



RIDGE

Property and Construction Consultants

Portsmouth City Council

Ground Condition Assessment
Land at Holybourne Road,
Havant

July 2015

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Ground Condition Assessment

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Ground Condition Assessment

Contents

Section 1 – Introduction	4
1.1. Introduction	4
1.2. Legal Context	4
1.3. Methodology	4
1.4. Proposed Use	5
1.5. Previous Reports Reviewed	5
1.6. Report Scope and Limitation	6
Section 2 – Hazard Identification	7
2.1. Site Location and Description	7
2.2. Site History	7
2.3. Documented Ground Conditions	7
2.4. Environmental Data Search	8
2.5. Department of Environment – Industry Profiles	9
2.6. Preliminary Conceptual Site Model	9
Section 3 – Fieldwork Summary of Scope and Rationale	10
3.1. Rationale and Summary of Scope	10
3.2. Sampling	10
3.3. Monitoring	10
3.4. Site Investigation Standards	10
Section 4 – Ground Conditions Encountered	11
4.1. Soil Conditions	11
4.2. Obstructions	12
4.3. Groundwater Conditions	12
4.4. Visual/Olfactory Evidence of Contamination	12
Section 5 – Generic Risk Assessment	13
5.1. Contamination Assessment Methodology	13
5.2. Soil Assessment	15
5.3. Statistical Analysis	16
5.4. Ground Gas Assessment	17
Section 6 – Conceptual Site Model	18
6.1. Sources	18
6.2. Pathways and Receptors	18
Section 7 – Geotechnical Assessment	19
7.1. Introduction	19

Ground Condition Assessment

7.2. Geotechnical Tests.....	19
7.3. Geotechnical and Geological Parameters.....	19
7.4. Aggressive Ground Soil Chemistry	26
Section 8 – Foundation and Ground Engineering.....	29
8.1. Introduction	29
Section 9 – Conclusions and Recommendations.....	35
9.1. Contamination	35
9.2. Geotechnical	36
Figure 1 – Site Location Plan.....	37
Figure 2 – Investigation Location Plan	38
Figure 3 – SPT N v Depth	39
Figure 4 – Undrained Shear Strength v Depth	40
Appendix 1 – Report Conditions	41
Appendix 2 – Engineering Logs	43
Appendix 3 – Generic Assessment Criteria	44
Appendix 4 – Soil Screening Summary.....	45
Appendix 5 – Chemical Analysis Results.....	46
Appendix 6 – Monitoring Records.....	47
Appendix 7 – Geotechnical Test Certificates	48
Appendix 8 – Geotechnical Calculations	49

Section 1 – Introduction

1.1. Introduction

Ridge and Partners LLP (Ridge) was commissioned by Portsmouth City Council in May 2015 to undertake a Ground Condition Assessment of a plot of land at Holybourne Road, Havant, Hampshire.

The brief was to undertake a site investigation and assessment to identify any ground contamination issues and geotechnical conditions that may affect the proposed development. This report provides an assessment of the identified and potential ground conditions of the site, with regard to the proposed works in accordance with the Model Procedures for the Management of Land Contamination (CLR 11), published by the Environment Agency. In addition, the geotechnical sections of this report provide a detailed assessment of the materials present beneath the site and present characteristic parameters that should be used in design of all geotechnical facets of the proposed development.

This report is prepared in line with the agreed brief and is subject to the report conditions shown in Appendix 1.

1.2. Legal Context

Part IIA of the Environmental Protection Act 1990 (inserted by Section 57 of the Environment Act 1995) provides a regime for the control of specific threats to health or the environment from land contamination. In accordance with the Act and the statutory guidance document 'The Contaminated Land (England) Regulations 2000', the definition of contaminated land is intended to embody the concept of risk assessment. Within the meaning of the Act, land is only "contaminated land" where it appears to the Regulatory Authority, by reason of substances within or under the land, that:

- Significant harm is being caused, or there is a significant possibility of such harm being caused; or
- Pollution of controlled waters is being, or is likely to be, caused."

Inherent in this definition is the requirement for contamination risk assessment to be undertaken on a site specific basis, as the potential for harm is determined by the site's end use and its specific environmental setting.

The guidance defines "risk" as the combination of:

- The probability, or frequency, of occurrence of a defined hazard (for example, exposure of a property to a substance with the potential to cause harm); and
- The magnitude (including the seriousness) of the consequences.

1.3. Methodology

This report has been prepared in accordance with published Environment Agency guidance ('Model Procedures for the Management of Land Contamination – Contaminated Land Report (CLR) 11'). CLR 11 provides the technical framework for structured decision making about land contamination and builds on previous work carried out under the Contaminated Land Research Programme (of the former Department of the Environment). CLR 11 has adopted and refined the well recognised methodology and terminology that has been used in contaminated land risk assessment for a number of years.

Ground Condition Assessment

Pollutant Linkage Concept

In the context of land contamination, there are three essential elements to any risk:

- A **contaminant source** – a substance that is in, on or under the land and has the potential to cause harm or to cause pollution of controlled waters.
- A **receptor** – in general terms, something that could be adversely affected by a contaminant, such as people, an ecological system, property, or a water body.
- A **pathway** – a route or means by which a receptor can be exposed to, or affected by, a contaminant.

Each of these elements can exist independently, but they create a risk only where they are linked together, so that a particular contaminant affects a particular receptor through a particular pathway. This kind of linked combination of contaminant–pathway–receptor is described as a pollutant linkage.

Conceptual Model

An important thread throughout the overall process of risk assessment is the need to formulate and develop a conceptual model for the site, which supports the identification and assessment of pollutant linkages. A conceptual model represents the characteristics of the site in diagrammatic or written form that shows the possible relationships between contaminants, pathways and receptors (pollutant linkages).

Risk Assessment

CLR 11 advocates a phased approach to risk assessment comprising the following in order, as necessary:

Preliminary Risk Assessment – a desk study consisting of a review of documentary, anecdotal and site walk over evidence.

Generic Quantitative Risk Assessment (GQRA) - comparison of contaminant concentrations obtained from site investigation with generic assessment criteria.

Detailed Quantitative Risk Assessment (DQRA) - comparison of contaminant concentrations obtained from site investigation with site-specific assessment criteria.

This document constitutes a Preliminary Risk Assessment, Generic Quantitative Risk Assessment and a Geotechnical Design Report.

1.4. Proposed Use

It is currently understood that the site is proposed for low rise residential development. A change in the site use from that currently proposed may result in the need for re-assessment of risk criteria and the conclusions and recommendations resulting from the risk assessment could therefore significantly change.

1.5. Previous Reports Reviewed

An Environmental Desk Study was conducted for Portsmouth City Council by Omnia Environmental Consulting Ltd, (Ref: A1057762/150218/R1, dated 18th February 2015). The Omnia report was reviewed as part of this assessment and should be read in conjunction with this assessment.

1.6. Report Scope and Limitation

This report is based upon a review of readily available historical and current information and the recent site investigation data detailed herein.

The report presents an interpretation of the borehole and laboratory data provided by the Ridge site investigation undertaken between the 1st and 3rd June 2015. In addition, this report outlines the basic ground conditions encountered in the exploratory holes and the results of any monitoring of ground installations. This information has been collated, processed and used to provide an interpretation of the ground conditions, with recommendations on potential ground contamination risks for the proposed development.

The recommendations and opinions expressed in this report are based on the strata observed in the exploratory holes, the results of the site and laboratory tests, and information obtained as part of the desk study or provided by others. Ridge takes no responsibility for conditions that have not been revealed by the exploratory holes, or which occur between them. Whilst every effort has been made to interpret the conditions between investigation locations, such information is only indicative and liability cannot be accepted for its accuracy. Information provided from other sources is taken in good faith and Ridge cannot guarantee its accuracy.

The information contained in this report is intended for the use of Portsmouth City Council. Ridge can take no responsibility for the use of this information by any other party or for uses other than that described in this report.

Section 2 – Hazard Identification

2.1. Site Location and Description

The site is located to the east of Holybourne Road in a predominantly residential area of Havant, neighbouring Trosant Junior School.

The site is irregular in plan and covers an area of approximately 0.29ha. of open flat grassland. The northern boundary of the site is denoted by the fences and hedges of neighbouring residential properties. The eastern edge of the site is defined by the wall to a neighbouring residential property and a line of vegetation. The southern site boundary is marked by a number of tall conifers and fence line. The western site limit meets a pedestrian footpath, fence line to the sports ground of the neighbouring school lying further to the west and a low post and rail fence separating the site from Holybourne Road.

2.2. Site History

According to the Ordnance Survey maps provided and reviewed from 1866 to 2014 (scales 1:2,500, 1:10,000, 1:1,250, 1:10,560) the site appears to have remained effectively unchanged in its current use since at least 1869. The residential areas surrounding the site were progressively developed over the course of the 1950s and early 1960s, with no notable industrial uses in the immediate vicinity of the site.

2.3. Documented Ground Conditions

Ground conditions recorded in readily available sources are summarised below.

Geology

Reference to the British Geological Survey (BGS) Map (Sheet 315, Southampton, Scale 1:50,000) indicates the site to directly overlie superficial geology of River Terrace Deposits (sand, silt and clay) and the London Clay Formation (clay, silt and sand). No Artificial or Made Ground deposits are recorded as present on the site, however the site is surrounded by developed properties and it is considered likely that some Made Ground may be present.

Hydrogeology

The Environment Agency Groundwater Vulnerability Map (Sheet 52, Southern Hampshire, Scale 1:100,000) indicates that the site is underlain by superficial Secondary A Aquifer, interpreted as both the River Terrace Deposits. The site overlies bedrock Unproductive Strata, interpreted as the London Clay Formation.

Secondary A Aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

Unproductive Strata are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Ground Condition Assessment

The site lies within a groundwater source protection zone (SPZ), recorded as 1C – Inner catchment within a confined aquifer, this is interpreted as the underlying deep Chalk Aquifer.

Hydrology

The nearest surface water feature to the site is a culvert that runs along the southern boundary of the site.

Radon

Radon is a naturally occurring radioactive gas which may be harmful to human health. Radon is generally released into the atmosphere in areas underlain by granite and limestone. Harmful concentrations of radon may build up if it becomes trapped in an enclosed space such as a building.

National Radiological Protection Board data presented within the Landmark Envirocheck Report indicates that the percentage of houses exceeding the Action Levels for Radon in this area is 1-3%. Therefore the British Geological Survey recommends that no radon protective measures are necessary in the construction of new dwellings or extensions.

2.4. Environmental Data Search

A search of an environmental database, provided in the Omnia report, was undertaken together with information from various other organisations as part of the desk study and is summarised in the following sections. The following summary is generally limited to locations within 250m of the site boundaries unless it is considered that installations or activities beyond that range could potentially have an impact on the site or be affected by the redevelopment of the site.

Table 2.1: Data search results

Discharge consents	There are no recorded active discharge consents within 250m of the site.
Pollution incidents	There are no recorded pollution incidents to controlled waters within 250m of the site.
Water abstractions	There are no recorded water abstractions within 500m of the site.
Fuel stations	There are no recorded fuel stations within 250m of the site.
Landfill sites	There are no recorded landfill sites within 250m of the site.

The site is located in an area which may not be affected by coal mining.

The following ground hazards were identified:

- Compressible ground stability hazards – Negligible hazard
- Collapsible ground stability hazards – Low hazard
- Ground dissolution stability hazards – Negligible hazard
- Landslide ground stability hazard – Very Low hazard
- Shrinking or swelling clay ground stability hazard – Low hazard
- Running sand ground stability hazards – Low hazard

Ground Condition Assessment

2.5. Department of Environment – Industry Profiles

The Industry Profile produced by the Department of the Environment do not cover the current or past uses of the site.

2.6. Preliminary Conceptual Site Model

Table 2.2: Pollutant linkage assessment

Source	Pathway	Receptor
Potential ACM in Made Ground	Inhalation of fibres	Construction workers
		Future site users
Ground gas from natural strata	Vertical migration leading to accumulation and inhalation	Future site users

The preliminary risk assessment identified several potentially viable pollutant linkages that could present a significant risk, based on the proposed use, although the potential risk is considered to be low. As such, it was considered prudent to further assess these risks as part of a predominantly geotechnically driven intrusive investigation.

Ground Condition Assessment

Section 3 – Fieldwork Summary of Scope and Rationale

3.1. Rationale and Summary of Scope

Site investigation works were undertaken by Ridge between the 1st and 3rd June 2015. The scope and rationale of the ground investigation are presented below.

- 3no. cable percussive boreholes (BH) to a maximum depth of 12.0mbgl.
- 5no. windowless sample boreholes (WS) to a maximum depth of 5.0mbgl.
- Collection of representative samples to undergo chemical and geotechnical laboratory testing as detailed in later sections of this report.
- Installation of 3no. gas / water monitoring standpipes.

It should be noted that additional sources of contamination may become apparent during any future investigation and development of the site.

Table 3.1: Exploratory hole location rationale

Location	Rationale	Max Depth (mbgl)
BH1-3	3no. cable percussive boreholes positioned across the proposed development area to assess the nature and stratigraphy of the subsurface materials and allow collection of representative samples for geotechnical and environmental analyses and installation of monitoring wells.	12.0
WS1-5	5no. windowless sample boreholes positioned across the proposed development area to assess the nature and stratigraphy of the subsurface materials and allow collection of representative samples for chemical analysis	2.0*

**All WS boreholes refused within the dense gravels*

The layout of the exploratory positions is presented in Figure 2.

3.2. Sampling

Prior to the investigation it was determined that the primary receptors that would potentially be at risk on this site would be the future site users and construction workers with additional potential risk to the underlying Secondary Aquifer. It was therefore considered appropriate to target the near surface deposits, at a depth representative of the material that is likely to remain following site clearance for chemical analysis as this is the material most likely to be encountered by the receptor following the development of the site.

3.3. Monitoring

One groundwater level and ground gas monitoring rounds were undertaken on completion of the intrusive investigation works to provide an assessment of the ground gas regime at the site.

3.4. Site Investigation Standards

Methods employed during the investigation were generally undertaken in accordance with BS10175, BS EN 1997-2 and BS5930.

Ground Condition Assessment

Section 4 – Ground Conditions Encountered

4.1. Soil Conditions

Ground conditions encountered during the recent ground investigation were broadly consistent with those identified in the published literature and in summary comprised Topsoil overlying clays, sands and gravels, of the River Terrace Deposits, overlying clays of the London Clay Formation.

Variations in strata thicknesses are summarised in Table 4.1 below, engineering logs are presented in Appendix 2.

Table 4.1: Summary of encountered ground conditions

Location	Topsoil/Made Ground		River Terrace Deposits		London Clay Formation	
	From (mbgl)	Thickness (m)	From (mbgl)	Thickness (m)	From (mbgl)	Thickness (m)
BH1	GL	0.10	0.10	3.10	3.20	>8.80
BH2	GL	0.10	0.10	3.20	3.30	>8.70
BH3	GL	0.10	0.10	4.00	4.10	>7.90
WS1	GL	0.30	0.30	>1.70	N/E	N/E
WS2	GL	0.40	0.40	>1.40	N/E	N/E
WS3	GL	0.35	0.35	>1.45	N/E	N/E
WS4	GL	0.25	0.25	>1.55	N/E	N/E
WS5	GL	0.60	0.60	>1.20	N/E	N/E

Surfacing

The site comprises grassland. No other surfaced areas are present on site.

Topsoil

Topsoil was encountered in all locations and was recorded as light brown clayey and/or silty fine to medium sand with rootlets and locally flint gravel or a dark brown clayey sandy silt with occasional rootlets. Topsoil was recorded as having a thickness of 0.10 to 0.60m.

Made Ground

Made ground was encountered in WS2 only and comprised brown silty clayey gravelly fine sand clay with frequent rootlets and small brick fragments from ground level to 0.40mbgl.

River Terrace Deposits

River Terrace Deposits were recorded immediately beneath the Topsoil / Made Ground and comprised silty and gravelly clays and silty, clayey and gravelly sands overlying dense gravels. River Terrace Deposits are recorded up to 4.0m in thickness.

Ground Condition Assessment

London Clay Formation

The London Clay Formation was encountered immediately beneath the River Terrace Deposits at depths of between 3.20 and 4.10 mbgl. The London Clay Formation comprised a superficial weathered horizon comprising firm brown silty clay or a brown silty clayey sand overlying unweathered firm to stiff grey clay.

The London Clay Formation persisted to the full depth of the ground investigation. A minimum thickness of > 8.80m was encountered in BH1.

4.2. Obstructions

Dense flint gravels proved to be an obstruction during the windowless sampling phase of the ground investigation.

4.3. Groundwater Conditions

Water ingress was not noted in the intrusive investigation locations. One round of groundwater and gas monitoring was undertaken subsequent to installation of groundwater and gas monitoring standpipe in each cable percussive borehole location. Groundwater levels recorded during the monitoring are presented in Appendix 6 and were recorded at depths varying from 3.24mbgl to 3.72mbgl.

4.4. Visual/Olfactory Evidence of Contamination

No notable evidence of contamination was encountered.

Section 5 – Generic Risk Assessment

5.1. Contamination Assessment Methodology

In order to assess the human health and environmental risks posed by potential contaminants within the underlying soils and groundwater, Ridge undertook an initial screen of the laboratory results using generic assessment criteria. Generic assessment criteria (GAC) are conservative contaminant concentration values used for comparison purposes to assess the risk associated with contaminant concentrations found on site and are derived using non-site-specific information.

Soils

In order to assess the soil analyses results with regard to potential human health risks, Ridge has adopted the LQM/CIEH Suitable 4 Use Levels (S4ULs), generic assessment criteria (GACs) derived in accordance with the UK framework set out in the most recent CLR (Contaminated Land Report) documents using the Contaminated Land Exposure Assessment (CLEA) Model.

S4ULs have been published for an extensive suite of contaminants, with assessment criteria derived for each contaminant for four different land use scenarios namely:

- Residential with homegrown produce;
- Residential without homegrown produce
- Allotments; and
- Commercial and industrial.

A full list of the GACs together with an indication of the method used for their derivation is provided in Appendix 3. GACs applicable to residential end use have been used for the assessment of the site. Contaminant concentrations below the GACs are considered not to warrant further risk assessment. However, concentrations of contaminants above the GACs may require further consideration through statistical analysis, if appropriate, or further detailed assessment using site specific data.

This document does not constitute a Site Assessment Report (SAR) as outlined in the UKWIR Guidance for the Selection of Water Supply Pipes to be Used in Brownfield Sites (Ref: 10/WM/03/21, 2010). As such, the full generic suite of testing recommended in the UKWIR guidance may not have been undertaken for this site and may be required by some water companies. However, consideration has been given to the 'threshold' concentrations presented in Table 3.1 of the UKWIR guidance, where they are applicable to the analysis undertaken, to provide an indication of the potential risks to buried water supply pipes.

Assessment framework

In regards to human health, the CLEA model states that, 'the contamination is assumed to be at or within 1m of the surface' (CLR10 pg10). It is considered that at depths greater than 1m, the probability of human exposure via the direct contact pathways are significantly reduced, leaving inhalation of volatile compounds as the dominant pathway with regard to human health risks. Typically, volatile compounds only significantly affect the indoor inhalation pathway. Therefore, for the purposes of statistical analysis, data from the top 1.0 to 1.5m is used for assessment of risks to human health via direct contact pathways in accordance with the CLEA model, dependant on proposed future site levels.

Ground Condition Assessment

Statistical analysis

The CLEA guidelines state that for each contaminant, the upper 95th percentile confidence limit on the mean measured concentration (95%UCL) should be calculated and this value should be compared to the GAC. Maximum value tests should also be performed in accordance with the method outlined in Annex 1 of CLR7.

The objective of these tests is to decide whether the maximum concentration observed should be treated as an outlier or whether it can reasonably be considered to come from the same underlying population as the other samples.

Annex 1 of CLR 7 describes a simplistic method for calculation of the 95%UCL value based on the arithmetic mean of the sample distribution, assuming the contaminant concentrations fall within a normal distribution. However, it is known that contaminant concentrations often tend towards other distribution forms.

Therefore, in order to calculate what are considered to be more representative 95%UCL values, the contaminant concentrations have first been assessed to determine if each contaminant distribution is closer to a normal or another distribution. If a dataset was found to be normally distributed, the arithmetic mean was used to calculate the 95%UCL using the 'One sample t-test' as described in CLR 7. If the distribution was determined to be significantly removed from normal, the one-sided Chebychev Theorem was used to calculate the 95%UCL. Constituent non-detects were assigned a value equal to the reported analytical laboratory limit of detection, considered reasonably conservative in accordance with CLR principles. Any identified outliers are excluded from the datasets used in calculation of the 95%UCL value, with justification.

Groundwater

Groundwater analyses, where undertaken, shall be assessed by direct comparison with the freshwater Environmental Quality Standards (EQS), or, in the absence of EQSs, UK or WHO Drinking Water Standards or other appropriate guidance values. For certain compounds, the EQS is quoted as a range of values based on the alkalinity of the water, where the measured concentration lies within this range, the results are interpreted qualitatively. The guideline values selected as appropriate GACs for each contaminant are presented in Appendix 3.

Leachate

Leachate analyses, where undertaken, shall be assessed in the same manner as the groundwater samples. The guideline values selected as appropriate GACs for each contaminant are presented in Appendix 3.

Ground Gas

The criteria used to assess the ground gas monitoring results, where monitored, have been taken from the following guidance documents:

- Assessing risks posed by ground gases to buildings, CIRIA Report C665, 2007
- Code of practice for the characterisation and remediation from ground gas in affected developments, British Standard BS 8576, 2013

Ground Condition Assessment

The frequency and period of monitoring is assessed based on the gas generation potential of the source material and the sensitivity of the development, in accordance with Figure 6 of BS8576 and Table 5.5 of CIRIA C665. As BS8576 promotes a risk based approach to ground gas assessment, it recognises that ground gas monitoring might not be necessary if a viable pollutant linkages is not present, e.g. if a 'credible' source with significant ground gas generation potential and/or a 'credible' migration pathway are not present.

The typical monitoring recommendations present in BS8576 and CIRIA C665 vary between four sets of readings over a one month period for a commercial development and a very low generation potential source to 24 rounds over 24 months for a residential property and a very high generation potential source. However, these are recognised as typical recommendations that may require fewer or additional readings depending on site specific circumstances.

Where possible, monitoring rounds are undertaken during a range of atmospheric conditions to enable their influence on gas conditions to be assessed. As monitoring over the recommended periods is frequently impractical on development sites, the monitoring rounds undertaken are conducted during the worst case conditions (e.g. low and falling atmospheric pressure) during the time available, as far as reasonably practicable, in order to limit the level of uncertainty resulting from the reduced monitoring period. It may, however, be appropriate to raise the Characteristic Situation to account for uncertainties on a site by site basis.

The Characteristic Situation for a monitoring location is determined using the worst case gas screening value for methane or carbon dioxide from all of the monitoring rounds at that location. Following the precautionary principal, the most stringent of the Characteristic Situations for the monitoring locations within the Site is generally used to classify the Site as a whole.

5.2. Soil Assessment

General

A total of 10no. near surface soil samples collected during the site investigation were submitted to a UKAS accredited laboratory for analysis for a suite of heavy metals, phenols, speciated polyaromatic hydrocarbons (PAHs), fractionated total petroleum hydrocarbons (TPH), BTEX compounds and several inorganic parameters. The results of the laboratory analyses are summarised in Appendix 4, in which they are compared to the relevant generic assessment criteria. A full set of all the laboratory test certificates is presented as Appendix 5.

The range of potentially hazardous contaminants present on the site can be wide and varied and the suite has been chosen to reflect both commonly found contaminants and others indicated by research to have a significant risk of being present. It is, however, possible that others may exist for which analyses have not been carried out or which were outside the scope of completed exploratory holes.

The decision to recommend acceptability or a requirement for remediation is based on the evaluation of a number of factors which when combined present a statutory or non-statutory risk that may require remedial action.

Ground Condition Assessment

Heavy metals

The heavy metals included in the analysis of the samples from the site were identified at concentrations well below the relevant GACs. Therefore heavy metals are not considered to present a significant source of contamination with regard to human health.

Petroleum hydrocarbons

Total petroleum hydrocarbon (TPH) concentrations were recorded to be well below GACs in the majority of the soil samples across the site with concentrations below the laboratory detection limits recorded in all of the samples. Therefore TPH is not considered to represent a significant source of contamination with regard to human health across the site.

Concentrations of TPH C11-C40 fractions were not recorded to exceed the UKWIR 'threshold' values for mineral oil. TPH is therefore considered unlikely to represent a potentially significant source of contamination to proposed water supply pipes. However, the designers of the water supply pipes for this site should review the data in this report to inform their decision making process.

Polyaromatic hydrocarbons (PAHs)

Polyaromatic hydrocarbons (PAH) compounds were recorded to be well below the relevant residential GACs in the majority of the soil samples across the site with concentrations below the laboratory detection limits recorded in the all of the samples. Therefore PAHs are not considered to represent a significant source of contamination with regard to human health across the site.

BTEX compounds and MTBE

BTEX compounds and MTBE were generally not identified at concentrations in excess of the laboratory detection limits and were well below the relevant GACs in all of the samples from across the site. Therefore BTEX compounds and MTBE are not considered to represent a significant source of contamination with regard to human health.

Concentrations of BTEX and MTBE were not recorded to exceed the UKWIR 'threshold' values. BTEX and MTBE are therefore not considered to represent a significant source of contamination to proposed water supply pipes.

Inorganics

The concentrations of free cyanide fell below laboratory detection limits in all of the soil samples analysed.

The pH of the soil samples analysed was generally slightly alkali falling within the 5-9 range, with the exception of one sample, which was recorded as Ph6.87, at 0.2mbgl in WS2.

No asbestos containing materials or fibres were identified in the samples analysed.

5.3. Statistical Analysis

Statistical analysis was not considered to be appropriate on the analysis result for the samples from this site.

5.4. Ground Gas Assessment

The intrusive investigation of the site identified Topsoil, Made Ground and River Terrace Deposits overlying the London Clay Formation. Minimal quantities of Made Ground were encountered and no significant quantities of organic matter were observed within the natural soils during the investigation and the soil organic matter test data confirms the presence of moderately low organic content. With reference to Figure 6 of BS8576, the ground gas potential of the soils underlying the site is considered to be less than “very low”. Ground gas monitoring is therefore not considered to be necessary for the majority of the site.

However, to provide additional confidence to this assessment and to highlight any potential unexpected gas generation sources, an initial monitoring round of the three monitoring wells was undertaken. The presence and concentrations of ground gases in the installed monitoring wells were monitored in accordance with the monitoring methodology outlined in CIRIA C665 on one occasion to give a preliminary view of the ground gas regime at the site. The monitoring results are presented in Appendix 6.

During the gas monitoring round, flow rates of $<0.1\text{l/hr}$ were recorded in monitoring wells. Slightly elevated concentrations of carbon dioxide were detected in all three wells (up to 2.1% by volume) and flammable gas as methane was recorded at a steady state of up to 0.1% by volume.

The Gas Screening Values (GSVs) in all locations fell well below the boundary between Characteristic 1 and 2 (NHBC Green and Amber 1). The exception was WS117 during the first monitoring round only and was the result of a highly elevated recorded flow rate of 21.5l/hr and a slightly elevated carbon dioxide concentration of 5.3% by volume that resulted in a GSV of 1.14l/hr . As the elevated flow rate is considered to be the direct result of the high water level compressing the air in the sealed section of the well at this location, the calculated GSV is not considered to be representative of the ground gas regime and is not considered to warrant further consideration or protection measures.

The recorded concentrations and flow rates for the site, in conjunction with the recorded ground conditions, indicate a classification of Characteristic Situation 1 (very low risk) or NHBC “Green” is an appropriate classification. This characterisation is based on the concentrations of both carbon dioxide and flammable gas as methane falling well below the recommended additional factors/typical maximum concentrations in CIRIA C665, the Gas Screening Values (GSVs) falling well below the boundary between Characteristic 1 and 2 (NHBC Green and Amber 1) at all locations and the absence of any material with a significant potential to generate ground gas. Therefore, no ground gas protection measures are recommended for the site.

Section 6 – Conceptual Site Model

6.1. Sources

No significant on or off site sources of contamination have been identified by this assessment.

6.2. Pathways and Receptors

As no significant sources of contamination have been identified, no viable pollutant linkages are considered to be present. As such, further discussion of pathways and receptors is not considered to be appropriate.

Ground Condition Assessment

Section 7 – Geotechnical Assessment

7.1. Introduction

The geotechnical assessment and the subsequent foundation design recommendations will use the findings of the ground investigation and the results of the in-situ and geotechnical testing carried out in the boreholes and on representative samples of the material encountered.

7.2. Geotechnical Tests

A programme of geotechnical laboratory testing was carried out on representative samples collected from the strata encountered during the ground investigation.

Details of the specific procedure used in each case are shown below in Table 7.1 and the geotechnical test certificates are presented in Appendix 7.

Table 7.1: Summary of Geotechnical Testing

Test	Standard (BS1377:1990) unless otherwise indicated	No.
Classification Tests		
Atterberg Limits	Part 2, Clauses 4.3, 5.3 & 5.4	11
PSD Wet Sieves	Part 2, Clause 9.2	6
PSD Sedimentation	Part 2, Clause 9.5	3
Shear Strength Tests		
Quick Undrained Triaxial	Part 7, Clause 8.4	6
Chemical Tests		
BRE SD1	Various	4
Sulphate Content 2:1 soil water extract	Part 3, Clause 5.3	2
pH value	Part 3, Clause 9.0	2

7.3. Geotechnical and Geological Parameters

This section discusses the key geotechnical characteristics of each encountered stratum as determined from field observations, in-situ and laboratory geotechnical testing.

Topsoil / Made Ground

Topsoil

Topsoil was encountered at all exploratory hole locations attaining a maximum thickness of 0.60m (WS5) and comprising light brown clayey / silty fine sand / silt with occasional rootlets.

Ground Condition Assessment

Made Ground

Made ground comprising 0.40m brown silty clayey gravelly fine sand with frequent rootlets and small brick fragments was identified in WS2 from ground level.

No in-situ or geotechnical laboratory testing was carried out within the Topsoil / Made Ground as all foundations will be constructed beneath these superficial materials.

River Terrace Deposits

River Terrace Deposits (RTD) were encountered immediately below the Topsoil / Made Ground at all exploratory locations. The RTD comprised 3.10 to 4.00 of firm to stiff orange brown silty fine sand / clay overlying dense gravel.

The full thickness of the RTD was not encountered within the WS boreholes as the density of the gravels caused the early termination of these boreholes.

In-situ testing

Standard penetration testing (SPT) was carried out throughout the RTD. The distribution of SPT N and corrected N' values are shown in Table 7.2 and presented graphically in Figure 3.

Table 7.2: Distribution of SPT N Values in the River Terrace Deposits

BH No.	Depth (mbgl)	SPT N Value	N'	Major Constituent	BH No.	Depth (mbgl)	SPT N Value	N'	Major Constituent
BH1	2.00	49	>50	Gravel	WS3	1.00	7	19	Silty Clay
BH2	2.00	>50	>50			1.90	>50	>50	Gravel
BH3	1.80	>50	>50		WS4	1.00	24	>50	Sandy Clay
	2.80	28	50			2.00	>50	>50	Gravel
WS1	1.00	7	19	Silty Clay	WS5	1.00	9	25	Sandy Clay
	2.00	>50	>50	Gravel		1.80	>50	>50	Gravel
WS2	1.00	8	22	Silty Clay					
	1.80	>50	>50	Gravel					

**Values of N' derived in accordance with BS8002*

Careful inspection of the SPT results identifies a clear variation between the N-values recorded in the upper fine sands, silts and clays, and the underlying dense gravels (Figure 3). N-values recorded in the upper horizons of the RTD are in the range 7 to 24 which after correction give N' values of 19 to >50. Whilst N-values in the dense gravels are generally greater than 50 with one exception (BH3 at 2.80mbgl) which after correction give N' values of 50 or greater. These differences and their geotechnical effects will be more fully considered in the following section of this Report.

Ground Condition Assessment

Classification Testing

Consistency Limits

One Atterberg limits test was carried out on a representative sample of the upper fine-grained RTD. The results of this analysis are shown in Table 7.3.

Table 7.3: Results of the Atterberg Limits Analyses – Upper River Terrace Deposits

Location	Depth (mbgl)	Natural Moisture Content, w (%)	Liquid Limit w _L (%)	Plastic Limit w _P (%)	Plasticity Index I _P (%)	Corrected Plasticity Index (%)
WS2	0.50-1.00	21	45	20	25	25

The calculated plasticity index of 20% is consistent with an intermediate plasticity clay. As the whole sample passed the 425µm sieve no correction to the plasticity index was necessary indicating the material to be of medium volume change potential.

The consistency index is the numerical difference between the liquid limit and the natural moisture content expressed as a percentage ratio of the plasticity index, and can be written as:

$$I_C = \frac{w_L - w}{I_P}$$

Calculations based on the results of the Atterberg limits test (Table 7.3) give a consistency index of 0.96 which is indicative of a stiff consistency.

Particle Size Distribution

Six representative samples of the RTD underwent laboratory determination of the particle size distribution using the wet sieve method, of these samples three were subject to follow sedimentation analyses to identify their fine-grained composition. The results of these analyses are presented in Table 7.4 and copies of the grading envelopes and laboratory test certificates are located in Appendix 7.

Table 7.4: Results of the Particle Size Distribution Analyses – River Terrace Deposits

Location (BH no.)	Depth (mbgl)	Sample Proportions					Uniformity Coefficient
		Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Cobbles (%)	
BH1	0.50	18	57	24	1	0	NC
	2.00	17		21	62	0	NC
BH2	0.50	21	61	18	1	0	NC
	2.00	4		21	62	0	27
BH3	1.20	31	42	27	1	0	NC
	2.80	5		26	69	0	28

NC – Not Calculated

Ground Condition Assessment

The results of the particle size distribution analyses clearly show the differences in composition of the two materials present within the RTD. The upper horizons of the RTD are dominated by clays and silts and therefore should be considered as fine-grained; whilst the samples from beneath 2.00m are gravels with subordinate amounts of sand-sized material.

Shear Strength

As the differences in composition will have a profound effect on the shear strength of the RTD they will be considered separately in the following section of this Report.

Fine Grained River Terrace Deposits

Undrained Shear Strength

One representative sample of the fine-grained RTD underwent laboratory quick undrained triaxial compression testing. The results of the laboratory testing are presented in Table 7.5; whilst the laboratory test certificates are located in Appendix 7.

Table 7.5: Results of the QU triaxial Compression Testing – Fine-grained River Terrace Deposits

Location	Depth (mbgl)	Bulk Density (Mg/m ³)	Cell Pressure (kN/m ²)	Undrained Shear Strength c_u (kN/m ²)
WS2	0.50-1.00	2.21	15	119

The result of the QU triaxial testing give a c_{uk} value of 119kN/m² which is consistent with a high strength material.

This laboratory test result has been augmented with c_{uk} values derived from the widely accepted empirical relationship:

$$c_u = f_1 \times SPTN$$

Where f_1 is a correlation factor based on the I_p

Using a correlation factor of 5, all the undrained shear strength data has been plotted and reveals reasonable agreement between the lab data and the results of the correlation with SPT N value (Figure 4). The results indicate a characteristic undrained shear strength of 95kN/m² is appropriate for the upper fine-grained RTD.

Drained (Effective) Shear Strength

The widely accepted relationship between drained shear strength and plasticity index for remoulded clays has been used to determine the effective shear strength parameters. In terms of effective stress, the shear strength of a fine-grained soil can be considered as frictional, such that $c'_k = 0$ kN/m².

A characteristic plasticity index of 25% has been determined for the upper fine-grained suggesting that a characteristic effective angle of shearing resistance (ϕ'_k) of 25° is appropriate for this material.

Ground Condition Assessment

Coarse-Grained River Terrace Deposits

Given the free draining nature of the coarse-grained RTD, as evidenced by the granular composition, the total and effective shear strength parameters will be the same.

The strength of the RTD has been determined from the corrected SPT data. The peak and critical state shearing resistance have been calculated using the following equations:

The estimated peak angle of shearing resistance is:

$$\phi'_{\max} = 30 + A + B + C$$

The estimated critical state angle of shearing resistance is:

$$\phi'_{\text{crit}} = 30 + A + B$$

Where A is the angularity of the particles
 B is the grading of the Sand/Gravel
 C is the results of the corrected SPT N values.

Based on the above equations and the values for the A,B & C coefficients presented in BS8002, a peak angle of shearing resistance of 38° and a critical angle of shearing resistance of 36° are considered appropriate for the coarse – grained RTD.

Other Geotechnical Parameters

Fine-Grained River Terrace Deposits

Modulus of Deformation (E_k)

CIRIA R 143 presents a relationship between SPT N values and Modulus of Deformation for clay materials, where the undrained modulus (E_{uk}) is taken as the equivalent of the characteristic N' value and the drained modulus (E'_k) is taken as $0.75E_{uk}$. Given an N' value of 20 then the undrained and drained moduli for the fine-grained RTD are 20 and 15MN/m² respectively.

Coefficient of Volume Compressibility

The coefficient of volume compressibility (m_v) has been determined from the empirical relationship with the plasticity index (I_p), where:

$$m_v = \frac{1}{f_2 N}$$

Where f_2 is a correlation factor based on the characteristic I_p
and N is the characteristic SPT- N value.

The above relationship gives an m_{vk} of 0.10m²/MN which is indicative of a material of low to medium compressibility.

Ground Condition Assessment

Coarse-Grained River Terrace Deposits

Modulus of Deformation (E_k)

The deformation modulus for square and long strip foundations can be obtained by multiplying the static cone resistance by a factor of 2.5 or 3.5 respectively. Where only SPT data is available the static cone resistance q_c (in kg/cm^2) can be obtained by multiplying the N value by an empirical factor. For clean fine to medium sands a value of 3.5 is recommended, whilst in gravels and sandy gravels a value of 6 is appropriate. As the RTD is described as a sandy Gravel a factor of 6 will be used. The determination of the deformation modulus is presented in Table 7.6.

Table 7.6: Deformation Modulus for the Coarse-Grained River Terrace Deposits

Mean SPT N Value	Equivalent Static Cone Resistance (kg/cm^2)	Static Cone Resistance (MN/m^2)	Deformation Modulus E_k (MN/m^2)	
			Strip	Square
50	300	29	100	72

London Clay Formation

London Clay Formation (LCF) was encountered immediately below the RTD and persisted to the full depth of the ground investigation. The LCF consisted of a superficial weathered material comprising stiff brown silty clay/sand over stiff grey silty clay.

The full thickness of the LCF was not encountered in any borehole although a maximum proven thickness of > 8.8m was encountered in BH1.

In-situ testing

Standard penetration testing (SPT) was carried out throughout the LCF. The distribution of SPT N and corrected N' values are shown in Table 7.7 and presented graphically in Figure 3.

Table 7.7: Distribution of SPT N Values in the London Clay Formation

BH No.	Depth (mbgl)	SPT N Value	N'	Weathered/ Unweathered	BH No.	Depth (mbgl)	SPT N Value	N'	Weathered/ Unweathered
BH1	3.00	8	14	Weathered	BH3	3.90	7	11	Weathered
	5.00	12	15	Unweathered		5.00	6	8	
	8.50	19	19			8.50	26	26	Unweathered
	11.50	28	28			11.50	29	29	
BH2	5.00	6	8	Weathered					
	8.00	22	22	Unweathered					
	11.50	28	28						

Ground Condition Assessment

**Values of N' derived in accordance with BS8002*

Careful inspection of the SPT results identifies the differences between the weathered and unweathered LCF. SPT N values of the weathered LCF range from 6 to 8; whilst the N-values within unweathered LCF exhibit a clear increase with depth from an initial N-value of 12 at 5.00mbgl to a maximum of 28 at 11.5mbgl.

Further discussion of these results will be undertaken in subsequent sections of this Report.

Classification Testing

Consistency Limits

Eleven Atterberg limits tests were carried out on a representative samples of the LCF. The results of these tests are shown in Table 7.8.

Table 7.8: Results of the Atterberg Limits Analyses – London Clay Formation

Location	Depth (mbgl)	Natural Moisture Content, w (%)	Liquid Limit w _L (%)	Plastic Limit w _P (%)	Plasticity Index I _P (%)	Corrected Plasticity Index (%)
BH1	4.00-4.45	25	30	22	8	8
	6.00	29	63	23	40	40
	9.50	31	76	27	49	49
	10.00-10.45	27	76	27	49	49
BH2	4.00-4.45	23	32	18	14	14
	6.50-6.85	28	75	27	48	48
	8.00	29	77	24	53	53
	11.00	29	77	28	49	49
BH3	7.00	28	76	26	50	50
	9.50	28	72	25	47	47

The calculated plasticity indices range between 8 and 53%. Ignoring the two lower values, associated with a clayey sand horizon at approximately 4.00mbgl, the range of plasticity indices is 40 to 53% which is consistent with a high to very high plasticity clay. No corrections to the plasticity indices were required as all the samples passed the 425µm sieve indicating the material to be of high volume change potential.

Calculations based on the results of the Atterberg limits test (Table 7.8) give a range of consistency indices between 1.00 and 0.85 which are indicative of a stiff consistency.

Shear Strength

Undrained Shear Strength

Five representative samples of the LCF underwent laboratory quick undrained triaxial compression testing. The results of the laboratory testing are presented in Table 7.9; whilst the laboratory test certificates are located in Appendix 7.

Table 7.9: Results of the QU triaxial Compression Testing – London Clay Formation

Location	Depth (mbgl)	Bulk Density (Mg/m ³)	Cell Pressure (kN/m ²)	Undrained Shear Strength c_u (kN/m ²)
BH1	4.00-4.45	2.10	80	68
	10.00	1.88	200	114
BH2	4.00-4.45	Sample Water Softened & Disturbed		
	6.50-6.85	2.04	130	90
BH3	7.00-7.35	2.01	140	105

The result of the QU triaxial testing give c_{uk} values of between 68 and 114kN/m² which are consistent with a medium to high strength material.

This laboratory test results have been augmented with c_{uk} values derived from empirical relationship with SPT N values and a correlation factor of 4.5.

All the undrained shear strength data has been plotted and reveals reasonable agreement between the lab data and the results of the correlation with SPT N value (Figure 4). The results indicate a characteristic undrained shear strength of 45kN/m² at 3.00mbgl increasing to 150kN/m² at 13.00mbgl is appropriate for the LCF including the weathered material.

Drained (Effective) Shear Strength

The widely accepted relationship between drained shear strength and plasticity index for remoulded clays has been used to determine the effective shear strength parameters. In terms of effective stress, the shear strength of a fine-grained soil can be considered as frictional, such that $c'_k = 0$ kN/m².

A characteristic plasticity index of 48% has been determined for the LCF suggesting that a characteristic effective angle of shearing resistance (ϕ'_k) of 21° is appropriate for this material.

Other Geotechnical Parameters

Modulus of Deformation (E_k)

Butler (1974) gives an E_{uk}/c_u ratio of 400 for London Clay giving an undrained modulus of 18MN/m² at 3.00mbgl rising to 60MN/m² at 13.00mbgl. CIRIA R 143 suggests that the drained modulus (E'_k) should be taken as $0.75E_{uk}$. Therefore an E'_k of 14MN/m² at 3.00mbgl rising to 45MN/m² at 13.00mbgl is considered appropriate for the LCF.

Coefficient of Volume Compressibility

The coefficient of volume compressibility (m_v) has been determined from the empirical relationship with the plasticity index (I_p) giving an m_{vk} of 0.11m²/MN which is indicative of a material of medium compressibility.

7.4. Aggressive Ground Soil Chemistry

Chemical testing was carried out on seven samples of the encountered materials in accordance with Box C10, BRE Special Digest 1. The results are summarised in Table 7.10 and 7.11.

Ground Condition Assessment

Table 7.10: Summary of the Results of Chemical Testing for Concrete Classification

Test	BH1	BH2	BH3
	0.50	0.50	1.20
	RTD	RTD	RTD
pH	7.7	7.8	7.6
Soluble Sulphate (g/l)	0.45	0.43	0.56

Table 7.11: Summary of BRE SD1 Results

Test	BRE SD1			
	BH1	BH1	BH2	BH3
	4.00 (LCF)	9.50 (LCF)	11.00 (LCF)	11.50 (LCF)
pH	8.7	8.2	7.9	8.1
Total Sulphate (% SO ₄)	0.04	0.08	0.14	0.08
Total Sulphur (% S)	0.03	0.25	0.25	0.29
Water Soluble Sulphate (g/l) SO ₄)	0.06	0.31	0.48	0.32
Water Soluble Chloride (mg/kg)	44	<40	<40	<40
Water Soluble Nitrate (mg/kg)	<40	<40	<4	<40
Ammonium (mg/kg)	<0.1	<0.1	<0.1	<0.1

The amounts of oxidisable sulphides have been determined, for the LCF, following the procedure documented in Paragraph C5.1.2 of BRE SD1. The results indicate that pyrite is likely to be present in significant amounts. Based on the maximum determined total potential sulphate content Table C2 of BRE SD1 gives a Design Sulphate classification of DS3 and an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-2s assuming static groundwater conditions in LCF.

However, for shallow foundations placed entirely within the RTD the results indicate a Design Sulphate classification of DS-2 and ACEC of AC-2s.

7.5. Characteristic Geotechnical Parameters

Based on the laboratory test results, in-situ testing and subsequent analysis a range of characteristic geotechnical parameters, which should be used in all subsequent geotechnical and foundation design calculations are presented in Table 7.12.

Ground Condition Assessment

Table 7.12: Characteristic Geotechnical Parameters

Stratum		Parameter		Source	Value	
Topsoil /Made Ground		All foundations to be constructed beneath Made Ground				
River Terrace Deposits	Fine Grained	Unit Weight γ_k (kN/m ³)		BS8002	19kN/m ³	
		Undrained Shear Strength	c_{uk} (kN/m ²)	Laboratory QU Triaxial Testing	95kN/m ²	
			ϕ_{uk} (°)		0°	
		Drained Shear Strength	c'_k (kN/m ²)	Relationship with Ip	0kN/m ²	
			ϕ'_k (°)		25°	
		Modulus of Deformation	Undrained E_{uk} (MN/m ²)	CIRIA C R143	20MN/m ²	
			Drained E'_k (MN/m ²)		15MN/m ²	
		Modulus of Volume compressibility	m_v (m ² /MN)	Relationship with SPT and I _p	0.10m ² /MN	
	Coarse Grained	Unit Weight γ_k (kN/m ³)		BS8002	18kN/m ³	
		Shear Strength	c_k (kN/m ²)			
			ϕ_k (°)			
		Modulus of Deformation	E_k (MN/m ²)	Correlation with q _c	Pad	72MN/m ²
					Strip	100 MN/m ²
London Clay Formation	Unit Weight γ_k (kN/m ³)		BS8002	19kN/m ³		
	Undrained Shear Strength	c_{uk} (kN/m ²)	Laboratory QU Triaxial Testing	45KN/m ² at 3.00mbgl rising to 150kN/m ² at 13.00mbgl		
		ϕ_{uk} (°)		0°		
	Drained Shear Strength	c'_k (kN/m ²)	Relationship with Ip	0kN/m ²		
		ϕ'_k (°)		21°		
	Modulus of Deformation	Undrained E_{uk} (MN/m ²)	400 x c_{uk}	18MN/m ² at 3.00mbgl rising to 60MN/m ² at 13.00mbgl		
	Modulus of Volume compressibility	m_v (m ² /MN)	Relationship with SPT and I _p	0.11m ² /MN		

Section 8 – Foundation and Ground Engineering

8.1. Introduction

The geotechnical assessment below relates to the details of the proposed development. It is understood that the proposed development is to comprise a residential development. It is unclear at the time of writing if any of the proposed dwellings are to comprise multi-storey blocks of flats.

Three cable percussive boreholes (BH1-3) and five windowless sample boreholes (WS1-5) were undertaken on the site. The ground conditions encountered comprised Topsoil / Made Ground overlying River Terrace Deposits with London Clay Formation forming the basal unit in BHs1-3. The River Terrace Deposits comprised a fine-grained Silt / Clay / Fine Sand superficial material underlain by a dense sandy Gravel. The London Clay Formation comprised an upper weathered horizon to a depth of approximately 5.00-6.00mbgl underlain by firm to stiff becoming stiff grey silty Clay.

Groundwater was not recorded during the ground investigation; however during return a monitoring visit groundwater was recorded at a minimum depth of 3.24mbgl within the River Terrace Deposits.

Shallow Foundations

Depth of Foundations

All foundations must be constructed below the Made Ground / Topsoil within the natural strata. The minimum depth of foundation will be controlled by the volume change potential of the underlying strata. Atterberg testing of the underlying materials showed the fine-grained RTD to be of medium volume change potential with the London Clay Formation being of high volume change potential. NHBC guidance offer the following conditions that need to be met such that foundations can be designed for the medium volume change case effectively ignoring the deeper high volume change material:

- Consistent soil conditions exist across each plot. This should be confirmed by the site investigation;
- The depth of the non-shrinkable soil is greater than $\frac{3}{4}$ depth X, where X is the foundation depth determined, assuming that all the soil is shrinkable;
- The thickness T of non-shrinkable soil below the foundation is equal to or greater than the width of the foundation B.

As all the above conditions are met it is appropriate to design the depth of foundation to meet the requirements for a medium volume change potential material (Table 8.1).

Ground Condition Assessment

Table 8.1: Minimum Depth of Foundations for Medium Volume Change Soil (after NHBC)

Depth of Foundation	Description	No Tree Planting Zone (m)		
		High Water Demand	Moderate Water Demand	Low Water Demand
0.90m	No tree planting within Zone of Influence	1.25 x mature height	0.75 x mature height	0.50 x mature height
1.25m	Restricted tree planting within zone of influence	1.00 x mature height	0.50 x mature height	0.20 x mature height

Therefore a minimum foundation depth of 0.90m with restrictions placed on planting is recommended across the site.

Ultimate Limit State Bearing Resistance

Bearing resistance analysis was carried out in order to check the Ultimate Limit State (ULS) bearing resistance of the fine-grained RTD. The ground model and characteristic material properties used in the ULS analysis are presented in Table 8.2.

Table 8.2: Ground Model used in the ULS Bearing Resistance Calculations

Ground Model	Stratum	Thickness		Shear Strength Parameters			
		From (mbgl)	To (mbgl)	Total		Effective	
				c_{uk} (kN/m ²)	ϕ_{uk} (°)	c'_k (kN/m ²)	ϕ'_k (°)
GM1	Topsoil / Made Ground	GL	0.30	Not used			
	Fine Grained River Terrace Deposits	0.30	2.00	95	0	0	25
	RTD Dense Gravels	2.00	3.20	0	36	0	36
	London Clay Formation	3.20	>11.00	45	0	0	21

The UK has implemented Design Approach 1 (DA1) of BS EN1997-1:2004 (Eurocode 7: Geotechnical Design), which requires two design combinations to be satisfied:

Combination 1 (C1): A1 "+" M1 "+" R1

Combination 2 (C2): A2 "+" M2 "+" R1

Where A, M and R refer to groups of partial factors relating to actions, materials and resistance respectively.

Ground Condition Assessment

Table 8.3: Partial Factors Applied to the Bearing Resistance Analysis

	Combination 1			Combination 2		
	A1	M1	R1	A2	M2	R2
Tangent of the Angle of Shearing Resistance ($\tan \phi$)		1.00			1.25	
Cohesion Intercept (c')		1.00			1.25	
Undrained Cohesion c_u		1.00			1.40	
Permanent Action	1.35					
Variable Action	1.50					
Resistance						1.00

The summary of the bearing checks are presented in Table 8.4 and the geotechnical calculation sheets are located in Appendix 8.

Table 8.4: Summary of ULS Bearing Resistance Checks

GM	Foundation Type	Foundation Dimensions	Depth (mbgl)	DA1 Combination	Bearing Resistance (kN/m^2)	
					Drained	Undrained
1	Strip	0.75m wide	0.90	1	245	772
				2	137	558

These calculations indicate that combination 2 presents the most critical case. The results given represent the ultimate limit state that is the maximum load that can be supported by the soil without failure occurring within the soil mass.

The bearing resistances calculated indicate a ULS of 135kN/m^2 for a 0.75m wide strip foundation at a minimum depth of 0.90mbgl.

Serviceability Limit State

Eurocode 7 states that calculations of settlement must always be carried out on footings on soft clays - and should be carried out on footings on firm to stiff clays when the risk is anything other than negligible.

Verification of serviceability limit state (SLS) is demonstrated by satisfying the inequality:

$$s_{Ed} = s_0 \leq s_{Cd}$$

where s_{Ed} is the total settlement; and
 s_{Cd} is the limiting value of that settlement

Ground Condition Assessment

Without site / structure specific data a limiting value of settlement (s_{Ed}) of 25mm is considered appropriate for the type of construction under consideration. Partial factors for serviceability limit state analyses have all been taken as 1.

The settlement analysis has been carried out using the Rockscience software programme Settle 3D. The results are presented in Appendix 8 and précised in Table 8.5.

Table 8.5: Results of Settlement Analyses

Foundation Type	Depth (m)	Applied Foundation Loading (kN/m ²)	Founding Stratum	Immediate Settlement (mm)	Consolidation Settlement (mm)	Total Settlement (mm)
Strip	0.90	135	Fine-Grained RTD	5	10	15

The results of the settlement analyses show that if bearing pressures do not exceed 135kN/m² settlements will remain less 25mm.

The foundation design presented in the previous sections is considered appropriate for any two-storey dwellings. However, if multi storey blocks are to be constructed on the site the calculated bearing resistance may prove to be too restrictive.

If this proves to be the case it is recommended that a piled foundation is considered for these elements of the development.

8.2. Piled Foundations

The pile design has been carried out using the partial factors recommended in the UK National Annexe to BSEN 1997.

Pile Calculations

Given the properties of the strata beneath the site, values for an axially loaded piles have been determined using the following relationships:

Characteristic Shaft Resistance – RTD – Dense Gravel

$$R_{sk} = \frac{K_s \sigma'_v \tan \delta}{\gamma_{rd}}$$

Characteristic Shaft Resistance – Fine-Grained RTD & London Clay Formation

$$R_{sk} = \frac{\alpha \times \bar{c}_{u,d} \times A_s}{\gamma_{rd}}$$

Ground Condition Assessment

Characteristic End Bearing – London Clay Formation

$$R_{Bk} = \frac{N_c \times c_{u,d,B} \times A_B}{\gamma_{rd}}$$

Design Approach

The pile design has been carried out using the UK National Annex to EC7. The design approach and combination of partial factors and their values are presented in Table 8.6.

Table 8.6: Design Approach and Partial Factors used in Pile Design

CFA Pile								
Combination	Design Action Load	γ_G	Material Factors	All Partial Factors	Design Resistance	γ_b	γ_s	γ_{Rd}
1	A1	1.35	M1	1.00	R1	1.00	1.00	1.4
2	A2	1.00	M1	1.00	R4	2.00	1.60	1.4

Although higher carrying capacities are often achieved by driven piles, however, as the use of driven piles can cause environmental issues (noise and vibration) the initial axial resistance calculations have been carried out on augured piles.

The ULS axial resistances of a 0.3, 0.4, and 0.5m diameter augured pile of varying length have been determined for the ground model presented in Table 8.2. The Geocentrix Repute Software programme has been used to calculate the axial resistances. The resultant calculation worksheets are presented in Appendix 8 and a précis of the results is shown in Table 8.7.

Table 8.7: Design Pile Resistances – Augured Pile

Pile Diameter (m)	Pile Length (m)	Combination	Design Pile Resistance (kN)			
			MG	Skin Friction (R_{sd})	End Bearing (R_{bd})	Design Axial Pile Resistance (kN)
0.30	5.00	C2	No input in Axial Resistance	66	11	77
	7.50			114	15	129
	10.00			181	20	201
0.40	5.00	C2	No input to Axial Resistance	86	19	105
	7.50			152	27	179
	10.00			241	36	277
0.50	5.00	C2	No input to Axial Resistance	108	29	137
	7.50			190	43	233
	10.00			301	56	357

Ground Condition Assessment

The above pile axial resistances should be used as a guide only. It is recommended that if a piled foundation solution is the preferred option then the advice of an experienced piling contractor is sought.

When dimensioning a pile the applied load must be multiplied by the appropriate partial factor, γ_G (Table 8.6).

It must be remembered that the carrying capacity of a pile group is generally less than the sum of the individual piles. Therefore it is recommended that a pile group analysis is carried out once all the loads and serviceability limits are known.

Other Foundation Considerations

During the ground investigation no groundwater seepages were reported. However, return monitoring visits placed the groundwater at 3.24mbgl well below the depth of any proposed foundation excavation. Therefore it is considered probable that foundation excavations will remain stable in the short term.

It is recommended that foundation excavations are left open for the minimum time prior to the placement of the foundation concrete. The founding material in any foundation excavation that is left exposed to standing water will undergo a degree of softening and the softened material will require excavation prior to the placement of foundation concrete. If it becomes apparent that excavations are to remain open for any length of time it is recommended that the foundation excavation is left short of the finished level to avoid deterioration of the founding stratum.

The ground investigation has shown that the volume change potential of the shallow fine-grained RTD is medium. Using a simple assessment to determine the onset of desiccation none of the clay was identified as desiccated, therefore ground bearing floor slabs are considered appropriate across the whole site.

8.3. Other Geotechnical Considerations

Chemical Attack on Buried Concrete

BRE testing of the London Clay Formation has shown it to be potentially pyritic and conforms to a Design Sulphate classification of DS-3 and an ACEC of AC-2s.

For concrete placed entirely within the RTD a Design Sulphate classification of DS-2 and ACEC of AC-2s is considered appropriate for foundation concrete.

Section 9 – Conclusions and Recommendations

9.1. Contamination

No significant sources of contamination have been identified in association with the site. No viable pollutant linkages are therefore considered to be present in relation to the proposed residential development at the site.

General Notes

In order to mitigate the generic risks associated with development on potentially contaminated land the following mitigation measures are recommended:

- Preparation of a Discovery Strategy outlining the procedures to be followed in the event that unanticipated contamination is encountered during the development.
- Compliance with relevant Health and Safety procedures during construction works.
- Contractors on site should wear appropriate PPE to mitigate the risks from the chemical and physical impacts to the Made Ground at the site.
- The local authority should be informed if any sources of contamination are identified during the development that have not been assessed in this report. These sources should then be assessed and dealt with appropriately, with the agreement of the local authority.

The conclusions of this assessment are subject to agreement with the regulatory authority, be it the Local Authority for human health related issues or the Environment Agency for environmental issues.

It is recommended that any removal and disposal of sub-soil arisings and/or groundwater from the site should be undertaken in a controlled manner to a licensed facility, with due regard to Duty of Care responsibilities. In addition, an appropriate degree of health and safety provision should be incorporated to protect both the site workers and the general public alike.

During any ground works, it is recommended that skin contact with soils is kept to a minimum in accordance with good working practice / specific control measures and the HSE guidance document 'Protection of Workers and the General Public During the Development of Contaminated Land', 1991.

Ground Condition Assessment

9.2. Geotechnical

The ground investigation revealed the site to be underlain by Topsoil / Made Ground over River Terrace Deposits in turn overlying London Clay Formation to the full depth of the investigation. The River Terrace Deposits comprised an upper layer of fine-grained deposits overlying dense gravels.

Groundwater seepages were not recorded during the ground investigation but subsequent monitoring visits indicated a minimum at rest groundwater level to be 3.24mbgl.

Shallow Foundations

It is recommended that shallow foundations at a minimum depth of 0.90mbgl or below the any Made Ground, should thicker sequences be encountered, are adopted for this site. Foundation excavations should remain stable in the short term; however founding materials should not be left exposed for extended periods of time.

Ultimate bearing resistance calculations have been carried out for foundations constructed in the fine-grained RTD and returned a ULS bearing resistance of 135kN/m².

Serviceability limit state settlement analyses were carried out under a foundation loading of 135kN/m² on a strip foundation constructed within the upper RTD. The results show that, with the foundation loading of 135kN/m², total settlement of less than 25mm should be expected.

Piled Foundations

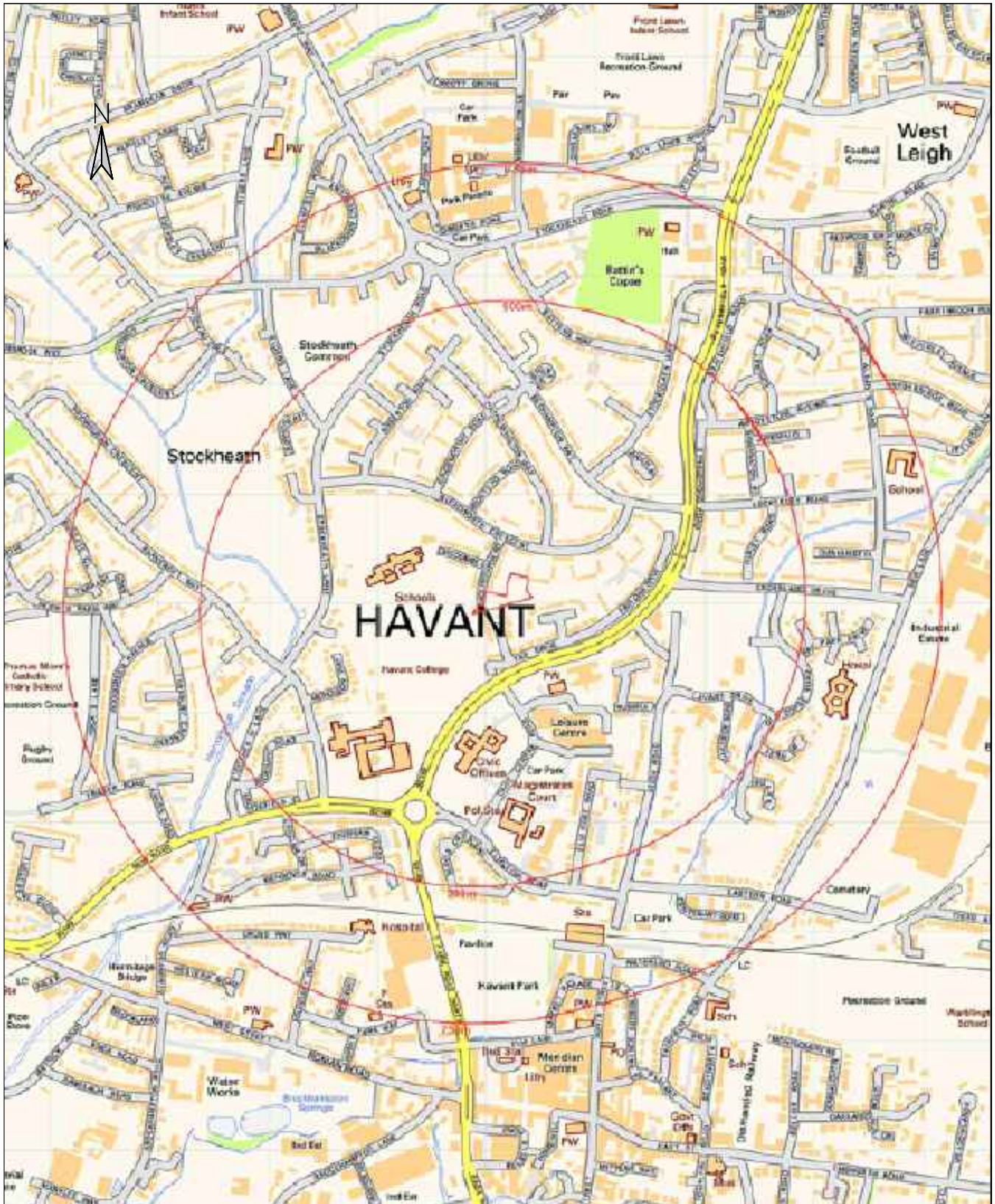
It is unclear at the time of reporting whether any multi-storey blocks are to form part of this development. If this is the case it is possible that the calculated bearing resistance may be too restrictive. Therefore, ULS axial pile resistances have been calculated for a range of diameters and lengths of augured pile. However, when sizing piles from these results all applied actions must be factored in accordance with the UK National Annex to Eurocode 7.

It should be noted that the carrying capacity of a pile group is usually less than the sum of the individual piles. Therefore it is recommended that a detailed pile group analysis is carried out when all loads and serviceability limits are known.

Other Geotechnical Considerations

Ground bearing floor slabs are considered appropriate for this site.

Figure 1 – Site Location Plan



-	10.07	PRELIMINARY	DAP	AP
REF	DATE	REVISION	DRAWN	CHECKED

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PARTNERSHIP HOUSE
MOORSIDE ROAD
WINCHESTER
HAMPSHIRE, SO23 7RX
Also at Reading, Bristol, London and Leicester

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151239 - SITE LOCATION

SCALE
NTS @ A4

DATE
10.07.15

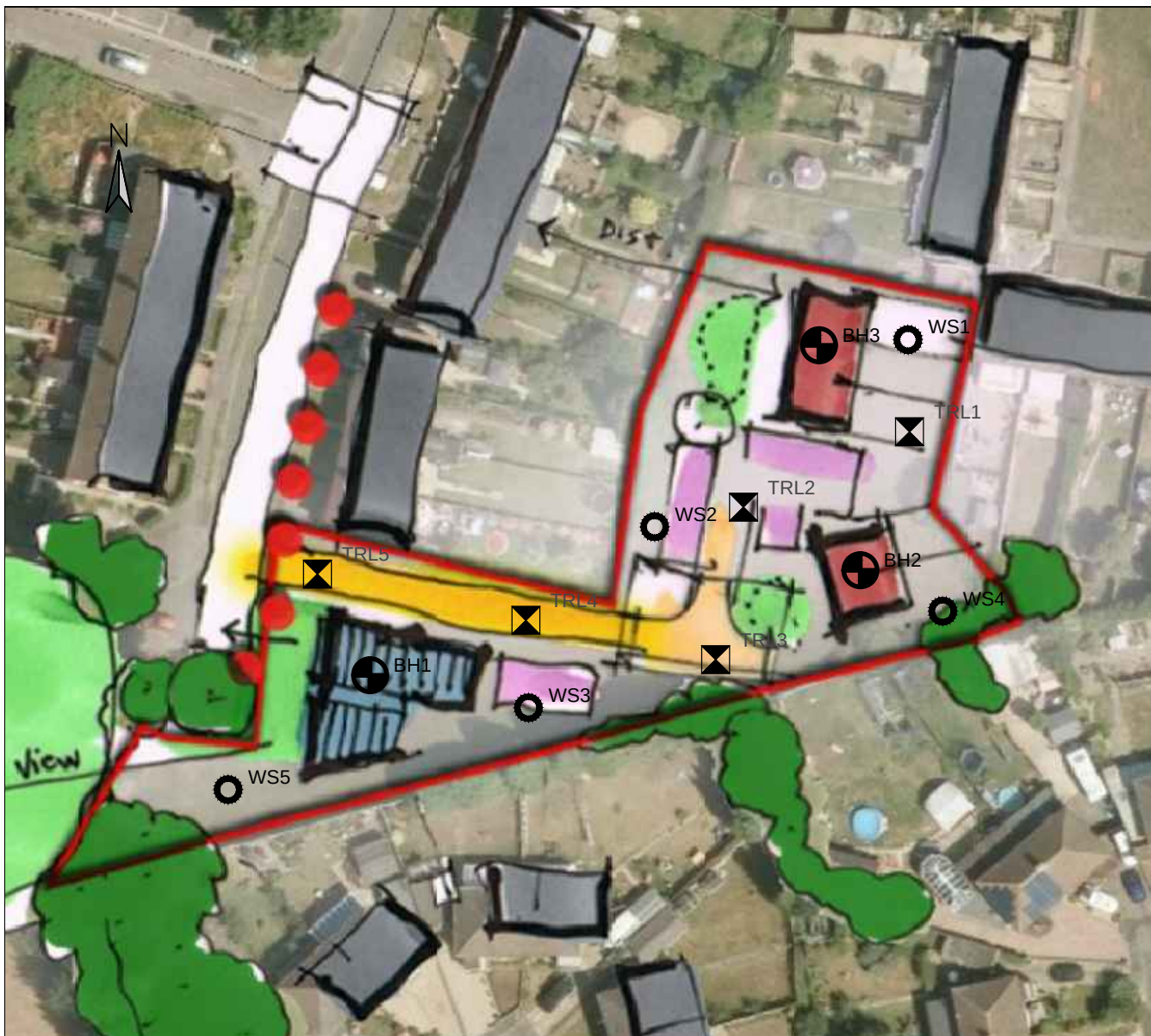
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FIGURE 1

REV

Figure 2 – Investigation Location Plan



KEY:



BOREHOLE LOCATION



WINDOW SAMPLE LOCATION



TRL PROBE LOCATION

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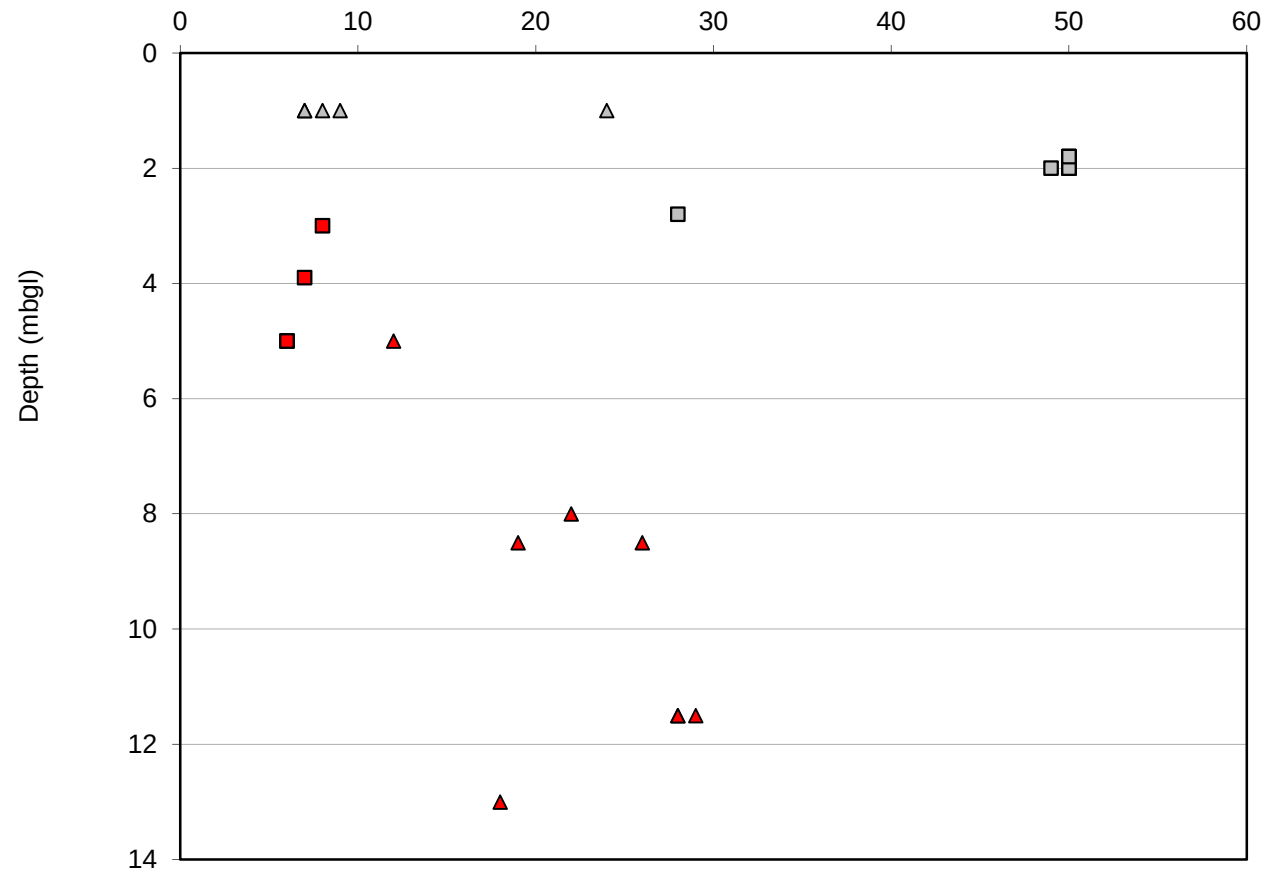
FIGURE 2

REV

-

Figure 3 – SPT N v Depth

SPT N



□ Dense Gravels

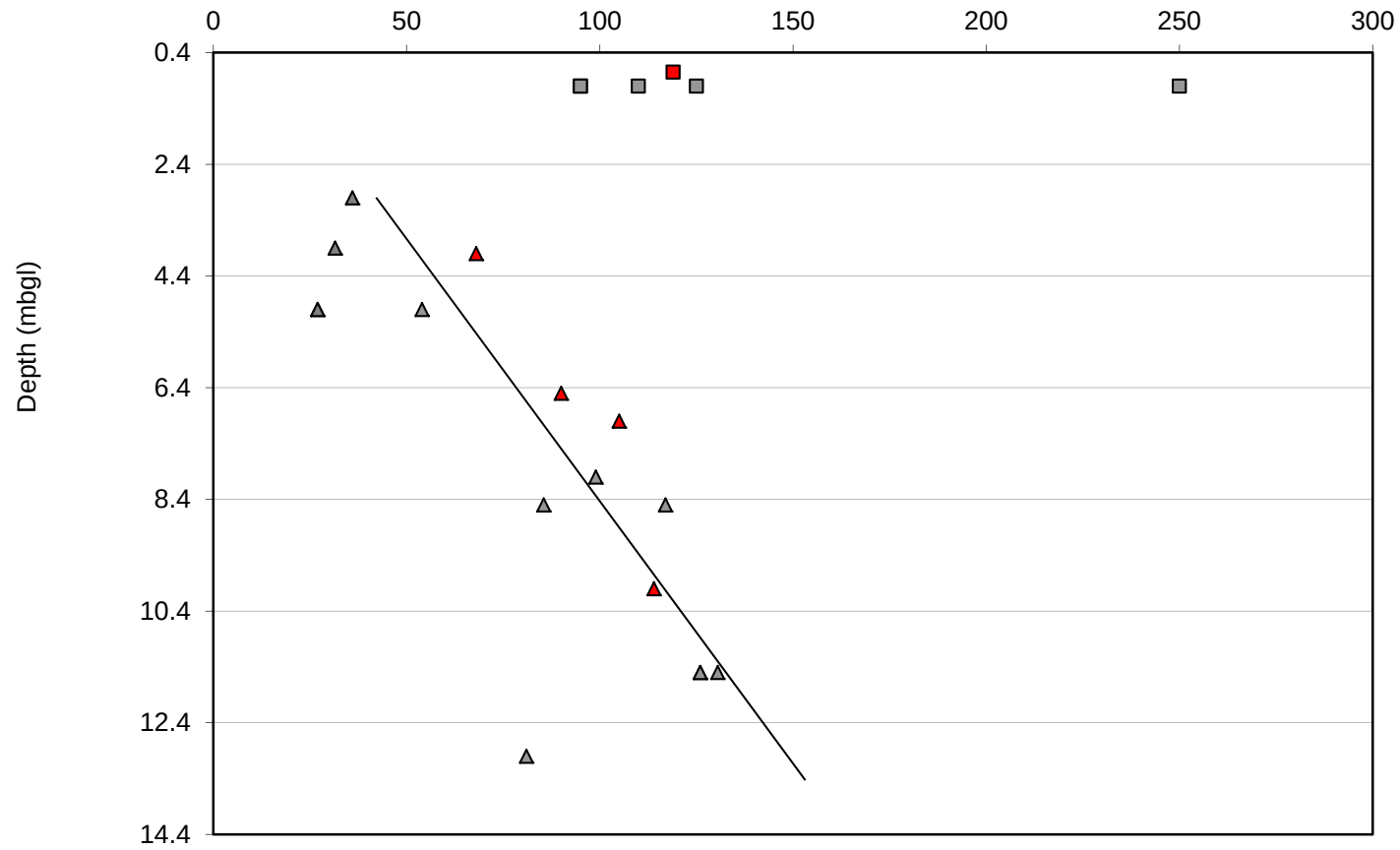
△ Fine Sand, Silt and Clay

■ Weathered LCF

▲ LCF

Figure 4 – Undrained Shear Strength v Depth

Undrained Shear Strength (kN/m²)



■ Lab QU

■ SPT Correlation

▲ Lab QU LCF

▲ SPT LCF

Appendix 1 – Report Conditions

Ground Condition Assessment

This report is produced solely for the benefit of **Portsmouth City Council** and no liability is accepted for any reliance placed on it by any other party unless specifically agreed in writing otherwise.

This report refers, within the limitations stated, to the condition of the site at the time of the inspections. No warranty is given as to the possibility of future changes in the condition of the site.

This report is based on a visual site inspection, study of readily accessible referenced historical records, information supplied by those parties noted in the text and preliminary discussions with local and Statutory Authorities. Some of the opinions are based on unconfirmed data and information and are presented in good faith without exhaustive clarification. Where ground contamination is suspected but no physical site test results are available to confirm this, the report must be regarded as initial advice only, and further assessment should be undertaken prior to detailed activities related to the site. Where test results undertaken by others have been made available these can only be regarded as a limited sample. The possibility of the presence of contaminants, not revealed by this research cannot be discounted.

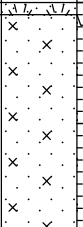
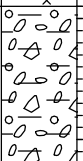
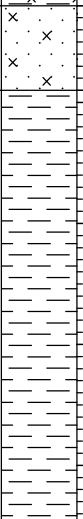
Whilst confident in the findings detailed within this report because there are no exact UK definitions of these matters, being subject to risk analysis, we are unable to give categorical assurances that they will be accepted by Authorities or Funds etc. without question, as such bodies may have unpublished, often more stringent objectives. This report is prepared for the proposed uses stated in the report and should not be used in a different context without reference to Ridge and Partners LLP. In time improved practices or amended legislation may necessitate a re-assessment.

The report is necessarily limited to those aspects of land contamination specifically reported on and no liability is accepted for any other aspect especially concerning gradual or sudden pollution incidents that may occur. The opinions expressed cannot be absolute due to the limitations of time and resources within the context of the agreed brief and the possibility of unrecorded previous use and abuse of the site and adjacent sites. The report concentrates on the site as defined in the report and provides an opinion on surrounding sites. If migrating pollution or contamination (past or present) exists this can only practically be better assessed following extensive on and off site intrusive investigations and monitoring.

Appendix 2 – Engineering Logs

BOREHOLE LOG

Project Holybourne Rd				BOREHOLE No BH1
Job No Holybourne Rd	Date 01-06-15 01-06-15	Ground Level (m)	Co-Ordinates ()	
Contractor DJ Drilling				Sheet 1 of 2

SAMPLES & TESTS			Water	Reduced Level	Legend	Depth (Thickness)	STRATA	Geology	Instrument/Backfill
Depth	Type No	Test Result					DESCRIPTION		
0.30 0.30-0.50 0.50-0.70	D1 ESA B2	30 blows				0.10	Brown silty clayey fine SAND with frequent rootlets		
1.20-1.55 1.55	U3 D4					(1.80)	Brown silty clayey fine SAND		
2.00-2.45 2.00	D5					1.90	Dense silty clayey fine to coarse angular to sub angular flint GRAVEL		
3.00-3.45 3.00	D6	N8				3.20			
4.00-4.45 4.45	U7 D8	(1.00)				Firm brown grey silty CLAY			
5.00 5.00	D9	4.20				Brown silty clayey fine SAND			
6.00 6.50-7.00 7.00-7.50	D10 B11 B12	N12				4.90			
8.00-8.20 8.50 8.50	D13 D14					(7.10)	Firm to stiff grey CLAY		
9.50	D15								

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Depth	Date	Time	Casing Depth	Casing Dia. mm	Water Depth	From	To	Hours	From	To	
All dimensions in metres Scale 1:62.5		Client PCC				Method/ Plant Used Dando 2000				Logged By DAP	

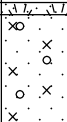
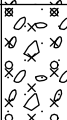
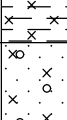
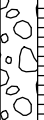
BOREHOLE LOG

Project Holybourne Rd				BOREHOLE No BH1
Job No Holybourne Rd	Date 01-06-15 01-06-15	Ground Level (m)	Co-Ordinates ()	
Contractor DJ Drilling				Sheet 2 of 2

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BOREHOLE LOG

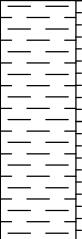
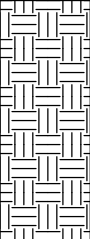
Project Holybourne Rd				BOREHOLE No BH2
Job No Holybourne Rd	Date 02-06-15 02-06-15	Ground Level (m)	Co-Ordinates ()	
Contractor DJ Drilling				Sheet 1 of 2

SAMPLES & TESTS			Water	Reduced Level	Legend	Depth (Thickness)	STRATA	Geology	Instrument/Backfill
Depth	Type No	Test Result					DESCRIPTION		
0.30	D1	45 blows			0.10	Brown silty clayey fine SAND with frequent rootlets			
0.50-0.70	B2				(1.60)	Brown silty clayey gravelly fine SAND. Gravel is of fine to medium angular flint			
0.50	ESA								
1.20-1.40	U3	N50/ 225 mm			1.70				
1.40	D4				2.00	Brown silty clayey sandy fine to medium angular flint GRAVEL			
2.00-2.50	B5				(1.30)	Dense silty sandy medium to coarse angular to sub angular flint GRAVEL			
2.00	B6	N14			3.30				
3.00-3.50					(1.00)	Firm brown silty CLAY			
3.00					4.30				
4.00-4.45	U7	N6			4.30				
4.45	D8				(0.80)	Brown silty gravelly fine SAND. Gravel is of fine to medium angular flint			
5.00	D9				5.10				
5.00	D10	N22			(0.90)	Soft to firm grey silty CLAY			
6.00					6.00				
6.50-6.85					U11				
6.85	D12				(6.00)	Firm to stiff grey CLAY			
7.50	D13								
8.00	D14								
8.00	D15								
9.00									
9.50									B16

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Depth	Date	Time	Depth	Casing Dia. mm	Water Depth	From	To	Hours	From	To	

BOREHOLE LOG

Project Holybourne Rd				BOREHOLE No BH2	
Job No Holybourne Rd	Date 02-06-15 02-06-15	Ground Level (m)	Co-Ordinates ()		
Contractor DJ Drilling				Sheet 2 of 2	

SAMPLES & TESTS			Water				STRATA	Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
10.00-10.45	U17	65 blows				12.00	Firm to stiff grey CLAY (continued)		
10.45	D18								
11.00	D19								
11.50	D20								
11.50		N28							

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Depth	Date	Time	Depth	Casing Dia. mm	Water Depth	From	To	Hours	From	To	
All dimensions in metres Scale 1:62.5			Client PCC			Method/ Plant Used Dando 2000			Logged By DAP		

BOREHOLE LOG

Project Holybourne Rd				BOREHOLE No BH3
Job No Holybourne Rd	Date 03-06-15 03-06-15	Ground Level (m)	Co-Ordinates ()	
Contractor DJ Drilling				Sheet 1 of 2

SAMPLES & TESTS			Water	STRATA			Geology	Instrument/ Backfill				
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)			DESCRIPTION			
0.30	D1 ESA B2	N50/ 210 mm			0.10	Brown silty clayey SAND with frequent rootlets						
0.30												
0.50-0.70												
1.20-1.70	B3				(1.70)							
1.80-2.30	B4				1.80							
1.80					2.00							
2.80-3.30	B5			N28		(2.10)			Brown silty clayey gravelly fine SAND. Gravel is of fine to medium angular to sub angular flint			
2.80												Dense silty slightly sandy clayey fine to coarse angular to sub rounded flint GRAVEL
3.90-4.40	B6			N7		4.10						
3.90		(0.70)	Firm brown CLAY									
		4.80										
5.00-5.45	D7	N6		(0.50)	Brown silty fine SAND							
5.00				5.30								
				(1.10)	Firm grey silty CLAY							
6.00	D8	N26		6.40								
6.50-7.00	B9				Firm to stiff grey CLAY							
7.00-7.35	U10											
7.35	D11											
8.00	D12											
8.50-8.95	D13											
8.50		(5.60)										
9.50	D14											

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Depth	Date	Time	Casing Depth	Dia. mm	Water Depth	From	To	Hours	From	To	

Project Holybourne Rd				BOREHOLE No BH3
Job No Holybourne Rd	Date 03-06-15 03-06-15	Ground Level (m)	Co-Ordinates ()	
Contractor DJ Drilling				Sheet 2 of 2

[illegible][illegible]

BOREHOLE LOG

Project Holybourne Rd				BOREHOLE No WS1
Job No Holybourne Rd	Date 01-06-15 01-06-15	Ground Level (m)	Co-Ordinates ()	
Contractor DJ Drilling				Sheet 1 of 1

SAMPLES & TESTS			Water	STRATA			Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick- ness)		
0.20	ES1	N7			0.30	Light brown clayey silty fine SAND with occasional rootlets and small brick fragments (TOPSOIL)		
0.45	ES2				0.50	Firm to stiff orange brown slightly sand silty CLAY		
1.00					(1.10)	Stiff orange brown sikty clay		
					1.60			
					2.00	Dense coarse angular flint GRAVEL		
2.00		N50/ 70 mm						

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Depth	Date	Time	Casing Depth	Dia. mm	Water Depth	From	To	Hours	From	To	

SAMPLES & TESTS			Water	STRATA			Geology	Instrument/ Backfill	
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick- ness)			DESCRIPTION
0.20	ES1	N8				0.40	Brown silty clayey gravelly fine SAND with frequent rootlets and small brick fragments		
0.40	ES2					(1.10)	Firm to stiff orange brown slightly sandy silty CLAY		
0.50-1.00	U3								
1.00	ES4								
1.30-1.60						1.50			
1.80				1.80	Dense silty clayey fine to coarse angular flint GRAVEL				
		N50/ 110 mm							

BOREHOLE LOG

Project Holybourne Rd				BOREHOLE No WS3
Job No Holybourne Rd	Date 01-06-15 01-06-15	Ground Level (m)	Co-Ordinates ()	
Contractor DJ Drilling				Sheet 1 of 1

SAMPLES & TESTS			Water	STRATA			Geology	Instrument/ Backfill		
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)			DESCRIPTION	
0.10-0.30	ES1	N7				0.35	Light brown silty slightly clayey gravelly fine SAND. Gravel is of fine to medium angular flint			
0.50-0.60	ES2					(1.15)	Firm to stiff orange brown slightly sandy silty CLAY			
1.00							1.50	Dense slightly clayey fine to coarse angular flint GRAVEL		
1.90				N50/ 170 mm			1.90			

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BOREHOLE LOG

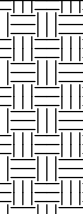
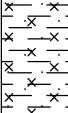
Project Holybourne Rd				BOREHOLE No WS4
Job No Holybourne Rd	Date 01-06-15 02-06-15	Ground Level (m)	Co-Ordinates ()	
Contractor DJ Drilling				Sheet 1 of 1

[illegible]

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Depth	Date	Time	Casing Depth	Dia. mm	Water Depth	From	To	Hours	From	To	
All dimensions in metres Scale 1:62.5			Client PCC			Method/ Plant Used Terrier			Logged By DAP		

BOREHOLE LOG

Project Holybourne Rd				BOREHOLE No WS5
Job No Holybourne Rd	Date 01-06-15 02-06-15	Ground Level (m)	Co-Ordinates ()	
Contractor DJ Drilling				Sheet 1 of 1

SAMPLES & TESTS			Water	STRATA			Geology	Instrument/ Backfill	
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)			DESCRIPTION
0.10-0.40	ES1	N9				(0.60) 0.60	Light brown silty gravelly fine SAND. Gravel is of medium to coarse angular to sub angular flint		
0.60-0.80	ES2					(1.00) 1.60	Firm to stiff orange brown silty slightly sandy CLAY		
1.00						1.80	Dense clayey fine to coarse angular flint GRAVEL		
1.80		N50/ 165 mm							

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Depth	Date	Time	Casing Depth	Dia. mm	Water Depth	From	To	Hours	From	To	
All dimensions in metres Scale 1:62.5			Client PCC			Method/ Plant Used Terrier			Logged By DAP		

Appendix 3 – Generic Assessment Criteria

SOIL - HUMAN HEALTH SCREENING VALUES

Status	End Use	Issue No	Issue Date		
ISSUE	Residential with Homegrown Produce	1	June 2015		
Determinand	Units	SOIL ORGANIC MATTER			SOURCE
		1%	2.5 %	6 %	
pH		<5, >9			
Asbestos	%	Presence			
HEAVY METALS/ METALLOIDS					
Arsenic	mg/kg		37		S4UL
Cadmium	mg/kg		11		S4UL
Chromium (III)	mg/kg		910		S4UL
Chromium (VI)	mg/kg		6		S4UL
Lead	mg/kg		200		S4UL
Mercury (Elemental)	mg/kg		1.2		S4UL
Mercury (Inorganic)	mg/kg		40		S4UL
Mercury (Methyl)	mg/kg		11		S4UL
Nickel	mg/kg		180		S4UL
Selenium	mg/kg		250		S4UL
Beryllum	mg/kg		1.7		S4UL
Boron	mg/kg		290		S4UL
Vanadium	mg/kg		410		S4UL
Copper	mg/kg		2,400		S4UL
Zinc	mg/kg		3,700		S4UL
GENERAL INORGANICS					
Easily Liberatable Cyanide (free)	mg/kg		36		Acute effects infant 1 dose 3g soil
US EPA PRIORITY PAHs					
Acenaphthene	mg/kg	210	510	1100	S4UL
Acenaphthylene	mg/kg	170	420	920	S4UL
Anthracene	mg/kg	2,400	5,400	11000	S4UL
Benzo(a)anthracene	mg/kg	72	11	13	S4UL
Benzo(b)fluoranthene	mg/kg	2.6	3.3	3.7	S4UL
Benzo(k)fluoranthene	mg/kg	77	93	100.0	S4UL
Benzo(g,h,i)perylene	mg/kg	320	340	350	S4UL
Benzo(a)pyrene	mg/kg	2.20	2.7	3	S4UL
Chrysene	mg/kg	15	22	27.0	S4UL
Di-benzo(a,h)anthracene	mg/kg	0.24	0.28	0.30	S4UL
Fluoranthene	mg/kg	280	560	890	S4UL
Fluorene	mg/kg	170	400	860	S4UL
Indeno(1,2,3-cd)pyrene	mg/kg	27.0	36	41.0	S4UL
Naphthalene	mg/kg	2.3	5.6	13.0	S4UL
Phenanthrene	mg/kg	95	220	440	S4UL
Pyrene	mg/kg	620	1200	2000	S4UL
Total PAHs	mg/kg	No Sum	No Sum	No Sum	
Chlorinated Solvents/VOCs					
1,2-Dichloroethane (DCE)	mg/kg	0.0071	0.011	0.019	S4UL
1,1,1-Trichloroethane (111 TCA)	mg/kg	8.8	18	39	S4UL
1,1,1,2-Tetrachloroethane (1112 PCA)	mg/kg	1.2	2.8	6.40	S4UL
1,1,2,2-Tetrachloroethane (1122 PCA)	mg/kg	1.60	3.4	7.5	S4UL
Tetrachloroethene (PCE)	mg/kg	0.18	0.39	0.9	S4UL
Tetrachloroethane (Carbon Tetrachloride)	mg/kg	0.026	0.056	0.13	S4UL
Trichloroethene (TCE)	mg/kg	0.016	0.034	0.075	S4UL
Trichloromethane (Chloroform)	mg/kg	0.91	1.7	3.4	S4UL
Vinyl Chloride	mg/kg	0.00064	0.00087	0.0014	S4UL
Chlorobenzene	mg/kg	0.46	1	2.4	S4UL
1,2-Dichlorobenzene	mg/kg	23	55	130	S4UL
1,3-Dichlorobenzene	mg/kg	0.4	1	2.3	S4UL
1,4-Dichlorobenzene	mg/kg	61	150	350	S4UL
1,2,3-Trichlorobenzene	mg/kg	1.5	3.6	8.6	S4UL
1,2,4-Trichlorobenzene	mg/kg	2.6	6.4	15	S4UL
1,3,5-Trichlorobenzene	mg/kg	0.33	0.81	1.9	S4UL
1,2,3,4-Tetrachlorobenzene	mg/kg	15	36	78	S4UL
1,2,3,5-Tetrachlorobenzene	mg/kg	0.66	1.6	3.7	S4UL
1,2,4,5-Tetrachlorobenzene	mg/kg	0.33	0.77	1.6	S4UL
Pentachlorobenzene	mg/kg	5.8	12	22	S4UL
Hexachlorobenzene	mg/kg	1.8	3.3	4.9	S4UL
Carbon Disulphide	mg/kg	0.14	0.29	0.62	S4UL
Hexachlorobutadiene	mg/kg	0.29	0.7	1.6	S4UL
Phenolics					
Phenol	mg/kg	280	550	1100	S4UL
Chlorophenols	mg/kg	0.87	2.00	4.50	S4UL
Pentachlorophenol	mg/kg	0.22	0.52	1.20	S4UL
Explosives					
2,4,6-Trinitrotoluene (TNT)	mg/kg	1.6	3.7	8.1	S4UL
RDX	mg/kg	120.0	250.0	540.0	S4UL
HMX	mg/kg	5.7	13.0	26.0	S4UL
Insecticides/ Herbicides					
Aldrin	mg/kg	5.70	6.60	7.10	S4UL
Dieldrin	mg/kg	0.97	2.00	3.50	S4UL
Atrazine	mg/kg	3.30	7.60	17.40	S4UL
Dichlorvos	mg/kg	0.032	0.066	0.140	S4UL
Alpha-Endosulfan	mg/kg	7.4	18.0	41.0	S4UL
Beta-Endosulfan	mg/kg	7.0	17.0	39.0	S4UL
Alpha-Hexachlorocyclohexane	mg/kg	0.23	0.55	1.20	S4UL
Beta-Hexachlorocyclohexane	mg/kg	0.085	0.200	0.460	S4UL
Gamma-Hexachlorocyclohexanes (Lindane)	mg/kg	0.06	0.14	0.33	S4UL
TPH					
TPH Aliphatic >C5-6	mg/kg	42	78	160	S4UL
TPH Aliphatic >C6-8	mg/kg	100	230	530	S4UL
TPH Aliphatic >C8-10	mg/kg	27	65	150	S4UL
TPH Aliphatic >C10-12	mg/kg	130	330	760	S4UL
TPH Aliphatic >C12-15	mg/kg	1100	2,400	4,300	S4UL
TPH Aliphatic >C16-35	mg/kg	65,000	92,000	110,000	S4UL
TPH Aliphatic >C35-44	mg/kg	65,000	92,000	110,000	S4UL
TPH Aromatic >EC5-7 (Benzene)	mg/kg	70	140.00	300	S4UL
TPH Aromatic >EC7-8	mg/kg	130	290	660	S4UL
TPH Aromatic >EC8-10	mg/kg	34	83	190	S4UL
TPH Aromatic >EC10-12	mg/kg	74	180	390	S4UL
TPH Aromatic >EC12-16	mg/kg	140	330	660	S4UL
TPH Aromatic >EC16-21	mg/kg	260	540	930	S4UL
TPH Aromatic >EC21-35	mg/kg	1100	1,500	1,700	S4UL
TPH Aromatic >EC35-44	mg/kg	1100	1,500	1,700	S4UL
TPH Aliphatic & Aromatic >EC44-70	mg/kg	1,600	1,800	1,900	S4UL
Total TPH	mg/kg	No Sum	No Sum	No Sum	
BTEX					
Benzene	mg/kg	0.087	0.17	0.37	S4UL
Toluene	mg/kg	130	290	660	S4UL
Ethylbenzene	mg/kg	47	110	260	S4UL
m-Xylene	mg/kg	60	140	330	S4UL
p-Xylene	mg/kg	59	140	320	S4UL
o-Xylene	mg/kg	56	130	310	S4UL

NOTES

- Compare individual samples values against Soil Screening Values (SSV). If exceedences are noted consider further in relation to averaging areas and statistical analysis.
- These values are for initial screening for potential **risk to human health only**. They are **not remediation thresholds**. Screening for other receptors to be done separately as appropriate for the site, e.g. for water, ecology, building materials.
- Screening criteria denoted with an asterisk (*) were capped at the lower vapour/aqueous saturation limits for Tier 1 human health risk assessment purposes and considered **conservative**. Where concentrations are recorded at levels greater than the SSV, free phase (NAPL) contamination may be present and should be considered qualitatively. Further information to support the interpretation of assessment criteria that exceed theoretical soil saturation limits is provided in Section 4.12 of the CLEA Software Handbook (SR4).
- Screening criteria denoted with hash (#) were capped at 1000000mg/kg. It is noted that aesthetic (e.g. odour) and other site specific factors may also be relevant when providing advice relating to these compounds.
- LQM/CIEH S4ULs November 2014 - Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3439. All rights reserved.
- SSVs derived for certain constituents may be low in relation to standard laboratory Limits of Detection (LoD). It is the responsibility of the project engineer to check with the laboratory that appropriate detection limits can be achieved. As a target, a LoD would be no larger than 10% of the SSV, but this is not practicable for some constituents. Clearly an LoD greater than the SSV would prevent use of this SSV screening and/or be interpreted as if all samples exceeded the SSV.
- Human Health Soil Screening Values (SSV)** were calculated using a Soil Organic Matter (SOM) value of 1.0%, 2.5% and 6%. This is equivalent to an Fraction Organic Carbon (FOC) values of approx. 0.6%, 1.45% and 3.5% respectively (For reference FOC = 0.58*SOM). **Note that some soils have different SOM/FOC, which may give require more stringent SSVs for organic compounds. It is the responsibility of the project engineer to check the SOM with the site specific conditions.**
- In general, SSVs above 100mg/kg are rounded down to 3 significant figures. Similarly, SSVs below 100mg/kg are rounded down to 2 significant figures

Appendix 4 – Soil Screening Summary

Sample Point / Determinands	Relevant Residential Quality Standard			WS1	WS1	WS2	WS2	WS3	WS3	WS4	WS4	WS5	WS5
Depth				0.20	0.45	0.20	0.40	0.10	0.50	0.15	0.50	0.10	0.60
	1% SOM	2.5% SOM	6% SOM					0.30	0.60	0.25	0.60	0.40	0.80
HEAVY METALS	mg/kg			01/06/15	01/06/15	01/06/15	01/06/15	01/06/15	01/06/15	01/06/15	01/06/15	01/06/15	01/06/15
Antimony	NA			<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Arsenic	37			8	11	8	8	8	10	7	10	7	11
Barium	NA			63	58	68	62	62	68	56	64	54	54
Beryllium	1.7			1	1	1	1	1	1	1	1	1	1
Boron	290			<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	11			<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium (III)	910			26	36	26	25	31	38	21	37	23	33
Copper	2,400			13	11	13	13	12	13	14	13	13	13
Lead	200			36	13	41	35	27	15	48	14	30	13
Mercury (Inorganic)	40			<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	0.19	<0.17	<0.17
Molybdenum	NA			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	180			13	20	13	13	17	22	11	21	13	21
Selenium	250			1	<1	2	<1	1	2	2	2	<1	2
Zinc	3,700			45	50	54	43	53	52	148	50	49	52
ORGANICS	mg/kg												
Phenols	280	550	1100	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Polycyclic Aromatic Hydrocabons	mg/kg												
Naphthalene	2.3	5.6	13.00	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Acenaphthylene	170	420	920	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	210	510	1100	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	170	400	860	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	95	220	440	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.14	<0.03
Anthracene	2,400	5400	11000	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02
Fluoranthene	280	560	890	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.56	<0.08
Pyrene	620	1200	2000	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	0.53	<0.07
Benzo(a)anthracene	72.0	11.0	13.0	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.17	<0.04
Chrysene	15.0	22.0	27.0	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	0.36	<0.06
Benzo(b)fluoranthene	2.6	3.3	3.7	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.22	<0.05
Benzo(k)fluoranthene	77.0	93.0	100.0	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	0.25	<0.07
Benzo(a)pyrene	2.2	2.7	3.0	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.16	<0.04
Indeno(123cd)pyrene	27.0	36.0	41.0	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.17	<0.03
Dibenzo(a,h)anthracene	0.2	0.3	0.3	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Benzo(ghi)perylene	320.0	340.0	350.0	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.14	<0.05
Total PAHs	NA			<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	2.72	<0.08
TPH	mg/kg												
Aliphatics													
Ali >C5-C6	42	78	160	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ali >C6-C8	100	230	530	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ali >C8-C10	27	65	150	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ali >C10-C12	130	330	760	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ali >C12-C16	1100	2,400	4,300	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ali >C16-C21	45000	64000	76000	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ali >C21-C35	45000	64000	76000	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
EC>C35-C44	65,000	92,000	110,000										
Total Aliphatics	NA			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aromatics													
Aromatics >EC5-EC7	70	140.000	300.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aromatics >EC7-EC8	130	290	660	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aromatics >EC8-EC10	34	83	190	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aromatics >EC10-EC12	74	180	380	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aromatics >EC12-EC16	140	330	660	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aromatics >EC16-EC21	260	540	930	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aromatics >EC21-EC35	1100	1,500	1,700	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	<0.1
Total Aromatics	NA			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.1	<0.1
"Total" Hydrocarbons (C5-C44)	NA			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.1	<0.1
MTBE	49	84	160	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzene	0.087	0.17	0.37	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Toluene	130	290	660	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ethylbenzene	47	110	260	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
m,p-Xylenes	56	130	310	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
o-Xylene	59	140	320	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
INORGANICS	mg/kg												
pH (pH Units)	5	to	9	7.03	7.51	6.87	7.34	7.23	8.23	7.51	8.16	8.02	8.15
Free Cyanide	36			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Asbestos													
Asbestos Screen	Presence			NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD
Fractional Organic Carbon													
Fractional Organic Carbon	NA			0.012	0.0029	0.0122	0.0211	0.0139	0.0031	0.0134	0.0029	0.0115	0.0025
SOM (%)	NA			2.07	0.50	2.10	3.64	2.40	0.53	2.31	0.50	1.98	0.43

1. CLEA Soil Guideline Value (CLEA v.1.06)
2. LQM CIEH GAC (2nd Edition)
3. SGV Report 10 (withdrawn)
4. EIC/AGS/CL:AIRE GAC (CLEA v.1.06)
5. Acute effects infant 1 dose 3g soil
6. Provisional C4SL
%SOM = FOC (100/0.58)
NA Not available
NAD No ACM Detected

Appendix 5 – Chemical Analysis Results

FINAL ANALYTICAL TEST REPORT

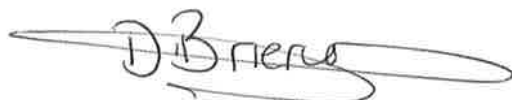
Envirolab Job Number: 15/04102
Issue Number: 1

Date: 30 June, 2015

Client: Ridge and Partners Ltd
Partnership House
Moorside Road
Winchester
UK
SO23 7RX

Project Manager: Antony Platt
Project Name: Holybourne Road
Project Ref: 151239
Order No: 994210
Date Samples Received: 05/06/15
Date Instructions Received: 22/06/15
Date Analysis Completed: 30/06/15

Prepared by:



Danielle Brierley
Administrative Assistant

Approved by:



Iain Haslock
Analytical Consultant

Envirolab Job Number: 15/04102

Client Project Name: Holybourne Road

Client Project Ref: 151239

Lab Sample ID	15/04102/3	15/04102/4	15/04102/5	15/04102/6	15/04102/8	15/04102/9	15/04102/10	15/04102/11	Units	Method ref
Client Sample No										
Client Sample ID	WS1	WS1	WS2	WS2	WS3	WS3	WS4	WS4		
Depth to Top	0.20	0.45	0.20	0.40	0.10	0.50	0.15	0.50		
Depth To Bottom					0.30	0.60	0.25	0.60		
Date Sampled	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15		
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil		
Sample Matrix Code	5E	5E	5AE	5AE	5AE	5E	6AE	5		
% Stones >10mm _A [#]	<0.1	<0.1	4.2	<0.1	<0.1	<0.1	4.5	<0.1	% w/w	A-T-044
pH _D ^{M#}	7.03	7.51	6.87	7.34	7.23	8.23	7.51	8.16	pH	A-T-031s
Ammonium NH ₄ (exchangeable/water soluble) _D	0.75	<0.26	1.43	1.26	3.12	<0.26	3.41	<0.26	mg/kg	A-T-033s
Sulphate (water sol 2:1) _D ^{M#}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	g/l	A-T-026s
Cyanide (free) _A ^{M#}	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-042sFCN
Phenols - Total by HPLC _A	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	mg/kg	A-T-050s
Fraction of organic carbon _D [#]	0.0120	0.0029	0.0122	0.0211	0.0139	0.0031	0.0134	0.0029	N/A	A-T-032 FOC
Antimony _D	<5	<5	<5	<5	<5	<5	<5	<5	mg/kg	A-T-024s
Arsenic _D ^{M#}	8	11	8	8	8	10	7	10	mg/kg	A-T-024s
Barium _D	63	58	68	62	62	68	56	64	mg/kg	A-T-024s
Beryllium _D [#]	1	1	1	1	1	1	1	1	mg/kg	A-T-024s
Boron (water soluble) _D ^{M#}	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	mg/kg	A-T-027s
Cadmium _D ^{M#}	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	mg/kg	A-T-024s
Copper _D ^{M#}	13	11	13	13	12	13	14	13	mg/kg	A-T-024s
Chromium _D ^{M#}	26	36	26	25	31	38	21	37	mg/kg	A-T-024s
Lead _D ^{M#}	36	13	41	35	27	15	48	14	mg/kg	A-T-024s
Mercury _D	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	0.19	mg/kg	A-T-024s
Molybdenum _D ^{M#}	<1	<1	<1	<1	<1	<1	<1	<1	mg/kg	A-T-024s
Nickel _D ^{M#}	13	20	13	13	17	22	11	21	mg/kg	A-T-024s
Selenium _D ^{M#}	1	<1	2	<1	1	2	2	2	mg/kg	A-T-024s
Zinc _D ^{M#}	45	50	54	43	53	52	148	50	mg/kg	A-T-024s

Envirolab Job Number: 15/04102

Client Project Name: Holybourne Road

Client Project Ref: 151239

Lab Sample ID	15/04102/3	15/04102/4	15/04102/5	15/04102/6	15/04102/8	15/04102/9	15/04102/10	15/04102/11	Units	Method ref
Client Sample No										
Client Sample ID	WS1	WS1	WS2	WS2	WS3	WS3	WS4	WS4		
Depth to Top	0.20	0.45	0.20	0.40	0.10	0.50	0.15	0.50		
Depth To Bottom					0.30	0.60	0.25	0.60		
Date Sampled	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15		
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil		
Sample Matrix Code	5E	5E	5AE	5AE	5AE	5E	6AE	5		
TPH CWG										
Ali >C5-C6 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C6-C8 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C8-C10 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Ali >C10-C12 _A [#]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Ali >C12-C16 _A [#]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Ali >C16-C21 _A [#]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Ali >C21-C35 _A [#]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Total Aliphatics _A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-022+23s
Aro >C5-C7 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C8-C9 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C9-C10 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
Aro >C10-C12 _A [#]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Aro >C12-C16 _A [#]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Aro >C16-C21 _A [#]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Aro >C21-C35 _A [#]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-023s
Total Aromatics _A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-022+23s
TPH (Ali & Aro) _A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	mg/kg	A-T-022+23s
BTEX - Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
BTEX - o Xylene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s
MTBE _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-022s

Envirolab Job Number: 15/04102

Client Project Name: Holybourne Road

Client Project Ref: 151239

Lab Sample ID	15/04102/3	15/04102/4	15/04102/5	15/04102/6	15/04102/8	15/04102/9	15/04102/10	15/04102/11	Units	Method ref
Client Sample No										
Client Sample ID	WS1	WS1	WS2	WS2	WS3	WS3	WS4	WS4		
Depth to Top	0.20	0.45	0.20	0.40	0.10	0.50	0.15	0.50		
Depth To Bottom					0.30	0.60	0.25	0.60		
Date Sampled	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15		
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil		
Sample Matrix Code	5E	5E	5AE	5AE	5AE	5E	6AE	5		
Asbestos in Soil (inc. matrix)										
Asbestos in soil _A [#]	NAD	NAD	NAD	NAD	NAD	NAD	NAD	NAD		A-T-045
Asbestos ACM - Suitable for Water Absorption Test? _D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		Gravimetry

Envirolab Job Number: 15/04102

Client Project Name: Holybourne Road

Client Project Ref: 151239

Lab Sample ID	15/04102/3	15/04102/4	15/04102/5	15/04102/6	15/04102/8	15/04102/9	15/04102/10	15/04102/11	Units	Method ref
Client Sample No										
Client Sample ID	WS1	WS1	WS2	WS2	WS3	WS3	WS4	WS4		
Depth to Top	0.20	0.45	0.20	0.40	0.10	0.50	0.15	0.50		
Depth To Bottom					0.30	0.60	0.25	0.60		
Date Sampled	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15	01-Jun-15		
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil		
Sample Matrix Code	5E	5E	5AE	5AE	5AE	5E	6AE	5		
PAH-16MS (Ridge+Partners)										
Naphthalene _A ^{M#}	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	mg/kg	A-T-019s
Acenaphthylene _A ^{M#}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-019s
Acenaphthene _A ^{M#}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-019s
Fluorene _A ^{M#}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/kg	A-T-019s
Phenanthrene _A ^{M#}	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	mg/kg	A-T-019s
Anthracene _A ^{M#}	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	mg/kg	A-T-019s
Fluoranthene _A ^{M#}	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	mg/kg	A-T-019s
Pyrene _A ^{M#}	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	mg/kg	A-T-019s
Benzo(a)anthracene _A ^{M#}	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	mg/kg	A-T-019s
Chrysene _A ^{M#}	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	mg/kg	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	mg/kg	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	mg/kg	A-T-019s
Benzo(a)pyrene _A ^{M#}	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	mg/kg	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	mg/kg	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	mg/kg	A-T-019s
Benzo(ghi)perylene _A ^{M#}	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	mg/kg	A-T-019s
PAH (total 16) _A ^{M#}	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	mg/kg	A-T-019s

Envirolab Job Number: 15/04102

Client Project Name: Holybourne Road

Client Project Ref: 151239

Lab Sample ID	15/04102/13	15/04102/14							Units	Method ref
Client Sample No										
Client Sample ID	WS5	WS5								
Depth to Top	0.10	0.60								
Depth To Bottom	0.40	0.80								
Date Sampled	01-Jun-15	01-Jun-15								
Sample Type	Soil	Soil								
Sample Matrix Code	5AE	5AE								
% Stones >10mm _A [#]	0.8	<0.1							% w/w	A-T-044
pH _D ^{M#}	8.02	8.15							pH	A-T-031s
Ammonium NH4 (exchangeable/water soluble) _D	2.42	<0.26							mg/kg	A-T-033s
Sulphate (water sol 2:1) _D ^{M#}	<0.01	<0.01							g/l	A-T-026s
Cyanide (free) _A ^{M#}	<1	<1							mg/kg	A-T-042sFCN
Phenols - Total by HPLC _A	<0.2	<0.2							mg/kg	A-T-050s
Fraction of organic carbon _D [#]	0.0115	0.0025							N/A	A-T-032 FOC
Antimony _D	<5	<5							mg/kg	A-T-024s
Arsenic _D ^{M#}	7	11							mg/kg	A-T-024s
Barium _D	54	54							mg/kg	A-T-024s
Beryllium _D [#]	1	1							mg/kg	A-T-024s
Boron (water soluble) _D ^{M#}	<1.0	<1.0							mg/kg	A-T-027s
Cadmium _D ^{M#}	<0.5	<0.5							mg/kg	A-T-024s
Copper _D ^{M#}	13	13							mg/kg	A-T-024s
Chromium _D ^{M#}	23	33							mg/kg	A-T-024s
Lead _D ^{M#}	30	13							mg/kg	A-T-024s
Mercury _D	<0.17	<0.17							mg/kg	A-T-024s
Molybdenum _D ^{M#}	<1	<1							mg/kg	A-T-024s
Nickel _D ^{M#}	13	21							mg/kg	A-T-024s
Selenium _D ^{M#}	<1	2							mg/kg	A-T-024s
Zinc _D ^{M#}	49	52							mg/kg	A-T-024s

Envirolab Job Number: 15/04102

Client Project Name: Holybourne Road

Client Project Ref: 151239

Lab Sample ID	15/04102/13	15/04102/14							Units	Method ref
Client Sample No										
Client Sample ID	WS5	WS5								
Depth to Top	0.10	0.60								
Depth To Bottom	0.40	0.80								
Date Sampled	01-Jun-15	01-Jun-15								
Sample Type	Soil	Soil								
Sample Matrix Code	5AE	5AE								
TPH CWG										
Ali >C5-C6 _A [#]	<0.01	<0.01							mg/kg	A-T-022s
Ali >C6-C8 _A [#]	<0.01	<0.01							mg/kg	A-T-022s
Ali >C8-C10 _A [#]	<0.01	<0.01							mg/kg	A-T-022s
Ali >C10-C12 _A [#]	<0.1	<0.1							mg/kg	A-T-023s
Ali >C12-C16 _A [#]	<0.1	<0.1							mg/kg	A-T-023s
Ali >C16-C21 _A [#]	<0.1	<0.1							mg/kg	A-T-023s
Ali >C21-C35 _A [#]	<0.1	<0.1							mg/kg	A-T-023s
Total Aliphatics _A	<0.1	<0.1							mg/kg	A-T-022+23s
Aro >C5-C7 _A [#]	<0.01	<0.01							mg/kg	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01							mg/kg	A-T-022s
Aro >C8-C9 _A [#]	<0.01	<0.01							mg/kg	A-T-022s
Aro >C9-C10 _A [#]	<0.01	<0.01							mg/kg	A-T-022s
Aro >C10-C12 _A [#]	<0.1	<0.1							mg/kg	A-T-023s
Aro >C12-C16 _A [#]	<0.1	<0.1							mg/kg	A-T-023s
Aro >C16-C21 _A [#]	0.3	<0.1							mg/kg	A-T-023s
Aro >C21-C35 _A [#]	0.8	<0.1							mg/kg	A-T-023s
Total Aromatics _A	1.1	<0.1							mg/kg	A-T-022+23s
TPH (Ali & Aro) _A	1.1	<0.1							mg/kg	A-T-022+23s
BTEX - Benzene _A [#]	<0.01	<0.01							mg/kg	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01							mg/kg	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	<0.01							mg/kg	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	<0.01							mg/kg	A-T-022s
BTEX - o Xylene _A [#]	<0.01	<0.01							mg/kg	A-T-022s
MTBE _A [#]	<0.01	<0.01							mg/kg	A-T-022s

Envirolab Job Number: 15/04102

Client Project Name: Holybourne Road

Client Project Ref: 151239

Lab Sample ID	15/04102/13	15/04102/14							Units	Method ref
Client Sample No										
Client Sample ID	WS5	WS5								
Depth to Top	0.10	0.60								
Depth To Bottom	0.40	0.80								
Date Sampled	01-Jun-15	01-Jun-15								
Sample Type	Soil	Soil								
Sample Matrix Code	5AE	5AE								
Asbestos in Soil (inc. matrix)										
Asbestos in soil _A [#]	NAD	NAD								A-T-045
Asbestos ACM - Suitable for Water Absorption Test? _D	N/A	N/A								Gravimetry

Envirolab Job Number: 15/04102

Client Project Name: Holybourne Road

Client Project Ref: 151239

Lab Sample ID	15/04102/13	15/04102/14							Units	Method ref
Client Sample No										
Client Sample ID	WS5	WS5								
Depth to Top	0.10	0.60								
Depth To Bottom	0.40	0.80								
Date Sampled	01-Jun-15	01-Jun-15								
Sample Type	Soil	Soil								
Sample Matrix Code	5AE	5AE								
PAH-16MS (Ridge+Partners)										
Naphthalene _A ^{M#}	<0.03	<0.03							mg/kg	A-T-019s
Acenaphthylene _A ^{M#}	<0.01	<0.01							mg/kg	A-T-019s
Acenaphthene _A ^{M#}	<0.01	<0.01							mg/kg	A-T-019s
Fluorene _A ^{M#}	<0.01	<0.01							mg/kg	A-T-019s
Phenanthrene _A ^{M#}	0.14	<0.03							mg/kg	A-T-019s
Anthracene _A ^{M#}	0.03	<0.02							mg/kg	A-T-019s
Fluoranthene _A ^{M#}	0.56	<0.08							mg/kg	A-T-019s
Pyrene _A ^{M#}	0.53	<0.07							mg/kg	A-T-019s
Benzo(a)anthracene _A ^{M#}	0.17	<0.04							mg/kg	A-T-019s
Chrysene _A ^{M#}	0.36	<0.06							mg/kg	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	0.22	<0.05							mg/kg	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	0.25	<0.07							mg/kg	A-T-019s
Benzo(a)pyrene _A ^{M#}	0.16	<0.04							mg/kg	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	0.17	<0.03							mg/kg	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	<0.04	<0.04							mg/kg	A-T-019s
Benzo(ghi)perylene _A ^{M#}	0.14	<0.05							mg/kg	A-T-019s
PAH (total 16) _A ^{M#}	2.72	<0.08							mg/kg	A-T-019s

REPORT NOTES

Notes - Soil chemical analysis

All results are reported as dry weight (<40 °C).

For samples with Matrix Codes 1 - 6 natural stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis. For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.

Notes - General

This report shall not be reproduced, except in full, without written approval from Envirolab.

Subscript "A" indicates analysis performed on the sample as received. "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.

All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supercedes any "A" subscripts.

All analysis is performed on the sample as received for soil samples from outside the European Union and this supercedes any "D" subscripts.

Superscript "M" indicates method accredited to MCERTS.

If results are in italic font they are associated with an AQC failure. These are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

TPH analysis of water by method A-T-007

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Asbestos in soil

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if present as discrete fibres/fragments. Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed.

Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample. Samples with Matrix Code 7 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

IS indicates Insufficient sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Analytical results reflect the quality of the sample at the time of analysis only. Opinions and interpretations expressed are outside the scope of our accreditation.

Please contact us if you need any further information.

Appendix 6 – Monitoring Records

GROUND GAS AND GROUNDWATER MONITORING RESULTS

SITE/REF: Holybourne Road, Havant						General Site comments		
DATE: 08/07/2015		1... of 1...						
OPERATOR(S): DAP/AP								
Ambient Conditions:								
	Barometric Pressure (mb)	CH ₄ (%v/v)	CO ₂ (%v/v)	O ₂ (%v/v)	PID (ppm)			
Before Monitoring	1012	<0.1	<0.1	20.5	-			
After Monitoring	1012	<0.1	<0.1	20.5	-			
Atmospheric Pressure Trend: Falling						EQUIPMENT		
Ground Conditions: Dry						Instrument / Model Type	Serial Number	Comments
Weather Conditions: Overcast						GA2000 Gas Analyser	GA12820	
						Standard Dipmeter	79301	

Ground Gas Note: "0" readings to be recorded as instrument detection limit

Borehole ID	Time	Flow (l/hr)	Relative Pressure (mb)	Steady CH ₄ (%v/v)	CO ₂ (%v/v)	O ₂ (%v/v)	Peak CH ₄ (%v/v)	% of Lower Explosive Limit	CO (ppm)	H ₂ S (ppm)	Balance (%)	PID (ppm)	Response Zone		Response Strata	Gas screening value CH ₄	Gas screening value CO ₂
													From (mbgl)	To (mbgl)			
BH1	10:21	<0.1	8.78	<0.1	2.1	18.5	<0.1	<1	<1	<1	79.4	-	1	7.01	Head/silt	0.0001	0.0021
BH2	10:49	<0.1	8.79	<0.1	2.1	12.8	<0.1	<1	<1	<1	85.1	-	1	5.91	Head/silt	0.0001	0.0021
BH3	11:01	<0.1	8.79	0.1	2.0	19.1	0.1	1	<1	<1	78.9	-	1	5.62	Head/silt	0.0001	0.0001

Groundwater

Borehole ID	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	Free Phase LNAPL Thickness (m)	Free Phase DNAPL Thickness (m)	Water Quality Indicators					Well Volume (l)	Purge Volume (l)	Comments (samples)
					Eh	EC	pH	DO	Temp			
BH1	3.24	7.01	-	-	-	-	-	-	-	-	-	
BH2	3.43	5.91	-	-	-	-	-	-	-	-	-	
BH3	3.72	5.62	-	-	-	-	-	-	-	-	-	

Well volume (l) = $(3.14 \times (\text{hole diameter (m)}/2)^2 \times (\text{base dip (m)} - \text{standing water level (m)})) \times 1000$ (2l/m in 50mm well)

Gas screening value = gas concentration (%) x gas flow rate (l/hr)

%v/v - Percentage volume by total volume; mbgl - metres below ground level; ppm - parts per million; mb - millibars; l/hr - litres per hour; vv - water vial; gb - 1l glass bottle; pb - 1l plastic bottle

Appendix 7 – Geotechnical Test Certificates



Unit A2
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Ponswood Industrial Estate
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East Sussex
TN38 9BY
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Facsimile: (01424) 729911
info@elab-uk.co.uk

THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 15-02645

Issue: 1

Date of Issue: 01/07/2015

Contact: Ken Phaure

Customer Details: K4 Soils Laboratory Ltd
Unit 8
Watford
Hertfordshire

Quotation No: Q15-00248

Order No: Not Supplied

Customer Reference: 19011

Date Received: 29/06/2015

Date Approved: 01/07/2015

Details: Holybourne Road, Leigh Park

Approved by:

Naomi Williams, Customer services officer

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)



Sample Summary

Report No.: 15-02645

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
32065	BH1 U 4.00	Not Provided	29/06/2015	Sandy silty loam	a
32066	BH1 D 9.50	Not Provided	29/06/2015	Clay	a
32067	BH2 D 11.00	Not Provided	29/06/2015	Clay	a
32068	BH3 D 11.5	Not Provided	29/06/2015	Clay	a



Results Summary

2683

Report No.: 15-02645

ELAB Reference	32065	32066	32067	32068
Customer Reference	U	D	D	D
Sample ID				
Sample Type	SOIL	SOIL	SOIL	SOIL
Sample Location	BH1	BH1	BH2	BH3
Sample Depth (m)	4.00	9.50	11.00	11.5
Sampling Date				

Determinand	Codes	Units	LOD				
Anions							
Water Soluble Chloride	M	mg/kg	40	44	< 40	< 40	< 40
Water Soluble Nitrate	M	mg/kg	40	< 40	< 40	< 40	< 40
Water Soluble Sulphate	M	g/l	0.02	0.06	0.31	0.48	0.32
Water Soluble Sulphate	M	mg/kg	40	109	457	728	457
Inorganics							
Ammonia as NH ₄	N	mg/kg	0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Sulphur	N	%	0.01	0.03	0.25	0.25	0.29
Acid Soluble Sulphate (SO ₄)	U	%SO ₄	0.02	0.04	0.08	0.14	0.08
Miscellaneous							
Moisture Content	N	%	0.1	23.1	23.8	25.5	20.9
pH	M	units	0.1	8.7	8.2	7.9	8.1
Stones Content	N	%	0.1	1.4	25.6	24.9	28.3



Method Summary

Report No.: 15-02645

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
pH	M	Air dried sample	01/07/2015	113	Electromeric
Acid Soluble Sulphate	U	Air dried sample	01/07/2015	115	Ion Chromatography
Total organic carbon/Total sulphur	N	Air dried sample	30/06/2015	115	IR
Water soluble anions	M	Air dried sample	30/06/2015	172	Ion Chromatography

Tests marked N are not UKAS accredited

Report Information

Report No.: 15-02645

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

PCB congener results may include any coeluting PCBs

Uncertainty of measurement for the determinands tested are available upon request

Deviation Codes

-
- | | |
|---|--|
| a | No date of sampling supplied |
| b | No time of sampling supplied (Waters Only) |
| c | Sample not received in appropriate containers |
| d | Sample not received in cooled condition |
| e | The container has been incorrectly filled |
| f | Sample age exceeds stability time (sampling to receipt) |
| g | Sample age exceeds stability time (sampling to analysis) |

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month

All water samples will be retained for 7 days following the date of the test report

Charges may apply to extended sample storage



Summary of Classification Test Results

Job No. 19011	Project Name Holybourne Road, Leigh Park	Programme	
		Samples received	16/06/2015
Project No. -	Client Ridge and Partners	Schedule received	16/06/2015
		Project started	16/06/2015
		Testing Started	29/06/2015

Hole No.	Sample				Soil Description	NMC %	Passing 425µm %	LL %	PL %	PI %	Remarks
	Ref	Top	Base	Type							
BH1	7	4.00	4.45	U	Medium strength brown slightly clayey SAND	25	100	30	22	8	
BH1	10	6.00	6.00	D	Grey CLAY with brown very sandy clay staining	29	100	63	23	40	
BH1	15	9.50	9.50	D	Grey CLAY	31	100	76	27	49	
BH1	16	10.00	10.45	U	Hight strength slightly fissured dark grey CLAY	27	100	76	27	49	
BH2	7	4.00	4.45	U	Low strength brown sandy CLAY	23	100	32	18	14	
BH2	11	6.50	6.85	U	Hight strength slightly fissured dark grey CLAY	28	100	75	27	48	
BH2	14	8.00	8.00	D	Grey CLAY	29	100	77	24	53	
BH2	19	11.00	11.00	D	Grey CLAY	29	100	77	28	49	
BH3	10	7.00	7.35	U	High strength slightly fissured dark grey CLAY	28	100	76	26	50	
BH3	14	9.50	9.50	D	Grey CLAY with slity clay pockets	28	100	72	25	47	
WS2	3	0.50	1.00	U	Hight strength brown slightly sandy CLAY	21	100	45	20	25	

 2519	Test Methods: BS1377: Part 2: 1990: Natural Moisture Content : clause 3.2 Atterberg Limits: clause 4.3 and 5.0	Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU Tel: 01923 711 288 Email: James@k4soils.com	Checked and Approved Initials Date: 02/07/2015
	Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)		MSF-5-R1(a) -Rev. 0



PARTICLE SIZE DISTRIBUTION

Job Ref 19011

Borehole/Pit No. BH1

Site Name Holybourne Road, Leigh Park

Sample No. 2

Project No. Client Ridge and Partners

Depth 0.50 m

Soil Description Brown sandy very silty CLAY with rare fine gravel

Sample Type B

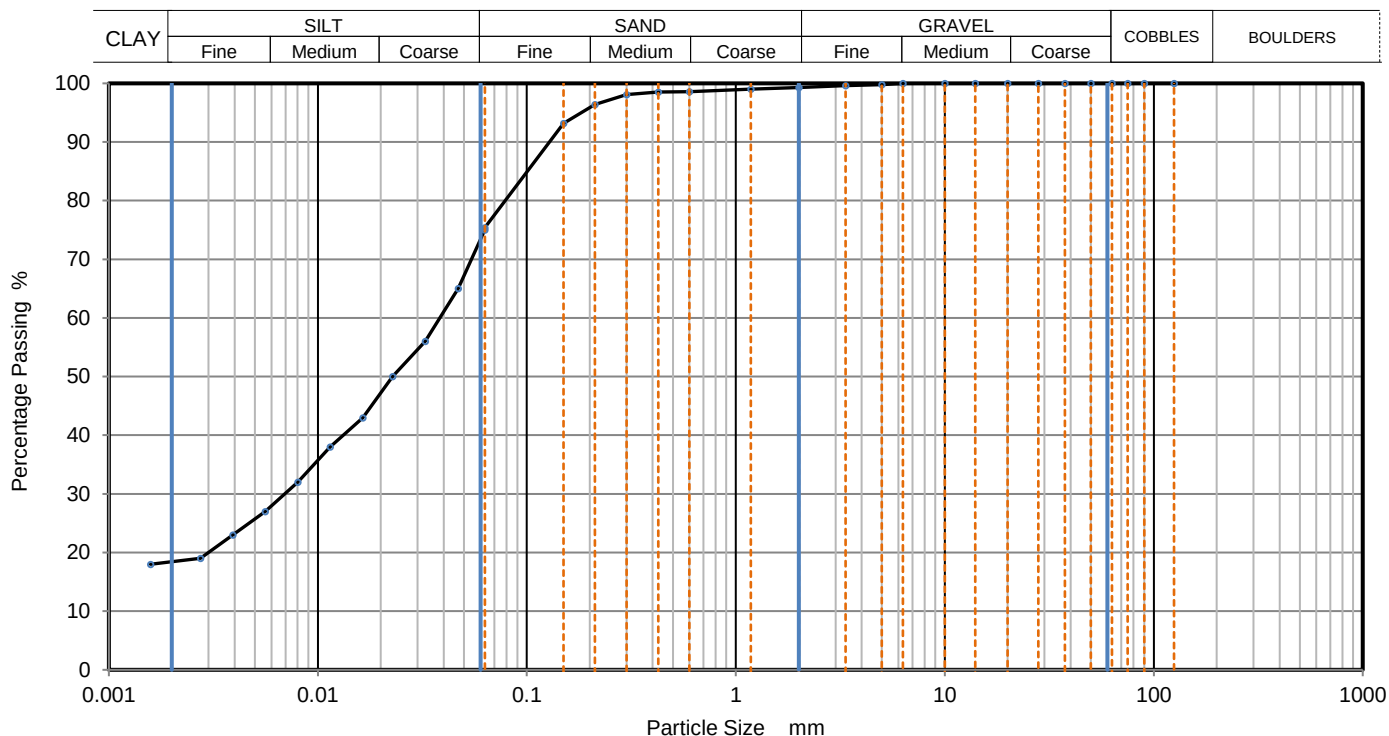
Samples received 16/06/2015

Schedules received 16/06/2015

Test Method BS1377:Part 2: 1990, clause 9.0

Project started 16/06/2015

Date tested 29/06/2015



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	75
90	100	0.0469	65
75	100	0.0326	56
63	100	0.0228	50
50	100	0.0164	43
37.5	100	0.0115	38
28	100	0.0080	32
20	100	0.0056	27
14	100	0.0039	23
10	100	0.0027	19
6.3	100	0.0016	18
5	100		
3.35	100		
2	99		
1.18	99		
0.6	99	Particle density (assumed) 2.70 Mg/m ³	
0.425	99		
0.3	98		
0.212	96		
0.15	93		
0.063	75		

Dry Mass of sample, g 150

Sample Proportions	% dry mass
Very coarse	0
Gravel	1
Sand	24
Silt	57
Clay	18

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below



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Tel: 01923 711288

Checked and Approved

Initials: J.P

Date: 02/07/2015

2519

Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

MSF-5-R3 (Rev.0)



PARTICLE SIZE DISTRIBUTION

Job Ref 19011

Borehole/Pit No. BH1

Site Name Holybourne Road, Leigh Park

Sample No. 5

Project No. Client Ridge and Partners

Depth 2.00 m

Soil Description Brown clayey sandy GRAVEL (gravel is fmc and sub-angular to angular)

Sample Type D

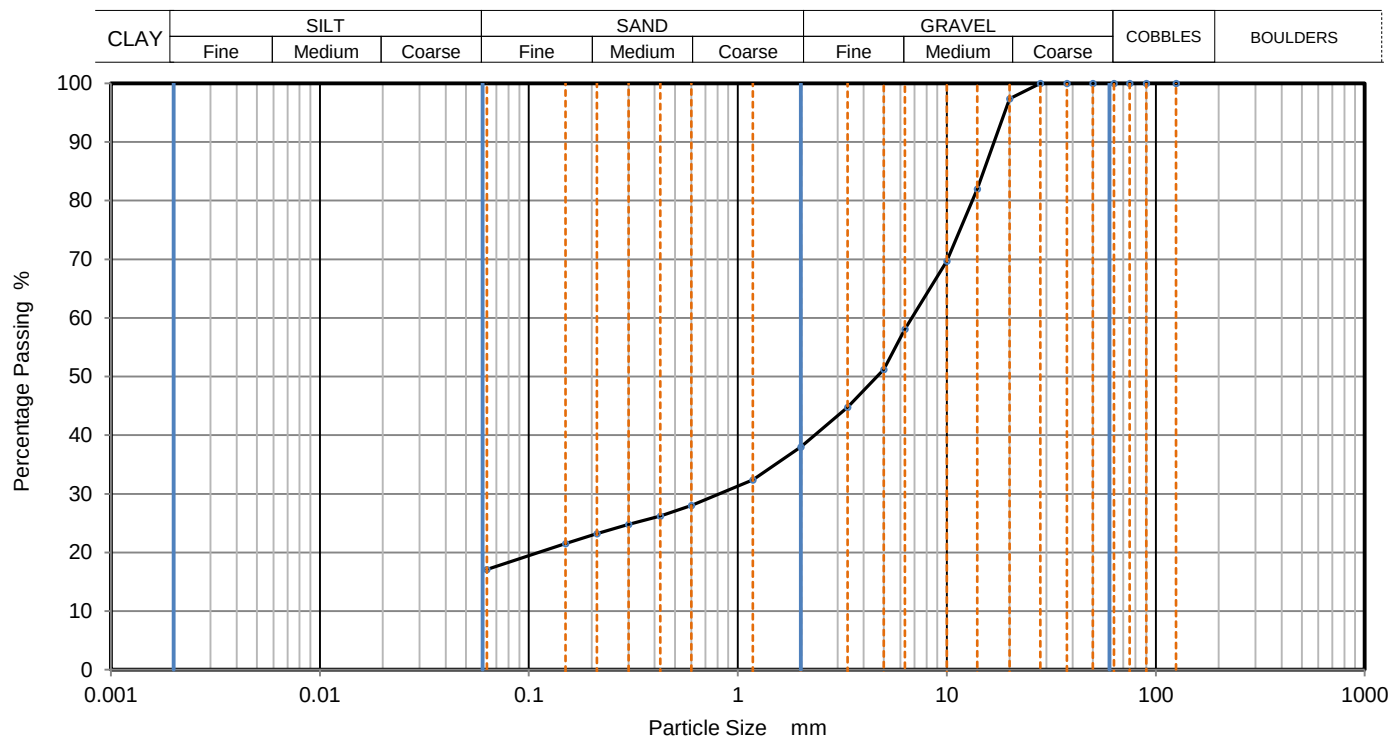
Samples received 16/06/2015

Schedules received 16/06/2015

Test Method BS1377:Part 2: 1990, clause 9.0

Project started 16/06/2015

Date tested 29/06/2015



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	97		
14	82		
10	70		
6.3	58		
5	51		
3.35	45		
2	38		
1.18	32		
0.6	28		
0.425	26		
0.3	25		
0.212	23		
0.15	22		
0.063	17		

Dry Mass of sample, g

Sample Proportions	% dry mass
Very coarse	0
Gravel	62
Sand	21
Fines <0.063mm	17

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below



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Initials: J.P

Date: 02/07/2015

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Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

MSF-5-R3 (Rev.0)



PARTICLE SIZE DISTRIBUTION

Job Ref 19011

Borehole/Pit No. BH2

Site Name Holybourne Road, Leigh Park

Sample No. 2

Project No. Client Ridge and Partners

Depth 0.50 m

Soil Description Brown sandy very silty CLAY with rare fine gravel

Sample Type B

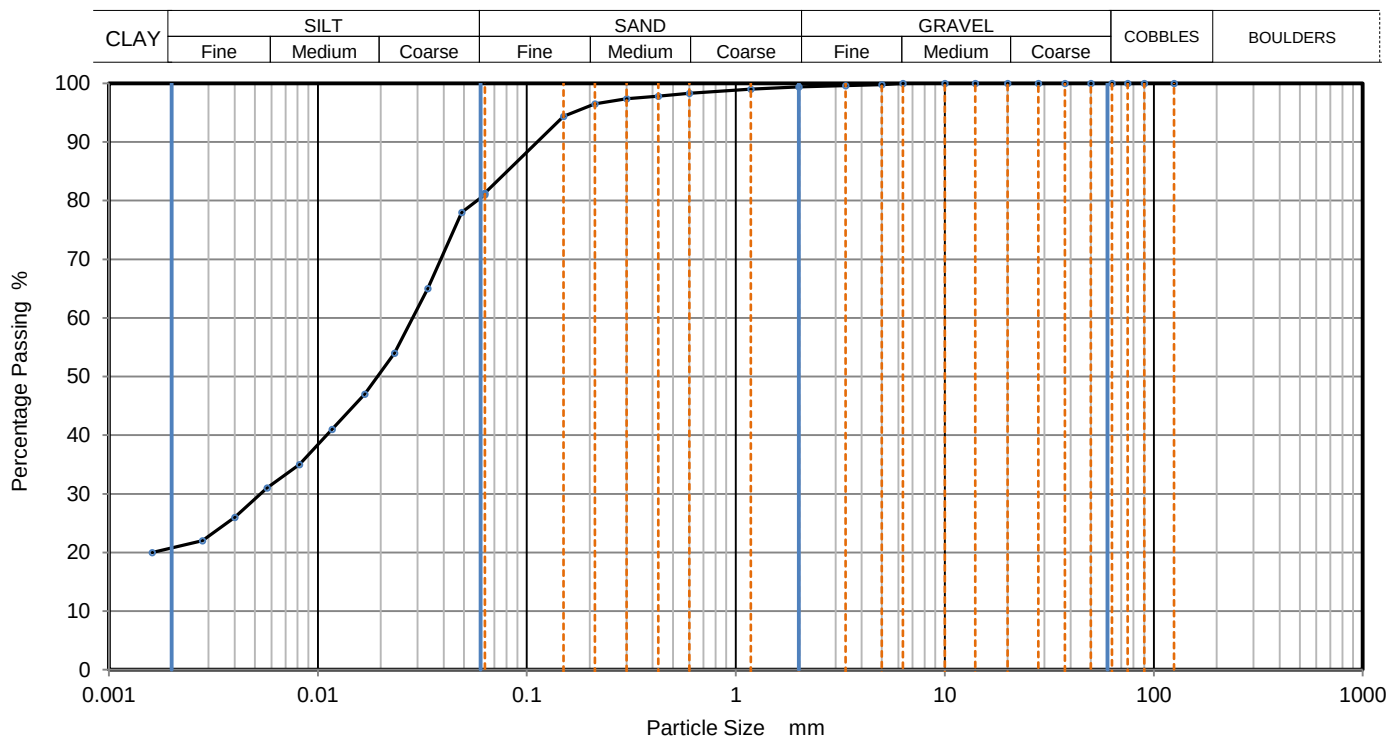
Samples received 16/06/2015

Schedules received 16/06/2015

Test Method BS1377:Part 2: 1990, clause 9.0

Project started 16/06/2015

Date tested



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	81
90	100	0.0487	78
75	100	0.0336	65
63	100	0.0233	54
50	100	0.0167	47
37.5	100	0.0117	41
28	100	0.0082	35
20	100	0.0057	31
14	100	0.0040	26
10	100	0.0028	22
6.3	100	0.0016	20
5	100		
3.35	100		
2	99		
1.18	99		
0.6	98	Particle density (assumed) 2.70 Mg/m3	
0.425	98		
0.3	97		
0.212	97		
0.15	94		
0.063	81		

Dry Mass of sample, g 164

Sample Proportions	% dry mass
Very coarse	0
Gravel	1
Sand	18
Silt	61
Clay	21

Grading Analysis	
D100	mm
D60	mm 0.0286
D30	mm 0.00527
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below



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MSF-5-R3 (Rev.0)



PARTICLE SIZE DISTRIBUTION

Job Ref 19011

Borehole/Pit No. BH2

Site Name Holybourne Road, Leigh Park

Sample No. 5

Project No. Client Ridge and Partners

Depth 2.00 m

Soil Description Brown slightly clayey very sandy GRAVEL with occasional cobbles (gravel is fmc and angular to rounded)

Sample Type B

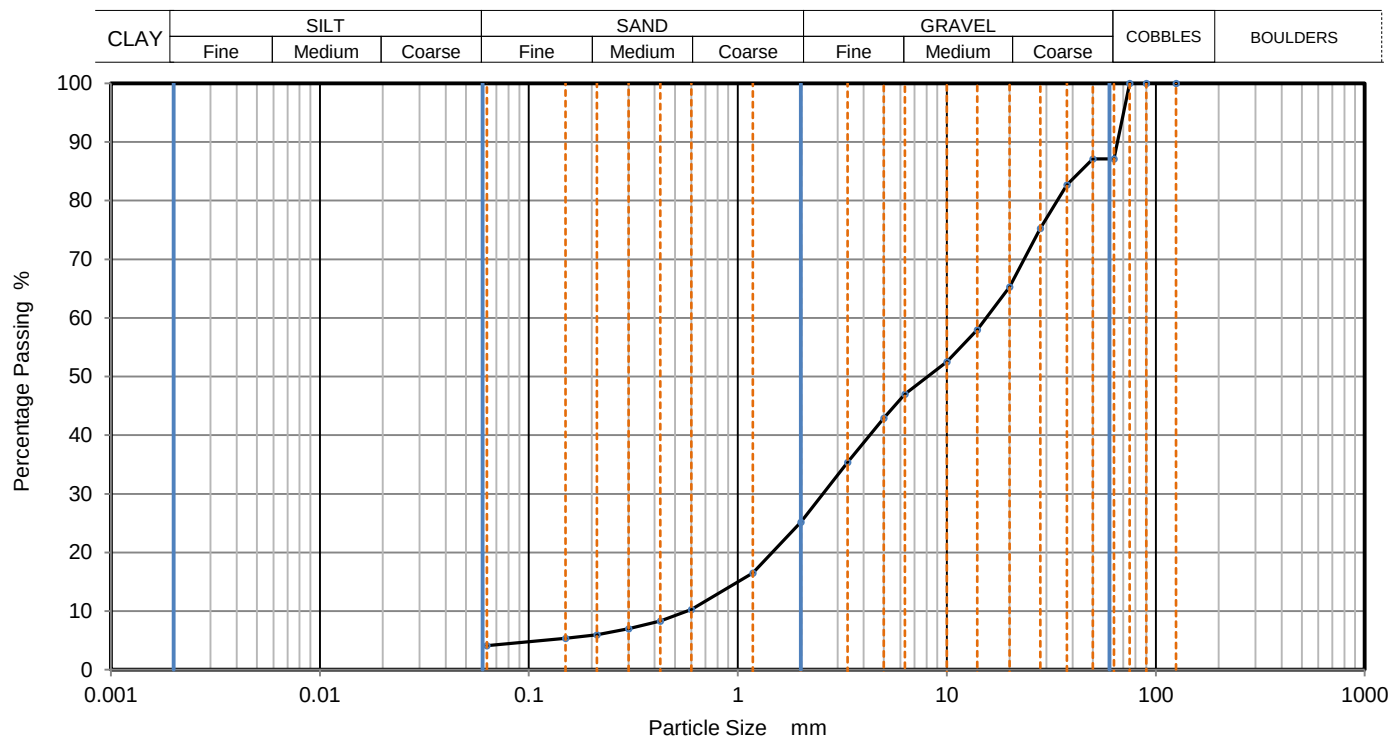
Samples received 16/06/2015

Schedules received 16/06/2015

Test Method BS1377:Part 2: 1990, clause 9.0

Project started 16/06/2015

Date tested



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	87		
50	87		
37.5	83		
28	75		
20	65		
14	58		
10	53		
6.3	47		
5	43		
3.35	35		
2	25		
1.18	17		
0.6	10		
0.425	8		
0.3	7		
0.212	6		
0.15	5		
0.063	4		

Dry Mass of sample, g 3583

Sample Proportions	% dry mass
Very coarse	13
Gravel	62
Sand	21
Fines <0.063mm	4

Grading Analysis	
D100	mm
D60	mm 15.4
D30	mm 2.55
D10	mm 0.566
Uniformity Coefficient	27
Curvature Coefficient	0.75

Remarks

Preparation and testing in accordance with BS1377 unless noted below



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Date: 02/07/2015

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MSF-5-R3 (Rev.0)



PARTICLE SIZE DISTRIBUTION

Job Ref 19011

Borehole/Pit No. BH3

Site Name Holybourne Road, Leigh Park

Sample No. 3

Project No. Client Ridge and Partners

Depth 1.20 m

Soil Description Brown sandy very silty CLAY with rare fine gravel

Sample Type B

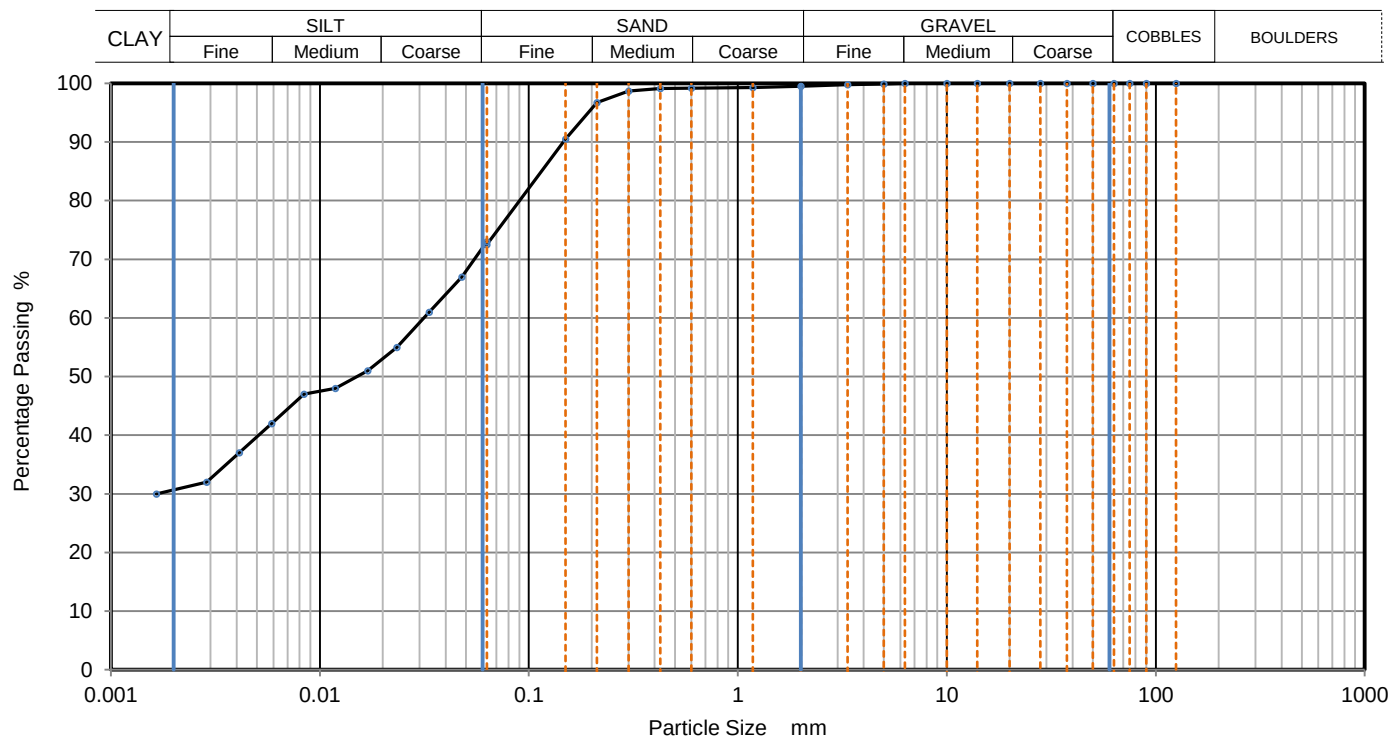
Samples received 16/06/2015

Schedules received 16/06/2015

Test Method BS1377:Part 2: 1990, clause 9.0

Project started 16/06/2015

Date tested



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	73
90	100	0.0477	67
75	100	0.0334	61
63	100	0.0233	55
50	100	0.0169	51
37.5	100	0.0119	48
28	100	0.0084	47
20	100	0.0059	42
14	100	0.0041	37
10	100	0.0029	32
6.3	100	0.0017	30
5	100		
3.35	100		
2	100		
1.18	99		
0.6	99	Particle density (assumed) 2.70 Mg/m ³	
0.425	99		
0.3	99		
0.212	97		
0.15	91		
0.063	73		

Dry Mass of sample, g 91

Sample Proportions	% dry mass
Very coarse	0
Gravel	1
Sand	27
Silt	42
Clay	31

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377 unless noted below



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Date: 02/07/2015

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MSF-5-R3 (Rev.0)



PARTICLE SIZE DISTRIBUTION

Job Ref 19011

Borehole/Pit No. BH3

Site Name Holybourne Road, Leigh Park

Sample No. 5

Project No. Client Ridge and Partners

Depth 2.80 m

Soil Description Brown clayey very sandy GRAVEL (gravel is fmc and angular to rounded)

Sample Type B

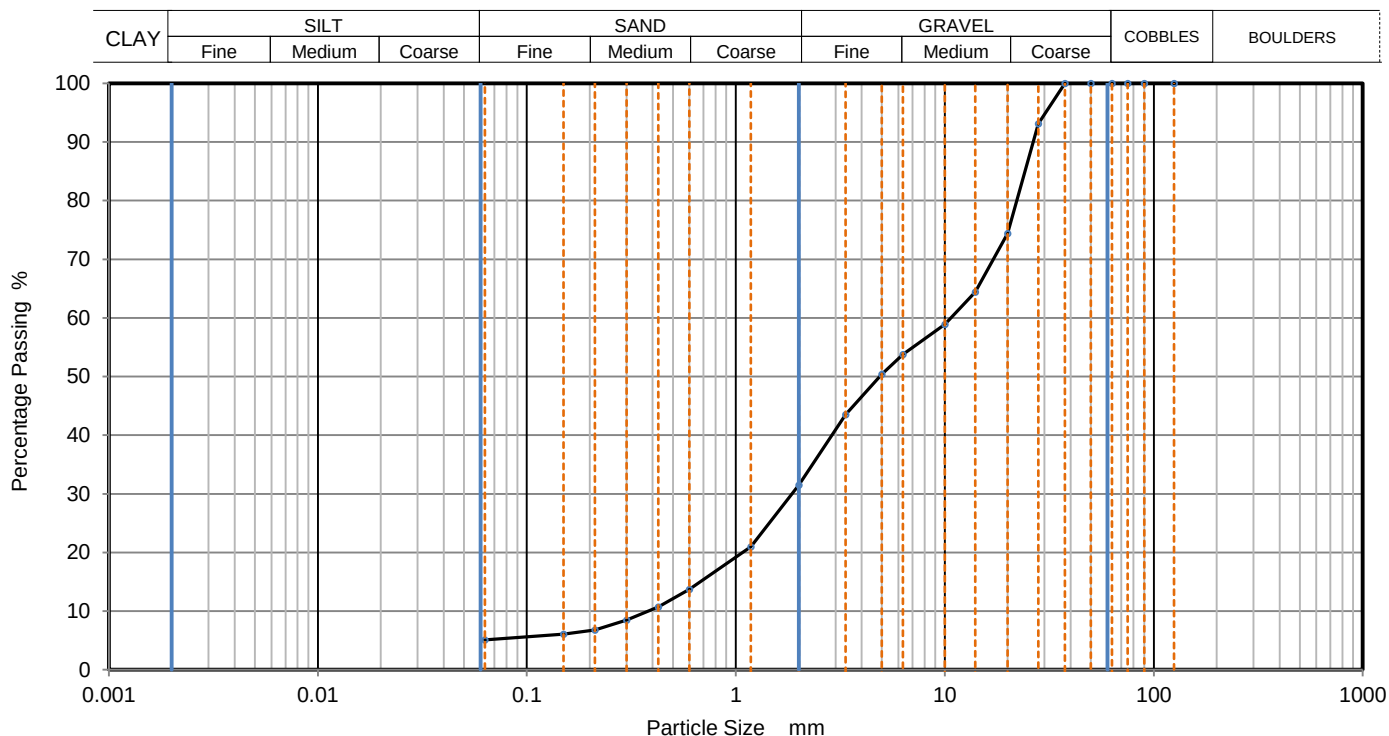
Samples received 16/06/2015

Schedules received 16/06/2015

Test Method BS1377:Part 2: 1990, clause 9.0

Project started 16/06/2015

Date tested



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	93		
20	74		
14	64		
10	59		
6.3	54		
5	50		
3.35	44		
2	32		
1.18	21		
0.6	14		
0.425	11		
0.3	9		
0.212	7		
0.15	6		
0.063	5		

Dry Mass of sample, g 2834

Sample Proportions	% dry mass
Very coarse	0
Gravel	69
Sand	26
Fines <0.063mm	5

Grading Analysis	
D100	mm
D60	mm 10.7
D30	mm 1.85
D10	mm 0.379
Uniformity Coefficient	28
Curvature Coefficient	0.85

Remarks

Preparation and testing in accordance with BS1377 unless noted below



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Checked and Approved

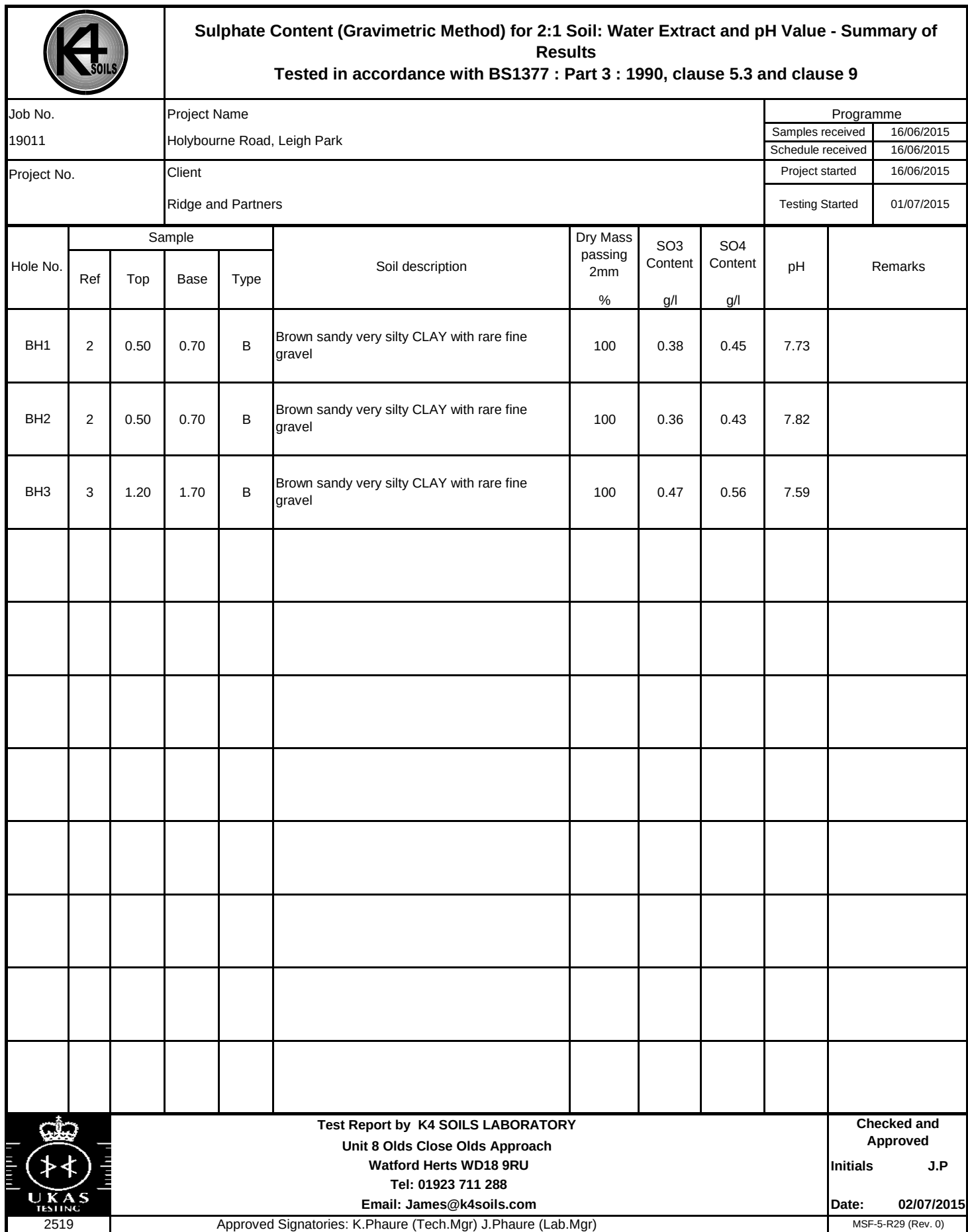
Initials: J.P

Date: 02/07/2015

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Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

MSF-5-R3 (Rev.0)





Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

Job Ref	19011
Borehole/Pit No.	BH1
Sample No.	7
Depth	4.00 m
Sample Type	U
Samples received	16/06/15
Schedules received	16/06/15
Date of test	29/06/15

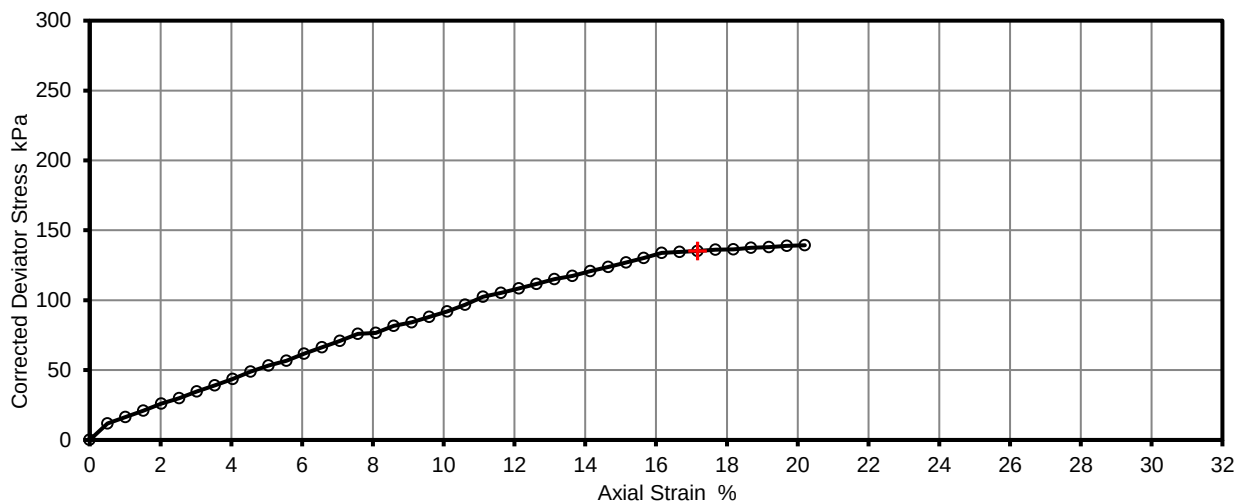
Site Name	Holybourne Road, Leigh Park		
Project No.		Client	Ridge and Partners
Soil Description	Medium strength brown slightly clayey SAND		
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen		

Remarks

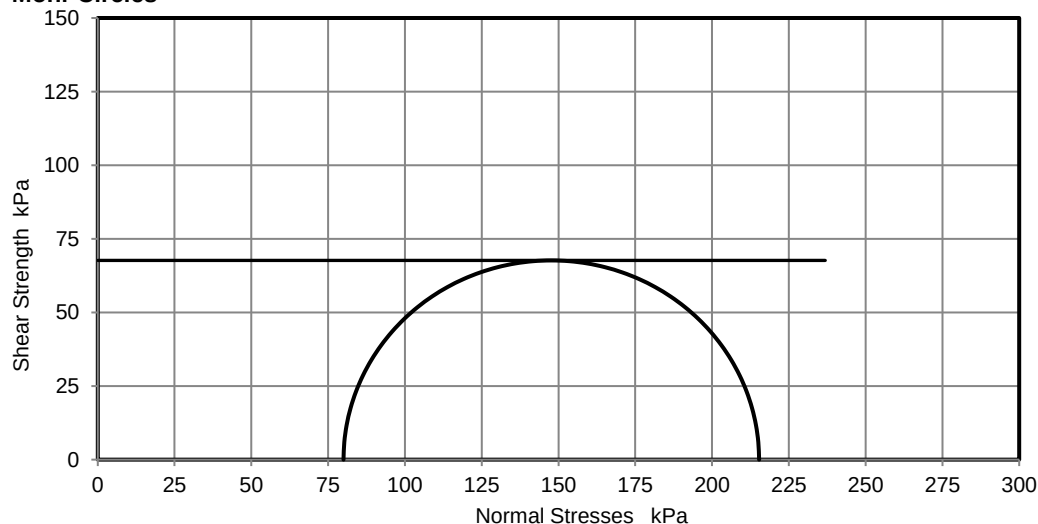
Position within sample

Test Number	1
Length	198.0 mm
Diameter	102.0 mm
Bulk Density	2.10 Mg/m3
Moisture Content	27 %
Dry Density	1.66 Mg/m3
Rate of Strain	2.0 %/min
Cell Pressure	80 kPa
Axial Strain	17.2 %
Deviator Stress, ($\sigma_1 - \sigma_3$)f	135 kPa
Undrained Shear Strength, cu	68 kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$ f
Mode of Failure	Plastic

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.



2519

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
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Checked and Approved

Initials: J.P

Date 02/07/2015

MSF-5 R7 (Rev.0)



Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

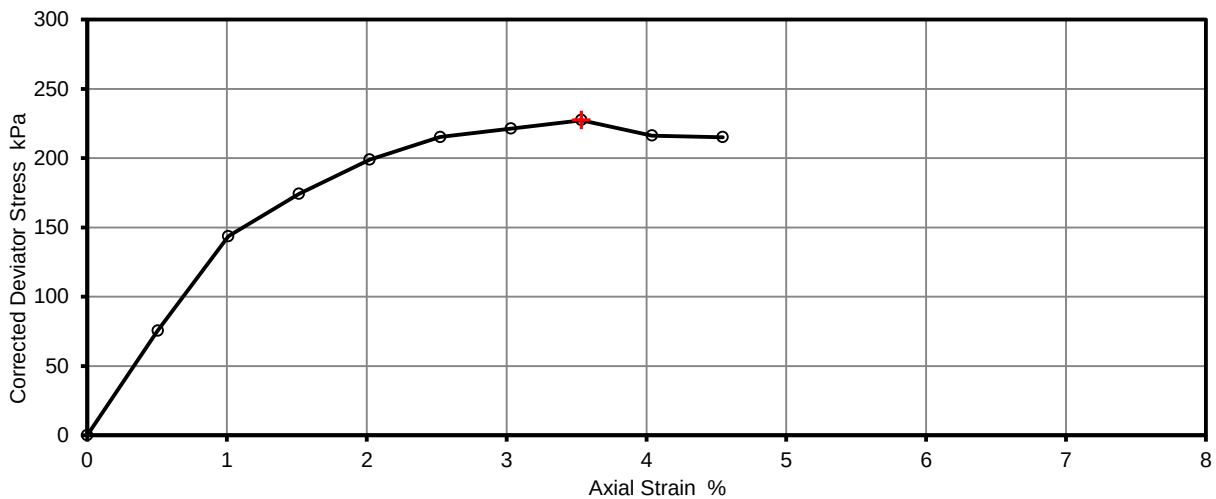
	Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen			Job Ref	19011	
				Borehole/Pit No.	BH1	
Site Name	Holybourne Road, Leigh Park			Sample No.	16	
Project No.		Client	Ridge and Partners	Depth	10.00	m
Soil Description	Hight strength slightly fissured dark grey CLAY			Sample Type	U	
				Samples received	16/06/15	
				Schedules received	16/06/15	
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen			Date of test	29/06/15	

Remarks

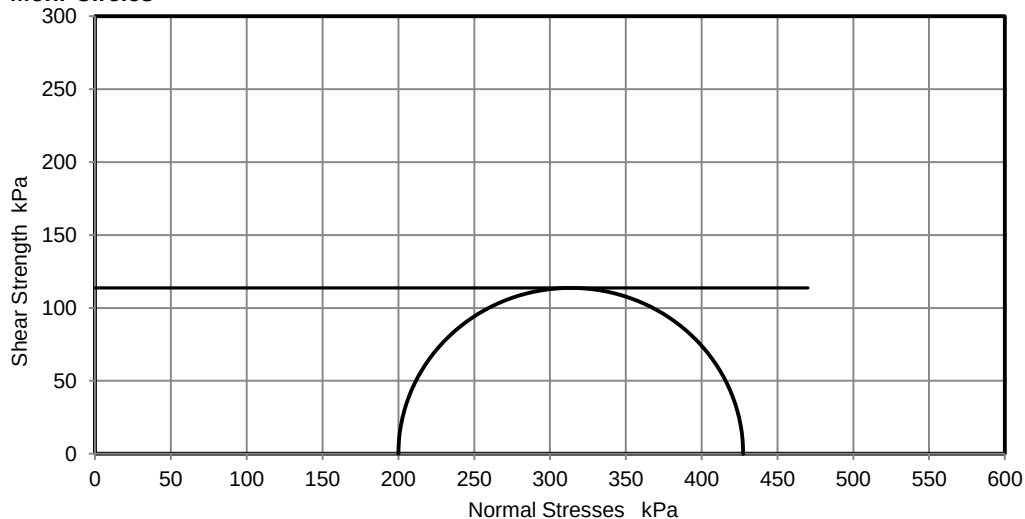
Position within sample

Test Number	1	
Length	198.0	mm
Diameter	102.0	mm
Bulk Density	1.88	Mg/m3
Moisture Content	28	%
Dry Density	1.47	Mg/m3
Rate of Strain	2.0	%/min
Cell Pressure	200	kPa
Axial Strain	3.5	%
Deviator Stress, ($\sigma_1 - \sigma_3$)f	227	kPa
Undrained Shear Strength, cu	114	kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$ f
Mode of Failure	Brittle	

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.



2519

Test Report by K4 SOILS LABORATORY
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Checked and Approved

Initials: J.P

Date 02/07/2015

MSF-5 R7 (Rev.0)

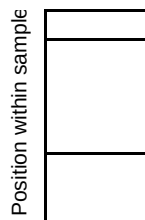


Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

Job Ref	19011		
	BH2		
Site Name	Holybourne Road, Leigh Park		
Sample No.	7		
Project No.		Client	Ridge and Partners
Soil Description	Low strength brown sandy CLAY	Depth	4.00 m
		Sample Type	U
		Samples received	16/06/15
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen	Schedules received	16/06/15
		Date of test	29/06/15

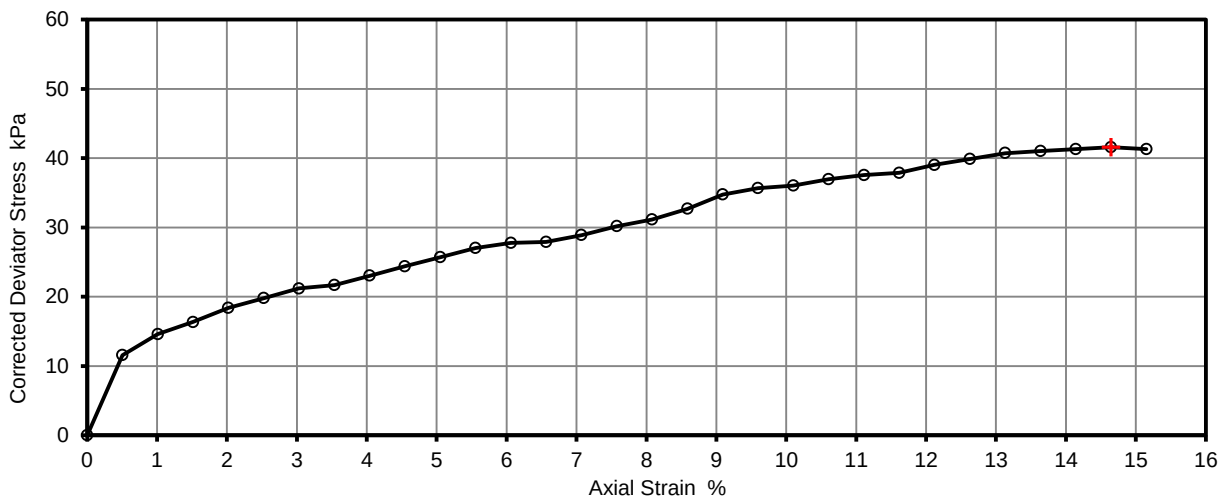
Remarks

Sample was water softened and disturbed

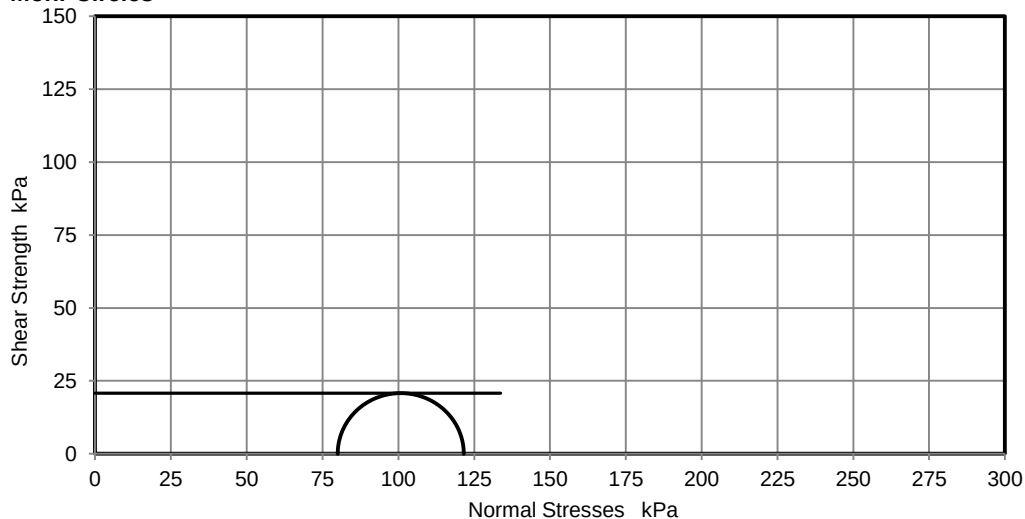


Test Number	1
Length	198.0 mm
Diameter	102.0 mm
Bulk Density	2.04 Mg/m3
Moisture Content	24 %
Dry Density	1.65 Mg/m3
Rate of Strain	2.0 %/min
Cell Pressure	80 kPa
Axial Strain	14.6 %
Deviator Stress, ($\sigma_1 - \sigma_3$) f	42 kPa
Undrained Shear Strength, c_u	21 kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$ f
Mode of Failure	Compound

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.



2519

Test Report by K4 SOILS LABORATORY
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Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

Checked and Approved

Initials: J.P

Date 02/07/2015

MSF-5 R7 (Rev.0)



Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

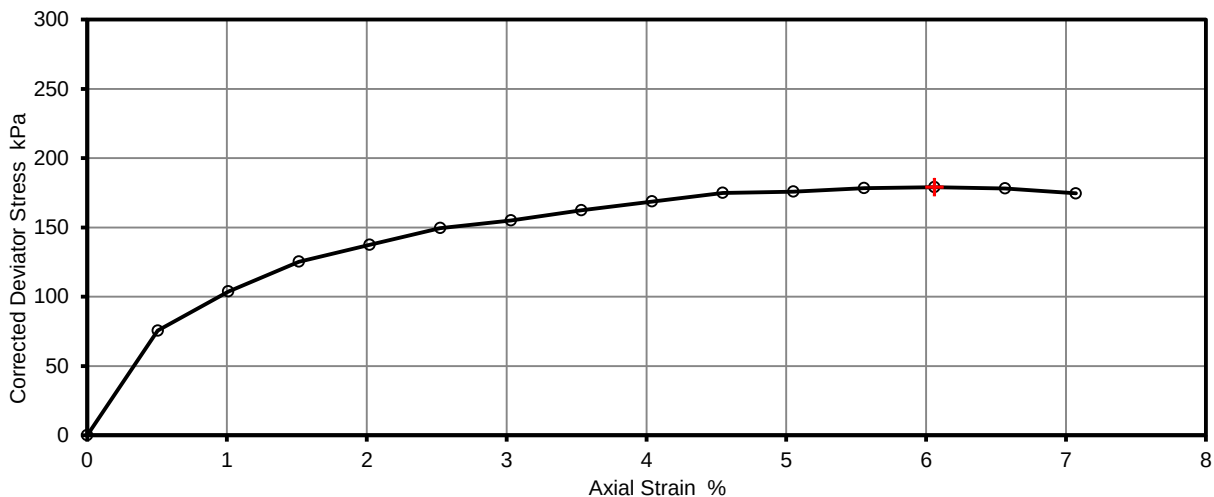
	Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen			Job Ref	19011	
				Borehole/Pit No.	BH2	
Site Name	Holybourne Road, Leigh Park			Sample No.	11	
Project No.		Client	Ridge and Partners	Depth	6.50	m
Soil Description	Hight strength slightly fissured dark grey CLAY			Sample Type	U	
				Samples received	16/06/15	
				Schedules received	16/06/15	
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen			Date of test	29/06/15	

Remarks

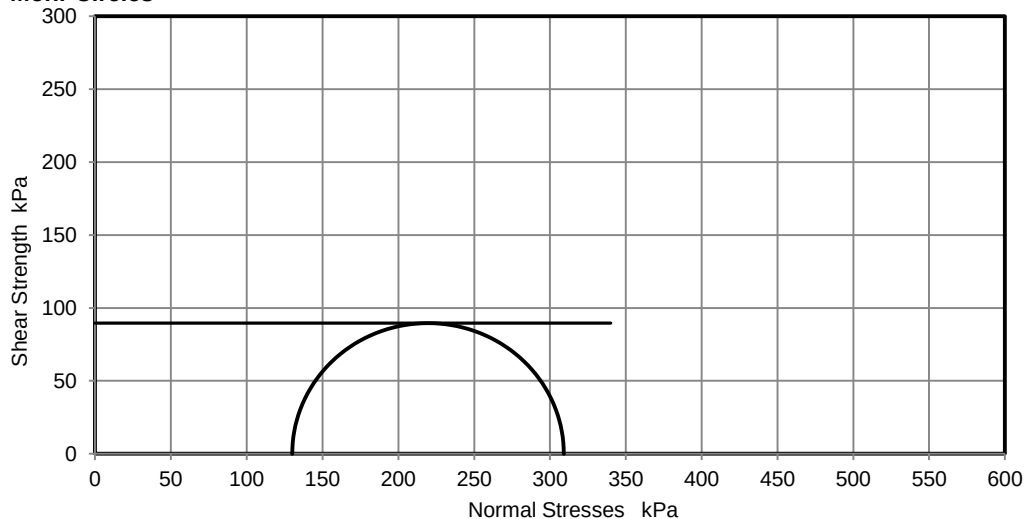
Position within sample

Test Number	1
Length	198.0 mm
Diameter	102.0 mm
Bulk Density	2.04 Mg/m3
Moisture Content	27 %
Dry Density	1.61 Mg/m3
Rate of Strain	2.0 %/min
Cell Pressure	130 kPa
Axial Strain	6.1 %
Deviator Stress, ($\sigma_1 - \sigma_3$)f	179 kPa
Undrained Shear Strength, cu	90 kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$ f
Mode of Failure	Brittle

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.



2519

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

Checked and
Approved

Initials: J.P

Date 02/07/2015

MSF-5 R7 (Rev.0)



Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

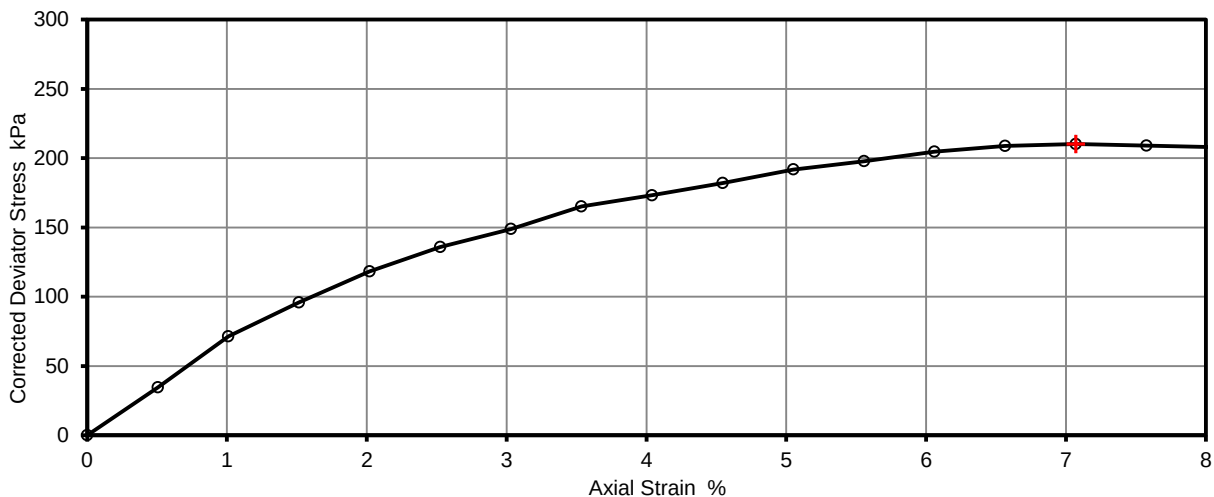
	Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen			Job Ref	19011	
				Borehole/Pit No.	BH3	
Site Name	Holybourne Road, Leigh Park			Sample No.	10	
Project No.		Client	Ridge and Partners	Depth	7.00	m
Soil Description	Hight strength slightly fissured dark grey CLAY			Sample Type	U	
				Samples received	16/06/15	
				Schedules received	16/06/15	
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen			Date of test	29/06/15	

Remarks

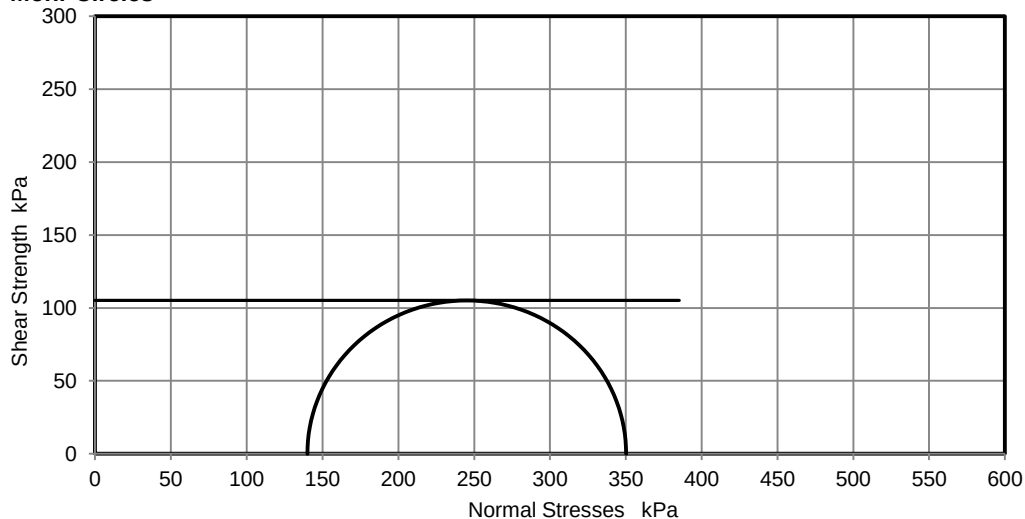
Position within sample

Test Number	1
Length	198.0 mm
Diameter	102.0 mm
Bulk Density	2.01 Mg/m3
Moisture Content	28 %
Dry Density	1.58 Mg/m3
Rate of Strain	2.0 %/min
Cell Pressure	140 kPa
Axial Strain	7.1 %
Deviator Stress, ($\sigma_1 - \sigma_3$)f	210 kPa
Undrained Shear Strength, cu	105 kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$ f
Mode of Failure	Brittle

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

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Checked and Approved

Initials: J.P

Date 02/07/2015

MSF-5 R7 (Rev.0)



Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

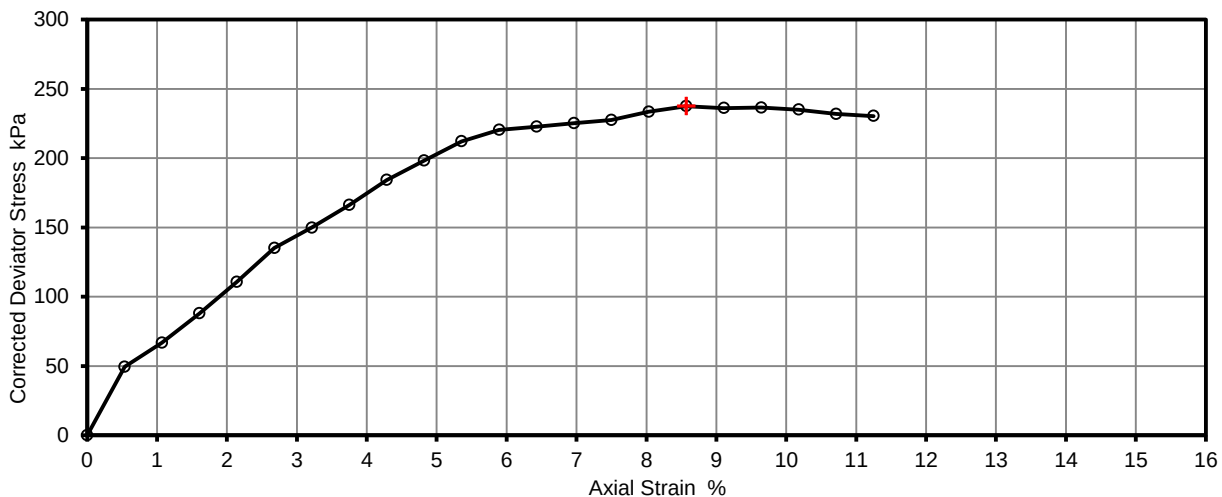
Job Ref	19011		
	Borehole/Pit No.		
Site Name		Holybourne Road, Leigh Park	
Sample No.		3	
Project No.		Client	Ridge and Partners
Soil Description	Hight strength brown slightly sandy CLAY		Depth
			0.50 m
			Sample Type
Test Method		BS1377 : Part 7 : 1990, clause 8, single specimen	Date of test
			29/06/15

Remarks

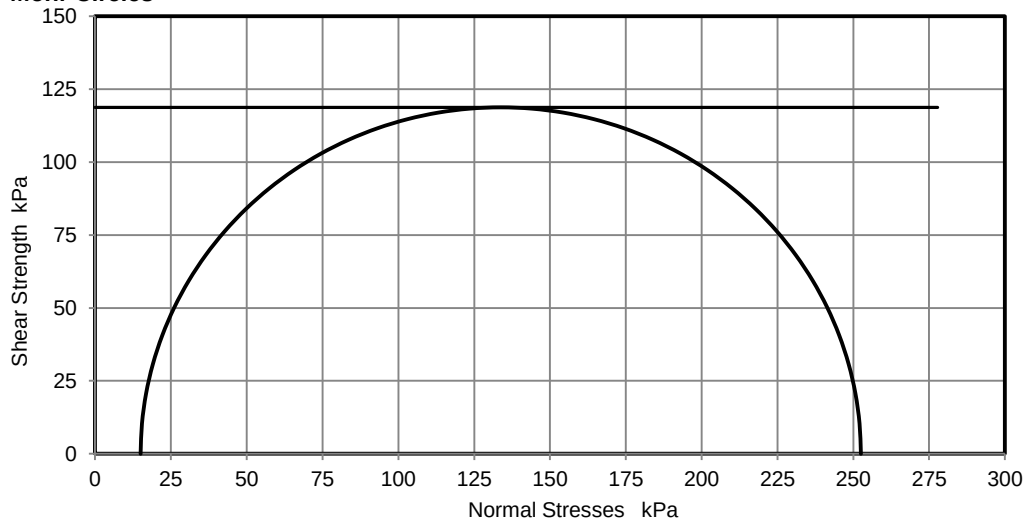
Position within sample

Test Number	1
Length	140.0 mm
Diameter	70.0 mm
Bulk Density	2.21 Mg/m3
Moisture Content	20 %
Dry Density	1.84 Mg/m3
Rate of Strain	2.0 %/min
Cell Pressure	15 kPa
Axial Strain	8.6 %
Deviator Stress, ($\sigma_1 - \sigma_3$)f	238 kPa
Undrained Shear Strength, cu	119 kPa $\frac{1}{2}(\sigma_1 - \sigma_3)$ f
Mode of Failure	Compound

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

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2519

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Checked and Approved

Initials: J.P

Date 02/07/2015

MSF-5 R7 (Rev.0)

Unconsolidated Undrained Triaxial Compression tests without measurement of pore pressure

Summary of Results

Tests carried out in accordance with BS1377:Part 7 : 1990 clause 8 or 9 as appropriate to test

Job No.	Project Name	Programme	
19011	Holybourne Road, Leigh Park	Samples received	16/06/2015
		Schedule received	16/06/2015
Project No.	Client Ridge and Partners	Project started	16/06/2015
		Testing Started	29/06/2015

[illegible]

Legend	UU - single stage test (single and multiple specimens)	σ_3	Cell pressure	Mode of failure ;	B - Brittle
	UUM - Multistage test on a single specimen	$\sigma_1 - \sigma_3$	Maximum corrected deviator stress		P - Plastic
	suffix R - remoulded or recompacted	cu	Undrained shear strength, $\frac{1}{2}(\sigma_1 - \sigma_3)$		C - Compound



Test Report by K4 SOILS LABORATORY

Unit 8 Olds Close Olds Approach

Watford Herts WD18 9RU

Tel: 01923 711 288

Email: james@k4soils.com

Checked and Approved

Initials:

Date: 02/07/2015

MSF-5-R7b (Rev. 0)

Estimated California Bearing Ratio - Derived using TRL (60° cone) in accordance with TRRL Road note 8

Site: Holybourne Road, Havant
Client: Portsmouth City Council

Ridge & Partners LLP
 Partnership House
 Moorside Road
 Winchester
 SO23 7RX

RIDGE

Project Number: 151238

Location ID: TRL1

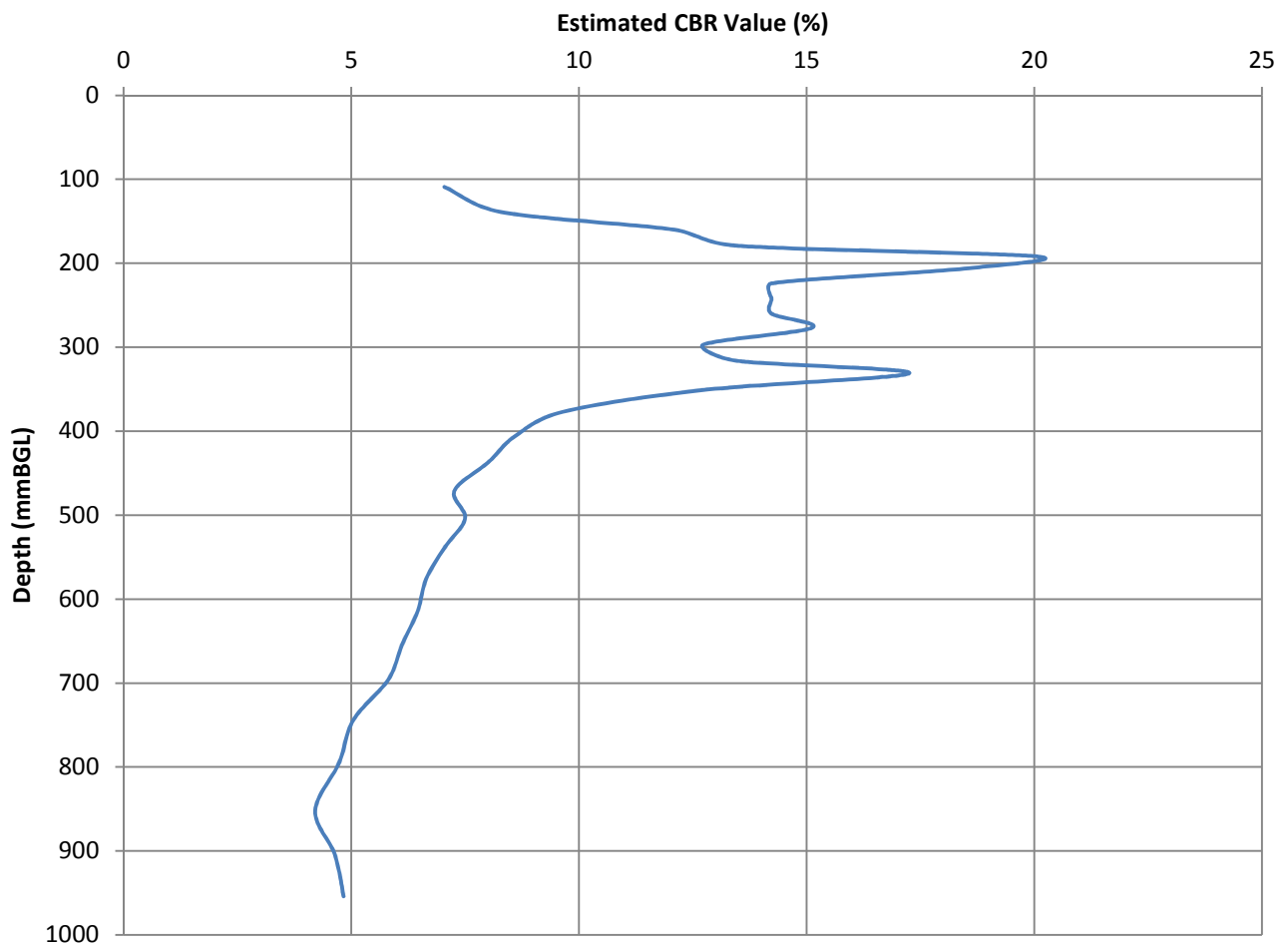
Date: 08/07/2015 **Engineer:** DAP

Easting: **Northing:**

Initial Depth (mmBGL): 74

Final Depth (mmBGL): 954

Estimated California Bearing Ratio (%) against Depth (mmBGL)



Summary Table

Start Depth	Finish Depth (mmBGL)	No of Blows	Blows per Layer	mm/Blows	Average Estimated CBR (%)
74	400	15	15	21.73	11.66
400	600	21	6	33.33	7.42
600	954	29	8	44.25	5.50

Comments:

Checked By:

Date:

Approved By:

Date:

Estimated California Bearing Ratio - Derived using TRL (60° cone) in accordance with TRRL Road note 8

Site: Holybourne Road, Havant
Client: Portsmouth City Council

Ridge & Partners LLP
 Partnership House
 Moorside Road
 Winchester
 SO23 7RX

RIDGE

Project Number: 151238

Location ID: TRL2

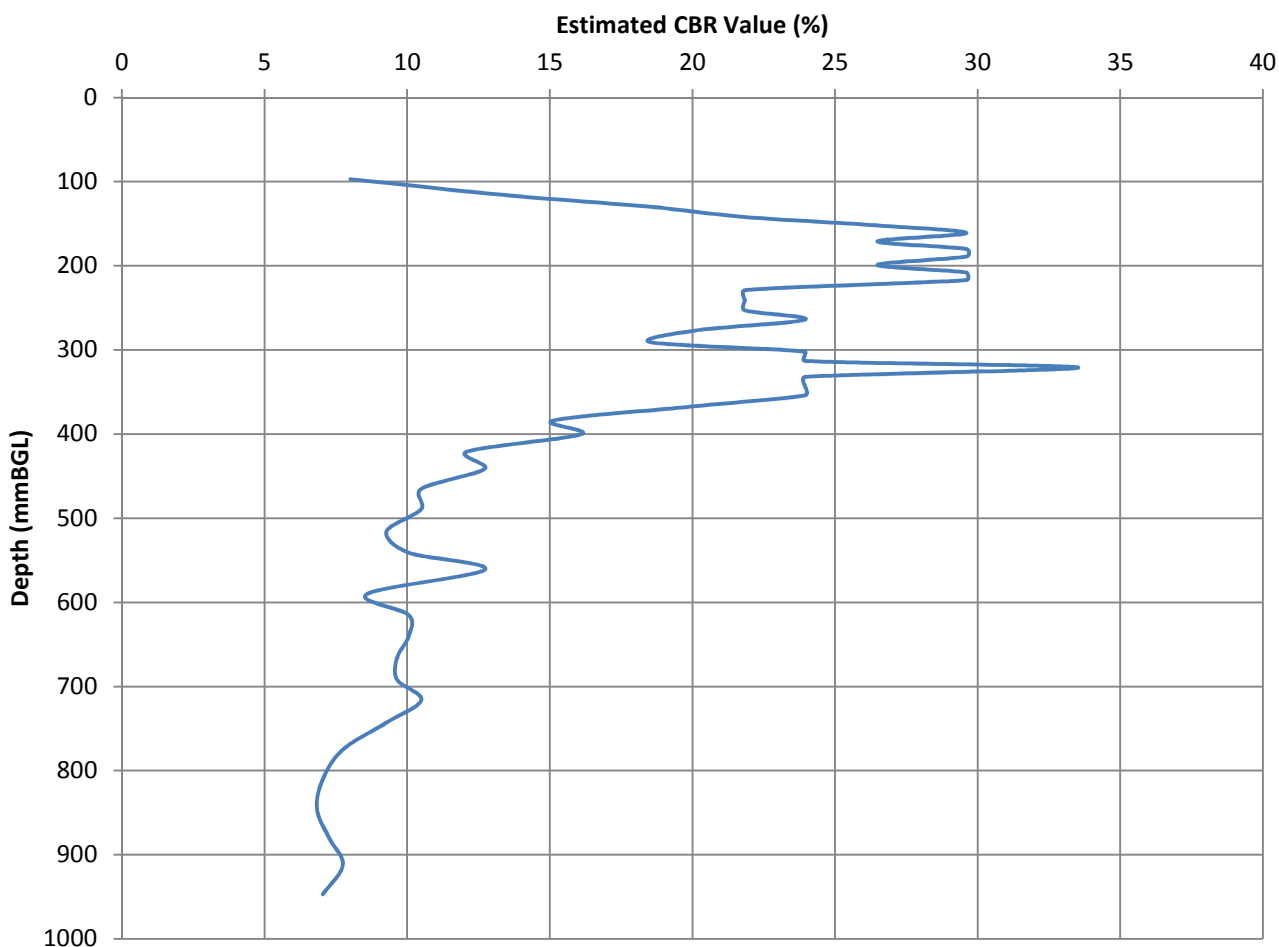
Date: 08/07/2015 **Engineer:** DAP

Easting: **Northing:**

Initial Depth (mmBGL): 66

Final Depth (mmBGL): 947

Estimated California Bearing Ratio (%) against Depth (mmBGL)



Summary Table

Start Depth	Finish Depth (mmBGL)	No of Blows	Blows per Layer	mm/Blows	Average Estimated CBR (%)
66	400	27	27	12.37	21.15
400	600	35	8	25.00	10.05
600	947	47	12	28.92	8.62

Comments:

Checked By:

Date:

Approved By:

Date:

Estimated California Bearing Ratio - Derived using TRL (60° cone) in accordance with TRRL Road note 8

Site: Holybourne Road, Havant
Client: Portsmouth City Council

Ridge & Partners LLP
 Partnership House
 Moorside Road
 Winchester
 SO23 7RX

RIDGE

Project Number: 151238

Location ID: TRL3

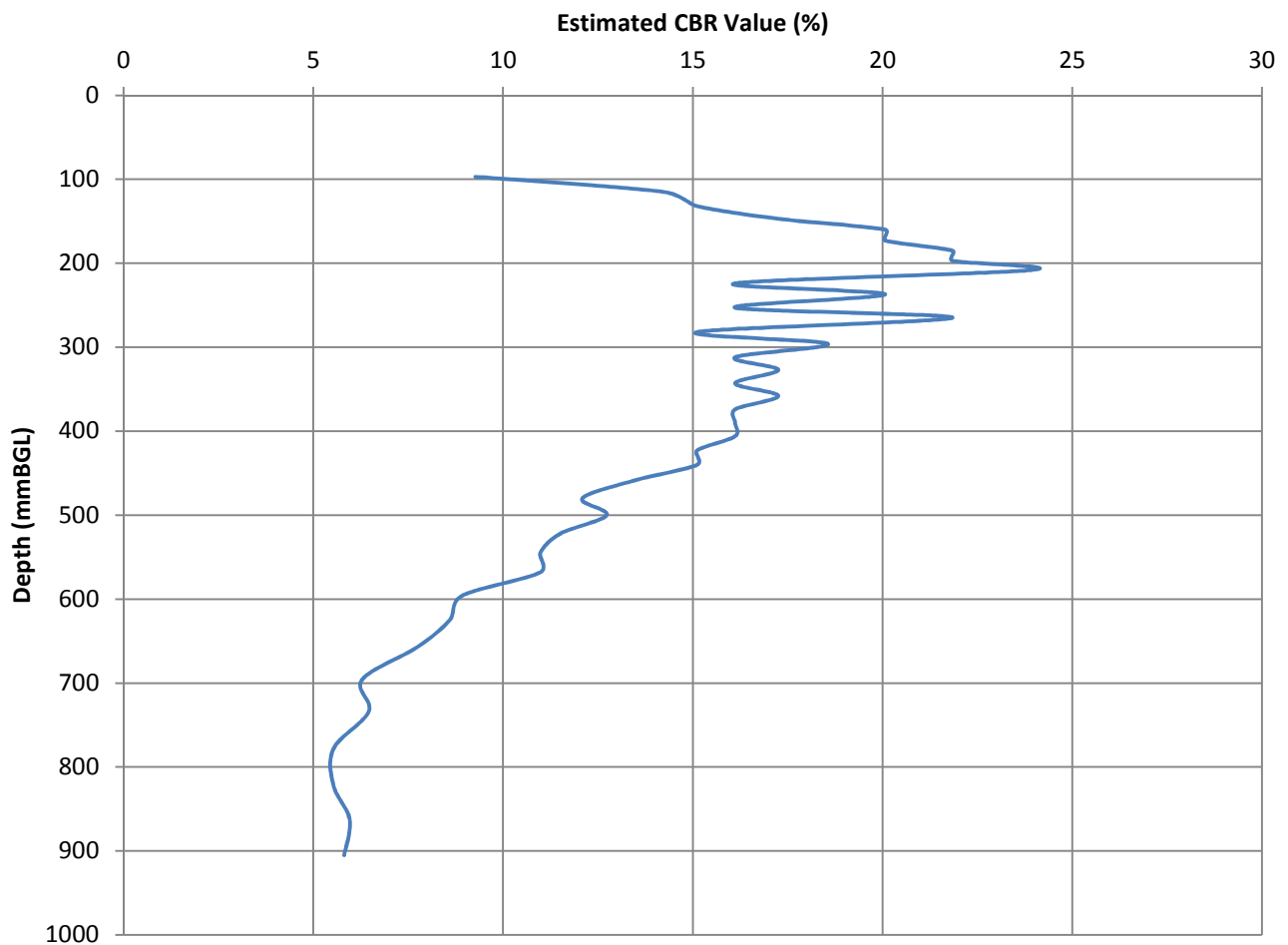
Date: 27/03/2015 **Engineer:** DAP

Easting: **Northing:**

Initial Depth (mmBGL): 70

Final Depth (mmBGL): 905

Estimated California Bearing Ratio (%) against Depth (mmBGL)



Summary Table

Start Depth	Finish Depth (mmBGL)	No of Blows	Blows per Layer	mm/Blows	Average Estimated CBR (%)
70	400	21	21	15.71	16.43
400	600	31	10	20.00	12.73
600	905	39	8	38.13	6.44

Comments:

Checked By:

Date:

Approved By:

Date:

Estimated California Bearing Ratio - Derived using TRL (60° cone) in accordance with TRRL Road note 8

Site: Holybourne Road, Havant
Client: Portsmouth City Council

Ridge & Partners LLP
 Partnership House
 Moorside Road
 Winchester
 SO23 7RX

RIDGE

Project Number: 151238

Location ID: TRL4

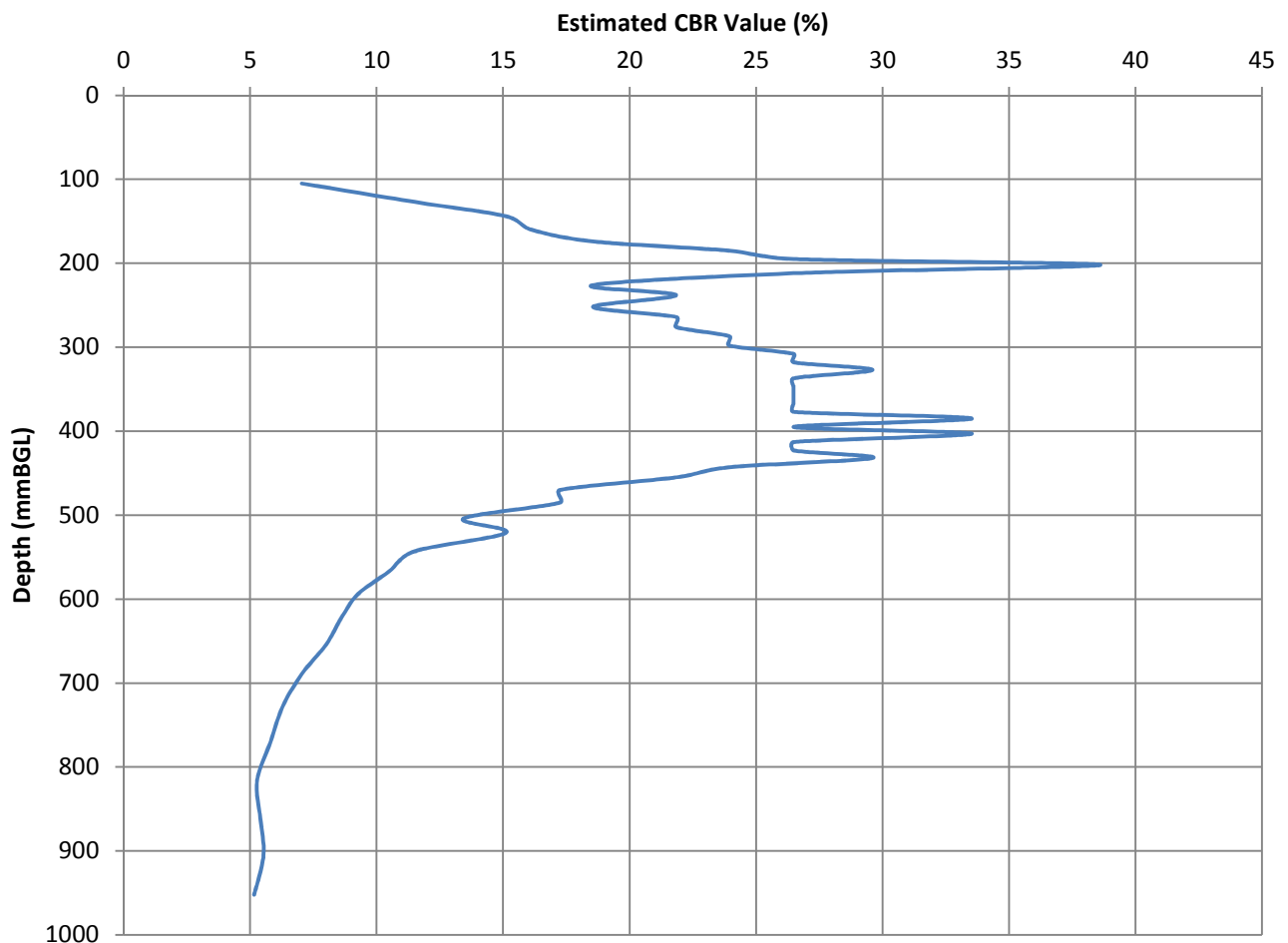
Date: 27/03/2015 **Engineer:** DAP

Easting: **Northing:**

Initial Depth (mmBGL): 70

Final Depth (mmBGL): 952

Estimated California Bearing Ratio (%) against Depth (mmBGL)



Summary Table

Start Depth	Finish Depth (mmBGL)	No of Blows	Blows per Layer	mm/Blows	Average Estimated CBR (%)
70	400	26	26	12.69	20.59
400	600	39	13	15.38	16.80
600	952	48	9	39.11	6.27

Comments:

Checked By:

Date:

Approved By:

Date:

Estimated California Bearing Ratio - Derived using TRL (60° cone) in accordance with TRRL Road note 8

Site: Holybourne Road, Havant
Client: Portsmouth City Council

Ridge & Partners LLP
 Partnership House
 Moorside Road
 Winchester
 SO23 7RX

RIDGE

Project Number: 151238

Location ID: TRL5

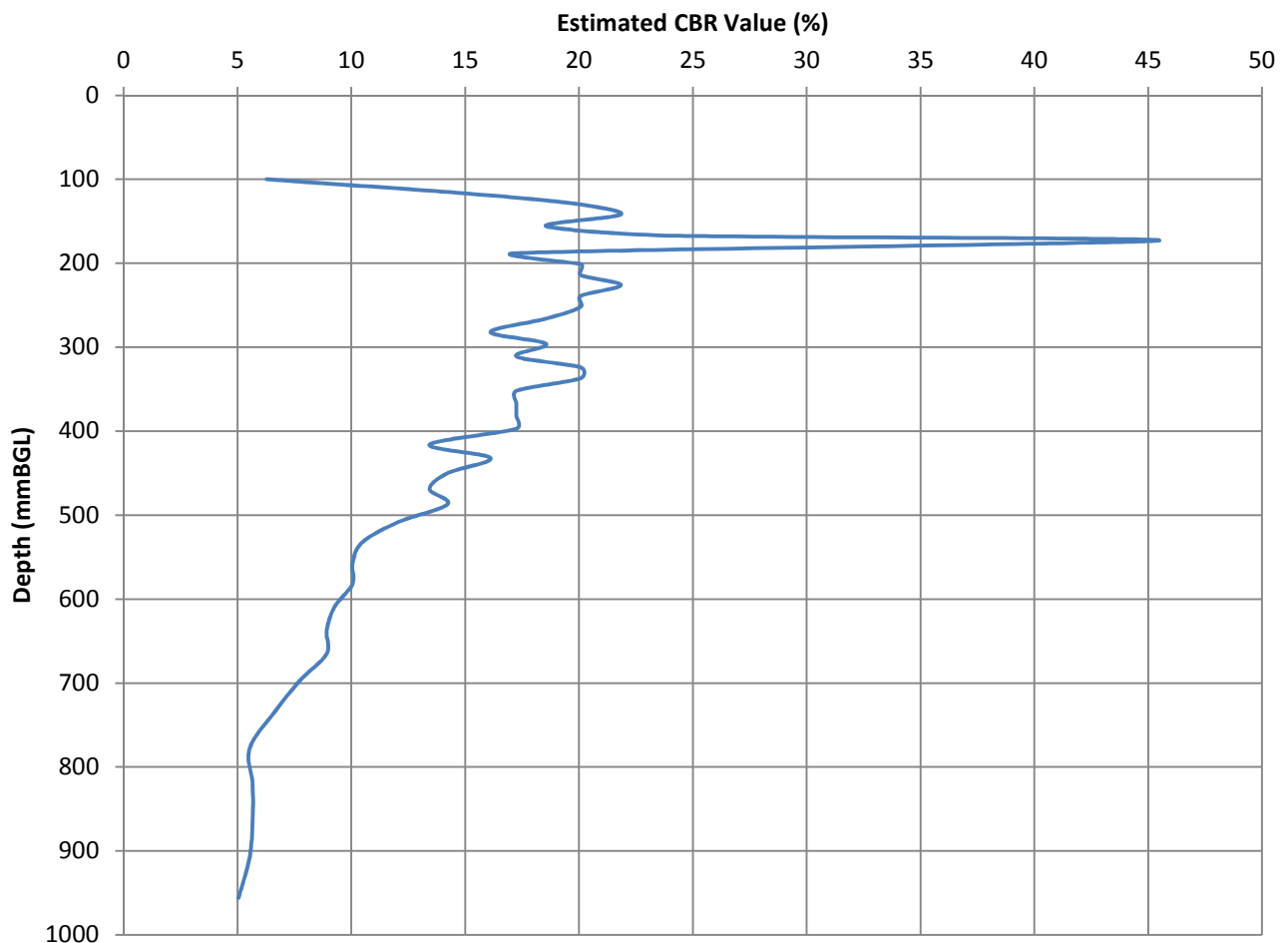
Date: 27/03/2015 **Engineer:** DAP

Easting: **Northing:**

Initial Depth (mmBGL): 61

Final Depth (mmBGL): 956

Estimated California Bearing Ratio (%) against Depth (mmBGL)



Summary Table

Start Depth	Finish Depth (mmBGL)	No of Blows	Blows per Layer	mm/Blows	Average Estimated CBR (%)
61	400	23	23	14.74	17.58
400	600	32	9	22.22	11.39
600	956	42	10	35.60	6.92

Comments:

Checked By:

Date:

Approved By:

Date:

Appendix 8 – Geotechnical Calculations

Project	Holybourne Road				
	Shallow Foundation				
	Determination of Bearing Resistance	Calcs by	DF	Checked by	RP
	<u>Design Approach 1</u>			Ground Model 1 Strip Foundation	
	Combination 1 A1 + M1 + R1				
	<u>Material Properties and Resistance</u>				
	Partial factors set M1: $\gamma_{cu} = 1$ $\gamma_{\phi} = 1$ and $\gamma_c = 1$				
	$c_{ud} = \frac{c_{uk}}{\gamma_{cu}} = 95\text{kN/m}^2$				
	Design shearing resistance is $\phi_d = \tan^{-1}\left(\frac{\tan \phi_K}{\gamma_{\phi}}\right) = 25^{\circ}$				
	Design cohesion is $c'_d = \frac{c_k}{\gamma_c} = 0\text{kN/m}^2$				
	<u>Drained Bearing Capacity Factors</u>				
	For overburden $N_q = \left[e^{(\pi \times \tan(\phi_d))} \times \left(\tan\left(45 + \frac{\phi_d}{2}\right) \right)^2 \right] = 10.64$				
	For cohesion $N_c = [(N_q - 1) \times \cot(\phi_d)] = 20.67$				
	For self-weight $N_{\gamma} = [2(N_q - 1) \times \tan(\phi_d)] = 8.99$				
	<u>Depth and Shape Factors</u>				
	Solgado's depth factor for undrained loading: $d_c = 1 + 0.27\sqrt{\frac{d}{B}} = 1.3$				
	Ignore depth factors for drained loading				
	Solgado's shape factor for undrained loading: $s_c = 1 + 0.17\sqrt{\frac{d}{B}} = 1.19$				
Shape factors are all 1.0 for drained loading and so can be ignored					
<u>Undrained Bearing Resitance</u>					
Total overburden at foundation base is $\sigma_{vk,b} = \gamma_k \times d = 17\text{kN/m}^2$					
Partial factors set R1: $\gamma_{Rv} = 1$					
Ultimate resistance is $q_{ult} = (\pi + 2) \times c_{ud} \times d_c \times s_c + \sigma_{vk,b} = 772\text{kN/m}^2$					
Design Resistance is $q_{Rd} = \frac{q_{ult}}{\gamma_{Rv}} = 772\text{kN/m}^2$					

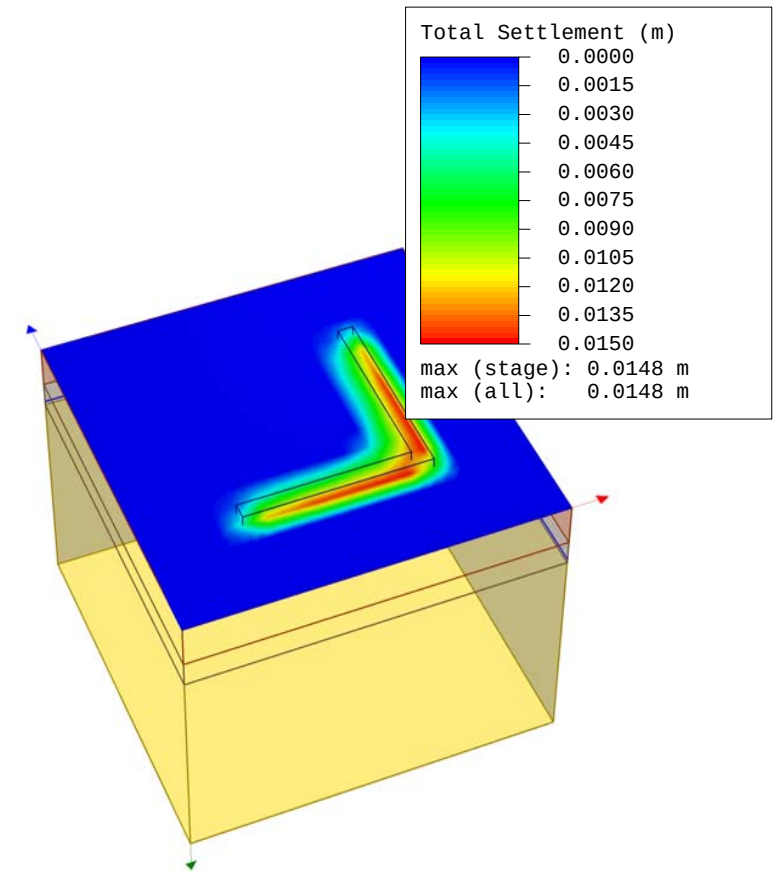
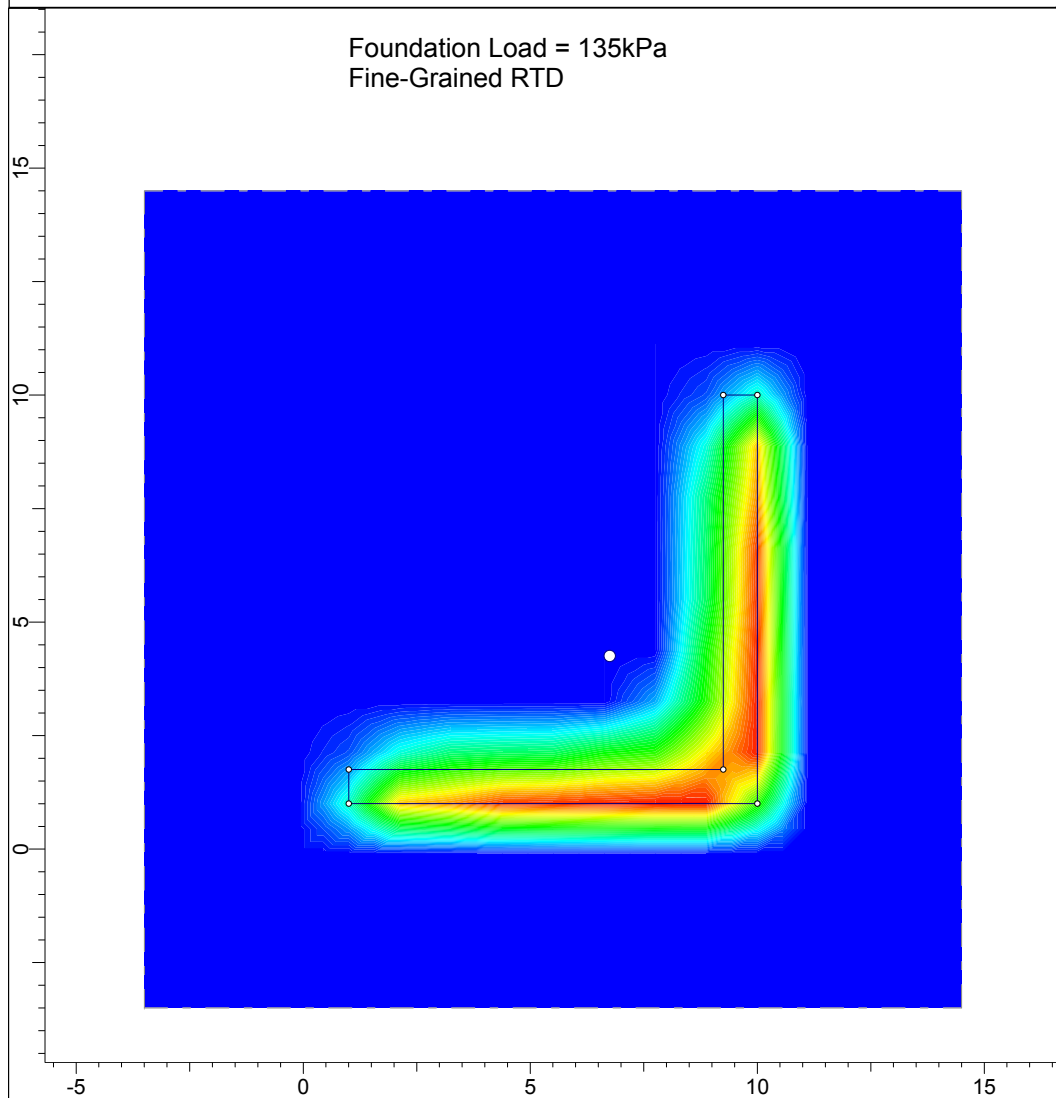
Project	Holybourne Road			
	Shallow Foundation			
	Determination of Bearing Resistance	Calcs by	DF	Checked by
	<u>Drained Bearing Resistance</u> Strip Foundation Effective overburden at foundation base is $\sigma'_{vk,b} = \sigma_{vk,b} - u_{k,b} = 17\text{kN/m}^2$ From overburden $q'_{ult_1} = N_q \times \sigma'_{wk,b} = 181\text{kN/m}^2$ From cohesion $q'_{ult_2} = N_C \times c'_d = 0\text{kN/m}^2$ From self-weight $q'_{ult_3} = \left[N_\gamma \times (\gamma_k - \gamma_w) \times \frac{B}{2} \right] = 64\text{kN/m}^2$ Total resistance is $q'_{ult} = \sum_{i=1}^3 q'_{ult_i} = 245\text{kN/m}^2$ Design resistance is $q'_{Rd} = \frac{q'_{ult}}{\gamma_{Rv}} = 245\text{kN/m}^2$ <u>Design Approach 1</u> Combination 2 A2 + M2 + R1 <u>Material Properties and Resistance</u> Partial factors set M2: $\gamma_{cu} = 1.4$ $\gamma_\phi = 1.25$ and $\gamma_c = 1.25$ Design undrained strength is $c_{ud} = \frac{c_{uk}}{\gamma_{cu}} = 68\text{kN/m}^2$ Design shearing resistance is $\phi_d = \tan^{-1} \left(\frac{\tan \phi_K}{\gamma_\phi} \right) = 20$ Design cohesion is $c'_d = \frac{c_k}{\gamma_c} = 0\text{kN/m}^2$ <u>Drained Bearing Capacity Factors</u> For overburden $N_q = \left[e^{(\pi \times \tan(\phi_d))} \times \left(\tan \left(45 + \frac{\phi_d}{2} \right) \right)^2 \right] = 6.4$ For cohesion $N_c = [(N_q - 1) \times \cot(\phi_d)] = 14.84$ For self-weight $N_\gamma = [2(N_q - 1) \times \tan(\phi_d)] = 3.93$			

Project	Holybourne Road			
	Shallow Foundation			
	Determination of Bearing Resistance	Calcs by	DF	Checked by
	<u>Depth and Shape Factors</u> Strip Foundation			
	Solgado's depth factor for undrained loading: $d_c = 1 + 0.27 \sqrt{\frac{d}{B}} = 1.3$			
	Ignore depth factors for drained loading			
	Solgado's shape factor for undrained loading: $s_c = 1 + 0.17 \sqrt{\frac{d}{B}} = 1.19$			
	Shape factors are all 1.0 for drained loading and so can be ignored			
	<u>Undrained Bearing Resitance</u>			
	Total overburden at foundation base is $\sigma_{vk,b} = \gamma_k \times d = 17\text{kN/m}^2$			
	Partial factors set R1: $\gamma_{Rv} = 1$			
	Ultimate resistance is $q_{ult} = (\pi + 2) \times c_{ud} \times d_c \times s_c + \sigma_{vk,b} = 558\text{kN/m}^2$			
	Design Resistance is $q_{Rd} = \frac{q_{ult}}{\gamma_{Rv}} = 558\text{kN/m}^2$			
	<u>Drained Bearing Resistance</u>			
	Effective overburden at foundation base is $\sigma'_{vk,b} = \sigma_{vk,b} - u_{k,b} = 17\text{kN/m}^2$			
	From overburden $q'_{ult_1} = N_q \times \sigma'_{wk,b} = 109\text{kN/m}^2$			
	From cohesion $q'_{ult_2} = N_C \times c'_d = 0\text{kN/m}^2$			
	From self-weight $q'_{ult_3} = \left[N_\gamma \times (\gamma_k - \gamma_w) \times \frac{B}{2} \right] 28\text{kN/m}^2$			
Total resistance is $q'_{ult} = \sum_{i=1}^3 q'_{ult_i} = 137\text{kN/m}^2$				
Design Resistance is $q'_{Rd} = \frac{q'_{ult}}{\gamma_{Rv}} = 137\text{kN/m}^2$				
Design Approach		Combination	Design Resistance	
			ULS (kN/m ²)	
			undrained	drained
DA1	Combination 1		772	245
	Combination 2		558	137

Stage 1

Data Type: Total Settlement

Foundation Load = 135kPa
Fine-Grained RTD



Project	Holybourne Road		
Analysis Description	Strip Foundation		
Drawn By	Dr David Fall	Company	Ridge
Date	16/07/2015	File Name	FG RTD Settlement.s3z

General	Actions		Material Properties			Calculation model		Effects of	Resistance			
	Design values		Design values					Design	Design values			
Depth (m)	F,d (kN)	W,d (kN)	phi,d (°)	c,d (kPa)	cu,d (kPa)	Skin friction (kPa)	Bearing pressure (kPa)	E,d (kN)	Rst,d (kN)	Rs,d (kN)	Rb,d (kN)	Rt,d (kN)
0	300	0	-	-	-	0	0	300	0	0	0	0
0	300	0	-	-	95	0	488.451302	300	0	0	12.3309243	12.3309243
0.1010101	300	0.17847924	-	-	95	0	490.370494	300.178479	0	0	12.3793742	12.3793742
0.2020202	300	0.35695848	-	-	95	0	492.289686	300.356958	0	0	12.4278241	12.4278241
0.3030303	300	0.53543772	-	-	95	0	494.208878	300.535438	0	0	12.4762739	12.4762739
0.4040404	300	0.71391696	-	-	95	0	496.12807	300.713917	0	0	12.5247238	12.5247238
0.50505051	300	0.8923962	-	-	95	0	498.047262	300.892396	0	0	12.5731737	12.5731737
0.60606061	300	1.07087544	-	-	95	0	499.966454	301.070875	0	0	12.6216236	12.6216236
0.70707071	300	1.24935468	-	-	95	0	501.885646	301.249355	0	0	12.6700735	12.6700735
0.75	300	1.32520835	-	-	95	0	502.701302	301.325208	0	0	12.6906647	12.6906647
0.751	300	1.3269753	-	-	95	57	502.720302	301.326975	-0.00959308	0.01199135	12.6911443	12.7031357
0.80808081	300	1.42783392	-	-	95	57	503.804837	301.427834	-1.10475432	1.3809429	12.7185234	14.0994663
0.90909091	300	1.60631316	-	-	95	57	505.724029	301.606313	-3.04274978	3.80343723	12.7669733	16.5704105
1.01010101	300	1.7847924	-	-	95	57	507.643221	301.784792	-4.98074525	6.22593157	12.8154232	19.0413547
1.11111111	300	1.96327164	-	-	95	57	509.562413	301.963272	-6.91874072	8.6484259	12.863873	21.5122989
1.21212121	300	2.14175088	-	-	95	57	511.481605	302.141751	-8.85673619	11.0709202	12.9123229	23.9832432
1.31313131	300	2.32023012	-	-	95	57	513.400797	302.32023	-10.7947317	13.4934146	12.9607728	26.4541874
1.41414141	300	2.49870936	-	-	95	57	515.319989	302.498709	-12.7327271	15.9159089	13.0092227	28.9251316
1.51515152	300	2.6771886	-	-	95	57	517.239181	302.677189	-14.6707226	18.3384032	13.0576726	31.3960758
1.61616162	300	2.85566784	-	-	95	57	519.158373	302.855668	-16.6087181	20.7608976	13.1061225	33.8670201
1.71717172	300	3.03414708	-	-	95	57	521.077565	303.034147	-18.5467135	23.1833919	13.1545724	36.3379643
1.81818182	300	3.21262631	-	-	95	57	522.996757	303.212626	-20.484709	25.6058862	13.2030222	38.8089085
1.91919192	300	3.39110555	-	-	95	57	524.915949	303.391106	-22.4227045	28.0283806	13.2514721	41.2798527
2	300	3.53388895	-	-	95	57	526.451302	303.533889	-23.9731008	29.9663761	13.290232	43.2566081
2	300	3.53388895	36	0	-	16.91869	1472.59489	303.533889	-23.9731008	29.9663761	37.1755711	67.1419472
2.02020202	300	3.56958479	36	0	-	17.0805914	1486.68671	303.569585	-24.0886981	30.1108727	37.5313182	67.6421909
2.12121212	300	3.74806403	36	0	-	17.8900981	1557.1458	303.748064	-24.6831985	30.8539981	39.3100537	70.1640518
2.22222222	300	3.92654327	36	0	-	18.6996048	1627.60488	303.926543	-25.305222	31.6315274	41.0887891	72.7203166
2.32323232	300	4.10502251	36	0	-	19.5091115	1698.06397	304.105023	-25.9547686	32.4434608	42.8675246	75.3109854

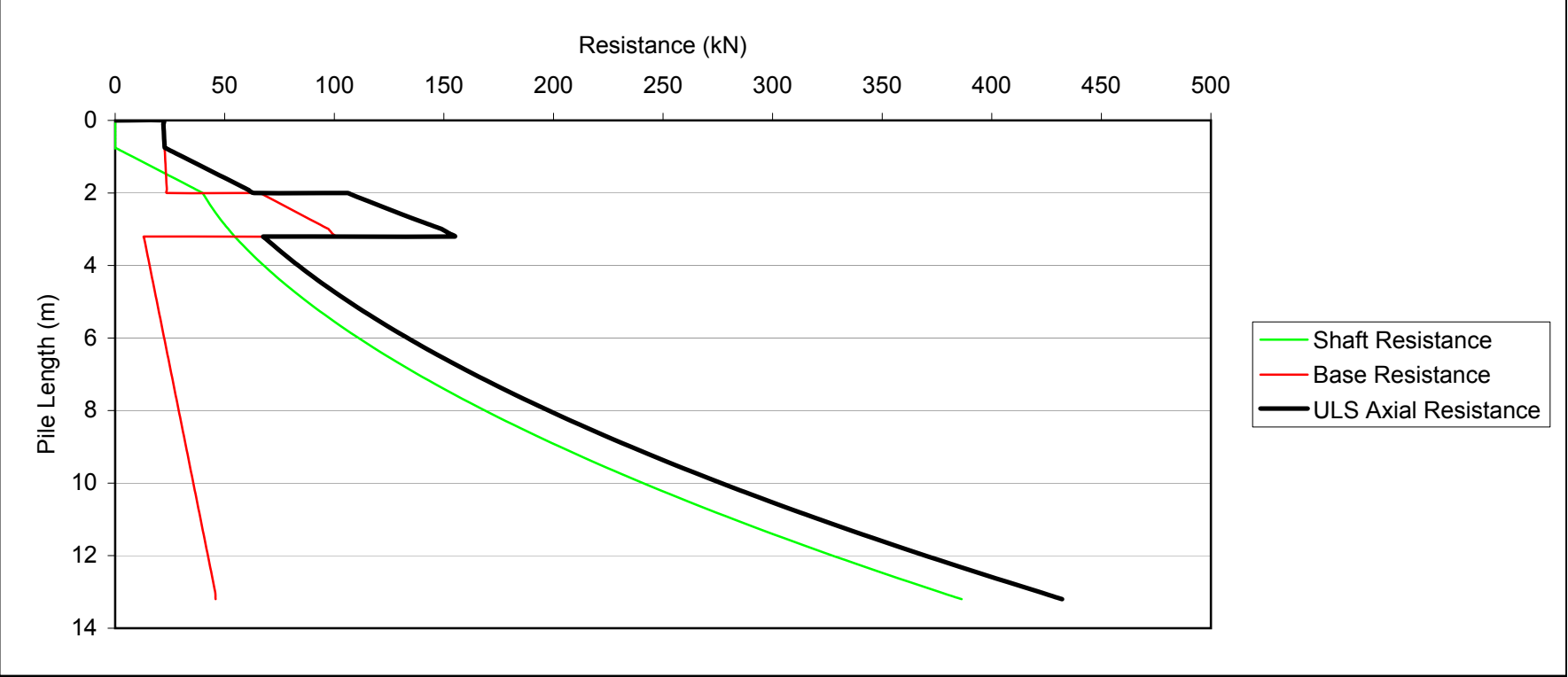
General	Actions		Material Properties			Calculation model		Effects of	Resistance			
	Design values		Design values					Design values	Design values			
Depth (m)	F,d (kN)	W,d (kN)	phi,d (°)	c,d (kPa)	cu,d (kPa)	Skin friction (kPa)	Bearing pressure (kPa)	E,d (kN)	Rst,d (kN)	Rs,d (kN)	Rb,d (kN)	Rt,d (kN)
0	300	0	-	-	-	0	0	300	0	0	0	0
0	300	0	-	-	95	0	488.4513021	300	0	0	21.92164318	21.92164318
0.101010101	300	0.317296426	-	-	95	0	490.370494	300.3172964	0	0	22.00777631	22.00777631
0.202020202	300	0.634592852	-	-	95	0	492.2896859	300.6345929	0	0	22.09390944	22.09390944
0.303030303	300	0.951889278	-	-	95	0	494.2088778	300.9518893	0	0	22.18004257	22.18004257
0.404040404	300	1.269185705	-	-	95	0	496.1280698	301.2691857	0	0	22.2661757	22.2661757
0.505050505	300	1.586482131	-	-	95	0	498.0472617	301.5864821	0	0	22.35230884	22.35230884
0.606060606	300	1.903778557	-	-	95	0	499.9664536	301.9037786	0	0	22.43844197	22.43844197
0.707070707	300	2.221074983	-	-	95	0	501.8856455	302.221075	0	0	22.5245751	22.5245751
0.75	300	2.355925964	-	-	95	0	502.7013021	302.355926	0	0	22.56118168	22.56118168
0.751	300	2.359067199	-	-	95	57	502.7203021	302.3590672	-0.01279077	0.015988463	22.5620344	22.57802286
0.808080808	300	2.538371409	-	-	95	57	503.8048374	302.5383714	-1.47300576	1.841257194	22.61070823	24.45196543
0.909090909	300	2.855667835	-	-	95	57	505.7240294	302.8556678	-4.05699971	5.071249641	22.69684136	27.768091
1.01010101	300	3.172964261	-	-	95	57	507.6432213	303.1729643	-6.64099367	8.301242088	22.78297449	31.08421658
1.111111111	300	3.490260688	-	-	95	57	509.5624132	303.4902607	-9.22498763	11.53123453	22.86910763	34.40034216
1.212121212	300	3.807557114	-	-	95	57	511.4816051	303.8075571	-11.8089816	14.76122698	22.95524076	37.71646774
1.313131313	300	4.12485354	-	-	95	57	513.400797	304.1248535	-14.3929755	17.99121943	23.04137389	41.03259332
1.414141414	300	4.442149966	-	-	95	57	515.319989	304.44215	-16.9769695	21.22121188	23.12750702	44.3487189
1.515151515	300	4.759446392	-	-	95	57	517.2391809	304.7594464	-19.5609635	24.45120432	23.21364015	47.66484448
1.616161616	300	5.076742818	-	-	95	57	519.1583728	305.0767428	-22.1449574	27.68119677	23.29977329	50.98097006
1.717171717	300	5.394039244	-	-	95	57	521.0775647	305.3940392	-24.7289514	30.91118922	23.38590642	54.29709563
1.818181818	300	5.711335671	-	-	95	57	522.9967566	305.7113357	-27.3129453	34.14118166	23.47203955	57.61322121
1.919191919	300	6.028632097	-	-	95	57	524.9159486	306.0286321	-29.8969393	37.37117411	23.55817268	60.92934679
2	300	6.282469238	-	-	95	57	526.4513021	306.2824692	-31.9641345	39.95516807	23.62707919	63.58224725
2	300	6.282469238	36	0	-	16.91869004	1472.594893	306.2824692	-31.9641345	39.95516807	66.08990423	106.0450723
2.02020202	300	6.345928523	36	0	-	17.08059138	1486.68671	306.3459285	-32.1182642	40.14783021	66.7223435	106.8701737
2.121212121	300	6.663224949	36	0	-	17.89009808	1557.145795	306.6632249	-32.9109313	41.1386641	69.88453988	111.023204
2.222222222	300	6.980521375	36	0	-	18.69960478	1627.604881	306.9805214	-33.7402959	42.17536992	73.04673625	115.2221062
2.323232323	300	7.297817801	36	0	-	19.50911148	1698.063967	307.2978178	-34.6063581	43.25794768	76.20893263	119.4668803

2.424242424	300	7.615114227	36	0	-	20.31861818	1768.523053	307.6151142	-35.5091179	44.38639738	79.371129	123.7575264
2.525252525	300	7.932410654	36	0	-	21.12812488	1838.982139	307.9324107	-36.4485752	45.56071903	82.53332538	128.0940444
2.626262626	300	8.24970708	36	0	-	21.93763159	1909.441224	308.2497071	-37.4247301	46.78091261	85.69552175	132.4764344
2.727272727	300	8.567003506	36	0	-	22.74713829	1979.90031	308.5670035	-38.4375825	48.04697812	88.85771813	136.9046963
2.828282828	300	8.884299932	36	0	-	23.55664499	2050.359396	308.8842999	-39.4871325	49.35891558	92.0199145	141.3788301
2.929292929	300	9.201596358	36	0	-	24.36615169	2120.818482	309.2015964	-40.57338	50.71672498	95.18211088	145.8988359
3	300	9.423703857	36	0	-	24.93280638	2170.139842	309.4237039	-41.3555883	51.69448536	97.39564834	149.0901337
3.03030303	300	9.518892784	36	0	-	25.04334924	2180.058612	309.5188928	-41.6954254	52.11928169	97.84080171	149.9600834
3.131313131	300	9.836189211	36	0	-	25.41182545	2213.12118	309.8361892	-42.8390733	53.54884163	99.32464629	152.8734879
3.2	300	10.05195078	36	0	-	25.66238927	2235.603726	310.0519508	-43.6262954	54.5328692	100.3336606	154.8665298
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3.232323232	300	10.15348564	-	-	45.34632035	27.20779221	293.366449	310.1534856	-44.0194816	55.02435203	13.16625544	68.19060747
3.333333333	300	10.47078206	-	-	46.42857143	27.85714286	300.8501351	310.4707821	-45.2676172	56.58452154	13.50212249	70.08664403
3.434343434	300	10.78807849	-	-	47.51082251	28.50649351	308.3338212	310.7880785	-46.54519	58.18148751	13.83798954	72.01947705
3.535353535	300	11.10537492	-	-	48.59307359	29.15584416	315.8175074	311.1053749	-47.8521999	59.81524992	14.17385659	73.98910651
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3.838383838	300	12.05726419	-	-	51.83982684	31.1038961	338.2685658	312.0572642	-51.9498527	64.93731587	15.18145773	80.1187736
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4.04040404	300	12.69185705	-	-	54.004329	32.4025974	353.235938	312.691857	-54.828807	68.53600875	15.85319183	84.38920058
4.141414141	300	13.00915347	-	-	55.08658009	33.05194805	360.7196242	313.0091535	-56.3124399	70.39054987	16.18905888	86.57960874
4.242424242	300	13.3264499	-	-	56.16883117	33.7012987	368.2033103	313.3264499	-57.8255099	72.28188743	16.52492592	88.80681336
4.343434343	300	13.64374632	-	-	57.25108225	34.35064935	375.6869964	313.6437463	-59.3680172	74.21002145	16.86079297	91.07081443
4.444444444	300	13.96104275	-	-	58.33333333	35	383.1706826	313.9610428	-60.9399615	76.17495192	17.19666002	93.37161194
4.545454545	300	14.27833918	-	-	59.41558442	35.64935065	390.6543687	314.2783392	-62.5413431	78.17667885	17.53252707	95.70920591
4.646464646	300	14.5956356	-	-	60.4978355	36.2987013	398.1380548	314.5956356	-64.1721618	80.21520222	17.86839412	98.08359633
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4.848484848	300	15.23022845	-	-	62.66233766	37.5974026	413.1054271	315.2302285	-67.5221106	84.40263831	18.54012821	102.9427665
4.949494949	300	15.54752488	-	-	63.74458874	38.24675325	420.5891132	315.5475249	-69.2412408	86.55155104	18.87599526	105.4275463
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5.151515152	300	16.18211773	-	-	65.90909091	39.54545455	435.5564855	316.1821177	-72.7678127	90.95976584	19.54772936	110.5074952
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5.454545455	300	17.13400701	-	-	69.15584416	41.49350649	458.0075439	317.134007	-78.2784491	97.84806142	20.5553305	118.4033919
5.555555556	300	17.45130344	-	-	70.23809524	42.14285714	465.49123	317.4513034	-80.1742023	100.2177528	20.89119755	121.1089504
5.656565657	300	17.76859986	-	-	71.32034632	42.79220779	472.9749162	317.7685999	-82.0993926	102.6242407	21.2270646	123.8513053
5.757575758	300	18.08589629	-	-	72.4025974	43.44155844	480.4586023	318.0858963	-84.05402	105.0675251	21.56293165	126.6304567
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6.060606061	300	19.03778557	-	-	75.64935065	45.38961039	502.9096607	319.0377856	-90.0945254	112.6181567	22.57053279	135.1886895
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6.565656566	300	20.6242677	-	-	81.06060606	48.63636364	540.3280914	320.6242677	-100.750778	125.9384719	24.24986803	150.18834
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6.868686869	300	21.57615698	-	-	84.30735931	50.58441558	562.7791498	321.576157	-107.497775	134.3722184	25.25746918	159.6296876
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8.080808081	300	25.38371409	-	-	97.29437229	58.37662338	652.5833834	325.3837141	-137.135108	171.418885	29.28787376	200.7067588
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8.686868687	300	27.28749265	-	-	103.7878788	62.27272727	697.4855002	327.2874926	-153.543381	191.9292267	31.30307605	223.2323027

8.787878788	300	27.60478907	-	-	104.8701299	62.92207792	704.9691863	327.6047891	-156.381124	195.4764045	31.6389431	227.1153476
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9.292929293	300	29.19127121	-	-	110.2813853	66.16883117	742.387617	329.1912712	-171.011392	213.7642406	33.31827834	247.0825189
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9.494949495	300	29.82586406	-	-	112.4458874	67.46753247	757.3549892	329.8258641	-177.06956	221.3369501	33.99001243	255.3269626
9.595959596	300	30.14316048	-	-	113.5281385	68.11688312	764.8386754	330.1431605	-180.1428	225.1784996	34.32587948	259.5043791
9.696969697	300	30.46045691	-	-	114.6103896	68.76623377	772.3223615	330.4604569	-183.245476	229.0568455	34.66174653	263.718592
9.797979798	300	30.77775334	-	-	115.6926407	69.41558442	779.8060476	330.7777533	-186.37759	232.9719879	34.99761358	267.9696014
9.898989899	300	31.09504976	-	-	116.7748918	70.06493506	787.2897338	331.0950498	-189.539141	236.9239267	35.33348063	272.2574073
10	300	31.41234619	-	-	117.8571429	70.71428571	794.7734199	331.4123462	-192.73013	240.9126619	35.66934767	276.5820096
10.1010101	300	31.72964261	-	-	118.9393939	71.36363636	802.257106	331.7296426	-195.950555	244.9381936	36.00521472	280.9434084
10.2020202	300	32.04693904	-	-	120.021645	72.01298701	809.7407922	332.046939	-199.200417	249.0005218	36.34108177	285.3416036
10.3030303	300	32.36423547	-	-	121.1038961	72.66233766	817.2244783	332.3642355	-202.479717	253.0996464	36.67694882	289.7765952
10.4040404	300	32.68153189	-	-	122.1861472	73.31168831	824.7081644	332.6815319	-205.788454	257.2355675	37.01281587	294.2483834
10.50505051	300	32.99882832	-	-	123.2683983	73.96103896	832.1918506	332.9988283	-209.126628	261.408285	37.34868292	298.7569679
10.60606061	300	33.31612475	-	-	124.3506494	74.61038961	839.6755367	333.3161247	-212.494239	265.617799	37.68454996	303.3023489
10.70707071	300	33.63342117	-	-	125.4329004	75.25974026	847.1592228	333.6334212	-215.891288	269.8641094	38.02041701	307.8845264
10.80808081	300	33.9507176	-	-	126.5151515	75.90909091	854.642909	333.9507176	-219.317773	274.1472163	38.35628406	312.5035003
10.90909091	300	34.26801402	-	-	127.5974026	76.55844156	862.1265951	334.268014	-222.773696	278.4671196	38.69215111	317.1592707
11.01010101	300	34.58531045	-	-	128.6796537	77.20779221	869.6102812	334.5853104	-226.259055	282.8238193	39.02801816	321.8518375
11.11111111	300	34.90260688	-	-	129.7619048	77.85714286	877.0939674	334.9026069	-229.773852	287.2173156	39.3638852	326.5812008
11.21212121	300	35.2199033	-	-	130.8441558	78.50649351	884.5776535	335.2199033	-233.318087	291.6476082	39.69975225	331.3473605
11.31313131	300	35.53719973	-	-	131.9264069	79.15584416	892.0613396	335.5371997	-236.891758	296.1146973	40.0356193	336.1503167
11.41414141	300	35.85449615	-	-	133.008658	79.80519481	899.5450257	335.8544962	-240.494866	300.6185829	40.37148635	340.9900693
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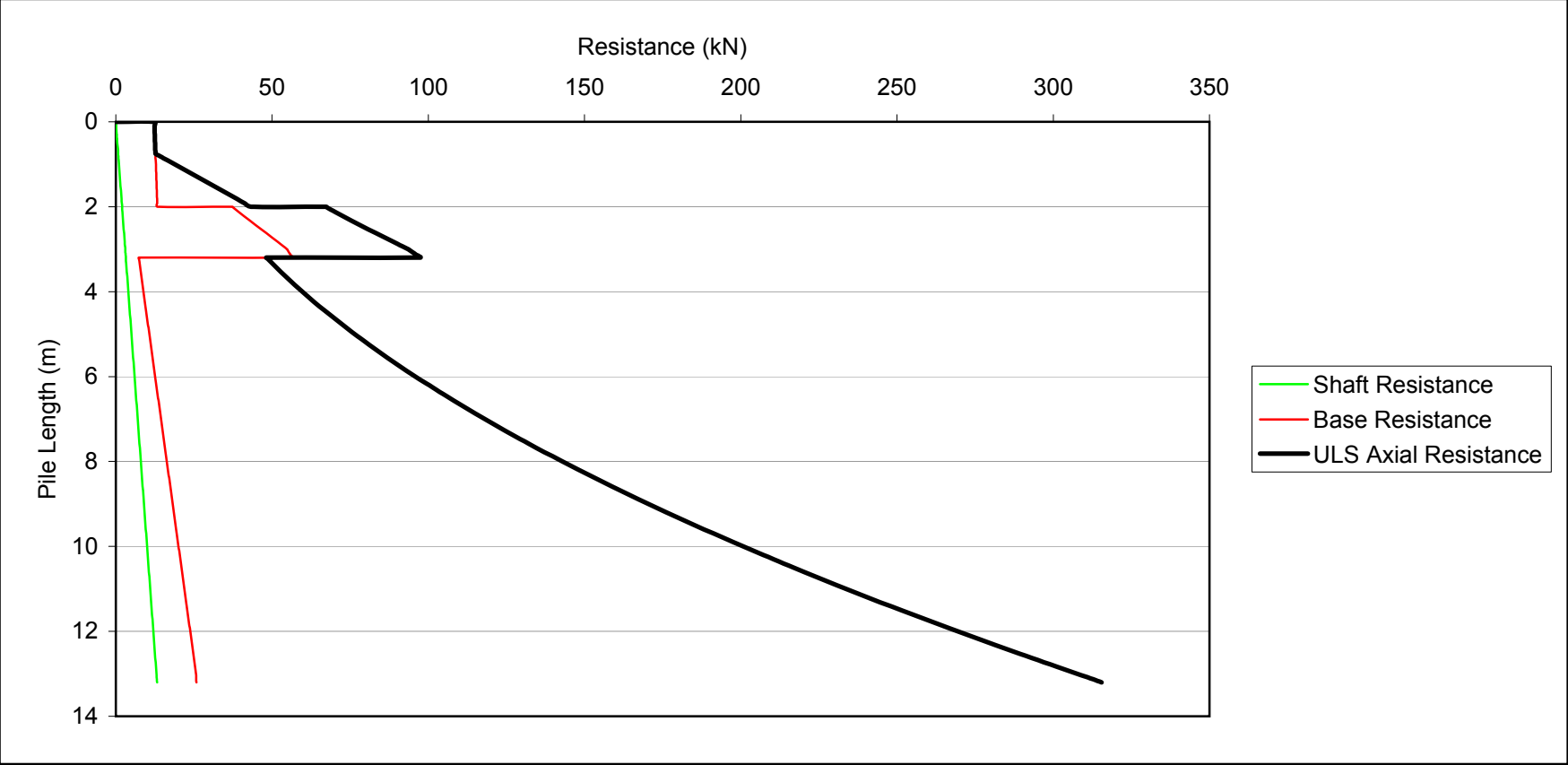


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12.3232323	300	21.7744672	-	-	142.748918	85.6493506	966.898201	321.774467	-205.685636	257.107045	24.409288	281.516333

12.4242424	300	21.9529465	-	-	143.831169	86.2987013	974.381887	321.952946	-208.608746	260.760933	24.5982132	285.359146
12.5252525	300	22.1314257	-	-	144.91342	86.9480519	981.865573	322.131426	-211.553934	264.442417	24.7871384	289.229556
12.6262626	300	22.309905	-	-	145.995671	87.5974026	989.349259	322.309905	-214.5212	268.1515	24.9760636	293.127563
12.7272727	300	22.4883842	-	-	147.077922	88.2467532	996.832945	322.488384	-217.510543	271.888179	25.1649889	297.053168
12.8282828	300	22.6668634	-	-	148.160173	88.8961039	1004.31663	322.666863	-220.521965	275.652456	25.3539141	301.00637
12.9292929	300	22.8453427	-	-	149.242424	89.5454545	1011.80032	322.845343	-223.555464	279.44433	25.5428393	304.98717
13.030303	300	23.0238219	-	-	150	90	1017.61466	323.023822	-226.60773	283.259662	25.6896219	308.949284
13.1313131	300	23.2023012	-	-	150	90	1019.53385	323.202301	-229.667723	287.084653	25.7380718	312.822725
13.2	300	23.323667	-	-	150	90	1020.8389	323.323667	-231.748518	289.685647	25.7710177	315.456665



General	Actions		Material Properties			Calculation model		Effects of	Resistance			
	Design values		Design values					Design values	Design values			
Depth (m)	F,d (kN)	W,d (kN)	phi,d (°)	c,d (kPa)	cu,d (kPa)	Skin friction (kPa)	Bearing pressure (kPa)	E,d (kN)	Rst,d (kN)	Rs,d (kN)	Rb,d (kN)	Rt,d (kN)
0	300	0	-	-	-	0	0	300	0	0	0	0
0	300	0	-	-	95	0	488.4513021	300	0	0	34.25256746	34.25256746
0.101010101	300	0.495775666	-	-	95	0	490.370494	300.4957757	0	0	34.38715048	34.38715048
0.202020202	300	0.991551332	-	-	95	0	492.2896859	300.9915513	0	0	34.5217335	34.5217335
0.303030303	300	1.487326998	-	-	95	0	494.2088778	301.487327	0	0	34.65631652	34.65631652
0.404040404	300	1.983102663	-	-	95	0	496.1280698	301.9831027	0	0	34.79089954	34.79089954
0.505050505	300	2.478878329	-	-	95	0	498.0472617	302.4788783	0	0	34.92548255	34.92548255
0.606060606	300	2.974653995	-	-	95	0	499.9664536	302.974654	0	0	35.06006557	35.06006557
0.707070707	300	3.470429661	-	-	95	0	501.8856455	303.4704297	0	0	35.19464859	35.19464859
0.75	300	3.681134319	-	-	95	0	502.7013021	303.6811343	0	0	35.25184637	35.25184637
0.751	300	3.686042498	-	-	95	57	502.7203021	303.6860425	-0.01598846	0.019985578	35.25317875	35.27316433
0.808080808	300	3.966205327	-	-	95	57	503.8048374	303.9662053	-1.84125719	2.301571493	35.32923161	37.6308031
0.909090909	300	4.461980993	-	-	95	57	505.7240294	304.461981	-5.07124964	6.339062052	35.46381463	41.80287668
1.01010101	300	4.957756659	-	-	95	57	507.6432213	304.9577567	-8.30124209	10.37655261	35.59839765	45.97495026
1.111111111	300	5.453532324	-	-	95	57	509.5624132	305.4535323	-11.5312345	14.41404317	35.73298067	50.14702384
1.212121212	300	5.94930799	-	-	95	57	511.4816051	305.949308	-14.761227	18.45153373	35.86756369	54.31909741
1.313131313	300	6.445083656	-	-	95	57	513.400797	306.4450837	-17.9912194	22.48902429	36.0021467	58.49117099
1.414141414	300	6.940859322	-	-	95	57	515.319989	306.9408593	-21.2212119	26.52651484	36.13672972	62.66324457
1.515151515	300	7.436634988	-	-	95	57	517.2391809	307.436635	-24.4512043	30.5640054	36.27131274	66.83531814
1.616161616	300	7.932410654	-	-	95	57	519.1583728	307.9324107	-27.6811968	34.60149596	36.40589576	71.00739172
1.717171717	300	8.428186319	-	-	95	57	521.0775647	308.4281863	-30.9111892	38.63898652	36.54047878	75.1794653
1.818181818	300	8.923961985	-	-	95	57	522.9967566	308.923962	-34.1411817	42.67647708	36.6750618	79.35153888
1.919191919	300	9.419737651	-	-	95	57	524.9159486	309.4197377	-37.3711741	46.71396764	36.80964482	83.52361245
2	300	9.816358184	-	-	95	57	526.4513021	309.8163582	-39.9551681	49.94396008	36.91731123	86.86127131
2	300	9.816358184	36	0	-	16.91869004	1472.594893	309.8163582	-39.9551681	49.94396008	103.2654754	153.2094354
2.02020202	300	9.915513317	36	0	-	17.08059138	1486.68671	309.9155133	-40.1478302	50.18478776	104.2536617	154.4384495
2.121212121	300	10.41128898	36	0	-	17.89009808	1557.145795	310.411289	-41.1386641	51.42333012	109.1945936	160.6179237
2.222222222	300	10.90706465	36	0	-	18.69960478	1627.604881	310.9070646	-42.1753699	52.7192124	114.1355254	166.8547378
2.323232323	300	11.40284031	36	0	-	19.50911148	1698.063967	311.4028403	-43.2579477	54.0724346	119.0764572	173.1488918

2.424242424	300	11.89861598	36	0	-	20.31861818	1768.523053	311.898616	-44.3863974	55.48299673	124.0173891	179.5003858
2.525252525	300	12.39439165	36	0	-	21.12812488	1838.982139	312.3943916	-45.560719	56.95089878	128.9583209	185.9092197
2.626262626	300	12.89016731	36	0	-	21.93763159	1909.441224	312.8901673	-46.7809126	58.47614076	133.8992527	192.3753935
2.727272727	300	13.38594298	36	0	-	22.74713829	1979.90031	313.385943	-48.0469781	60.05872266	138.8401846	198.8989072
2.828282828	300	13.88171864	36	0	-	23.55664499	2050.359396	313.8817186	-49.3589156	61.69864448	143.7811164	205.4797609
2.929292929	300	14.37749431	36	0	-	24.36615169	2120.818482	314.3774943	-50.716725	63.39590622	148.7220482	212.1179545
3	300	14.72453728	36	0	-	24.93280638	2170.139842	314.7245373	-51.6944854	64.6181067	152.1807005	216.7988072
3.03030303	300	14.87326998	36	0	-	25.04334924	2180.058612	314.87327	-52.1192817	65.14910211	152.8762527	218.0253548
3.131313131	300	15.36904564	36	0	-	25.41182545	2213.12118	315.3690456	-53.5488416	66.93605204	155.1947598	222.1308119
3.2	300	15.70617309	36	0	-	25.66238927	2235.603726	315.7061731	-54.5328692	68.1660865	156.7713447	224.9374312
3.2	300	15.70617309	-	-	45	27	290.9716694	315.7061731	-54.5328692	68.1660865	20.4043406	88.5704271
3.232323232	300	15.86482131	-	-	45.34632035	27.20779221	293.366449	315.8648213	-55.024352	68.78044004	20.57227413	89.35271417
3.333333333	300	16.36059697	-	-	46.42857143	27.85714286	300.8501351	316.360597	-56.5845215	70.73065193	21.09706639	91.82771832
3.434343434	300	16.85637264	-	-	47.51082251	28.50649351	308.3338212	316.8563726	-58.1814875	72.72685938	21.62185865	94.34871804
3.535353535	300	17.3521483	-	-	48.59307359	29.15584416	315.8175074	317.3521483	-59.8152499	74.7690624	22.14665092	96.91571332
3.636363636	300	17.84792397	-	-	49.67532468	29.80519481	323.3011935	317.847924	-61.4858088	76.85726098	22.67144318	99.52870416
3.737373737	300	18.34369964	-	-	50.75757576	30.45454545	330.7848796	318.3436996	-63.1931641	78.99145512	23.19623544	102.1876906
3.838383838	300	18.8394753	-	-	51.83982684	31.1038961	338.2685658	318.8394753	-64.9373159	81.17164483	23.7210277	104.8926725
3.939393939	300	19.33525097	-	-	52.92207792	31.75324675	345.7522519	319.335251	-66.7182641	83.3978301	24.24581997	107.6436501
4.04040404	300	19.83102663	-	-	54.004329	32.4025974	353.235938	319.8310266	-68.5360087	85.67001094	24.77061223	110.4406232
4.141414141	300	20.3268023	-	-	55.08658009	33.05194805	360.7196242	320.3268023	-70.3905499	87.98818733	25.29540449	113.2835918
4.242424242	300	20.82257797	-	-	56.16883117	33.7012987	368.2033103	320.822578	-72.2818874	90.35235929	25.82019676	116.172556
4.343434343	300	21.31835363	-	-	57.25108225	34.35064935	375.6869964	321.3183536	-74.2100215	92.76252682	26.34498902	119.1075158
4.444444444	300	21.8141293	-	-	58.33333333	35	383.1706826	321.8141293	-76.1749519	95.21868991	26.86978128	122.0884712
4.545454545	300	22.30990496	-	-	59.41558442	35.64935065	390.6543687	322.309905	-78.1766788	97.72084856	27.39457354	125.1154221
4.646464646	300	22.80568063	-	-	60.4978355	36.2987013	398.1380548	322.8056806	-80.2152022	100.2690028	27.91936581	128.1883686
4.747474747	300	23.3014563	-	-	61.58008658	36.94805195	405.621741	323.3014563	-82.290522	102.8631525	28.44415807	131.3073106
4.848484848	300	23.79723196	-	-	62.66233766	37.5974026	413.1054271	323.797232	-84.4026383	105.5032979	28.96895033	134.4722482
4.949494949	300	24.29300763	-	-	63.74458874	38.24675325	420.5891132	324.2930076	-86.551551	108.1894388	29.4937426	137.6831814
5.050505051	300	24.78878329	-	-	64.82683983	38.8961039	428.0727994	324.7887833	-88.7372602	110.9215753	30.01853486	140.9401101
5.151515152	300	25.28455896	-	-	65.90909091	39.54545455	435.5564855	325.284559	-90.9597658	113.6997073	30.54332712	144.2430344
5.252525253	300	25.78033462	-	-	66.99134199	40.19480519	443.0401716	325.7803346	-93.2190679	116.5238349	31.06811939	147.5919543
5.353535354	300	26.27611029	-	-	68.07359307	40.84415584	450.5238578	326.2761103	-95.5151664	119.393958	31.59291165	150.9868697

5.454545455	300	26.77188596	-	-	69.15584416	41.49350649	458.0075439	326.771886	-97.8480614	122.3100768	32.11770391	154.4277807
5.555555556	300	27.26766162	-	-	70.23809524	42.14285714	465.49123	327.2676616	-100.217753	125.2721911	32.64249617	157.9146872
5.656565657	300	27.76343729	-	-	71.32034632	42.79220779	472.9749162	327.7634373	-102.624241	128.2803009	33.16728844	161.4475893
5.757575758	300	28.25921295	-	-	72.4025974	43.44155844	480.4586023	328.259213	-105.067525	131.3344063	33.6920807	165.026487
5.858585859	300	28.75498862	-	-	73.48484848	44.09090909	487.9422884	328.7549886	-107.547606	134.4345073	34.21687296	168.6513803
5.95959596	300	29.25076429	-	-	74.56709957	44.74025974	495.4259746	329.2507643	-110.064483	137.5806038	34.74166523	172.3222691
6.060606061	300	29.74653995	-	-	75.64935065	45.38961039	502.9096607	329.74654	-112.618157	140.7726959	35.26645749	176.0391534
6.161616162	300	30.24231562	-	-	76.73160173	46.03896104	510.3933468	330.2423156	-115.208627	144.0107836	35.79124975	179.8020334
6.262626263	300	30.73809128	-	-	77.81385281	46.68831169	517.877033	330.7380913	-117.835893	147.2948668	36.31604201	183.6109088
6.363636364	300	31.23386695	-	-	78.8961039	47.33766234	525.3607191	331.2338669	-120.499956	150.6249456	36.84083428	187.4657799
6.464646465	300	31.72964261	-	-	79.97835498	47.98701299	532.8444052	331.7296426	-123.200816	154.00102	37.36562654	191.3666465
6.565656566	300	32.22541828	-	-	81.06060606	48.63636364	540.3280914	332.2254183	-125.938472	157.4230899	37.8904188	195.3135087
6.666666667	300	32.72119395	-	-	82.14285714	49.28571429	547.8117775	332.7211939	-128.712924	160.8911554	38.41521107	199.3063664
6.767676768	300	33.21696961	-	-	83.22510823	49.93506494	555.2954636	333.2169696	-131.524173	164.4052164	38.94000333	203.3452198
6.868686869	300	33.71274528	-	-	84.30735931	50.58441558	562.7791498	333.7127453	-134.372218	167.965273	39.46479559	207.4300686
6.96969697	300	34.20852094	-	-	85.38961039	51.23376623	570.2628359	334.2085209	-137.25706	171.5713252	39.98958785	211.5609131
7.070707071	300	34.70429661	-	-	86.47186147	51.88311688	577.746522	334.7042966	-140.178698	175.2233729	40.51438012	215.7377531
7.171717172	300	35.20007228	-	-	87.55411255	52.53246753	585.2302082	335.2000723	-143.137133	178.9214162	41.03917238	219.9605886
7.272727273	300	35.69584794	-	-	88.63636364	53.18181818	592.7138943	335.6958479	-146.132364	182.6654551	41.56396464	224.2294198
7.373737374	300	36.19162361	-	-	89.71861472	53.83116883	600.1975804	336.1916236	-149.164392	186.4554895	42.08875691	228.5442464
7.474747475	300	36.68739927	-	-	90.8008658	54.48051948	607.6812666	336.6873993	-152.233216	190.2915195	42.61354917	232.9050687
7.575757576	300	37.18317494	-	-	91.88311688	55.12987013	615.1649527	337.1831749	-155.338836	194.1735451	43.13834143	237.3118865
7.676767677	300	37.6789506	-	-	92.96536797	55.77922078	622.6486388	337.6789506	-158.481253	198.1015662	43.66313369	241.7646999
7.777777778	300	38.17472627	-	-	94.04761905	56.42857143	630.132325	338.1747263	-161.660466	202.0755829	44.18792596	246.2635088
7.878787879	300	38.67050194	-	-	95.12987013	57.07792208	637.6160111	338.6705019	-164.876476	206.0955951	44.71271822	250.8083133
7.97979798	300	39.1662776	-	-	96.21212121	57.72727273	645.0996972	339.1662776	-168.129282	210.1616029	45.23751048	255.3991134
8.080808081	300	39.66205327	-	-	97.29437229	58.37662338	652.5833834	339.6620533	-171.418885	214.2736063	45.76230275	260.0359091
8.181818182	300	40.15782893	-	-	98.37662338	59.02597403	660.0670695	340.1578289	-174.745284	218.4316052	46.28709501	264.7187003
8.282828283	300	40.6536046	-	-	99.45887446	59.67532468	667.5507556	340.6536046	-178.10848	222.6355997	46.81188727	269.447487
8.383838384	300	41.14938027	-	-	100.5411255	60.32467532	675.0344418	341.1493803	-181.508472	226.8855898	47.33667953	274.2222693
8.484848485	300	41.64515593	-	-	101.6233766	60.97402597	682.5181279	341.6451559	-184.94526	231.1815754	47.8614718	279.0430472
8.585858586	300	42.1409316	-	-	102.7056277	61.62337662	690.001814	342.1409316	-188.418845	235.5235566	48.38626406	283.9098207
8.686868687	300	42.63670726	-	-	103.7878788	62.27272727	697.4855002	342.6367073	-191.929227	239.9115334	48.91105632	288.8225897

8.787878788	300	43.13248293	-	-	104.8701299	62.92207792	704.9691863	343.1324829	-195.476405	244.3455057	49.43584859	293.7813543
8.888888889	300	43.6282586	-	-	105.952381	63.57142857	712.4528724	343.6282586	-199.060379	248.8254736	49.96064085	298.7861144
8.98989899	300	44.12403426	-	-	107.034632	64.22077922	719.9365586	344.1240343	-202.68115	253.351437	50.48543311	303.8368701
9.090909091	300	44.61980993	-	-	108.1168831	64.87012987	727.4202447	344.6198099	-206.338717	257.923396	51.01022537	308.9336214
9.191919192	300	45.11558559	-	-	109.1991342	65.51948052	734.9039308	345.1155856	-210.03308	262.5413506	51.53501764	314.0763682
9.292929293	300	45.61136126	-	-	110.2813853	66.16883117	742.387617	345.6113613	-213.764241	267.2053007	52.0598099	319.2651106
9.393939394	300	46.10713692	-	-	111.3636364	66.81818182	749.8713031	346.1071369	-217.532197	271.9152464	52.58460216	324.4998486
9.494949495	300	46.60291259	-	-	112.4458874	67.46753247	757.3549892	346.6029126	-221.33695	276.6711877	53.10939443	329.7805821
9.595959596	300	47.09868826	-	-	113.5281385	68.11688312	764.8386754	347.0986883	-225.1785	281.4731245	53.63418669	335.1073112
9.696969697	300	47.59446392	-	-	114.6103896	68.76623377	772.3223615	347.5944639	-229.056846	286.3210569	54.15897895	340.4800358
9.797979798	300	48.09023959	-	-	115.6926407	69.41558442	779.8060476	348.0902396	-232.971988	291.2149848	54.68377121	345.898756
9.898989899	300	48.58601525	-	-	116.7748918	70.06493506	787.2897338	348.5860153	-236.923927	296.1549083	55.20856348	351.3634718
10	300	49.08179092	-	-	117.8571429	70.71428571	794.7734199	349.0817909	-240.912662	301.1408274	55.73335574	356.8741832
10.1010101	300	49.57756659	-	-	118.9393939	71.36363636	802.257106	349.5775666	-244.938194	306.1727421	56.258148	362.4308901
10.2020202	300	50.07334225	-	-	120.021645	72.01298701	809.7407922	350.0733423	-249.000522	311.2506523	56.78294027	368.0335925
10.3030303	300	50.56911792	-	-	121.1038961	72.66233766	817.2244783	350.5691179	-253.099646	316.374558	57.30773253	373.6822906
10.4040404	300	51.06489358	-	-	122.1861472	73.31168831	824.7081644	351.0648936	-257.235567	321.5444594	57.83252479	379.3769842
10.50505051	300	51.56066925	-	-	123.2683983	73.96103896	832.1918506	351.5606692	-261.408285	326.7603563	58.35731706	385.1176733
10.60606061	300	52.05644491	-	-	124.3506494	74.61038961	839.6755367	352.0564449	-265.617799	332.0222487	58.88210932	390.904358
10.70707071	300	52.55222058	-	-	125.4329004	75.25974026	847.1592228	352.5522206	-269.864109	337.3301367	59.40690158	396.7370383
10.80808081	300	53.04799625	-	-	126.5151515	75.90909091	854.642909	353.0479962	-274.147216	342.6840203	59.93169384	402.6157142
10.90909091	300	53.54377191	-	-	127.5974026	76.55844156	862.1265951	353.5437719	-278.46712	348.0838995	60.45648611	408.5403856
11.01010101	300	54.03954758	-	-	128.6796537	77.20779221	869.6102812	354.0395476	-282.823819	353.5297742	60.98127837	414.5110525
11.11111111	300	54.53532324	-	-	129.7619048	77.85714286	877.0939674	354.5353232	-287.217316	359.0216444	61.50607063	420.5277151
11.21212121	300	55.03109891	-	-	130.8441558	78.50649351	884.5776535	355.0310989	-291.647608	364.5595103	62.0308629	426.5903732
11.31313131	300	55.52687458	-	-	131.9264069	79.15584416	892.0613396	355.5268746	-296.114697	370.1433717	62.55565516	432.6990268
11.41414141	300	56.02265024	-	-	133.008658	79.80519481	899.5450257	356.0226502	-300.618583	375.7732287	63.08044742	438.8536761
11.51515152	300	56.51842591	-	-	134.0909091	80.45454545	907.0287119	356.5184259	-305.159265	381.4490812	63.60523968	445.0543209
11.61616162	300	57.01420157	-	-	135.1731602	81.1038961	914.512398	357.0142016	-309.736743	387.1709293	64.13003195	451.3009612
11.71717172	300	57.50997724	-	-	136.2554113	81.75324675	921.9960841	357.5099772	-314.351018	392.9387729	64.65482421	457.5935971
11.81818182	300	58.0057529	-	-	137.3376623	82.4025974	929.4797703	358.0057529	-319.00209	398.7526121	65.17961647	463.9322286
11.91919192	300	58.50152857	-	-	138.4199134	83.05194805	936.9634564	358.5015286	-323.689958	404.6124469	65.70440874	470.3168557
12.02020202	300	58.99730424	-	-	139.5021645	83.7012987	944.4471425	358.9973042	-328.414622	410.5182773	66.229201	476.7474783

12.12121212	300	59.4930799	-	-	140.5844156	84.35064935	951.9308287	359.4930799	-333.176083	416.4701032	66.75399326	483.2240964
12.22222222	300	59.98885557	-	-	141.6666667	85	959.4145148	359.9888556	-337.97434	422.4679247	67.27878552	489.7467102
12.32323232	300	60.48463123	-	-	142.7489177	85.64935065	966.8982009	360.4846312	-342.809393	428.5117417	67.80357779	496.3153195
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12.52525253	300	61.47618257	-	-	144.9134199	86.94805195	981.8655732	361.4761826	-352.58989	440.7373625	68.85316231	509.5905248
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12.72727273	300	62.4677339	-	-	147.0779221	88.24675325	996.8329455	362.4677339	-362.517572	453.1469655	69.90274684	523.0497123
12.82828283	300	62.96350956	-	-	148.1601732	88.8961039	1004.316632	362.9635096	-367.536608	459.4207603	70.4275391	529.8482994
12.92929293	300	63.45928523	-	-	149.2424242	89.54545455	1011.800318	363.4592852	-372.592441	465.7405507	70.95233136	536.6928821
13.03030303	300	63.95506089	-	-	150	90	1017.614656	363.9550609	-377.67955	472.0994374	71.36006085	543.4594982
13.13131313	300	64.45083656	-	-	150	90	1019.533848	364.4508366	-382.779538	478.4744225	71.49464387	549.9690663
13.2	300	64.78796401	-	-	150	90	1020.838898	364.787964	-386.24753	482.8094123	71.58616033	554.3955727

