & Installations

Strata

Depth	Type	Result	S/Pipe	Elev	Legend	Depth/(Thk)	Description
0.10	J					0.30	Turf over dark sandy gravelly SILT. Sand is fine to medium, gravel is fine to coarse sub-angular to sub-rounded made up of flint and brick and frequent rootlets. MADE GROUND
0.45	J					0.70	
0.70	J					1.00	Soft dark orangish brown sandy slightly gravelly CLAY. Sand is fine to coarse, gravel is fine to medium sub-angular to sub-rounded made up of flint and occasional rootlets. RIVER TERRACE DEPOSITS
1.30	D					1.00	
1.60	D					2.00	Very soft light orangish brown sandy gravelly CLAY. Sand is fine to coarse, gravel is fine to medium sub-angular to sub-rounded made up of flint. RIVER TERRACE DEPOSITS Becoming lighter and stiffer with depth
2.10	D					1.00	
2.80	D					3.00	Dark yellowish brown slightly gravelly fine to coarse SAND. Gravel is fine to coarse angular to sub-rounded made up of flints. RIVER TERRACE DEPOSITS.
End of Borehole at 3.00 m							

Daily Progress

Water Strikes

Chiselling

Hole Diameter

Casing Diameter

Date	Time	Hole	Depth	Water Depth	Strike Depth	Casing Depth	Date	Time	Post Depth	Elapsed Minutes	Depth Sealed	Start Depth	End Depth	Hours	Depth	Diam. (mm)	Depth	Diam. (mm)

General Remarks:

Roots observed to 1.00m bgl

Soils Limited
Newton House
Cross Road
Tadworth
Surrey KT20 5SR
Tel: 01895 811221



Record of Borehole WS 3

Sheet 1 of 1

Start Date: 17/12/2013

End Date: 17/12/2013

Logged By: CF

Ground Level: -

Easting: -

Northing: -

Site: 251 Pagham Road, Bognor Regis
Client: Orchard Homes & Developments Ltd
Project No: 14011

Boring Method: WS

Weather:

Driller: SC

Samples, In-situ Tests & Installations

Strata

Depth	Type	Result	S/Pipe	Elev	Legend	Depth/(Thk)	Description
0.10	J					0.30	Turf over dark sandy gravelly SILT. Sand is fine to medium, gravel is fine to coarse sub-angular to sub-rounded made up of flint and brick with strong odour (stagnant / decomposition) MADE GROUND
0.60	J					0.60	
0.90	J					1.10	Soft dark orangish brown sandy gravelly CLAY. Sand is fine to coarse, gravel is fine to coarse, sub-angular to sub-rounded made up of flint and brick with frequent rootlets and becoming less gravelly with depth. MADE GROUND
1.50	D					1.70	
2.30	D					1.30	Light orangish brown sandy very gravelly CLAY. Sand is fine to coarse, gravel is fine to medium sub-angular to sub-rounded made up of flint. RIVER TERRACE DEPOSITS
2.80	D					3.00	Dark yellowish brown slightly gravelly fine to coarse SAND. Gravel is fine to coarse angular to sub-rounded made up of flint. RIVER TERRACE DEPOSITS
End of Borehole at 3.00 m							

Daily Progress

Water Strikes

Chiselling

Hole Diameter

Casing Diameter

Date	Time	Hole	Depth	Water Depth	Strike Depth	Casing Depth	Date	Time	Post Depth	Elapsed Minutes	Depth Sealed	Start Depth	End Depth	Hours	Depth	Diam. (mm)	Depth	Diam. (mm)

General Remarks:

No roots observed

Soils Limited
Newton House
Cross Road
Tadworth
Surrey KT20 5SR



Record of Borehole WS 4

Sheet 1 of 1

Start Date: 17/12/2013

End Date: 17/12/2013

Logged By: CF

Ground Level: -

Easting: -

Northing: -

Site: 251 Pagham Road, Bognor Regis
Client: Orchard Homes & Developments Ltd
Project No: 14011

Boring Method: WS

Weather:

Driller: SC

Samples, In-situ Tests & Installations

Strata

Depth	Type	Result	S/Pipe	Elev	Legend	Depth/(Thk)	Description
0.20	J					0.40	Turf over dark sandy gravelly SILT. Sand is fine to medium, gravel is fine to coarse sub-angular to sub-rounded made up of flint and brick MADE GROUND
0.60	J					0.70	
0.80	J					1.10	Soft dark orangish brown sandy gravelly CLAY. Sand is fine to coarse, gravel is fine to coarse, sub-angular to sub-rounded made up of flint and brick with frequent rootlets and becoming less gravelly with depth. MADE GROUND
1.50	D					0.90	
2.10	D					2.00	Very soft light orangish brown sandy gravelly CLAY. Sand is fine to coarse, gravel is fine to medium sub-angular to sub-rounded made up of flints. RIVER TERRACE DEPOSITS Becoming lighter and stiffer with depth.
2.70	D					1.00	
						3.00	Dark yellowish brown slightly gravelly fine to coarse SAND. Gravel is fine to coarse angular to sub-rounded made up of flints. RIVER TERRACE DEPOSITS.
							End of Borehole at 3.00 m

Daily Progress

Water Strikes

Chiselling

Hole Diameter

Casing Diameter

Date	Time	Hole	Depth	Water Depth	Strike Depth	Casing Depth	Date	Time	Post Depth	Elapsed Minutes	Depth Sealed	Start Depth	End Depth	Hours	Depth	Diam. (mm)	Depth	Diam. (mm)

General Remarks:

No roots observed

Soils Limited
Newton House
Cross Road
Tadworth
Surrey KT20 5SB



Record of Borehole WS 5

Sheet 1 of 1

Start Date: 17/12/2013

End Date: 17/12/2013

Logged By: CF

Ground Level: -

Easting: -

Northing: -

Site: 251 Pagham Road, Bognor Regis
Client: Orchard Homes & Developments Ltd
Project No: 14011

Boring Method: WS

Weather:

Driller: SN

Samples, In-situ Tests & Installations

Strata

Depth	Type	Result	S/Pipe	Elev	Legend	Depth/(Thk)	Description
0.20	J					0.40	Turf over dark sandy gravelly SILT. Sand is fine to medium, gravel is fine to coarse sub-angular to sub-rounded made up of flint and brick MADE GROUND
0.60	J					0.60	
0.80	J					1.00	Soft dark orangish brown sandy gravelly CLAY. Sand is fine to coarse, gravel is fine to coarse, sub-angular to sub-rounded made up of flint and brick with frequent rootlets and becoming less gravelly with depth. MADE GROUND
							End of Borehole at 1.00 m

Daily Progress

Water Strikes

Chiselling

Hole Diameter		Casing Diameter	
Depth	Diam. (mm)	Depth	Diam. (mm)

General Remarks:

No roots observed

Soils Limited
Newton House
Cross Road
Tadworth
Surrey KT20 5SB



Record of Borehole WS 6

Sheet 1 of 1

Start Date: 17/12/2013

End Date: 17/12/2013

Logged By: CF

Ground Level: -

Easting: -

Northing: -

Site: 251 Pagham Road, Bognor Regis
Client: Orchard Homes & Developments Ltd
Project No: 14011

Boring Method: WS

Weather:

Driller: SC

Samples, In-situ Tests & Installations					Strata	
Depth	Type	Result	S/Pipe	Elev	Legend	Description
0.20	J					Turf over dark sandy gravelly SILT. Sand is fine to medium, gravel is fine to coarse sub-angular to sub-rounded made up of flint and brick MADE GROUND
0.50	J					
0.80	J					
1.20	D					Soft dark orangish brown sandy gravelly CLAY. Sand is fine to coarse, gravel is fine to coarse, sub-angular to sub-rounded made up of flint and brick with frequent rootlets and becoming less gravelly with depth. MADE GROUND
1.60	D					
1.90	D					Dark orangish brown gravelly SAND. Gravel is fine to coarse, sub-angular to sub-rounded made up of flint. RIVER TERRACE DEPOSITS
2.50	D					Light orangish brown sandy very gravelly CLAY. Sand is fine to coarse, gravel is fine to medium sub-angular to sub-rounded made up of flint. RIVER TERRACE DEPOSITS
						Dark yellowish brown slightly gravelly fine to coarse SAND. Gravel is fine to coarse angular to sub-rounded made up of flint. RIVER TERRACE DEPOSITS
						End of Borehole at 3.00 m

Daily Progress					Water Strikes							Chiselling			Hole Diameter		Casing Diameter	
Date	Time	Hole	Depth	Water Depth	Strike Depth	Casing Depth	Date	Time	Post Depth	Elapsed Minutes	Depth Sealed	Start Depth	End Depth	Hours	Depth	Diam. (mm)	Depth	Diam. (mm)

General Remarks:

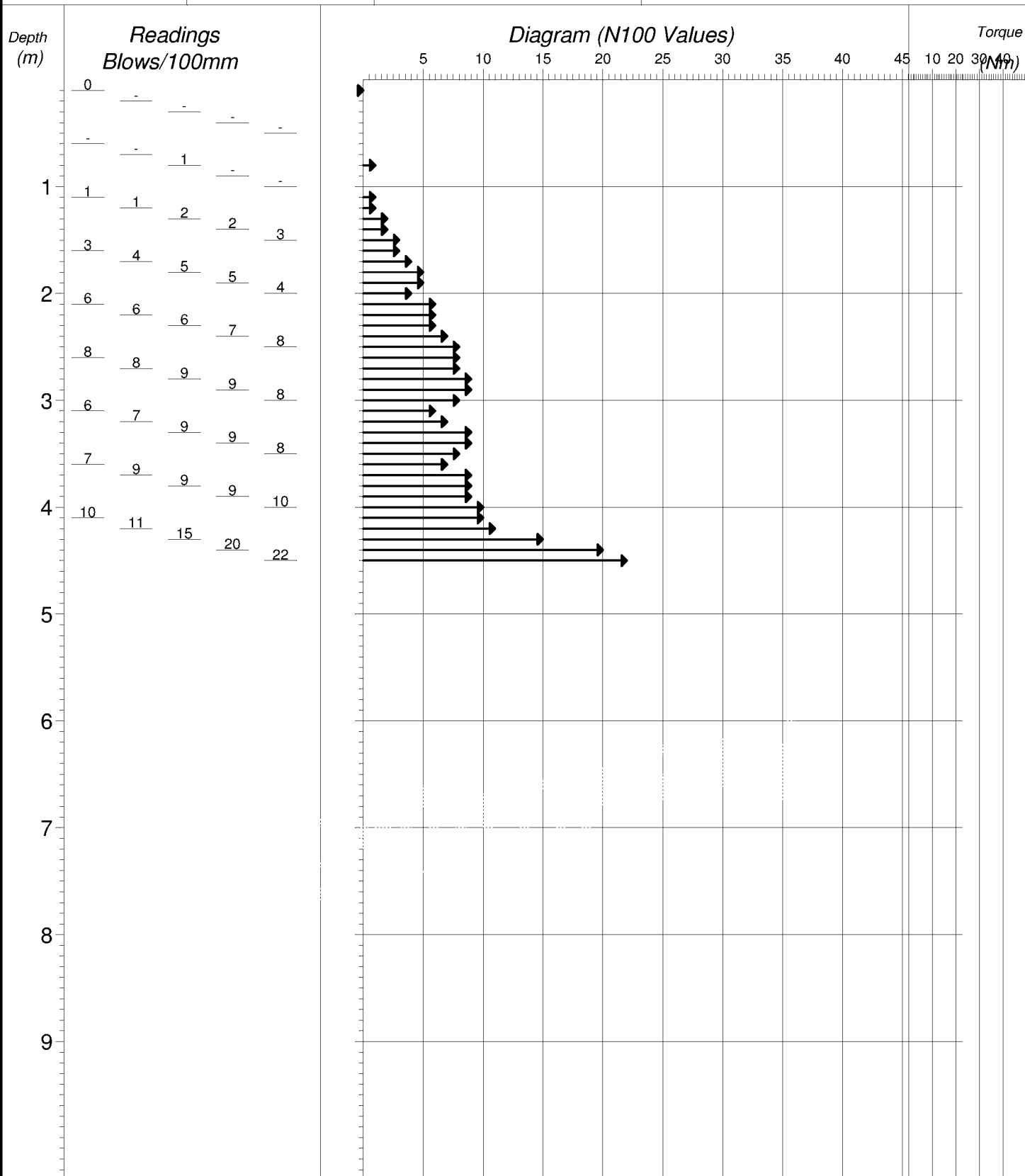
No roots observed

Probe No **DP 1**

Sheet 1 of 1

Location No 14011

Date **17/12/2013**



Logger

SC

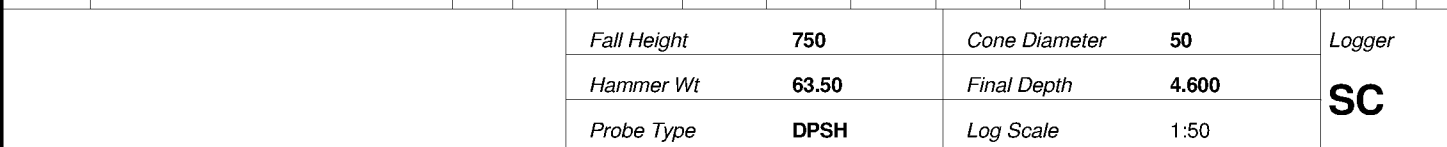
Log Scale 1:50

Probe No **DP 2**

Sheet 1 of 1

Location No 14011

<i>E</i> -	<i>N</i> -	<i>Level</i> -	<i>Date</i> 17/12/2013
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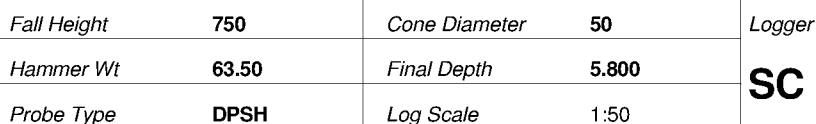


Probe No **DP 3**

Sheet 1 of 1

Location No 14011

<i>E</i> -	<i>N</i> -	<i>Level</i> -	<i>Date</i> 17/12/2013
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<i>DYNAMIC PROBING</i>	Probe No DP 4
------------------------	----------------------

<i>Client</i> Orchard Homes & Developments Ltd	Sheet 1 of 1
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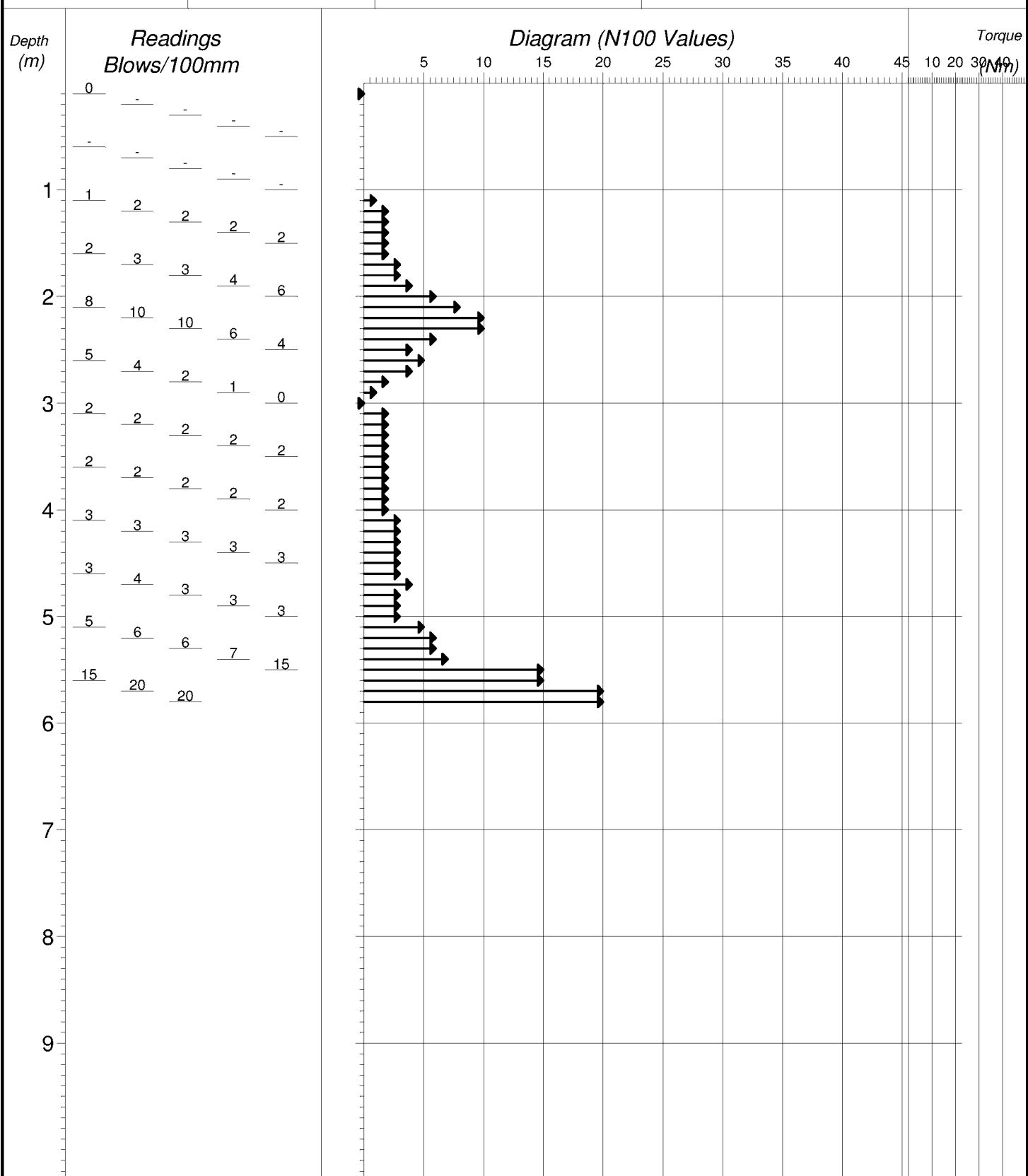
Sheet 1 of 1

<i>Site</i>	Pagham Road	<i>Location No</i>	14011
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<i>E</i> -	<i>N</i> -	<i>Level</i> -	<i>Date</i> 17/12/2013
------------	------------	----------------	-------------------------------

<i>E</i> -	<i>N</i> -	<i>Level</i> -
------------	------------	----------------

Date **17/12/2013**



<i>Fall Height</i>	750
--------------------	------------

<i>Cone Diameter</i>	50
----------------------	-----------

Logger

<i>Hammer Wt</i>	63.50
------------------	--------------

<i>Final Depth</i>	5.700
--------------------	--------------

SC

Probe Type	DPSH
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<i>Log Scale</i>	1:50
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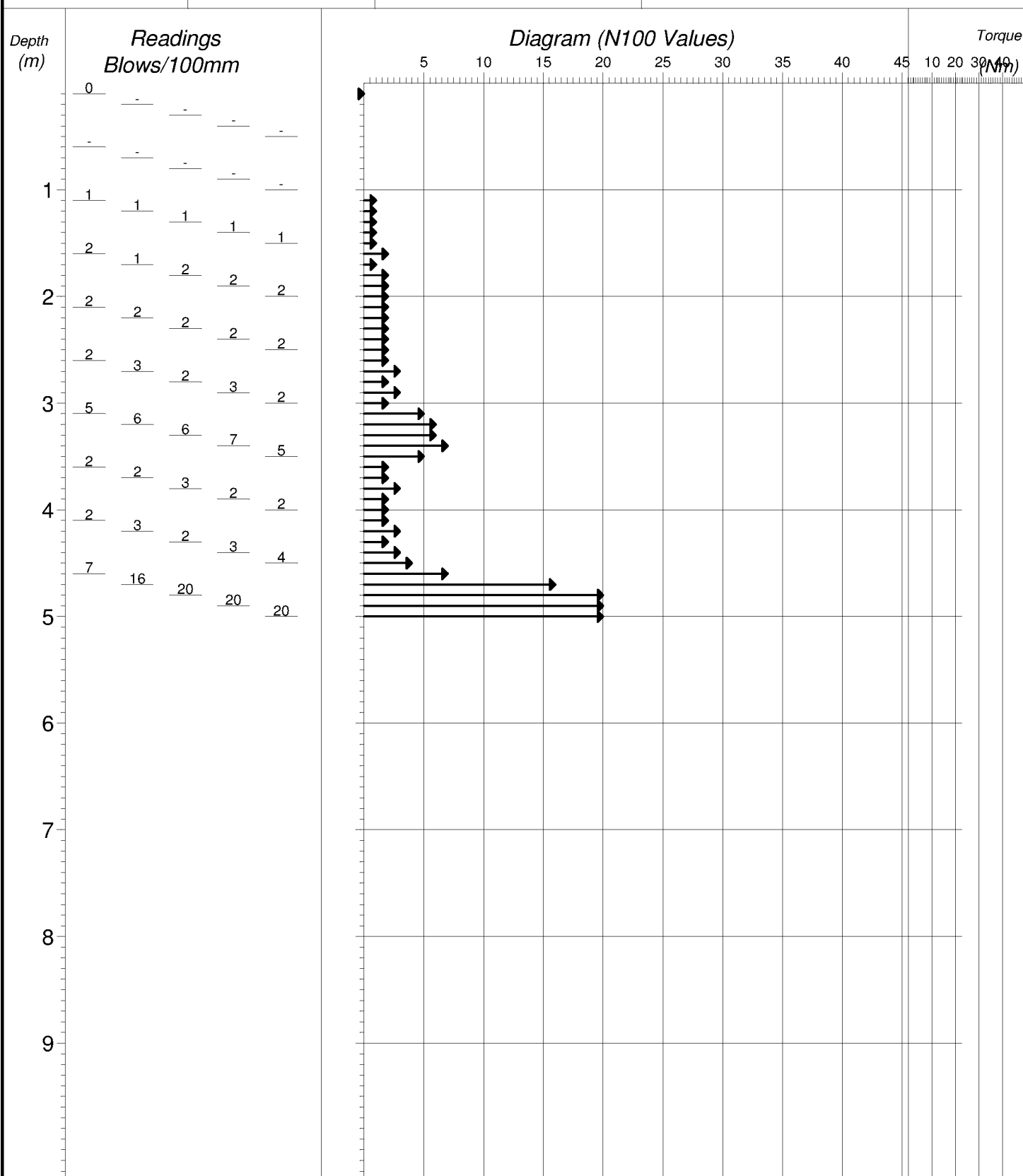
DYNAMIC PROBING					Probe No DP 5							
Client Orchard Homes & Developments Ltd					Sheet 1 of 1							
Site Pagham Road					Location No 14011							
E -		N -		Level -		Date 17/12/2013						
Depth (m)	Readings Blows/100mm				Diagram (N100 Values)					Torque (Nm)		
0	-	-	-	-								
1	1	1	1	1								
	2	7	6	9								
2	8	7	7	6								
	5	3	2	2								
3	7	9	8	8								
	3	2	3	2								
4	2	2	2	2								
	2	2	3	4								
5	3	2	3	3								
6												
7												
8												
9												
					Fall Height		750		Cone Diameter		50	
					Hammer Wt		63.50		Final Depth		4.900	
					Probe Type		DPSH		Log Scale		1:50	
									Logger		SN	

Probe No **DP 6**

Sheet 1 of 1

Location No 14011

Date **17/12/2013**



Logger

SC

Log Scale 1:50



Trial Pit: TP 1

Site: 251 Pagham Road, Bognor Regis	Start Date: 17/12/2013	Ground Level: -
Client: Orchard Homes & Developments Ltd	End Date: 17/12/2013	Easting: -
Project No: 14011	Logged By: CF	Northing: -
Site National Grid Reference:	Excavation Method:	
Site Level (mOD): 0.000	Plant:	
	Shoring/Support: None	
	Trial Pit Length: -	Trial Pit Width: -

Samples & Tests				Strata Details			
Depth	Type	Result	Hand Pen.	Elev.	Legend	DepthThick	Description
0.20 -	D					0.25	Turf over dark, sandy, gravelly SILT. Sand is fine to coarse, gravel is fine to coarse, sub-angular to sub-rounded, made up of brick and flint. MADE GROUND
0.50 -	B					0.60	
0.90 -	D					0.85	
						1.10	Soft to firm, dark brown, sandy, gravelly CLAY. Sand is fine to coarse, gravel is fine to coarse, sub-angular to sub-rounded, made up of brick and flint. MADE GROUND
							Soft to firm, light orangish brown, slightly sandy CLAY with occasional rootlets, occasional fine to coarse gravel made up of flint. RIVER TERRACE DEPOSIT
							End of Trial Pit at 1.10 m

General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data. 3. Trial pit logged from the ground surface below 1.2 m depth.		
Groundwater Observations: Dry	Stability: Stable	General Remarks: Roots observed to 0.50m bgl



Trial Pit: TP 2

Site: 251 Pagham Road, Bognor Regis	Start Date: 17/12/2013	Ground Level: -
Client: Orchard Homes & Developments Ltd	End Date: 17/12/2013	Easting: -
Project No: 14011	Logged By: CF	Northing: -
Site National Grid Reference:	Excavation Method:	
Site Level (mOD): 0.000	Plant:	
	Shoring/Support: None	
	Trial Pit Length: -	Trial Pit Width: -

Samples & Tests				Strata Details			
Depth	Type	Result	Hand Pen.	Elev.	Legend	DepthThick	Description
0.20 -	D					0.25	Turf over dark, sandy, gravelly SILT. Sand is fine to coarse, gravel is fine to coarse, sub-angular to sub-rounded, made up of flint and brick. MADE GROUND
0.50 -	D					0.25	
0.90 -	D					0.85	
						1.10	Soft to firm, light orangish brown, slightly sandy CLAY with occasional rootlets. Gravel is fine to coarse flints. RIVER TERRACE DEPOSITS End of Trial Pit at 1.10 m

General Notes:

1. All linear dimensions are in metres unless otherwise stated

2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.

3. Trial pit logged from the ground surface below 1.2 m depth.

Groundwater Observations: 1.10m bgl	Stability: Stable	General Remarks: Roots observed to 0.60m bgl
--	----------------------	---

Site: 251 Pagham Road, Bognor Regis
Client: Orchard Homes & Developments Ltd
Project No: 14011

Start Date: 17/12/2013
End Date: 17/12/2013
Logged By: CF

Ground Level:-	
Easting: -	
Northing: -	

Excavation Method:

Plant:
Shoring/Support: None

Trial Pit Length: -

Trial Pit Width: -

Strata Details

[illegible]

1. All linear dimensions are in metres unless otherwise stated
2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.
3. Trial pit logged from the ground surface below 1.2 m depth.

Stability:
Stable

General Remarks:
Roots observed to 1.00m bgl



Trial Pit: TP 4

Site: 251 Pagham Road, Bognor Regis	Start Date: 17/12/2013	Ground Level: -
Client: Orchard Homes & Developments Ltd	End Date: 17/12/2013	Easting: -
Project No: 14011	Logged By: CF	Northing: -
Site National Grid Reference:	Excavation Method:	
Site Level (mOD): 0.000	Plant:	
	Shoring/Support: None	
	Trial Pit Length: -	Trial Pit Width: -

Samples & Tests				Strata Details			
Depth	Type	Result	Hand Pen.	Elev.	Legend	DepthThick	Description
0.20 -	D					0.30	Turf over dark, sandy, gravelly SILT. Sand is fine to coarse, gravel is fine to coarse, sub-angular to sub-rounded, made up of brick and flint. MADE GROUND
0.50 -	D					0.30	
0.90 -	D						Soft to firm, light orangish brown, slightly sandy CLAY with occasional rootlets. Gravel is fine to coarse flints. RIVER TERRACE DEPOSITS
1.50 -	D					2.20	
2.00 -	D						
2.50 -	D					2.50	
							End of Trial Pit at 2.50 m

General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data. 3. Trial pit logged from the ground surface below 1.2 m depth.		
Groundwater Observations: 2.10m bgl	Stability: Unstable. Hole completely collapsing on 3 sides.	General Remarks: Roots observed to 1.00m bgl.



Trial Pit: TP 5

Site: 251 Pagnam Road, Bognor Regis	Start Date: 17/12/2013	Ground Level: -
Client: Orchard Homes & Developments Ltd	End Date: 17/12/2013	Easting: -
Project No: 14011	Logged By: CF	Northing: -
Site National Grid Reference:	Excavation Method:	
Site Level (mOD): 0.000	Plant:	
	Shoring/Support: None	
	Trial Pit Length: -	Trial Pit Width: -

Samples & Tests				Strata Details			
Depth	Type	Result	Hand Pen.	Elev.	Legend	DepthThick	Description
0.20 -	D					0.30	Turf over dark, sandy, gravelly SILT. Sand is fine to coarse, gravel is fine to coarse, sub-angular to sub-rounded, made up of brick and flint. MADE GROUND
0.50 -	D						Soft to firm, light orangish brown, slightly sandy CLAY with occasional rootlets. Gravel is fine to coarse flints and becoming very gravelly with depth. RIVER TERRACE DEPOSITS
0.90 -	D						
1.50 -	D					2.30	
2.00 -	D						
						2.60	At 2.30m bgl : Running sand.
							End of Trial Pit at 2.60 m

General Notes: 1. All linear dimensions are in metres unless otherwise stated 2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data. 3. Trial pit logged from the ground surface below 1.2 m depth.		
Groundwater Observations: 2.3m bgl	Stability: Unstable	General Remarks: Roots observed to 0.80m bgl

Site: 251 Pagham Road, Bognor Regis
Client: Orchard Homes & Developments Ltd
Project No: 14011

Ground Level:-

Easting: -

Northing: -

Excavation Method:

Plant:

Shoring/Support: None

Site National Grid Reference:

Site Level (mOD):	0.000
-------------------	-------

Trial Pit Length: -

Trial Pit Width: -

Samples & Tests

Strata Details

[illegible]

1. All linear dimensions are in metres unless otherwise stated
2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.
3. Trial pit logged from the ground surface below 1.2 m depth.

Stability:
Stable

General Remarks:
No roots observed



Trial Pit: TP 8

Site: 251 Pagham Road, Bognor Regis	Start Date: 17/12/2013	Ground Level: -
Client: Orchard Homes & Developments Ltd	End Date: 17/12/2013	Easting: -
Project No: 14011	Logged By: CF	Northing: -
Site National Grid Reference:	Excavation Method:	
Site Level (mOD): 0.000	Plant:	
	Shoring/Support: None	
	Trial Pit Length: -	Trial Pit Width: -

Samples & Tests				Strata Details			
Depth	Type	Result	Hand Pen.	Elev.	Legend	DepthThick	Description
0.20 -	D					0.30	Turf over dark, sandy, gravelly SILT. Sand is fine to coarse, gravel is fine to coarse, sub-angular to sub-rounded, made up of brick and flint. MADE GROUND
0.50 -	D					0.30	
0.90 -	D					1.70	Soft to firm, light orangish brown, slightly sandy CLAY with occasional rootlets. Gravel is fine to coarse flints and becoming very sandy with depth. RIVER TERRACE DEPOSITS
1.50 -	D						
1.80 -	D					2.00	End of Trial Pit at 2.00 m

General Notes:

1. All linear dimensions are in metres unless otherwise stated

2. All relative density/shear strength descriptions are based only on field observations and available in-situ test data.

3. Trial pit logged from the ground surface below 1.2 m depth.

Groundwater Observations: Dry	Stability: Stable	General Remarks: Roots observed to 0.60m bgl
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Appendix B

Geotechnical Laboratory Analysis

Project Name: Pagham Road, Bognor Regis						Samples Received: 20/01/2014		K4 SOILS 	
						Project Started: 21/01/2014			
Client: Soils Ltd						Testing Started: 04/02/2014			
Project No: J14011				Our job/report no: 15969		Date Reported: 06/02/2014			
Borehole No:	Sample No:	Depth (m)	Description	Moisture content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425 mm (%)	Remarks
WS1	D	1.30	Greyish brown gravelly sandy CLAY (gravel is fm and sub-angular to sub-rounded)	22	35	16	19	62	
WS1	D	2.80	Brown and occasional orange slightly sandy gravelly CLAY (gravel is fmc and sub-angular)	38	50	21	29	68	
WS3	D	0.90	Brown slightly silty slightly gravelly CLAY (gravel is fm and sub-angular)	24	54	22	32	93	
WS4	D	1.50	Yellowish brown slightly gravelly fine sandy silty CLAY with occasional rootlets (gravel is fm and sub-angular)	19	26	16	10	94	
 Summary of Test Results BS 1377 : Part 2 : Clause 4.4 : 1990 Determination of the liquid limit by the cone penetrometer method. BS 1377 : Part 2 : Clause 5 : 1990 Determination of the plastic limit and plasticity index. BS 1377 : Part 2 : Clause 3.2 : 1990 Determination of the moisture content by the oven-drying method. Checked and Approved Initials: K.P Date: 06/02/2014									
Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU Test Results relate only to the sample numbers shown above. Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) All samples connected with this report ,incl any on 'hold' will be stored and disposed off according to Company policy.Acopy of this policy is available on request.									



Report of California Bearing Ratio Test

BS 1377 : Part 4 : 1990:Clause 7.4

Project name: Pagham Road, Bognor Regis

Samples Received: 20/01/2014

Project Started: 21/01/2014

Client: Soils Ltd

Testing started: 27/01/2014

Project no: J14011

Our job /report no: 15969

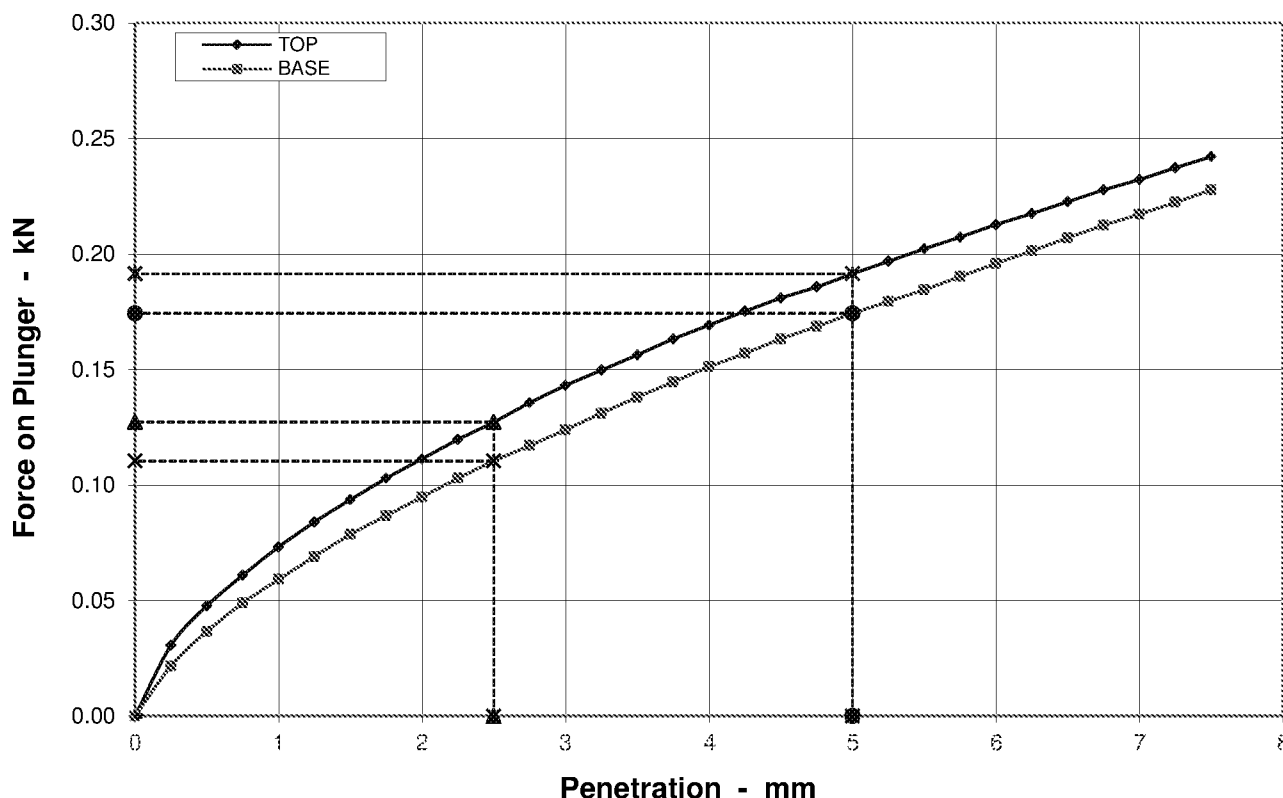
Date reported: 06/02/2014

BH / TP no: TP5

Sample no: B

Depth (m): 0.50 -

Soil Description: Brown slightly gravelly fine sandy/silty CLAY with occasional carbonaceous deposits and traces of rootlets (gravel is fm and sub-angular)



Preparation	Method of Compaction	
	Rammer compaction with specified effort	
	Hammer type	2.5kg Rammer
	Soaking Period	days N/A
	Amount of Swell	mm N/A

Sample Conditions		
Natural Moisture Content	%	24
Moisture Content - TOP	%	25
Moisture Content - BASE	%	23
Bulk Density	Mg/m³	1.98
Dry Density	Mg/m³	1.59

Test Conditions		
Sample Retained on 20 mm sieve	%	0.0
Sample Retained on 37.5 mm sieve	%	0.0
Seating Load - TOP	N	10
Seating Load - BASE	N	10
Surcharge	kg	4.4

Penetration mm	CBR Values %	
	TOP	BASE
2.5	0.96	0.84
5	0.96	0.87
Accepted CBR	0.96	0.87

K4 SOILS LABORATORY

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Approved Signatories:

K.Phaure(Tech.Mgr)

J.Phaure(Lab.Mgr)

Test results relate only to the sample numbers shown above

Checked and Approved

Initials: kp

Date: 06/02/2014



2519



Report of California Bearing Ratio Test

BS 1377 : Part 4 : 1990:Clause 7.4

Project name: Pagham Road, Bognor Regis

Samples Received: 20/01/2014

Project Started: 21/01/2014

Client: Soils Ltd

Testing started: 27/01/2014

Project no: J14011

Our job /report no: 15969

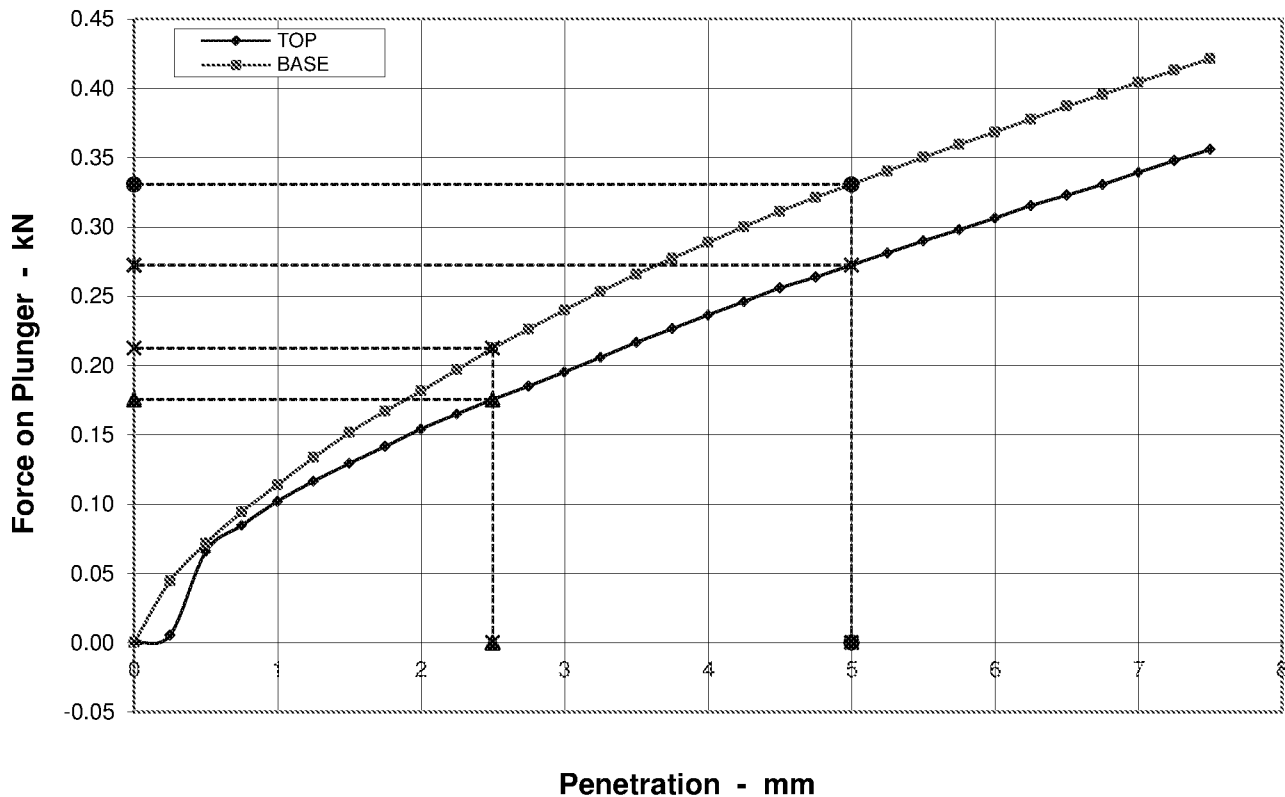
Date reported: 06/02/2014

BH / TP no: TP8

Sample no: B

Depth (m): 0.50 -

Soil Description: Brown slightly gravelly sandy CLAY with occasional rootlets and carbonaceous deposits (gravel is fm and sub-angular to sub-rounded)



Preparation	Method of Compaction	
	Rammer compaction with specified effort	
	Hammer type	2.5kg Rammer
	Soaking Period	days N/A
	Amount of Swell	mm N/A

Sample Conditions		
Natural Moisture Content	%	26
Moisture Content - TOP	%	26
Moisture Content - BASE	%	26
Bulk Density	Mg/m ³	1.94
Dry Density	Mg/m ³	1.54

Test Conditions		
Sample Retained on 20 mm sieve	%	0.0
Sample Retained on 37.5 mm sieve	%	0.0
Seating Load - TOP	N	10
Seating Load - BASE	N	10
Surcharge	kg	4.4

Penetration mm	CBR Values %	
	TOP	BASE
2.5	1.3	1.6
5	1.4	1.7
Accepted CBR	1.4	1.7

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Approved Signatories:

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Test results relate only to the sample numbers shown above

Checked and Approved

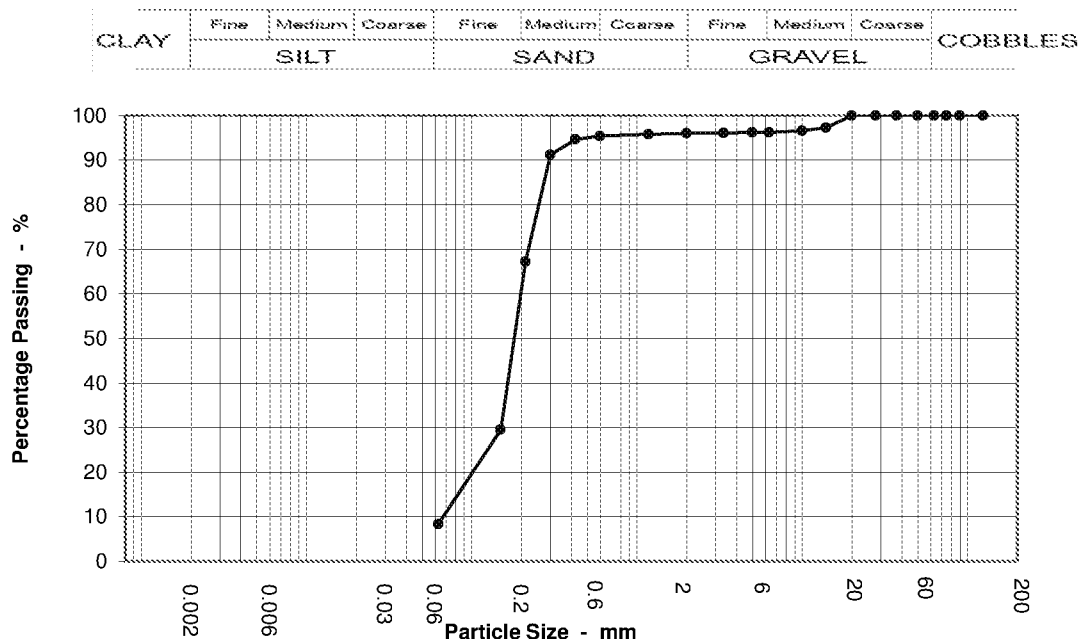
Initials: kp

Date: 06/02/2014



2519

K4 SOILS 	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	15969
		Project No:	J14011
Location	Pagham Road, Bognor Regis	Borehole / Trial Pit No:	WS2
		Depth	2.90 m
Visual Soil Description	Pale brown slightly gravelly slightly clayey SAND (gravel is fm and sub-angular to sub-rounded)	Sample Type/No	D -



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	97		
10	97		
6.3	96		
5	96		
3.35	96		
2	96		
1.18	96		
0.6	95		
0.425	95		
0.3	91		
0.212	67		
0.15	29		
0.063	8		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	N/A
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	4.0
Sand	87.7
Silt & Clay	8.3

Grading Analysis	
D100	125.0
D60	0.2
D10	0.1
Uniformity Coefficient	3

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Test results relate only to the sample numbers shown above

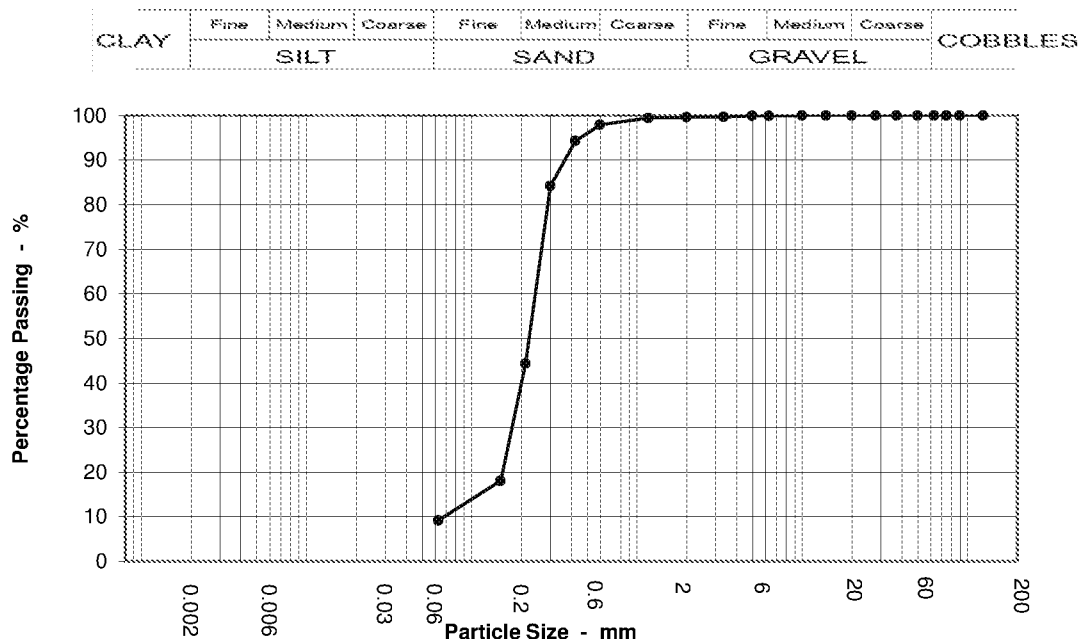
Checked and Approved

Initials: kp

Date: 05/02/2014



K4 SOILS 	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	15969
		Project No:	J14011
Location	Pagham Road, Bognor Regis	Borehole / Trial Pit No:	WS4
		Depth	2.10 m
Visual Soil Description	Brown slightly clayey SAND with rare fine and angular gravel	Sample Type/No	D -



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
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	99		
0.6	98		
0.425	94		
0.3	84		
0.212	44		
0.15	18		
0.063	9		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	N/A
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	0.4
Sand	90.5
Silt & Clay	9.1

Grading Analysis	
D100	125.0
D60	0.2
D10	0.1
Uniformity Coefficient	3

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Test results relate only to the sample numbers shown above

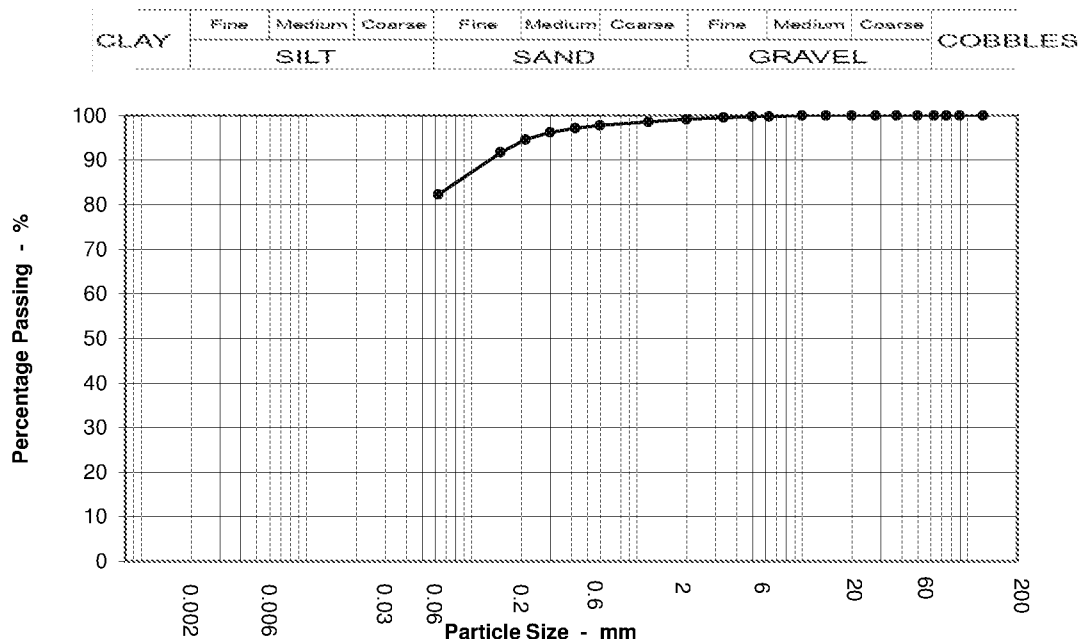
Checked and Approved

Initials: kp

Date: 05/02/2014



K4 SOILS 	PARTICLE SIZE DISTRIBUTION BS 1377 : Part 2 : 1990 : Clause 9	Our Report No:	15969
		Project No:	J14011
Location	Pagham Road, Bognor Regis	Borehole / Trial Pit No:	WS6
		Depth	1.20 m
Visual Soil Description	Brown sandy CLAY with rare fine sub-angular gravel	Sample Type/No	D -



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	99		
1.18	99		
0.6	98		
0.425	97		
0.3	96		
0.212	95		
0.15	92		
0.063	82		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.2
Sedimentation	N/A
Suitable Amount Of Sample Received	Yes

Sample Proportions	
Cobbles	0.0
Gravel	0.9
Sand	16.9
Silt & Clay	82.3

Grading Analysis	
D100	125.0
D60	
D10	
Uniformity Coefficient	N/A

K4 SOILS LABORATORY

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Approved Signatories:

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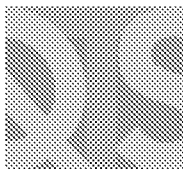
Test results relate only to the sample numbers shown above

Checked and Approved

Initials: kp

Date: 05/02/2014





Craig Morrison
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Chalcroft Distribution Park
Burnetts Lane
Southampton
Hampshire
SO30 2PA

QTS Environmental Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410
russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 14-18850

Site Reference: 251 Pagham Road, Bognor Regis

Project / Job Ref: 14011

Order No: None Supplied

Sample Receipt Date: 21/01/2014

Sample Scheduled Date: 21/01/2014

Report Issue Number: 1

Reporting Date: 27/01/2014

Authorised by:

Russell Jarvis
Director

On behalf of QTS Environmental Ltd

Authorised by:

Kevin Old
Director

On behalf of QTS Environmental Ltd

QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
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Kent ME17 2JN
Tel : 01622 850410



Soil Analysis Certificate						
QTS Environmental Report No: 14-18850	Date Sampled	17/01/14	17/01/14	17/01/14		
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: 251 Pagham Road, Bognor Regis	TP / BH No	WS1	WS2	WS6		
Project / Job Ref: 14011	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	Depth (m)	1.60	2.50	1.90		
Reporting Date: 27/01/2014	QTSE Sample No	91024	91025	91026		

Determinand	Unit	RL	Accreditation				
pH	pH Units	N/a	MCERTS	8.0	7.9	8.1	
Total Sulphate as SO ₄	mg/kg	< 200	NONE	399	265	250	
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	NONE	0.08	0.03	0.04	
Total Sulphur	mg/kg	< 200	NONE	< 200	< 200	< 200	
Ammonium as NH ₄	mg/kg	< 0.5	NONE	< 0.5	< 0.5	< 0.5	
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	27	16	17	
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	< 3	MCERTS	4	3	< 3	
W/S Magnesium	mg/kg	< 10	NONE	12	10	< 10	

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

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

Subcontracted analysis ⁽⁵⁾

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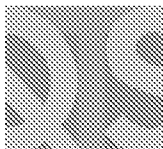


Soil Analysis Certificate - Sample Descriptions

QTS Environmental Report No: 14-18850	
Soils Ltd	
Site Reference: 251 Pagham Road, Bognor Regis	
Project / Job Ref: 14011	
Order No: None Supplied	
Reporting Date: 27/01/2014	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
91024	WS1	None Supplied	1.60	11.3	Beige sandy clay with chalk
91025	WS2	None Supplied	2.50	18.9	Light brown sandy clay
91026	WS6	None Supplied	1.90	11.2	Light brown loamy clay with stones

Insufficient sample ^{1/5}
 Unsuitable Sample ^{4/5}



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Tel : 01622 850410

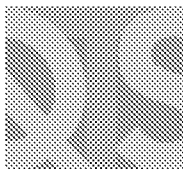


Soil Analysis Certificate - Methodology & Miscellaneous Information	
QTS Environmental Report No: 14-18850	
Soils Ltd	
Site Reference: 251 Pagham Road, Bognor Regis	
Project / Job Ref: 14011	
Order No: None Supplied	
Reporting Date: 27/01/2014	

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	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450°C	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO ₄) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO ₄) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO ₄) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	TPH LQM	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6 - C10)	Determination of hydrocarbons C6-C10 by headspace GC-MS	E001

D Dried
AR As Received

Appendix C
Chemical Laboratory Test Results;



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QTS Environmental Report No: 14-18837

Site Reference: 251 Pagham Road, Bognor Regis

Project / Job Ref: 14011

Order No: None Supplied

Sample Receipt Date: 21/01/2014

Sample Scheduled Date: 21/01/2014

Report Issue Number: 1

Reporting Date: 27/01/2014

Authorised by:

Russell Jarvis
Director

On behalf of QTS Environmental Ltd



Authorised by:

Kevin Old
Director

On behalf of QTS Environmental Ltd

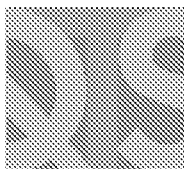




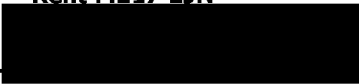
QTS Environmental Report No: 14-18837	Date Sampled	17/01/14	17/01/14	17/01/14	17/01/14
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: 251 Pagham Road, Bognor Regis	TP / BH No	WS1	WS3	WS4	WS5
Project / Job Ref: 14011	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	0.50	0.10	0.20	0.20
Reporting Date: 27/01/2014	QTSE Sample No	90959	90960	90961	90962

Determinand	Unit	RL	Accreditation					
Asbestos Screen ⁽⁵⁾	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Not Detected	
pH	pH Units	N/a	MCERTS	7.8	7.3	5.9	6.5	
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	NONE	0.03	0.05	0.01	0.03	
Sulphide	mg/kg	< 5	NONE	< 5	< 5	< 5	< 5	
Organic Matter	%	< 0.1	NONE	1.6	10.7	6.6	5.8	
Total Organic Carbon (TOC)	%	< 0.1	NONE	0.9	6.2	3.8	3.4	
Arsenic (As)	mg/kg	< 2	MCERTS	4	3	4	3	
Beryllium (Be)	mg/kg	< 0.5	NONE	< 0.5	< 0.5	< 0.5	< 0.5	
W/S Boron	mg/kg	< 1	NONE	< 1	3	1.2	< 1	
Cadmium (Cd)	mg/kg	< 0.5	MCERTS	< 0.5	< 0.5	< 0.5	< 0.5	
Chromium (Cr)	mg/kg	< 2	MCERTS	18	14	16	16	
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	
Copper (Cu)	mg/kg	< 4	MCERTS	11	11	13	12	
Lead (Pb)	mg/kg	< 3	MCERTS	24	28	33	175	
Mercury (Hg)	mg/kg	< 1	NONE	1	< 1	< 1	< 1	
Nickel (Ni)	mg/kg	< 3	MCERTS	14	10	11	10	
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3	< 3	
Vanadium (V)	mg/kg	< 2	NONE	26	21	21	24	
Zinc (Zn)	mg/kg	< 3	MCERTS	43	63	84	98	
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	

Subcontracted analysis ^(S)



QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
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Maidstone
Kent ME17 2JN

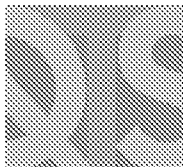


Soil Analysis Certificate - Speciated PAHs

QTS Environmental Report No: 14-18837	Date Sampled	17/01/14	17/01/14	17/01/14	17/01/14
Soils Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: 251 Pagham Road, Bognor Regis	TP / BH No	WS1	WS3	WS4	WS5
Project / Job Ref: 14011	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	0.50	0.10	0.20	0.20
Reporting Date: 27/01/2014	QTSE Sample No	90959	90960	90961	90962

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

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



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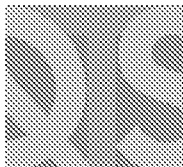


Soil Analysis Certificate - TPH CWG Banded

QTS Environmental Report No: 14-18837	Date Sampled	17/01/14	17/01/14			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: 251 Pagham Road, Bognor Regis	TP / BH No	WS1	WS4			
Project / Job Ref: 14011	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.50	0.20			
Reporting Date: 27/01/2014	QTSE Sample No	90959	90961			

Determinand	Unit	RL	Accreditation				
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01		
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05		
Aliphatic >C8 - C10	mg/kg	< 1	NONE	< 1	< 1		
Aliphatic >C10 - C12	mg/kg	< 1	NONE	< 1	< 1		
Aliphatic >C12 - C16	mg/kg	< 1	NONE	< 1	< 1		
Aliphatic >C16 - C21	mg/kg	< 1	NONE	< 1	< 1		
Aliphatic >C21 - C34	mg/kg	< 6	NONE	< 6	< 6		
Aliphatic (C5 - C34)	mg/kg	< 12	NONE	< 12	< 12		
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01		
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05		
Aromatic >C8 - C10	mg/kg	< 1	NONE	< 1	< 1		
Aromatic >C10 - C12	mg/kg	< 1	NONE	< 1	< 1		
Aromatic >C12 - C16	mg/kg	< 1	NONE	< 1	< 1		
Aromatic >C16 - C21	mg/kg	< 1	NONE	< 1	< 1		
Aromatic >C21 - C35	mg/kg	< 6	NONE	< 6	< 6		
Aromatic (C5 - C35)	mg/kg	< 12	NONE	< 12	< 12		
Total >C5 - C35	mg/kg	< 24	NONE	< 24	< 24		

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



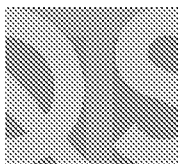
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Soil Analysis Certificate - BTEX / MTBE						
QTS Environmental Report No: 14-18837	Date Sampled	17/01/14	17/01/14			
Soils Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: 251 Pagham Road, Bognor Regis	TP / BH No	WS1	WS4			
Project / Job Ref: 14011	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.50	0.20			
Reporting Date: 27/01/2014	QTSE Sample No	90959	90961			

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2			
Toluene	ug/kg	< 5	MCERTS	< 5	< 5			
Ethylbenzene	ug/kg	< 10	MCERTS	< 10	< 10			
p & m-xylene	ug/kg	< 10	MCERTS	< 10	< 10			
o-xylene	ug/kg	< 10	MCERTS	< 10	< 10			

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



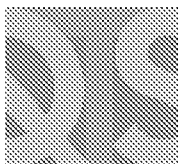
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Soil Analysis Certificate - Organochlorine Pesticides

QTS Environmental Report No: 14-18837	Date Sampled	17/01/14				
Soils Ltd	Time Sampled	None Supplied				
Site Reference: 251 Pagham Road, Bognor Regis	TP / BH No	TP2				
Project / Job Ref: 14011	Additional Refs	None Supplied				
Order No: None Supplied	Depth (m)	0.20				
Reporting Date: 27/01/2014	QTSE Sample No	90963				

Determinand	Unit	RL	Accreditation				
Aldrin	mg/kg	< 0.02	NONE	< 0.02			
alpha-HCH	mg/kg	< 0.02	NONE	< 0.02			
beta-HCH	mg/kg	< 0.02	NONE	< 0.02			
cis-chlordane	mg/kg	< 0.02	NONE	< 0.02			
delta-HCH	mg/kg	< 0.02	NONE	< 0.02			
Dieldrin	mg/kg	< 0.02	NONE	< 0.02			
Endosulfan A	mg/kg	< 0.02	NONE	< 0.02			
Endosulfan B	mg/kg	< 0.02	NONE	< 0.02			
Endrin	mg/kg	< 0.02	NONE	< 0.02			
gamma-HCH (Lindane)	mg/kg	< 0.02	NONE	< 0.02			
Heptachlor	mg/kg	< 0.02	NONE	< 0.02			
Heptachlor epoxide	mg/kg	< 0.02	NONE	< 0.02			
Hexachlorobenzene (HCB)	mg/kg	< 0.02	NONE	< 0.02			
Isodrin	mg/kg	< 0.02	NONE	< 0.02			
Methoxychlor	mg/kg	< 0.02	NONE	< 0.02			
o,p' - DDD	mg/kg	< 0.02	NONE	< 0.02			
o,p' - DDE	mg/kg	< 0.02	NONE	< 0.02			
o,p' - DDT	mg/kg	< 0.02	NONE	< 0.02			
p,p' - DDD	mg/kg	< 0.02	NONE	< 0.02			
p,p' - DDE	mg/kg	< 0.02	NONE	< 0.02			
p,p' - DDT	mg/kg	< 0.02	NONE	< 0.02			
trans-chlordane	mg/kg	< 0.02	NONE	< 0.02			
Trifluralin	mg/kg	< 0.02	NONE	< 0.02			

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



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Soil Analysis Certificate - Phenyl Urea Herbicides						
QTS Environmental Report No: 14-18837	Date Sampled	17/01/14				
Soils Ltd	Time Sampled	None Supplied				
Site Reference: 251 Pagham Road, Bognor Regis	TP / BH No	TP2				
Project / Job Ref: 14011	Additional Refs	None Supplied				
Order No: None Supplied	Depth (m)	0.20				
Reporting Date: 27/01/2014	QTSE Sample No	90963				

Determinand	Unit	RL	Accreditation				
Chloroxuron	mg/kg	< 0.1	NONE	< 0.1			
Chlortoluron	mg/kg	< 0.1	NONE	< 0.1			
Diflubenzuron	mg/kg	< 0.1	NONE	< 0.1			
Dimefuron	mg/kg	< 0.1	NONE	< 0.1			
Diuron	mg/kg	< 0.1	NONE	< 0.1			
Isoproturon	mg/kg	< 0.1	NONE	< 0.1			
Linuron	mg/kg	< 0.1	NONE	< 0.1			
Methabenzthiazuron	mg/kg	< 0.1	NONE	< 0.1			
Metoxuron	mg/kg	< 0.1	NONE	< 0.1			
Monolinuron	mg/kg	< 0.1	NONE	< 0.1			
Monuron	mg/kg	< 0.1	NONE	< 0.1			
Pencycuron	mg/kg	< 0.1	NONE	< 0.1			

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

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Soil Analysis Certificate - Sample Descriptions

QTS Environmental Report No: 14-18837

Soils Ltd

Site Reference: 251 Pagham Road, Bognor Regis

Project / Job Ref: 14011

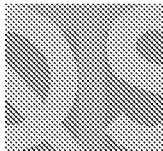
Order No: None Supplied

Reporting Date: 27/01/2014

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
90959	WS1	None Supplied	0.50	19.1	Light brown clay
90960	WS3	None Supplied	0.10	38.8	Brown clayey loam with vegetation
90961	WS4	None Supplied	0.20	30.1	Brown clayey loam with vegetation
90962	WS5	None Supplied	0.20	27	Brown clayey loam with vegetation
& 90963	TP2	None Supplied	0.20	23.8	Brown clay with chalk

Insufficient sample ^{1/5}

& samples received in inappropriate containers for hydrocarbon analysis



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Soil Analysis Certificate - Methodology & Miscellaneous Information	
QTS Environmental Report No: 14-18837	
Soils Ltd	
Site Reference: 251 Pagham Road, Bognor Regis	
Project / Job Ref: 14011	
Order No: None Supplied	
Reporting Date: 27/01/2014	

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 dphenylcarbazide 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	Determination of acetone/hexane extractable hydrocarbons by GC-FID	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	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	TPH LQM	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6 - C10)	Determination of hydrocarbons C6-C10 by headspace GC-MS	E001

D Dried
AR As Received

Appendix D
Soil Guideline Values and General Assessment Criteria;

Appendix D

Soil Guideline Values and General Assessment Criteria

D1 Assessment Criteria

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

D1.1 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:

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

The CLEA guidance and tools:

- *do not cover other types of risk to humans, such as fire, suffocation or explosion, or short-term and acute exposures.*
- *do not cover risks to the environment, such as groundwater, ecosystems or buildings.*
- *do not provide a definitive test for telling when human health risks are significant.*
- *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.*

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.

A new statutory DEFRA guidance recently (i.e. August 2014) published some SGV/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.

D1.2 Standard Land-use Scenarios

The CLEA model uses a range of standard land-use scenarios to develop conceptual exposure models as follows:

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 homegrown 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.

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.

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).

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

soils

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Consultants

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).

D1.3 Soil Guideline Values

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.

D1.4 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 will be used. For derivation of these Generic Assessment Criteria reference must be made to:

Nathanial, P., McCaffrey, C., Ashmore, M., Cheng, Y., Gillet, A., Ogden, R., Scott, D. *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition)*. **Land Quality Press**. 2009.

In the case of Lead, Category 4 screening levels (C4SLs) have replaced the AtRisk Soil SSV.

D1.5 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.

D1.6 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. |

D1.7 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.*

D1.8 Statistical Tests

DEFRA R&D Publication CLR 7 (DOE 1994) 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.

D2 Soil Guideline Values and General Acceptance Criteria

Soil Guideline Values and General Acceptance Criteria used in the preparation of this report is tabulated in the following pages:

DEFRA CLEA 1.04 Soil Guideline Values (as at July 2012) (Sandy Loam, pH 7, SOM 6%)

Contaminant	Residential (mg/kg DW)	Allotments (mg/kg DW)	Commercial (mg/kg DW)
Inorganic			
Mercury			
- Elemental	1.0	26	26
- Inorganic	170	80	3600
- Methyl	11	8	410
Nickel	130	230	1800
Selenium	350	120	13000
Organic			
May not be protective if SOM <6%			
Phenol	420	280	3200 (38,000*)
Benzene	0.33	0.07	95
Toluene	610	120	4400
Ethylbenzene	350	90	2800
Xylenes			
- o-xylene	250	160	2600
- m-xylene	240	180	3500
- p-xylene	230	160	3200
Dioxins			
Sum of PCDDs, PCDFs and dioxin-like PCB's.	8	8	240

* Based on a threshold protective of direct skin contact with phenol (guideline in brackets based on health affects following long term exposure provided for illustration only)

Category 4 screening levels (C4SL) (mg.kg⁻¹) for Metals and PAHs (SGV or GAC shown in brackets for comparison)

Substance Contaminant	Residential		Allotments	Commercial	Public Open Space (POS)	
	With home-grown produce	without home-grown produce			Residential	Park
Arsenic	37(32)	40	49 (43)	640 (640)	79	168
Cadmium	26 (10)	149	4.9 (1.8)	410 (230)	220	880
Chromium VI	21 (8.3) ^a	21	170 (2.1) ^a	49 (35) ^a	23	250
Lead	200 (450) ^b (342) ^c	310 (450) ^b (383) ^c	80 (450) ^b	2330 (750) ^b (6490) ^c	630 (1590) ^c	1300 (1590) ^c
benzene	0.87 (0.33)	3.3	0.18 (0.07)	98 (95)	140	230
Benzo(a)pyrene (as a surrogate marker for genotoxic PAHs)	5 (1.0) ^a	5.3	5.7 (2.1) ^a	76 (14) ^a	10	21

Note:

^aGAC from Nathanail *et al.*, 2009

^b Former SGV now withdrawn

^c Atkins AtRisk SSV Guideline Values For Lead

Published C4SL guidelines are for pH 7, SOM 6 %

LQM CIEH General Assessment Criteria (2nd edition) (mg/kg)

Contaminant	Residential	Allotment	Commercial
<i>mg/kg</i>			
Beryllium	51	55	420
Boron	291	45	192000
Chromium (III)	3000	34600	30400
Copper	2330	524	71700
Vanadium	140	150	4250
Zinc	3750	618	665000

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LQM CIEH General Assessment Criteria

General Assessment Criteria For Polycyclic Aromatic Hydrocarbons (PAH's) (mg/kg)

Determinants		Residential	Allotments	Commercial
Acenaphthene	1.0% SOM	210	34	85,000 (57) ^{sol}
	2.5% SOM	480	85	98,000 (141) ^{sol}
	6.0% SOM	100	200	100,000
Acenaphthylene	1.0% SOM	170	28	84,000 (86) ^{sol}
	2.5% SOM	400	69	97,000 (212) ^{sol}
	6.0% SOM	850	160	100,000
Anthracene	1.0% SOM	2,300	380	530,000
	2.5% SOM	4,900	950	540,000
	6.0% SOM	9,200	2200	540,000
Benzo(a)anthracene	1.0% SOM	3.1	2.5	90
	2.5% SOM	4.7	5.5	95
	6.0% SOM	5.9	10	97
Benzo(b)flouranthene	1.0% SOM	5.6	3.5	100
	2.5% SOM	6.5	7.4	100
	6.0% SOM	7.0	13	100
Benzo(ghi)perylene	1.0% SOM	44	70	650
	2.5% SOM	46	120	660
	6.0% SOM	47	160	660
Benzo(k)flouranthene	1.0% SOM	8.5	6.8	140
	2.5% SOM	9.6	14	140
	6.0% SOM	10	23	140
Chrysene	1.0% SOM	6.0	2.6	140
	2.5% SOM	8.0	5.8	140
	6.0% SOM	9.3	12	140
Dibenzo(ah)anthracene	1.0% SOM	0.76	0.76	13
	2.5% SOM	0.86	1.5	13
	6.0% SOM	0.90	2.3	13
Flouranthene	1.0% SOM	260	52	23,000
	2.5% SOM	460	130	23,000
	6.0% SOM	670	290	23,000
Flourene	1.0% SOM	160	27	64,000 (31) ^{sol}
	2.5% SOM	380	67	69,000
	6.0% SOM	780	160	71,000
Indeno(123-cd)pyrene	1.0% SOM	3.2	1.8	60
	2.5% SOM	3.9	3.8	61
	6.0% SOM	4.2	7.1	62
Naphthalene	1.0% SOM	1.5	4.1	200 (76) ^{sol}
	2.5% SOM	3.7	9.9	480 (183) ^{sol}
	6.0% SOM	8.7	23	1100 (432) ^{sol}
Phenanthrene	1.0% SOM	92	16	22,000
	2.5% SOM	200	38	22,000
	6.0% SOM	380	90	23,000
Pyrene	1.0% SOM	560	110	54,000
	2.5% SOM	1,000	270	54,000
	6.0% SOM	1,600	620	54,000

^{vap} – GAC presented exceeds the vapour saturation limit, which is presented in brackets.

^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.

General Assessment Criteria For TPH (mg/kg)

Determinants		Residential	Allotments	Commercial
<i>Aliphatic</i>				
EC 5-6	1.0% SOM	30	740	3,400 (304) ^{sol}
	2.5% SOM	55	1,700	6,200 (558) ^{sol}
	6.0% SOM	110	3,900	13,000 (1150) ^{sol}
EC >6-8	1.0% SOM	73	2,300	8,300 (144) ^{sol}
	2.5% SOM	160	5,600	18,000 (322) ^{sol}
	6.0% SOM	370	13,000	42,000 (736) ^{sol}
EC >8-10	1.0% SOM	19	320	2,100 (78) ^{sol}
	2.5% SOM	46	770	5,100 (118) ^{vap}
	6.0% SOM	110	1,700	12,000 (451) ^{vap}
EC >10-12	1.0% SOM	93 (48) ^{vap}	2,200	10,000 (48) ^{sol}
	2.5% SOM	230 (118) ^{vap}	4,400	24,000 (118) ^{vap}
	6.0% SOM	540 (283) ^{vap}	7,300	49,000 (283) ^{vap}
EC >12-16	1.0% SOM	740 (24) ^{sol}	11,000	61,000 (24) ^{sol}
	2.5% SOM	1,700 (59) ^{sol}	13,000	83,000 (59) ^{sol}
	6.0% SOM	3,000 (142) ^{sol}	13,000	91,000 (142) ^{sol}
EC >16-35	1.0% SOM	45,000 (8.48) ^{sol}	260,000	1,600,000
	2.5% SOM	64,000 (21) ^{sol}	270,000	1,800,000
	6.0% SOM	76,000	270,000	1,800,000
EC >35-44	1.0% SOM	45,000 (8.48) ^{sol}	260,000	1,600,000
	2.5% SOM	64,000 (21) ^{sol}	270,000	1,800,000
	6.0% SOM	76,000	270,000	1,800,000
<i>Aromatic</i>				
EC 5-7	1.0% SOM	65	13	28,000 (1220) ^{sol}
	2.5% SOM	130	27	49,000 (2260) ^{sol}
	6.0% SOM	280	57	90,000 (4710) ^{sol}
EC >7-8	1.0% SOM	120	22	59,000 (869) ^{vap}
	2.5% SOM	270	51	110,000 (1920) ^{sol}
	6.0% SOM	611	120	190,000 (4360) ^{vap}
EC >8-10	1.0% SOM	27	8.6	3,700 (613) ^{vap}
	2.5% SOM	65	21	8,600 (1500) ^{vap}
	6.0% SOM	151	51	18,000 (3580) ^{vap}
EC >10-12	1.0% SOM	69	13	17,000 (364) ^{sol}
	2.5% SOM	160	31	29,000 (899) ^{sol}
	6.0% SOM	346	74	34,500 (2150) ^{sol}
EC >12-16	1.0% SOM	140	23	36,000 (169) ^{sol}
	2.5% SOM	480	57	37,000
	6.0% SOM	770	130	37,800
EC >16-21	1.0% SOM	250	46	28,000
	2.5% SOM	480	110	28,000
	6.0% SOM	770	260	28,000
EC >21-35	1.0% SOM	890	370	28,000
	2.5% SOM	1,100	820	28,000
	6.0% SOM	1,230	1,600	28,000
EC >35-44	1.0% SOM	890	370	28,000
	2.5% SOM	1,100	820	28,000
	6.0% SOM	1,230	1,600	28,000
<i>Aromatic & Aliphatic</i>				
EC >44 - 70	1.0% SOM	1200	1200	28,000
	2.5% SOM	1300	2100	28,000
	5.0% SOM	1300	3000	28,000

Note: a) SOM = Soil Organic Matter Content (%) b) LQM CIEH GAC not set for Allotment land-use

ICRCL 70/90 Restoration of metalliferous mining areas (mg/kg)

Phytotoxicity (Harmful to Plants) Threshold Trigger Values	
Copper	250
Zinc	1000

Notes: Many cultivars and specifically grasses have a high tolerance and there will be no ill-effect at the threshold trigger values given for neutral or near neutral pH. Site observation of plant vitality may give additional guidance.

LQM CIEH General Assessment Criteria**Volatile and Semi-Volatile Organic Compounds (mg/kg)**

Contaminant	Residential	Allotment	Commercial
<i>Chloroalkanes & alkenes</i>			
1,2 Dichloroethane			
1.0% SOM	0.0054	0.0046	0.71
2.5% SOM	0.0080	0.0083	1.00
6.0% SOM	0.014	0.016	1.80
1,1,2,2 Tetrachloroethane			
1.0% SOM	1.4	0.41	290
2.5% SOM	2.9	0.89	580
6.0% SOM	6.3	2.0	1200
1,1,1,2 Tetrachloroethane			
1.0% SOM	0.90	0.79	120
2.5% SOM	2.1	1.9	260
6.0% SOM	4.8	4.4	590
Tetrachloroethene			
1.0% SOM	0.94	1.6	130
2.5% SOM	2.1	3.7	290
6.0% SOM	4.8	8.7	660
1,1,1 Trichloroethane			
1.0% SOM	6.2	48	700
2.5% SOM	13	110	1400
6.0% SOM	28	240	3100
Tetrachloromethene			
1.0% SOM	0.018	0.16	3.0
2.5% SOM	0.039	0.37	6.6
6.0% SOM	0.089	0.85	15
Trichloroethene			
1.0% SOM	0.11	0.43	12
2.5% SOM	0.22	0.95	25
6.0% SOM	0.49	2.2	55
Trichloromethane			
1.0% SOM	0.75	0.36	110
2.5% SOM	1.3	0.70	190
6.0% SOM	2.7	1.5	370
Vinyl Chloride			
1.0% SOM	0.00047	0.00055	0.063
2.5% SOM	0.00064	0.0010	0.081
6.0% SOM	0.00099	0.0018	0.12

Contaminant	Residential	Allotment	Commercial
<i>Explosives</i>			
2,4,6 Trinitrotoluene			
1.0% SOM	1.6	0.24	1000
2.5% SOM	3.7	0.58	1000
6.0% SOM	8.0	1.4	1100
RDX (Hexogen/Cyclonite/1,3,5-trinitro-1,3,5-triazacyclohexane)			
1.0% SOM	3.5	0.52	6400
2.5% SOM	7.4	1.1	6400
6.0% SOM	16	2.5	6400
HMX (Octogen/1,3,5,7-tetrenitro-1,3,5,7-tetrazacyclo-octane)			
1.0% SOM	5.7	0.86	110,000
2.5% SOM	13	1.9	110,000
6.0% SOM	26	3.9	110,000
Atrazine			
1.0% SOM	0.24	0.037	870
2.5% SOM	0.56	0.085	880
6.0% SOM	1.3	0.20	880
<i>Pesticides</i>			
Aldrin			
1.0% SOM	1.7	1.3	54
2.5% SOM	2.0	2.6	54
6.0% SOM	2.1	4.0	54
Dieldrin			
1.0% SOM	0.69	0.13	90
2.5% SOM	1.4	0.32	91
6.0% SOM	2.2	0.73	92
Dichlorvos			
1.0% SOM	0.29	0.044	942
2.5% SOM	0.6	0.091	972
6.0% SOM	1.3	0.2	983
Alpha - Endosulfan			
1.0% SOM	2.9	0.47	2310 (0.003) ^{vap}
2.5% SOM	7.0	1.2	2990 (0.007) ^{vap}
6.0% SOM	16	2.7	3390
Beta - Endosulfan			
1.0% SOM	2.8	0.44	2580 (0.00007) ^{vap}
2.5% SOM	6.6	1.1	3160 (0.0002) ^{vap}
6.0% SOM	15	2.6	3480
Alpha -Hexachlorocyclohexanes			
1.0% SOM	19	3.0	14000
2.5% SOM	46	7.4	14600
6.0% SOM	100	18	14900
Beta -Hexachlorocyclohexanes			
1.0% SOM	1.7	0.26	1120
2.5% SOM	3.9	0.64	1130
6.0% SOM	8.5	1.5	1130
Gamma -Hexachlorocyclohexanes			
1.0% SOM	0.58	0.089	532
2.5% SOM	1.4	0.22	546
6.0% SOM	3.0	0.52	552

<i>Chlorobenzenes</i>			
Chlorobenzene			
1.0% SOM	0.33	5.9	59
2.5% SOM	0.73	14	32
6.0% SOM	59	130	310
1,2-Dichlorobenzene			
1.0% SOM	16	94	2100 (571) ^{sol}
2.5% SOM	39	230	5100 (1370) ^{sol}
6.0% SOM	91	540	12000 (3240) ^{sol}
1,3-Dichlorobenzene			
1.0% SOM	0.29	0.25	32
2.5% SOM	0.70	0.61	77
6.0% SOM	1.7	1.5	180
1,4-Dichlorobenzene			
1.0% SOM	30	15	4500 (224) ^{vap}
2.5% SOM	72	37	10000 (540) ^{vap}
6.0% SOM	167	88	22000 (1280) ^{vap}
1,2,3,-Trichlorobenzene			
1.0% SOM	1.0	4.7	110
2.5% SOM	2.6	12	270
6.0% SOM	6.1	28	620
1,2,4,-Trichlorobenzene			
1.0% SOM	1.8	31	230
2.5% SOM	4.5	75	560
6.0% SOM	11	180	1300
1,3,5,-Trichlorobenzene			
1.0% SOM	0.23	4.7	24
2.5% SOM	0.57	12	57.8
6.0% SOM	1.3	28	140
1,2,3,4,-Tetrachlorobenzene			
1.0% SOM	12	4.4	1800 (122) ^{vap}
2.5% SOM	4.5	75	3200 (304) ^{vap}
6.0% SOM	11	180	4500 (728) ^{vap}
1,2,3,5,- Tetrachlobenzene			
1.0% SOM	0.49	0.38	52 (39.4) ^{vap}
2.5% SOM	1.2	0.94	120 (98.1) ^{vap}
6.0% SOM	2.8	2.2	250 (235) ^{vap}
1,2,4, 5,- Tetrachlobenzene			
1.0% SOM	0.30	0.064	44 (19.7) ^{sol}
2.5% SOM	0.68	0.16	73 (49.1) ^{sol}
6.0% SOM	1.4	0.37	97
Pentachlorobenzene			
1.0% SOM	5.2	1.2	650 (43.0) ^{sol}
2.5% SOM	10	3.1	770 (107) ^{sol}
6.0% SOM	17	7.1	830
Hexachlorobenzene			
1.0% SOM	0.59 (0.20) ^{vap}	0.18	48 (0.20) ^{vap}
2.5% SOM	1.0 (0.50) ^{vap}	0.42	53
6.0% SOM	1.4	0.92	55
<i>Phenols & Chlorophenols</i>			
Chlorophenols (4 Congeners)			
1.0% SOM	0.87	0.13	3500
2.5% SOM	2.0	0.30	4000
6.0% SOM	4.4	0.70	4200
Pentachlorophenols			
1.0% SOM	0.55	0.084	1200
2.5% SOM	1.3	0.21	0.49
6.0% SOM	1200	1300	1400

<i>Others</i>			
Carbon Disulphide			
1.0% SOM	0.10	4.8	12
2.5% SOM	0.20	10	23
6.0% SOM	0.44	23	50
Hexachloro-1,3-Butadiene			
1.0% SOM	0.21	0.25	32
2.5% SOM	0.51	0.61	69
6.0% SOM	1.2	1.4	120

^{vap} – GAC presented exceeds the vapour saturation limit, which is presented in brackets.

^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.

Appendix E
Information Provided By The Client



URBAN PULSE DESIGN

Unit 17, Vearage Farm, Winchester Road, Fairbairn, Hampshire, SO50 7HD
 T: 023 8069 7010 F: 023 8060 2756
 E: enquiries@urbanpulsearchitects.co.uk W: urbanpulsearchitects.co.uk

PROJECT
 Proposed Residential Development
 Land to the rear of 251 Pagham Road
 Pagham
 for Orchard Homes and Developments Ltd

Project type: Housing
 Drawings title: Site Plan
 Planning Layout

Orchard
 BUILDING HOMES FOR YOUR FUTURE

SCALE 1:500	SHEET SIZE A1	SHEET No. of 1	DRAWING P.L.	CHECKED	DATE 30/07/2014	CAD FILE
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Detail Planning 11-1065-005