

GROUND INVESTIGATION REPORT

Proposed Barwell Medical Centre
Land Rear of 55-59, High Street, Barwell

Prepared for: Apollo Capital Projects

Date: March 2021

Report No: 6552/GIR



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Proposed Barwell Medical Centre
Land Rear of 55-59, High Street, Barwell

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EXECUTIVE SUMMARY

Proposals		Apollo Capital Projects is proposing the construction of a new Medical Centre within land to the rear of 55-59, High Street, Barwell.
Geology		The Geological Map of the area shows the site to be underlain by the Mercia Mudstone Group, which typically comprises dominantly red, less commonly green-grey, mudstones and subordinate siltstones. Superficial deposits are shown to overlie the solid geology of the area. These deposits typically comprise: 1. Wigston Member (East): Sand and Gravel – Very high permeability 2. Bosworth Clay Member (West): Clay and Silt – Low permeability
Field Investigation		The site works were undertaken on the 18th of February and comprised 6No. mini percussive boreholes, 2No. machine excavated trial pits and in-situ soakaway tests, 1No. hand excavated trial pits and 5No. in-situ California Bearing Ratio (CBR) tests. Ground conditions encountered during the Ground Investigation typically comprised Made Ground of a surface layer of grey granite gravel overlying silty clayey gravelly clay with various anthropogenic inclusions to a depth of between 0.70m and 1.55m. Underlying the Made Ground were Superficial Deposits comprising either Very loose to loose orange, yellow and reddish brown clayey silty SAND with occasional sandy clay/silt bands (Wigston Member) or firm to stiff reddish brown to grey slightly silty slightly sandy CLAY (Boscombe Clay Member) to the maximum investigated depth of 6.00m. The Boscombe Clay Member was encountered within TP1 and WS1 only, which were located towards the west of the site. During site works, groundwater was encountered within all exploratory holes at depths of between 0.80m and 2.00m.
Contamination Risk Assessment	Chemical Evaluation	The determinants tested were all present at concentrations below the relevant guidelines and therefore, there are no contaminants of concern.
	Human Health	It is considered that the human health risks are low and that no mitigation measures will be required for the development. However, the soils beneath the existing buildings were not tested and therefore, it would be prudent that a watching brief is maintained during construction works.
	Aquatic Environment	It is considered that the risk to the aquatic environment is low due to environmental setting and low levels of contaminant concentrations encountered.
	Gas Migration	There is a low risk to the site end users from ground/landfill gas and a low risk from radon gas where no radon protection measures are likely to be required.
Engineering Recommendations	Foundation and Floor Slab Solution	Following site preparation all Made Ground should be removed from beneath the proposed building. The prepared surface, comprising Superficial Deposits, should then be covered by a geo-grid and 'terram' prior to filling with a minimum of 300mm of well compacted imported granular materials. A reinforced concrete raft type foundation solution should then be founded upon the compacted material. An allowable bearing pressure of 35kN/m ² may be used for design purposes.
	Earthworks	A Class 1B classification should be adopted for fill materials for any proposed earthworks at the site.
	Storm Drainage	The tests did not sufficiently drain to give an infiltration rate. Therefore, it is unlikely soakaways will be viable at the site.
	Highways	Based on the data available and variability of the underlying Made Ground deposits it is recommended that a CBR value of 2% is adopted for the site.
	Buried Concrete	Based on the above and using guidance within BRE Special Digest 1 (2005) it is recommended that any buried concrete within the site conforms to class AC-2 (Made Ground) or AC-1 (Superficial Deposits).

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Drawing 2.1: Site Location Plan
Drawing 2.2: Preliminary Site Conceptual Model
Drawing 3.1: Exploratory Hole Location Plan
Drawing 3.2: SPT vs Depth
Drawing 6.1: Revised Site Conceptual Model

SECTION 1 Introduction and Proposed Development

Apollo Capital Projects is proposing the construction of a new Medical Centre within land to the rear of 55-59, High Street, Barwell.

Expedite Project Services are the Consulting Project Engineers for the proposed development.

Terra Firma (South) have been commissioned as Geo-technical and Geo-environmental Engineers to carry out a Ground Investigation of the site.

The main objectives of the geo-technical ground investigation were to:

- Determine the type, strength and bearing characteristics of the near surface soils and underlying bedrock geology.
- Provide recommendations for a suitable and economic foundation/floor slab solution for the development.
- Provide recommendations with regard to any other geo-technical aspects pertaining to the development.

The main objectives of the geo-environmental assessment programme were to:

- Identify the potential environmental liabilities at the site associated with any soil and groundwater contamination from past site uses.
- Provide a summary of the environmental conditions at the site, together with any necessary remediation works to render the site fit for its intended use.
- Provide recommendations with regard to any other geo-environmental aspects pertaining to the development.

The Ground Investigation has been undertaken in accordance with the following advisory guidance:

- Code of Practice for Site Investigations - (BS 5930): 2015 + A1: 2020
- Investigation of Potentially Contaminated Sites - CoP (BS 10175): 2011 + A2 2017
- Methods of test for soils for civil engineering purposes - In-situ tests (BS 1377-9): 1999

In order to achieve the above objectives, Terra Firma (South) carried out an assessment programme including a review of existing data, followed by a field investigation to determine the prevailing ground conditions and also to collect and analyse soil samples from selected locations around the site.

1.1 Limitations and Exceptions of Investigation

Apollo Capital Projects has requested that a Ground Investigation Report (GIR) be performed in order to establish the ground conditions at the site and collect representative samples for laboratory analysis.

The Ground Investigation was conducted and this report has been prepared for the sole internal reliance of Apollo Capital Projects and their design and construction team. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Terra Firma (South). If an unauthorised third party comes into possession of this report, they rely on it at their peril and the authors owe them no duty of care and skill.

The report represents the findings and opinions of experienced geo-environmental and geo-technical consultants. Terra Firma (South) does not provide legal advice and the advice of lawyers may also be required.

The subsurface geological profiles, any contamination and other plots are generalised by necessity and have been based on the information found at the locations of the exploratory holes and depths sampled and tested.

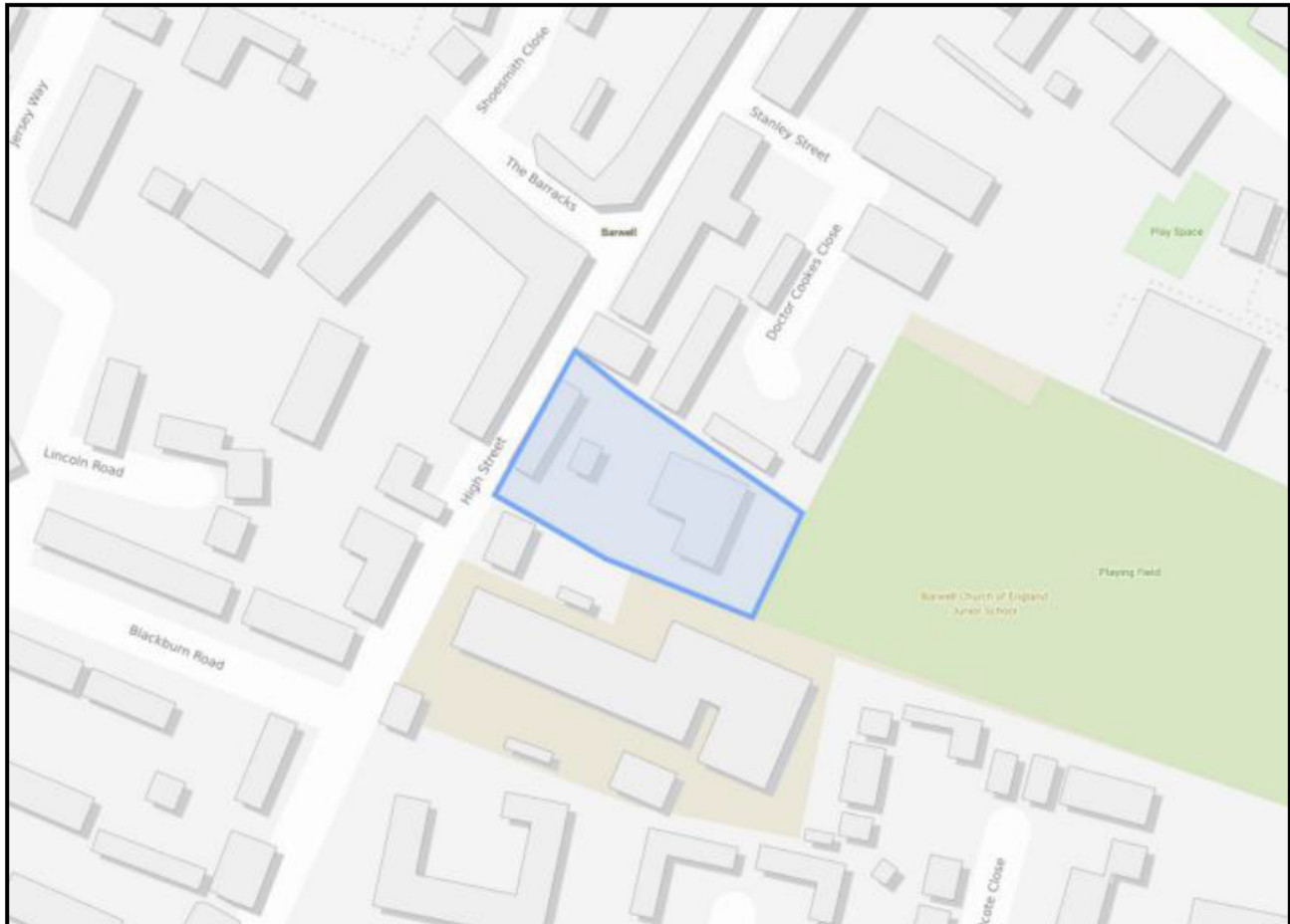
The ground investigation was limited by the following site constraints:

- The presence of underground services and utilities,
- The presence of existing buildings, structures and/or hard standing,
- The presence of underground obstructions and/or unexpected ground conditions, and
- The presence of time restraints outside of our reasonable control.

SECTION 2 Site Setting

2.1 Physical Setting

The proposed development is to be located on land to the rear of 55-59, High Street, Barwell, LE9 8DS. The site is centred approximately on National Grid Reference (NGR) 444350, 296682. The site location is presented in Drawing 2.1 below.



Drawing 2.1: Site Location Plan

The site is broadly rectangular in shape with a plan area of approximately 0.27 hectares and sits between approximately 117m and 118m above ordnance datum (aod).

The topography of the site is typically flat with a slight slope down to the west. The topography of the surrounding area typically slopes gently towards the southwest.

The site boundaries comprise the following:

- North – The northern boundary comprises 53 High Street and Dr Cookes Close.
- East – The eastern boundary comprises The George Ward Centre.
- South – The southern boundary comprises 61 High Street and Barwell Academy.
- West – The western boundary comprises The High Street.

2.1.1 Current Use and Site Conditions

A walk-over survey was undertaken on the 18th of February 2021 by a Terra Firma (South) Engineer.

The site is accessed between 53 and 55 High Street. At the time of the walk-over survey the western part of the site currently comprises a residential dwelling and landscaped gardens. The middle and western parts of the site currently comprise derelict buildings, a gravel yard, gravel heaps, stored materials within concrete retaining walls and two oil Above Ground Storage Tanks (AST). Mature conifers are present around the perimeter of the site. During the walk-over survey the following photographs were taken:

Table 2.1: Walk-over Survey Photographs



Photo 1: AST (Rear of site) / Facing NW



Photo 2: Access / Facing NW



Photo 3: Rear of site / Facing SW



Photo 4: Oil AST (Front of site) / Facing NE



Photo 5: Rear of site / Facing NE



Photo 6: Front of site / Facing SW

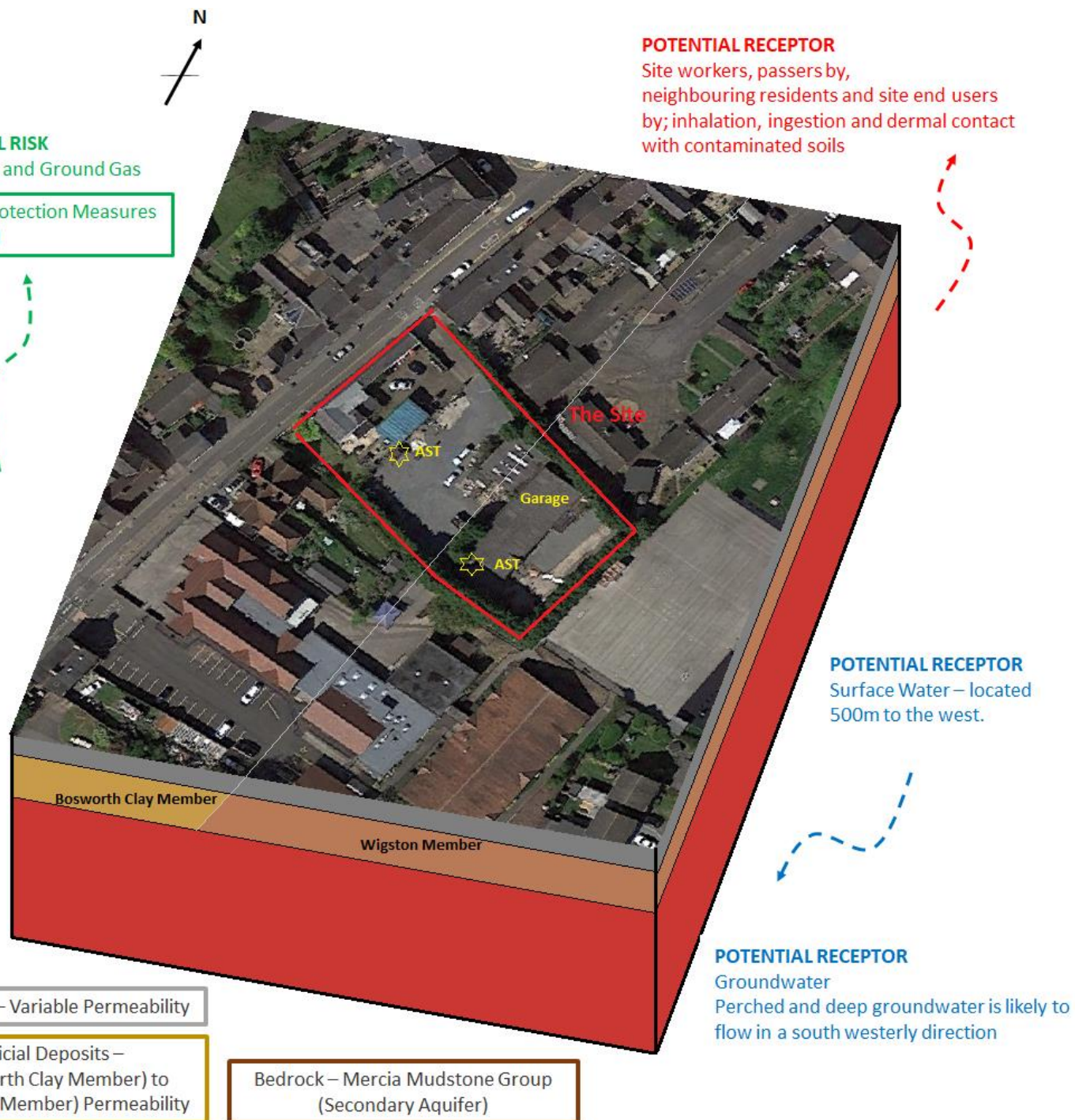
2.2 Phase 1 Risk Assessment

A Phase 1 Contaminated Land Risk Assessment was undertaken by Terra Firma (South) in March 2021 (Report number 6552/DS) and should be read in conjunction with this report. A summary of the report is detailed below:

Geology		The Geological Map of the area shows the site to be underlain by the Mercia Mudstone Group, which typically comprises dominantly red, less commonly green-grey, mudstones and subordinate siltstones. Superficial deposits are shown to overlie the solid geology of the area. These deposits typically comprise: 3. Wigston Member (East): Sand and Gravel – Very high permeability 4. Bosworth Clay Member (West): Clay and Silt – Low permeability				
Mining		In summary, the risk from underground and/or surface mining activity is likely to be low.				
Potential Sources of Contamination	On-site	Currently, the site walkover survey identified the following surface contamination details: <table><tr><td>Visual/Olfactory</td><td>Recent bonfire & used batteries (rear)</td></tr><tr><td>Storage Tanks</td><td>2No. AST's (Oil)</td></tr></table> Historically, the site has typically comprised various buildings since at least 1888, and has known to have been used as a Garage since c. 1972. Present day and historical uses of the site have a number of potential contamination sources including the Garage and Potential Made Ground.	Visual/Olfactory	Recent bonfire & used batteries (rear)	Storage Tanks	2No. AST's (Oil)
	Visual/Olfactory	Recent bonfire & used batteries (rear)				
	Storage Tanks	2No. AST's (Oil)				
Off-site	Historically, the surrounding area (<250m) has typically comprised open fields and residential development from the earliest date of mapping. Localised industrial uses including factories and depots are noted but a distance of at least 75m from the site. Based on the above it is considered that no contaminative sources are with influencing distance of the site. Therefore, significant levels of contamination are not expected from off-site sources.					
	Gas Migration	Due to the absence of any influencing active or historic landfills, underlying organic material (e.g., peat) and significant made ground (>3m), the presence of ground gas is considered unlikely.				
Preliminary Human Health & Environmental Risk Assessment		The preliminary human health and environmental risk assessment has revealed that due to the sites and surrounding areas current and past land uses that a Moderate risk is present from contamination present beneath the site, with particular risk specifically associated with the Garage and Potential Made Ground. In addition, a Low risk is present from the migration of radon gas, a Low risk from the migration of landfill gas and a Low risk from the migration of ground gas.				
Recommendations		Based on a Moderate overall risk rating, in order to confirm the above preliminary human health and environmental risk assessment it is recommended that a Phase 2 Ground Investigation is undertaken comprising site specific soil chemical testing in order to determine the ground conditions, soil chemistry and any environmental liability associated with the site.				

2.2.1 Preliminary Illustrative Site Conceptual Model

The following illustration represents a theorised model through the site. The drawing is generalised and not to scale.



Drawing 2.2: Preliminary Site Conceptual Model

SECTION 3 Field Investigation

3.1 General

The site works were scoped by Terra Firma (South) and comprised the following:

- 6No. mini percussive boreholes (WS1-WS6),
- 2No. machine excavated trial pits and in-situ soakaway tests (TP1-TP2),
- 1No. hand excavated trial pits (HP1), and
- 5No. in-situ California Bearing Ratio (CBR) tests (TRL1-TRL5).

The site works were carried out at the site on the 18th of February 2021.

Prior to the site works, the following Health and Safety measures were undertaken:

- Risk Assessment & Method Statement (RAMS) was issued and approved beforehand,
- Underground Utility Plans were obtained from the relevant Statutory Undertakers,
- Safety fencing was used to prevent unauthorised access into the site working area,
- Before any excavation, all exploratory hole locations were scanned using a Cable Avoidance Tool (CAT) and
- Before any drilling, a 1.20m deep inspection pit was excavated at each borehole location.

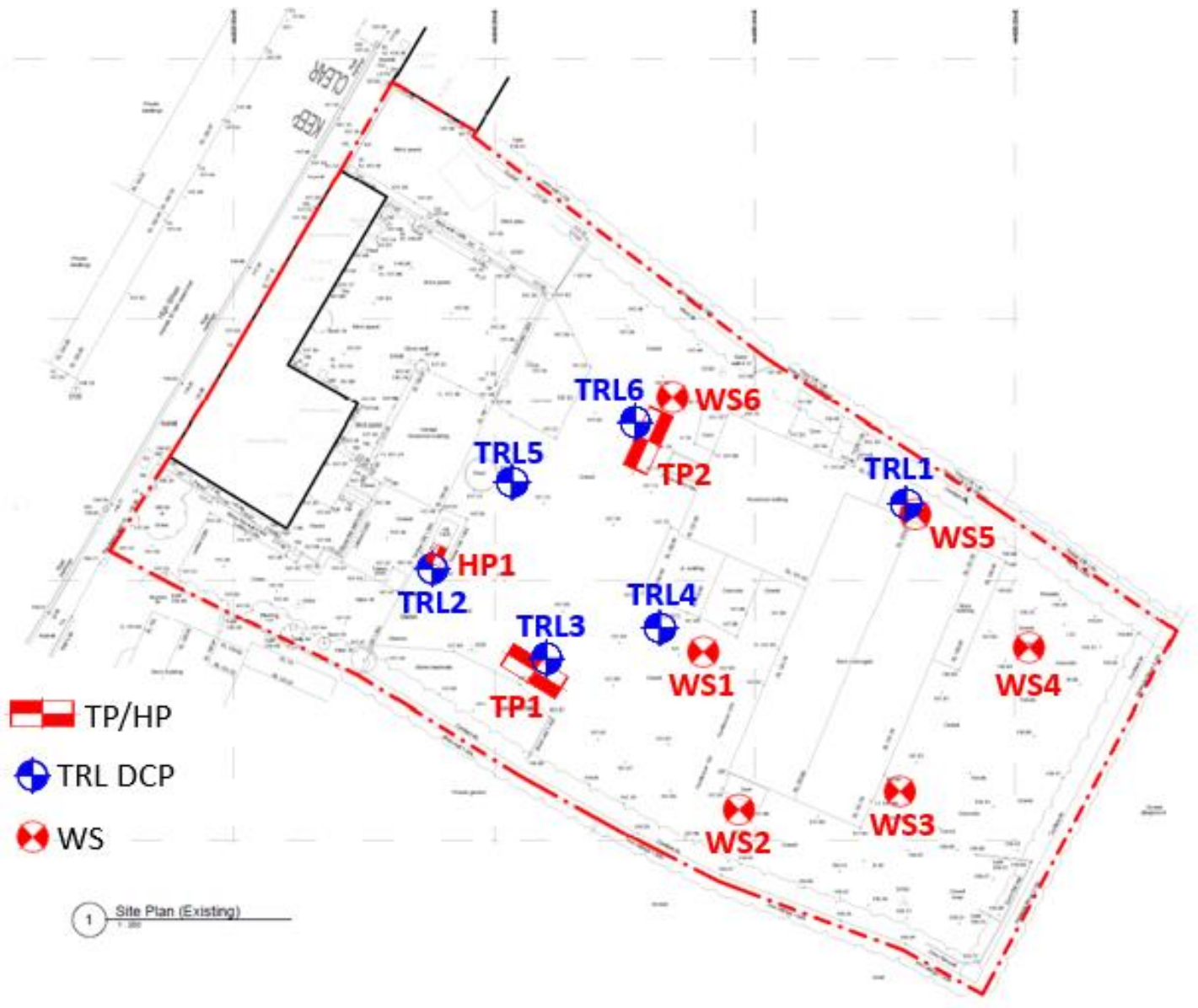
The exploratory holes were set out at locations determined by Terra Firma (South), and adjusted where necessary to take account of the site constraints detailed in Section 1.1.

Approximate exploratory hole co-ordinates and levels were picked up post-investigation using a hand-held Global Positioning System (GPS) receiver and presented in the table below:

Table 3.1: Exploratory Hole Co-ordinates		
Exploratory Hole	Easting	Northing
WS1	444357	296677
WS2	444360	296665
WS3	444372	296666
WS4	444380	296677
WS5	444372	296688
WS6	444353	296696
TP1	444342	296674
TP2	444351	296695
HP1	444336	296685
TRL1	444372	296688
TRL2	444336	296685
TRL3	444342	296674
TRL4	444350	296679
TRL5	444341	296692

The site works were supervised by Terra Firma (South), who also logged the exploratory holes to the requirements of BS5930:2015 + A1: 2020.

The exploratory hole logs and in-situ test results are presented in Annex A and Annex B respectively, and their locations shown on Drawing 3.1 below.



Drawing 3.1: Exploratory Hole Location Plan

3.2 Exploratory Holes

3.2.1 Mini Percussive Boreholes

The windowless sampling boreholes were bored using a Competitor Dart drilling rig.

Due to the presence of surface hard standing a concrete corer attachment or hydraulic breaker was used where necessary to progress drilling.

The windowless boreholes were used to recover soil samples. Standard Penetration Tests using either a split spoon or solid cone (SPT(S/C)) were undertaken at regular depths during the drilling in accordance with BS EN ISO 22476-3. Typically, tests were undertaken at the base of an inspection pit and every metre, a final test was undertaken at the base of each borehole.

Dynamic probing was also undertaken using the tracked mini percussive drilling rig with a super heavy weight (DPSH).

All boreholes were backfilled and reinstated using arisings.

3.2.2 Machine Excavated Trial Pits

The trial pits were excavated using a JCB 3CX wheeled excavator.

Following completion of soil logging, in-situ testing and sampling, the trial pits were backfilled using arisings and re-compacted as best as practicably possible using the excavator backhoe. If necessary, the trial pit was left slightly proud in order to allow for short-term settlement.

3.2.3 Hand Excavated Trial Pits

The hand excavated trial pits were sunk using conventional digging tools, limited to a maximum investigated depth of 1.20m and used to obtain shallow soil samples.

Following completion of soil logging, in-situ testing and sampling, the hand excavated trial pits were backfilled using arisings and re-compacted as best as practicably possible using hand tools.

3.3 In-situ Testing

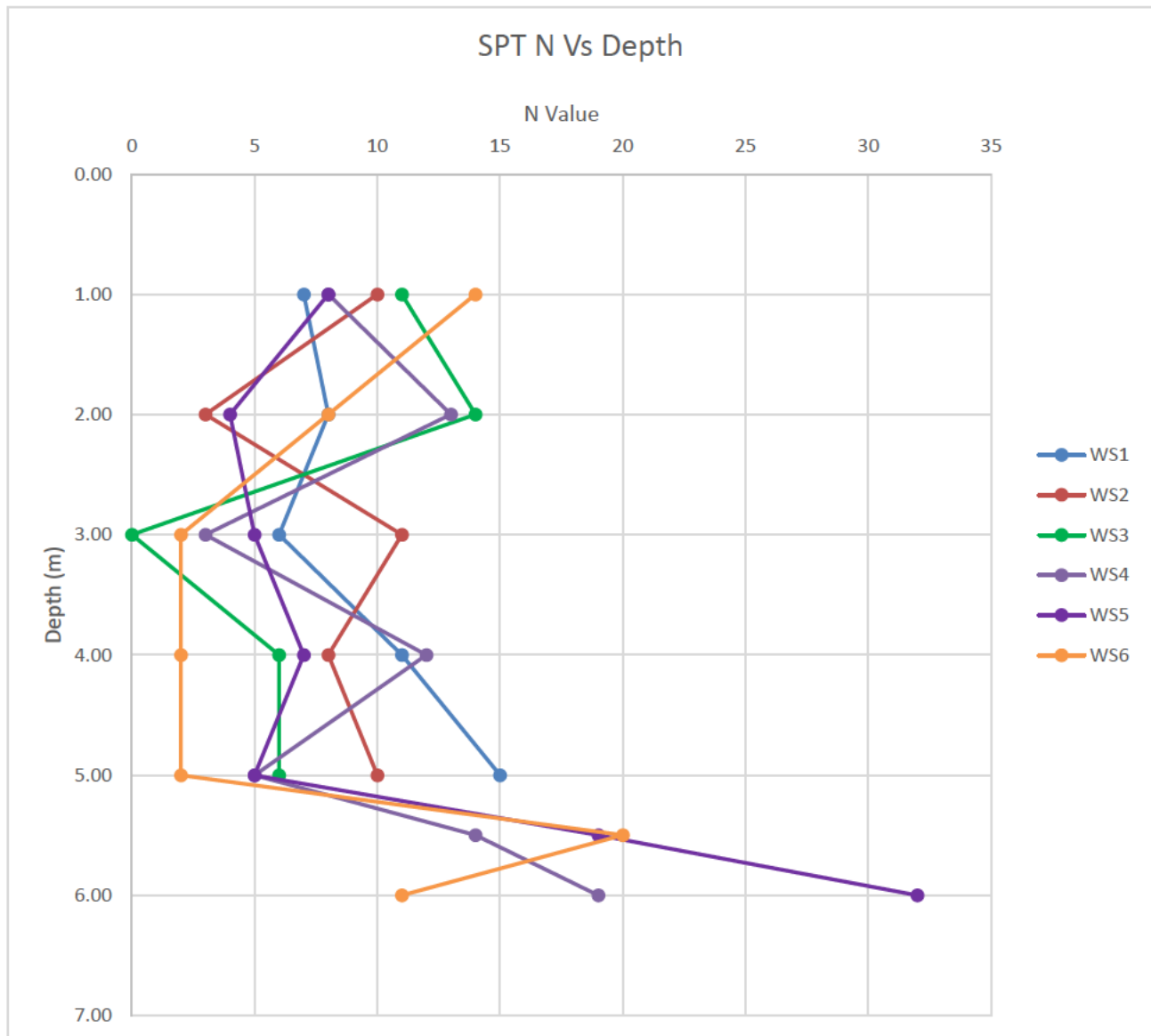
3.3.1 Strength Testing

SPTs

SPT N Values taken within the Superficial Deposits comprising the Wigston Member revealed an average N value of 9.4 (Range 0 to 32).

SPT N Values taken within the Superficial Deposits comprising the Boscombe Clay Member revealed an average N value of 10 (Range 6 to 15).

Drawing 3.2 below presents the distribution of SPT N values against depth (mbgl).



Drawing 3.2: SPT vs Depth

Hand Shear Vane

A Hand Shear Vane was used to obtain an approximate measure of the shear resistance at failure of cohesive and semi-cohesive soils. A value of the Undrained Shear Strength was read directly from the scale of the instrument (Range: 0 to 140 kPa).

Hand Shear Vane results taken within the Superficial Deposits comprising the Boscombe Clay Member revealed an average Undrained Shear Strength of 94 kPa (Range 75 to 110 kPa).

3.3.2 Permeability Testing

The in-situ permeability tests were undertaken within the excavated trial pits in order to provide a soil infiltration rate to be used in soakaway design. A 2000-gallon tractor-towed bowser was used to rapidly fill the pit with water.

During the site investigation, in-situ permeability tests were undertaken within TP1 and TP2 and where possible were carried out to the requirements of BRE Digest 365 or BS 5930:2015+A1:2020 (Section 7).

The appropriate calculation sheets are presented in Annex B and the results given in the table below.

Table 3.2: Infiltration Test Results				
Soak away Test	Depth (m)	Type	Soil Type	Infiltration Rate (m/s)
TP1	2.70	Storm Drainage	Superficial Deposits	*
TP2	2.70		Superficial Deposits	*

Notes:

- * The test did not drain sufficiently (75% effective depth) to give an infiltration rate

3.3.3 California Bearing Ratio (CBR) Testing

The in-situ CBR tests (5No.) were carried out using a TRL Dynamic Cone Penetrometer (DCP) probe. The probes were typically sunk to a depth of <1.00m below ground level, targeting the proposed formation layer.

The in-situ CBR tests were carried out in accordance with 'Methods of test for soils for civil engineering purposes' – BS1377; Part 9 (1999).

The in-situ CBR test results are presented on the relevant trial pit logs or in Annex B and should be referred to for specific depth related values.

3.4 Sampling

3.4.1 Sampling Quality Assurance

Care was taken to ensure that sampling quality assurance occurred during site works. This included the following measures:

- The use of nitrile gloves at each sampling point.
- Stainless steel shovels were used to collect soil samples. The tool was cleaned with distilled water between each sample point.
- Soil samples were stored at a temperature below 4 degrees.
- Soil samples were stored within sample containers according to the chemical testing required.
- No head space was left in sample containers.

3.4.2 Soil Chemical Test Sampling Regime

During the intrusive investigation small disturbed soil and/or water samples were collected for chemical testing.

The sample locations and depths are illustrated in the table below:

Table 3.3: Chemical Test Sample Descriptions			
Sample No.	Sample Type	Description	
WS1	0.70	MG	Brown sl. sandy sl. gravelly silty CLAY / anthropogenic inclusions
WS2	0.50	MG	Sl. clayey sl. gravelly SAND / anthropogenic inclusions
WS3	0.25	MG	Light brown sl. clayey sl. silty sandy GRAVEL / anthropogenic inclusions
WS4	0.30	MG	Dark brown gravelly SAND / anthropogenic inclusions
WS5	0.30	MG	Brown sl. silty sl. gravelly SAND / anthropogenic inclusions

WS6	0.80	MG	Sl. clayey sl. silty sandy gravelly COBBLES / anthropogenic inclusions
TP1	0.20	MG	Dark grey sl. clayey sl. silty sandy gravelly COBBLES / anthropogenic inclusions
TP1	1.50	SD	Light orange and light-yellow silty SAND / anthropogenic inclusions
TP2	1.00	MG	Blackish grey sl. clayey sl. silty sandy GRAVEL / anthropogenic inclusions
HP1	0.40	MG	Grey sl. sandy GRAVEL / anthropogenic inclusions

Notes

- Sample Type: MG (Made Ground), SD (Superficial Deposits)

3.4.3 Soil Property Test Sampling Regime

During the intrusive investigation bulk soil samples were collected for soil property testing.

The sample locations and depths are illustrated in the following table:

Table 3.4: Soil Property Test Sample Descriptions			
Sample No.		Sample Type	Description
WS1	0.80-1.00	SD	Brown slightly clayey slightly gravelly silty SAND
WS1	2.20-2.90	SD	Reddish grey CLAY
WS2	3.00-5.00	SD	Reddish brown slightly silty SAND
WS3	1.50-2.00	SD	Light brown slightly sandy silty CLAY
WS4	1.50-2.50	SD	Reddish brown slightly silty SAND
WS5	2.00-4.00	SD	Yellowish brown SAND
WS6	1.50-2.00	SD	Greyish orangish brown slightly silty slightly clayey SAND
TP1	1.50	SD	Light orange and light-yellow silty SAND
TP2	2.50	SD	Orangish brown slightly silty SAND
HP1	0.40	MG	Grey slightly sandy GRAVEL of granite

Notes

- Sample Type: MG (Made Ground), SD (Superficial Deposits)

SECTION 4 Ground Conditions

4.1 Summary

The ground conditions encountered by the exploratory holes were variable across the site and but can in general be summarised as shown in the following table:

Table 4.1: Summary of Ground Conditions					
Depth (mbgl)		Thickness (m)		Stratum	
From	To	Min	Max		
0.00	0.20 / 0.60	0.20	0.60	Grey slightly clayey slightly silty sandy GRAVEL of granite	Made Ground
0.20 / 0.60	0.70 / 1.30	0.25	1.15	Dark brown to blackish grey silty clayey gravelly SAND. Gravel is of various anthropogenic inclusions.	
0.70 / 1.30	>6.00	Unproven		Very loose to loose orange, yellow and reddish brown clayey silty SAND with occasional sandy clay/silt bands. Firm to stiff reddish brown to grey slightly silty slightly sandy CLAY.	Superficial Deposits

Within trial pits, the estimated strength of granular deposits was determined from visual assessment only (ease/difficulty of excavation and pit stability).

4.2 Stability

The sides of the excavations were typically found to be stable within the cohesive Superficial Deposits but unstable within the granular Superficial Deposits.

Due to the hole instability casing was locally needed to advance the boreholes.

4.3 Strata Details

4.3.1 Made Ground

The Made Ground was encountered within all exploratory hole locations and comprised a surface layer of grey to yellowy/brown grey slightly sandy slightly clayey slightly silty subangular fine to coarse granite GRAVEL with occasional brick, concrete and asphalt.

The surface layer was underlain by dark brown to blackish grey silty clayey gravelly SAND. Sand is fine to medium. Gravel is angular to subangular to rounded fine to coarse brick, concrete, ceramic, slate, flint, clinker, tile and glass. Occasional wood fragments and rare other anthropogenic matter. Medium cobble content of concrete and brick. Occasionally as clay.

Other than typical anthropogenic inclusions a Bituminous Containing Material (BCM) with strong hydrocarbon odour was noted within WS6 at a depth of between 0.25m and 0.30m.

4.3.2 Superficial Deposits

The Superficial Deposits were encountered within all exploratory hole locations with the exception of HP1.

The Superficial Deposits were encountered the maximum investigated depth and comprised either:

Wigston Member

Very loose to loose orange, yellow and reddish brown clayey silty SAND. Sand is predominantly fine to medium. Occasional sandy CLAY / SILT bands.

Boscombe Clay Member

Firm to stiff reddish brown to grey slightly silty slightly sandy CLAY. Rare relict rootlets.

The Boscombe Clay Member was encountered within TP1 and WS1 only, which were located towards the west of the site.

4.4 Water Strikes

During site works, groundwater was encountered within all exploratory holes at depths of between 0.80m and 2.00m.

Groundwater encountered by the exploratory holes can in general be summarised as shown in the following table:

Table 4.2: Summary of Groundwater			
Hole Location	Groundwater Strike Depth (mbgl)	Comments	Water Bearing Strata
TP2	0.80	Slight Seepage	MG
TP2	1.70	Moderate Seepage	SD
WS1	2.00	Perched above Bosworth Clay Member	SD
WS2	2.00	-	SD
WS3	2.00	-	SD
WS4	2.00	-	SD
WS5	0.90	-	MG
WS6	2.00	-	SD

Notes

- Water Bearing Strata: MG (Made Ground), SD (Superficial Deposits)

SECTION 5 Laboratory Chemical Testing

5.1 General

During the recent site works, 6No. soil samples were taken and dispatched to the laboratories of Chemtest for laboratory chemical testing. The following chemical testing was undertaken:

Table 5.1: Summary of Chemical Testing Suites

Inorganics	Metals	Arsenic (As), Cadmium (Cd), Chromium (Cr), Hexavalent Chromium (CrVI), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), Selenium (Se), Zinc (Zn)
	General	pH (acidity), Cyanide (CN ⁻), Sulphate (SO ₄ ²⁻), Organic Matter (OM)
Organics		Phenol Poly-Aromatic Hydrocarbons (PAH) Petroleum Hydrocarbons (PH): CWG Benzene, Toluene, Ethylbenzene, Xylene (BTEX) Methyl tert-butyl ether (MTBE)
Miscellaneous		Asbestos ID

The results of the above chemical tests are presented in Annex C and evaluated below.

5.2 Risk Assessment

5.2.1 Introduction

The results obtained from the investigation, which are discussed in detail in Section 5.3, were used to conduct an environmental risk assessment for the site. The risk assessment aimed to:

- Identify sensitive receptors
- Determine pathways for contaminant migration to the receptors
- Estimate contaminant impact on receptors
- Establish whether remedial action is required
- Calculate remediation target levels if required

The future use of the site i.e. whether it is to be used for residential or commercial has an impact on any risk assessment. As the site is expected to comprise a medical centre, soil guidance values (SGV) for a commercial end-use has been adopted.

5.2.2 Methodology

Soils

Environmental risk assessment evaluates the risk to receptors via an analysis of the 'source-pathway-target' linkage. In order for a risk to be present, there must be a contaminant source capable of causing a health risk, a vulnerable receptor, and a pathway linking the two.

This sort of risk assessment is usually conducted using a tiered approach. Tier 1 consists of a comparison of the analytical results obtained from the site investigation with Soil Guideline Values (SGV's) specific to the type of development obtained from The Environment Agency Contaminated Land Exposure Assessment (CLEA) Guidelines.

The CLEA model, technical guidance and Soil Guideline Values are currently under review, as a direct result of the publication published by DEFRA (2006) 'Soil Guideline Values: The Way Forward'. The technical guidance CLR 9 and CLR 10 have been superseded by Science Reports (SR) 2 and SR3.

Whilst the toxicological and risk assessment framework is under review, the laboratory soil chemical test results have been evaluated by comparison with published Generic Assessment Criteria (GAC), with preference in the following order:

1. Category 4 Screening Levels (C4SLs) - Department for Environment, Food and Rural Affairs (DEFRA, 2014),
2. Suitable for Use Levels (S4ULs) - Land Quality Management & Chartered Institute of Environmental Health (LQM & CIEH, 2015),
3. Soil Guideline Values (SGVs) - EA / DEFRA, 2002-2009,
4. Generic Assessment Criteria (GAC) - Contaminated Land: Applications in Real Environments (CL:AIRE, 2010), and
5. Generic Assessment Criteria (GAC) derived by Terra Firma (South).

In the absence of a GAC, the laboratory Limit of Detection (LoD) has been used for comparison in order to establish the presence/absence of determinants and for initial screening purposes.

The above sources typically have derived GAC with reference to the EA's Contaminated Land Exposure Assessment (CLEA) model and using the CLEA software.

All receptor profiles, source inputs and toxicological parameters comply with both peer reviewed literature and CLR 7 to CLR 10. As with SGV's the SSV's and CIEH GAC are not yet updated to SR2 and SR3.

Should Tier 1 levels be exceeded, a choice is made either to remediate the site to conservative Tier 1 levels, or proceed to Tier 2.

Tier 2 makes use of site-specific data to evaluate acceptable concentrations of chemicals for the particular conditions present at the site.

At each tier, the amount and detail of investigation work increases as more site-specific data are needed to refine the characterisation of the site. Conversely, as site conditions are better understood, a more site-specific remediation strategy can be determined.

Controlled Waters

In the case of groundwater and/or leachate, the acceptable concentrations are sourced from the Environment Agency Chemical Standards Report for each individual substance. The report presents a variety of target concentrations specific to protection goals and environmental media in which the standard applies. The most applicable protection goal and environmental media for this project is the protection of aquatic life in a freshwater environment.

Where there is no standard for a freshwater environment, the target concentrations are derived from UK standards for drinking water (for human consumption). In the absence of any published guideline, a conservative threshold is suggested.

5.2.3 Assessment of Zones/Areas

Following initial findings from the Phase 1 Desk Study and subsequent Ground Investigation, a site can be zoned into separate areas, for the purposes of contamination assessment.

This zoning can be based on the sites previous history and/or from the proposed end use of the site. These zones can then be subdivided into averaging areas which in turn can be assessed for differing soil types and potentially differing pathways. Each averaging area can then be considered independently of each other for human health exposure assessment.

Based upon a site end use as a medical centre and the findings from the Phase 1 Desk Study and Ground Investigation it is proposed that the site be treated as a single zoned site.

5.2.4 Sources

The sources of contamination considered in the risk assessment are taken to be concentrations of chemicals beneath the site.

5.2.5 Pathways

The various pathways considered in the risk assessment are summarized in the table below:

Table 5.2: Summary of Potential Contamination Pathways	
Potential Contamination Pathway	
Human Health	Ingestion of soil and soil dust
	Consumption of site grown produce
	Dermal contact (Inc. eye uptake) with soil, soil dust and water
	Inhalation of soil particles, dust, asbestos and vapours, both indoors and outdoors
	Inhalation of landfill / ground gas, accumulation and risk of explosion
	Contaminant permeation of drinking water pipes and ingestion of contaminated water supply
Aquatic Environment	Surface water runoff
	Migration of surface water into underlying soils and groundwater
	Leaching of contaminants via groundwater transport into the wider aquatic environment – surface waters and groundwater

5.2.6 Potential Receptors

A summary of the potential affected receptors at the site are summarized in the table below:

Table 5.3: Summary of Potentially Affected Receptors	
Potentially Affected Receptors	
Construction Workers	
Neighbouring Site Users	
Passers-by	
Future Visitors	
Maintenance Contractors	
Employees	
Residents in the surrounding area	
Persons who may come into contact with water in the vicinity of the site	
Vegetation from phytotoxic contaminants	
Building Materials from aggressive ground conditions	
The underlying secondary aquifer	
Nearby surface waters and the aquatic life within	

5.3 Evaluation of Analytical Results

5.3.1 Soils

A summary of the Inorganic (Metals) soil chemical test results are shown in the table below.

Table 5.4: Soil Chemical Test Results – Inorganics (Metals)					
Substance	Land Use / Guideline Values	Measured Levels of Substances (mg/kg)		Number of exceedances	95% UCL
	Commercial	Min	Max		
Arsenic	640	2.7	5.7	0	-
Cadmium	410	<0.1	0.41	0	-
Chromium	8600	9.9	15	0	-
Chromium III	8600	9.9	15	0	-
Chromium VI	49	<0.5	<0.5	0	-
Copper	68000	16	76	0	-
Lead	2330	23	120	0	-
Mercury (Total)	1100	<0.1	0.12	0	-
Nickel	980	14	27	0	-
Selenium	12000	<0.2	0.25	0	-
Zinc	730000	56	140	0	-

Notes

- C4SL - Provisional Category 4 Screening Levels
- S4UL - Suitable for Use Levels
- A total of 6No. representative soil samples were tested for these substances

A summary of the Inorganic (General) soil chemical test results are shown in the table below.

Table 5.5: Soil Chemical Test Results – Inorganics (General)					
Substance	Land Use / Guideline Values (mg/kg)	Measured Levels of Substances (mg/kg)		Number of exceedances	95% UCL
	Commercial	Min	Max		
pH (pH Units)	Considered in BRE SD1, BS3882, BS8601 and/or UKWIR	8.5	9.8	0	-
Cyanide (Total)	480	<0.5	<0.5	0	-
Organic Matter	Considered in Organic Contaminant Guideline Value Assessment, BS3882 and/or BS8601	0.4	1.9	0	-
Sulphate (Total) (%)	Considered in BRE SD1	<0.01	0.46	0	-

Notes

- SGV - Soil Guideline Value
- BRE SD1: 2005 - Concrete in Aggressive Ground
- BS 3882: 2015 - Specification for Topsoil
- BS 8601: 2013 - Specification for Subsoil and requirements for use
- UKWIR – Guidance for the Selection of Water Supply Pipe to be used in Brownfield Sites: 2010
- A total of 6No. representative soil samples were tested for these substances

A summary of the Organic (General) soil chemical test results are shown in the table below.

Table 5.6: Soil Chemical Test Results – Organics (General)								
Substance		Land Use / Guideline Values (mg/kg)		Measured Levels of Substances (mg/kg)		Number of exceedances	95% UCL	
		Commercial		Min	Max			
SOM								
Total Phenol	1	440		<0.3	<0.3	0	-	
	2.5	690				0		
	6	1300				0		
Total PAH*		-		<2	3.4	0	-	
Total EPH (C10-C40) **	1	9700+		<10	<10	0	-	
	2.5	23000+				0		
	6	2800++				0		
BTEX	Benzene		98		<0.001	<0.001	0	-
	Toluene	1	56000		<0.001	<0.001	0	-
		2.5	110000				0	
		6	180000				0	
	Ethylbenzene	1	5700		<0.001	<0.001	0	-
		2.5	13000				0	
		6	27000				0	
	Xylene***	1	5900		<0.001	<0.001	0	-
		2.5	14000				0	
		6	30000				0	
Methyl tert-butyl ether (MTBE)		1	7900		<0.001	<0.001	0	-
		2.5	13000				0	
		6	24000				0	

Notes

- C4SL - Provisional Category 4 Screening Levels
- S4UL - Suitable for Use Levels
- CL:AIRE - Generic Assessment Criteria (GAC)
- SOM - Soil Organic Matter
- * Total PAH - Poly-Aromatic Hydrocarbons, EPA 16 (See Speciated PAH Results Table)
- ** Total EPH – Extractable Petroleum Hydrocarbons, Ali/Aro (See Speciated PH Results Table)
- + Based on worse-case Aliphatic C₁₀-C₁₂ fraction
- ++ Based on worse-case Aromatic C₁₆-C₂₁ fraction
- *** - Guideline Value based on worse case of O, M or P - Xylene
- - No comparable Guideline Value
- A total of 6No. representative soil samples were tested for these substances

In order to accurately assess the risk from Total PAH, speciation was undertaken, which splits the total PAH concentration into its sixteen components.

A summary of the Organic (Speciated PAH) soil chemical test results are shown in the table below.

Table 5.7: Soil Chemical Test Results – Organics (Speciated PAH)

Substance	SOM	Land Use / Guideline Values (mg/kg)	Measured Levels of Substances (mg/kg)		Number of exceedances	95% UCL
		Commercial	Min	Max		
Naphthalene	1	190	<0.1	<0.1	0	-
	2.5	460			0	
	6	1100			0	
Acenaphthylene	1	83000	<0.1	<0.1	0	-
	2.5	97000			0	
	6	100000			0	
Acenaphthene	1	84000	<0.1	<0.1	0	-
	2.5	97000			0	
	6	10000			0	
Fluorene	1	63000	<0.1	<0.1	0	-
	2.5	68000			0	
	6	71000			0	
Phenanthrene	1	22000	<0.1	<0.1	0	-
	2.5	22000			0	
	6	23000			0	
Anthracene	1	520000	<0.1	<0.1	0	-
	2.5	540000			0	
	6	540000			0	
Fluoranthene	1	23000	<0.1	1.9	0	-
	2.5	23000			0	
	6	23000			0	
Pyrene	1	54000	<0.1	1.5	0	-
	2.5	54000			0	
	6	54000			0	
Benzo(a)anthracene	1	170	<0.1	<0.1	0	-
	2.5	170			0	
	6	180			0	
Chrysene	1	350	<0.1	<0.1	0	-
	2.5	350			0	
	6	350			0	
Benzo(b)fluoranthene	1	44	<0.1	<0.1	0	-
	2.5	44			0	
	6	45			0	
Benzo(k)fluoranthene	1	1200	<0.1	<0.1	0	-
	2.5	1200			0	
	6	1200			0	
Benzo(a)pyrene		77	<0.1	<0.1	0	-
Indeno(1,2,3-cd)pyrene	1	500	<0.1	<0.1	0	-
	2.5	510			0	
	6	510			0	
Dibenzo(a,h)anthracene	1	3.5	<0.1	<0.1	0	-
	2.5	3.6			0	
	6	3.6			0	

Benzo(g,h,i)perylene	1	3900	<0.1	<0.1	0	-
	2.5	4000			0	
	6	4000			0	

Notes

- C4SL - Provisional Category 4 Screening Levels
- S4UL - Suitable for Use Levels
- SOM - Soil Organic Matter
- A total of 6No. representative soil samples were tested for these substances

In order to accurately assess the risk from Total PH, speciation was undertaken, which splits the Total PH concentration into carbon bandings in accordance with the Total Petroleum Hydrocarbon Criteria Working Group (CWG).

A summary of the Organic (Speciated PH) soil chemical test results are shown in the table below.

Table 5.8: Soil Chemical Test Results – Organics (Speciated PH)							
Substance			Land Use / Guideline Values (mg/kg)	Measured Levels of Substances (mg/kg)		Number of exceedances	95% UCL
			Commercial	Min	Max		
Aliphatic	VPH <C5-C6	1	3200	<1	<1	0	-
		2.5	5900			0	
		6	12000			0	
	VPH <C6-C8	1	7800	<1	<1	0	-
		2.5	17000			0	
		6	40000			0	
	VPH <C8-C10	1	2000	<1	<1	0	-
		2.5	4800			0	
		6	11000			0	
	EPH <C10-C12	1	9700	<1	<1	0	-
		2.5	23000			0	
		6	47000			0	
	EPH <C12-C16	1	59000	<1	<1	0	-
		2.5	82000			0	
		6	90000			0	
	EPH <C16-C21 ⁺	1	1600000	<1	<1	0	-
		2.5	1700000			0	
		6	1800000			0	
	EPH <C21-C35 ⁺	1	1600000	<1	<1	0	-
		2.5	1700000			0	
		6	1800000			0	
Aromatic	VPH <C5-C7	1	260000	<1	<1	0	-
		2.5	46000			0	
		6	86000			0	
	VPH <C7-C8	1	56000	<1	<1	0	-
		2.5	110000			0	
		6	180000			0	
	VPH <C8-C10	1	3500	<1	<1	0	-
		2.5	8100			0	

	6	17000			0	
EPH <C10-C12	1	16000	<1	<1	0	-
	2.5	28000			0	
	6	34000			0	
EPH <C12-C16	1	36000	<1	<1	0	-
	2.5	37000			0	
	6	38000			0	
EPH <C16-C21	1	28000	<1	<1	0	-
	2.5	28000			0	
	6	28000			0	
EPH <C21-C35	1	28000	<1	<1	0	-
	2.5	28000			0	
	6	28000			0	

Notes

- S4UL - Suitable for Use Levels
- SOM - Soil Organic Matter
- VPH - Volatile Petroleum Hydrocarbons
- EPH - Extractable Petroleum Hydrocarbons
- + Based on worse-case Aliphatic C₁₆-C₃₅ fraction
- A total of 6No. representative soil samples were tested for these substances

A summary of the Miscellaneous (Asbestos) soil chemical test results are shown in the table below.

Table 5.9: Soil Chemical Test Results – Miscellaneous (Asbestos)				
Sample No.		ID Result	Comments	Total Mass (%)
HP1	0.40	NAD	-	-
TP2	1.00	NAD	-	-
WS2	0.50-0.60	NAD	-	-
WS3	0.25-0.50	NAD	-	-
WS4	0.30-0.40	NAD	-	-
WS5	0.30-0.50	NAD	-	-

Notes:

- NAD – No Asbestos Detected

5.4 Contaminants of Concern in Soils

5.4.1 Soils

Contaminants of concern are those where the measured concentrations and 95% Upper Confidence Limit exceeds the relevant Tier 1 CLEA Soil Guideline Value or CIEH Generic Assessment Criteria.

It can be seen from Tables 5.4 to 5.9 that none of the contaminants tested were above the SGV for their respective screening criteria, and therefore there are no contaminants of concern.

SECTION 6 Qualitative Risk Assessment/Mitigation Measures

The following is a representation of environmental processes on the site and its immediate vicinity. Its purpose is to identify potential contaminants, pathways and receptors with a view to identifying potential and significant pollution linkages.

6.1 Site Summary

Historically the site has comprised various buildings since at least 1888, and has known to have been used as a Garage since c. 1972.

Historically, the surrounding area (<250m) has typically comprised open fields and residential development from the earliest date of mapping. Localised industrial uses including factories and depots are noted but a distance of at least 75m from the site.

Ground conditions encountered during the Ground Investigation typically comprised Made Ground of a surface layer of grey granite gravel overlying silty clayey gravelly clay with various anthropogenic inclusions to a depth of between 0.70m and 1.30m. Underlying the Made Ground were Superficial Deposits comprising either Very loose to loose orange, yellow and reddish brown clayey silty SAND with occasional sandy clay/silt bands (Wigston Member) or firm to stiff reddish brown to grey slightly silty slightly sandy CLAY (Boscombe Clay Member) to the maximum investigated depth of 6.00m.

The Aquifer Designation Map for the area shows the underlying Superficial Deposits beneath the site to comprise a 'Secondary A' Aquifer (East) or Unproductive Strata (West). The underlying Bedrock Geology beneath the site comprises a 'Secondary B' Aquifer.

Surface and perched groundwater flows from the site are likely to be in a westerly direction following the natural topography of the wider area. These waters will probably be collected by a surface water stream located 500m to the west.

6.2 Potential Contaminants

6.2.1 Soils

It can be seen from Tables 5.4 to 5.9 that none of the contaminants tested were above the SGV for their respective zone screening criteria, and the site as a whole, can be considered uncontaminated.

6.3 Potential Receptors

The potential receptors at the site potentially affected during construction of the development are summarised in the table below:

Table 6.1: Summary of Potentially Affected Receptors

Potentially Affected Receptors
Construction Workers
Neighbouring Site Users
Passers-by
Future Visitors
Maintenance Contractors
Employees
Residents in the surrounding area

Persons who may come into contact with water in the vicinity of the site
Vegetation from phytotoxic contaminants
Building Materials from aggressive ground conditions
The underlying secondary aquifer
Nearby surface waters and the aquatic life within

The potential receptors at the site potentially affected following construction of the development are summarised in the table below:

Table 6.2: Summary of Potentially Affected Receptors Following Construction
Potentially Affected Receptors
Future Visitors
Maintenance Contractors
Employees
Vegetation from phytotoxic contaminants
Building Materials from aggressive ground conditions
The underlying secondary aquifer
Nearby surface waters and the aquatic life within

6.4 Potential Pathways

The site is planned to be occupied by a medical centre, parking and associated infrastructure.

How the proposed development finish affects the various possible contamination pathways is considered below, and summarised in Table 6.1.

Potential risks are present during and following construction of the development to potential receptors from ingestion, inhalation, dermal contact, surface water run-off, leaching and groundwater transport. By adhering to the following protection measures any risks can be considered very low.

Ingestion of soil/soil dust, dermal contact and ingestion of site grown vegetables

Any combustible materials found during excavations should be removed and replaced with suitable materials. The combustible materials should be suitably disposed of.

If materials are imported, which are not a natural quarry product with British Standard Certification, or are not sourced from a builders merchant, DIY store or retail outlet in bagged bulk form, analytical validation testing will be required, to ensure that imported materials is suitable and will not cause pollution to the site, and pose a risk to human health.

Any materials to be removed from site should be subject to the Waste Acceptance Procedure (WAP) in order to appropriately classify the waste for the correct type of landfill.

All service runs should be backfilled with inert materials to ensure that future maintenance workers / contractual workers do not come into contact with contaminated soils.

If during the development materials or abnormal ground conditions are encountered that are significantly different to those encountered in the investigation, the occurrence should be reported to the Engineer and appropriate action taken prior to continuing with the works.

The appointed contractor(s) should as a minimum;

1. Comply with all current Health and Safety regulations
2. Provide Method Statements and Risk Assessments in place to deal with measures set out in this section
3. Comply with Control of Substances Hazardous to Health (COSHH) Assessment
4. Maintain a good level of Personal Protection Equipment (PPE)
5. Maintain a good level of hygiene by site workers
6. Put in place dust suppression measures when necessary

The contractor(s) must also strictly adhere to the relevant Pollution Prevention Guidelines which aim to minimise detrimental harm to the environment and health.

Within the documentation prepared by the contractor(s), the following information should be provided, but not limited to:

1. Project Description
2. Key participants/contractor(s)
3. Technical procedures
4. Phasing of works and approximate timescales
5. Site plans to scale
6. Details of consents or license needed
7. Health and Safety, COSHH Assessment, Method Statements and Risk Assessments
8. Emergency contingencies

In addition, the following precautions should also be taken.

1. All potential chemicals and associated risks and emergency procedures for spills/leaks should be considered in a site risk assessment and the details provided to all site employees
2. Any potential pollutant materials or chemicals/detergents used on site should be adequately stored in suitable containers, with clear labelling.
3. Any oil or hazardous substance containers and associated pipe works should be enclosed within a bund.
4. Care taken during delivery of materials, with correct supervision and labelling detailing the substance and its quantities.
5. All delivery drivers should be informed of procedures and restrictions
6. Any materials on delivery should be covered to ensure no spillage from the vehicle.
7. Any detergents, paints, chemicals etc. should not be allowed to be discharged into surface drains or water courses
8. Washing out and cleaning of concrete/cement plant should be carried out in a contained area with adequate measures to collect all run-off water.
9. Security and prevention of vandalism, especially of oil drums/containers.

It is considered that the site will be sufficiently fenced off during development and that dust suppression measures will be made if required, meaning there will be no risk to neighbouring site occupants and passers-by.

The determinants tested were all present at concentrations below the relevant guidelines and therefore, there are no contaminants of concern. Therefore, it is considered that the human health risks are low and that no mitigation measures will be required for the development.

It should be noted that the soils beneath the existing buildings were not tested and it is possible that these may be impacted by contamination. Therefore, it would be prudent that a watching brief is maintained during construction works and if any significant evidence of contamination is encountered then guidance should be sought by a suitably qualified consultant to assess the risk.

Inhalation of soil dust /ground gas/radon

Protection of site workers from soil dust inhalation can be minimised by simple health and safety measures and dust suppression. Neighbouring site occupants and passers-by will similarly not be at risk with dust suppression.

It is considered that site workers, passers-by and neighbouring site occupants are not at risk from ground gas or vapours.

All risks to site users from dust inhalation will be eliminated by appropriate dust suppression measures.

Site end users, upon completion, will similarly not be at risk from soil dust/vapours once the above mentioned remedial measures have been carried out.

There is also a low risk to the site end users from ground/landfill gas and a low risk from radon gas where no radon protection measures are likely to be required.

Surface water run-off/leaching into the groundwater/groundwater transport**1. Short-term**

In respect of physical effects of the site works during the construction period, there is a very low risk to the environment/adjacent land and water bodies from digging foundations, moving contaminated soil, runoff from construction materials and/or exposed ground, wheel washings and oil or chemical spills.

All adverse effects should however be preventable by due diligence to good construction practice and housekeeping in preventing surface runoff and the spillage of materials. The basic measures that should be taken are as follows:

- Prepare a drainage plan
- Carry out any activities that could cause pollution in a designated, bunded area, away from rivers or boreholes
- Use settlement ponds to remove silty water;
- Store all oils and chemicals in a fully bunded area to prevent leaks or spills

It should be noted that the appointed contractor should provide Method Statements and Risk Assessments to deal with these matters.

2. Long-term

The chemical analysis of soil beneath the site constitutes a Level 2 assessment in terms of Remedial Targets Methodology, where the primary receptor/compliance point is the groundwater.

No leachate or groundwater chemical testing has been undertaken; however it is considered that the risk to the aquatic environment is low due to environmental setting as detailed below:

1. Contaminant concentrations within the site's near surface soils were low and leachates derived from these soils are likely to contain even lower contaminant concentrations. Therefore, if leachates did migrate to a controlled water the effect is likely to be negligible.
2. Site is proposed to be fully capped by hard standing limiting contact between surface water and potentially impacted materials.

3. The presence of an underlying Secondary Aquifer so the groundwater beneath the site will currently be of low value.
4. There are no groundwater abstraction licenses within the area.
5. Distance to the nearest surface water body (500m West).
6. The effect of natural attenuation, dilution and absorption will reduce contaminant concentrations with groundwater.

It is therefore considered that there is likely to be a low risk to the aquatic environment and that the next level of assessment (Level 3) is not required, given the environmental setting detailed above.

Permeation of Water Pipes

If water pipes are to be laid beneath the site an assessment should be made, by the water provider, of soils along the route of the pipe with reference to the material selection criteria using the UKWIR methodology.

6.5 Human Health Risks

A Qualitative Risk Assessment on the potential human health effects is detailed in Table 6.1 below:

Table 6.3: Human Health Risk Assessment				
Source	Pathway	Target	Risk Assessment	Mitigation Measures
Made Ground	Dermal contact with soil/dust. Inhalation and ingestion of soil/soil dust	Construction workers	Low Risk with protection measures	COSHH assessment and good level of PPE/ hygiene by site workers/ staff; dust suppression measures if required
Made Ground	Dermal contact with soil/dust. Inhalation and ingestion of soil/soil dust	Neighbouring site occupants, Passers-by	Low Risk during excavation phase of development and on completion	Site screening and dust suppression measures if required
Made Ground	Dermal contact with soil/dust. Inhalation and ingestion of soil/soil dust	Site end users	Low Risk	Contamination testing revealed no contaminants tested were above the regulatory guidelines for their respective end-use scenario. It is recommended a watching brief is undertaken during groundworks.
Landfill and Ground Gas	Inhalation	Site end users	Low Risk	No significant Made Ground or historic or active landfills within 250m of the site.
Radon Gas	Inhalation	Site end users	Low Risk	No Radon protective measures are required.
Made Ground	Permeation of water pipes	Site end users	Potential Risk	All chemical lab results to be forwarded to the water provider to assess pipe specification. Made Ground within service trenches should be removed and replaced with clean fill.

6.6 Risks to the Aquatic Environment

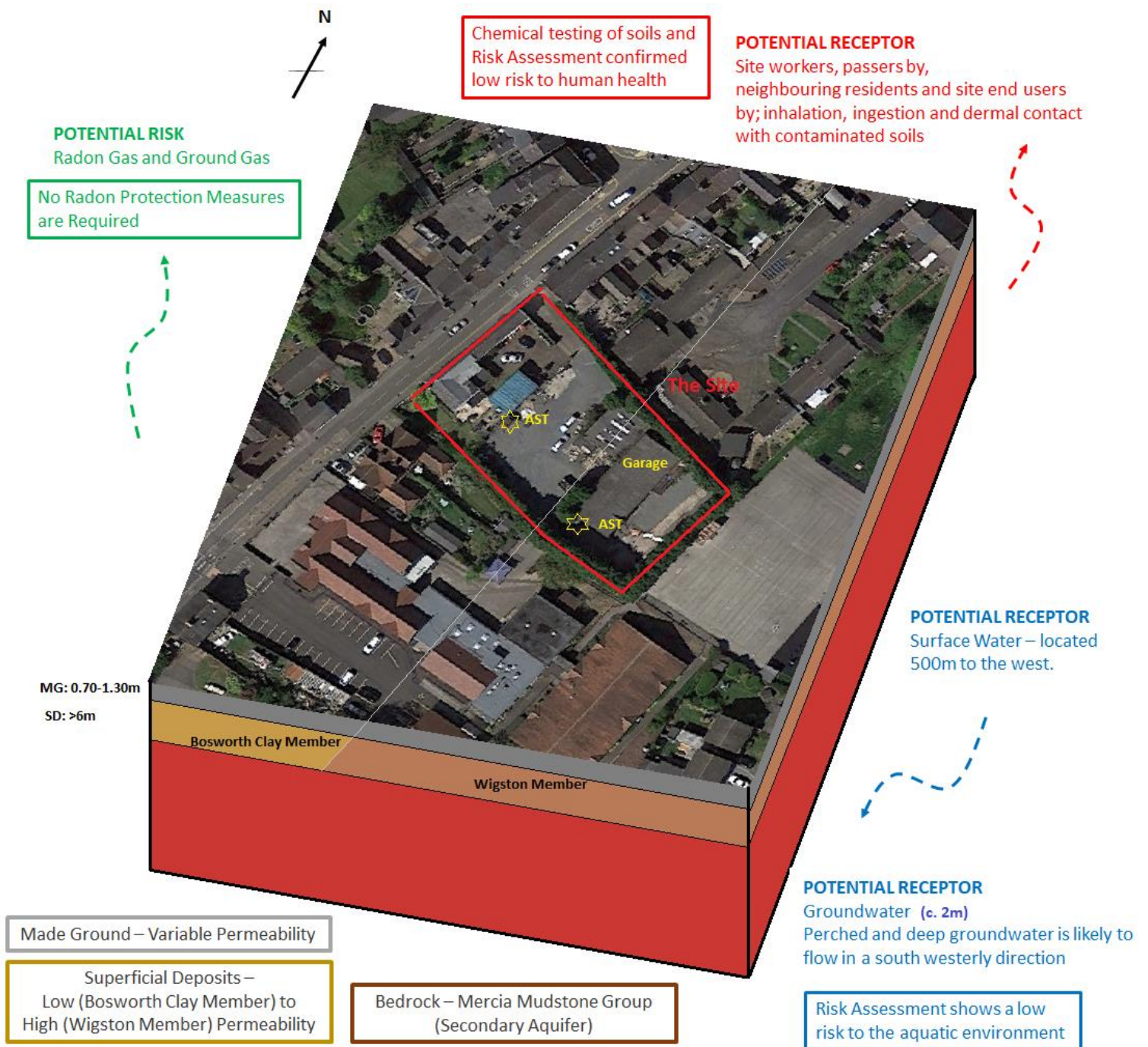
A Qualitative Risk Assessment on the potential effects to the aquatic environment is detailed in Table 6.2 below:

Table 6.4: Risks to the Aquatic Environment				
Source	Pathway	Target	Risk Assessment	Mitigation Measures
Made Ground	Surface water run-off	Surface Water	Low Risk due to the environmental setting and low concentrations identified.	Not Applicable
	Leaching into Groundwater	Groundwater	Reduced risk of contaminant migration and deep transmission is due to the installation of drainage systems and the effect of natural dilution and attenuation.	
Made Ground	Leaching into Groundwater	Groundwater	Low Risk during construction and excavation phase of development	Measures to avoid accidental spillage of materials during earthmoving activities, and to control surface run off

If groundwater sampling is required then additional work involving a mini percussive rig will be required to install groundwater monitoring standpipes.

6.7 Site Conceptual Model

A schematic cross-section of the site is presented below. The cross section is based on the information available from the recent desk study and site investigation. The model is schematic and not to scale.



Drawing 6.1: Revised Site Conceptual Model

6.8 Limitations of the Site Conceptual Model

The areas of uncertainty within the conceptual site model are:

- Presence of and composition of the groundwater within the bedrock
- Direction of groundwater flow

SECTION 7 Geotechnical Laboratory Testing Results

7.1 General

A number of bulk samples were collected, and dispatched to the UKAS accredited laboratories of Geolabs for soil property testing, in accordance with the following:

1. Methods of test for soils for civil engineering purposes – Parts 1 to 8 (BS 1377): 1999.

The results of the below property tests are presented in Annex D and discussed below.

7.1.1 Classification Testing

In order to assess the classification characteristics underlying the site, bulk samples were collected, and dispatched to the laboratory for the following soil property tests:

- 2No. Moisture Content (MC)
- 2No. Plasticity Index (P.I)
- 3No. Particle Size Distribution (PSD)

In addition, in order to assess the aggressiveness of the underlying the site, bulk samples were collected and dispatched to the laboratory for the following soil chemical tests:

- 5No. BRE SD1 Suite A

A summary of the soil classification test results are shown in the table below.

Table 7.1: Summary of Soil Classification Test Results							
Test		Location	WS1	WS3	WS4	WS5	WS6
		Depth (m)	2.20-2.90	1.50-2.00	1.50-2.50	2.00-4.00	1.50-2.00
		Unit	SD	SD	SD	SD	SD
Moisture Content		%	28.8	23.8	-	-	-
Plasticity	Liquid Limit	%	55	-	-	-	-
	Plastic Limit	%	27	NP	-	-	-
	Plasticity Index	%	28	-	-	-	-
	% <425µm	%	100	100	-	-	-
	Modified PI	%	28	-	-	-	-
Particle Size Distribution	Cobbles	%	-	-	0	0	0
	Gravels	%	-	-	0.4	2.5	0.8
	Sands	%	-	-	79.6	47.8	77.7
	Silt & Clay	%	-	-	20.0	49.7	21.5
BRE	2:1 Sulphate	mg/l	17	<10	<10	16	79
	pH	-	7.9	7.6	7.9	7.9	8.5

Notes

- Unit: SD (Superficial Deposits)

SECTION 8 Engineering Recommendations

8.1 Preparation of Site

Prior to the main site works, any buildings to be demolished should be subject to a full asbestos survey.

A structural survey should be undertaken of the adjacent buildings and structures (road and pavement structures) including pictorial records. This should be updated throughout the site development phases.

Any existing buildings, foundations, floor slabs, concrete/tarmac hard standings beneath the proposed buildings should be broken up and removed from site and disposed of at a suitable landfill facility.

Alternatively, the crushed site won materials may be re-used as structural fill, subject to laboratory chemical testing and compliance with site soil guidance values.

Significant allowances should be made for dealing with the historic foundations, floor slabs, basement structures and other buried obstructions.

The existing grass and scrub vegetation, including all roots and any trees to be removed (and not subject to preservation orders) should be grubbed up and removed from beneath the proposed buildings and roadways.

The reduced levels should be brought up to the required levels with well, compacted imported granular materials. Department of Transport (DoT) Type 2 sub-base or similar may be used and should be compacted in layers, in accordance with the Specification for Highway Works. Alternatively, appropriately selected inert imported fill could be used.

Allowances should be made for removing any 'soft spots/area' and their replacement with well compacted granular materials as previously described. The excavated materials will be unacceptable as structural fill and should be removed from site and taken to an appropriately licensed tip.

All materials to be removed from site should be subject to the appropriate Waste Acceptance Protocol (WAP) and taken to an appropriately licensed tip.

Contingencies should be made for the protection/diversion of any underground services present beneath the site, brought about as a result of the proposed works.

Contingencies should also be made for the protection and any necessary temporary/permanent support of nearby walls.

8.2 Foundation Solution

Ground conditions encountered during the Ground Investigation typically comprised Made Ground of a surface layer of grey granite gravel overlying silty clayey gravelly clay with various anthropogenic inclusions to a depth of between 0.70m and 1.30m. Underlying the Made Ground were Superficial Deposits comprising either Very loose to loose orange, yellow and reddish brown clayey silty SAND with occasional sandy clay/silt bands (Wigston Member) or firm to stiff reddish brown to grey slightly silty slightly sandy CLAY (Boscombe Clay Member) to the maximum investigated depth of 6.00m.

The Boscombe Clay Member was encountered within TP1 and WS1 only, which were located towards the west of the site.

During site works, groundwater was encountered at depths of between 0.80m and 2.00m.

The Made Ground deposits are variable in respect to their thickness and geotechnical properties and if foundations were extended to these strata in their current state it would lead to unacceptable levels of differential settlement.

Therefore, due to the variable nature of the underlying shallow deposits and shallow groundwater encountered a raft foundation solution is recommended.

Following the site preparation recommendations given in Section 8.1 all Made Ground deposits should be removed from beneath the proposed building.

The prepared surface, comprising the natural Superficial Deposits, should then be covered by a geo-grid and 'terram' prior to filling with a minimum of 300mm of well compacted imported granular materials.

A reinforced concrete raft type foundation/floor slab solution should then be founded at shallow depth upon the compacted imported granular materials.

For the above foundations founded within the above in-situ materials, an allowable bearing pressure of 35kN/m² may be used for design purposes.

The following recommendations should be adhered to:

- Raft is designed of adequate strength and durability,
- Uses concrete mixed and reinforced as necessary to support floor loads safely and resist chemical and frost action,
- Is a minimum of 300mm thick, and
- All soft spots/areas are removed from the formations and replaced with well compacted granular materials. Department of Transport (DoT) Type 2 materials or similar could be used and should be compacted in layers to the specification for Highway Works.

All foundation formations should be inspected by a suitably qualified Engineer before being concreted.

If higher loadings than those stated above are required a piled foundation solution will be required. Further investigation comprising deep boreholes will be required to firm up pile design parameters.

8.2.1 Expected Settlements

For the above given foundation solutions and bearing pressures, maximum total settlements of 25mm should result, with differential movements (δ/l) of the superstructure not exceeding 1:750 where δ is the differential settlement between two points of a foundation and l is the distance between these points.

8.2.2 Foundation Depth

The foundation depth will be determined by the worst case of the depth of foundation stratum, the plasticity of the soil, the effect of nearby trees. The table below summarises these depths:

Table 8.1 Foundation Depths		
	Worse case	Founding Depth (m)
Foundation Stratum	Superficial Deposits	0.70 – 1.30
Plasticity of Soil	None	0.45
Tree Effect	Spruce/Fir	N/A
Minimum Founding Depth Required		0.70-1.30

8.3 Excavations and Formations

Most shallow excavations should be possible with normal soil excavating machinery, although significant allowances should be made for a hydraulic breaker when excavating out any historic foundations, concrete floor slabs and other buried obstructions.

Post investigation groundwater was encountered between 0.80m and 2.00mbgl.

Therefore, excavations may encounter groundwater inflows. Any inflows should be dealt with by conventional pumping techniques. Heavy pumping should be avoided where possible as this will remove the fines from the soil and possibly cause localised settlement.

It should also be noted that during times of high rainfall a higher groundwater table may be encountered.

The sides of any excavations deeper than 1.00m, especially within the granular deposits, should be supported by planking and strutting or other proprietary means.

The sub-formations/formations will be susceptible to loosening, softening and deterioration by exposure to weather (rain, frost and drying conditions), the action of water (flood water or removal of groundwater) and site traffic.

Formations should never be left unprotected and continuously exposed to rain causing degradation, or left exposed/uncovered overnight, unless permitted by a qualified engineer.

Construction plant and other vehicular traffic should not be operated on unprotected formations. As a minimum the formation/excavation surfaces must be protected by a minimum thickness of 200mm of hard cover immediately after exposure.

Allowances should be made for trimming, re-trimming and re-compaction if necessary and for the removal of soft spots and their replacement with well compacted granular materials.

It is also recommended that if concerns still remain then a number of plate loading tests are carried out at formation level to confirm the suitability of the formations.

Allowances should be made for special precautions to prevent formation deterioration in addition to the above.

It is recommended that approval be gained from a qualified engineer of the formation condition before covering them with any subsequent construction.

8.4 Earthworks

Soil property testing comprising Plasticity (PI) and Particle Size Distribution (PSD) testing was undertaken on samples from the shallow deposits.

Based on the above testing, the following classes should be adopted for any proposed earthworks:

Table 8.2: Earthworks Classification		
Stratum	Earthworks Class	Compaction Method*
Superficial Deposits	1B	Table 6/4 – Method 3

Notes:

- * - Compaction method in accordance with Volume 1 Specification For Highway Works

It is likely that the in-situ materials can be used as structural fill. This material should be placed at or close to its optimum moisture content/maximum dry density and compacted in layers as per the requirements of the Specification for Highway Works.

These requirements should be followed by the appointed groundwork's contractor.

In order to ensure that the materials are being placed at or near to their maximum dry density, in-situ density tests should be undertaken during the earthworks. Following completion of the earthworks plate loading tests should be undertaken on the finished plateau.

8.5 New Access Road and Car Parking Areas

The in-situ CBR tests (5No.) were carried out using a TRL DCP Probe within the area of the proposed roads and parking areas. The tests were typically undertaken from ground level.

A summary of the CBR test results is given below:

Table 8.3: Equilibrium CBR Test Results				
Location	Depth (mbgl)	TRL DCP Result (%)	Modified Plasticity Index	Equilibrium CBR value %
TRL1	0.06-0.63	5.6	NP	N/A
	0.63-0.87	12.7	(MG: Gravelly SAND)	
TRL2	GL-0.14	9.3	NP	N/A
	0.14-0.31	23.5	(MG: Sandy GRAVEL)	
	0.31-0.72	6.0		
TRL3	0.08	Refusal	NP (MG: sandy GRAVEL)	N/A
TRL4	GL-0.33	25.9	NP	N/A
	0.33-0.60	9.3	(MG: Gravelly SAND)	
TRL5	GL-0.28	23.9	NP	N/A
	0.28-0.60	9.4	(MG: Sandy GRAVEL)	
TRL6	0.10	Refusal	NP (MG: Sandy GRAVEL)	N/A

Based on the data available and variability of the underlying Made Ground deposits it is recommended that a CBR value of 2% is adopted for the site.

Allowances should be made for the removal of any soft spots and their replacement with well-compacted imported granular materials as previously described.

8.6 Storm Drainage

2No. in-situ permeability/soakaway test were undertaken at TP1 and TP2 in accordance with the requirements of BRE 365.

The tests did not sufficiently drain to give an infiltration rate. Therefore, it is unlikely soakaways will be viable at the site.

In addition, soakaways would only be effective above the level of groundwater, which was encountered between 0.80m and 2.00mbgl.

8.7 Protection of Buried Concrete

The results of the BRE testing are given in Table 7.1 and the concrete design class is summarised in the table below:

Table 8.4: Summary of Concrete Design Class					
	Stratum	MG		SD	
	Unit	Min	Max	Min	Max
Total Sulphate	%	<0.01	0.46	-	-
2:1 Sulphate	mg/l	-	-	<10	79
pH	-	8.5	9.8	7.6	7.5
Design Sulphate Class		DS-2		DS-1	
ACEC Class		AC-2		AC-1	

Notes

- Sample Type: MG (Made Ground), SD (Superficial Deposits)

Groundwater was encountered at the site and it is conservatively deemed to be mobile.

Based on the above and using guidance within BRE Special Digest 1 (2005) it is recommended that any buried concrete within the site conforms to class AC-2 (Made Ground) or AC-1 (Superficial Deposits).

Annex A: Exploratory Hole Logs



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Borehole No.

HP1

Sheet 1 of 1

Project Name

Barwell

Project No.

6552

Date

18/02/2021 to 18/02/2021

Hole Type

IP

Client

Expedite PS

Co-ords

E:

N:

L:

Water Strike Details

Depth Strike

Remarks

Logged By

DW

Approved By

Scale 1:50

Contractor

360 Drilling Ltd

Plant Used

Hand tools

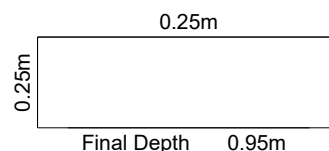
Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend
Results	Type	Depth				
	B ES	0.40 0.40	(0.60)		MADE GROUND: Grey subangular fine to medium granite gravel over: Grey slightly sandy subangular fine to medium granite GRAVEL.	
			0.60 (0.35)		MADE GROUND: Loose dark brown slightly silty clayey SAND. Rare subangular fine to medium flint gravel.	
			0.95	1	End of Trial Pit at 0.95m	
				2		
				3		
				4		

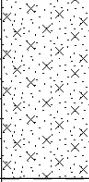
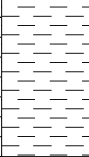
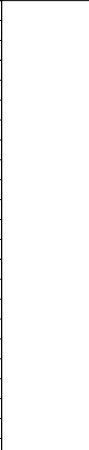
Remarks

Terminated at 0.95m.

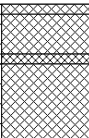
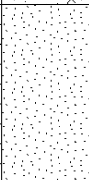
Pit Stability: Stable

Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.



 Consulting Geo-Technical & Geo-Environmental Engineers Site Investigation Contractors		The Slate Barn, Lower Lowley, Dunsford, Exeter, EX6 7BP 01647 252414 www.terrafirmasouth.co.uk		Borehole No. TP1 Sheet 1 of 1			
Project Name Barwell		Project No. 6552	Date 18/02/2021 to 18/02/2021		Hole Type TP		
Client Expedite PS		Co-ords E: N: L:	Water Strike Details		Logged By DW		
			Depth	Strike	Remarks		
Contractor Ambion Plant Hire		Plant Used JCB 3CX		Approved By			
				Scale 1:50			
Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend	
Results	Type	Depth					
HV = 75 HV = 90 HV = 95 HV = 105 HV = 110 HV = 90	ES B ES	0.20	(0.05)		MADE GROUND: Grey subangular fine granite GRAVEL.		
			0.05		MADE GROUND: Medium dense multicoloured slightly clayey slightly silty sandy subangular fine to coarse granite, an occasional brick and concrete GRAVEL. Highly compacted.		
			(0.20)		MADE GROUND: Medium dense dark grey slightly clayey slightly silty sandy gravelly concrete, brick and pathing slab COBBLES. Gravel is subangular fine to coarse brick, concrete and flint		
			0.25				
			(0.30)		MADE GROUND: Blackish grey slightly clayey slightly gravelly silty SAND. Sand is fine. Gravel is angular to subangular to rounded fine to medium flint brick and glass.		
			0.55				
			(0.45)				
			1	1.00	Light orange and light yellow silty SAND. Sand is predominantly fine to medium.		
							(0.90)
			1.50				
			1.50				
				1.90	Firm to stiff reddish brown slightly silty slightly sandy CLAY. Rare relict rootlets.		
			2				
			2.10				
			2.10				
			2.10				
				2.70	End of Trial Pit at 2.70m		
			2.70				
			2.70				
			2.70				
			3				
			4				
Remarks Terminated at 2.70m							
Pit Stability: Stable							
Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.							
0.45m 1.90m Final Depth 2.70m							

Project Name Barwell		Project No. 6552	Date 18/02/2021 to 18/02/2021		Hole Type TP
Client Expedite PS		Co-ords E: N: L:	Water Strike Details		Logged By DW
			Depth Strike	Remarks	
Contractor Ambion Plant Hire	Plant Used JCB 3CX		0.80 1.70	Slight seepage Moderate seepage	Approved By
					Scale 1:50

Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend	
Results	Type	Depth					
	ES	1.00	(0.05)		MADE GROUND: Grey subangular fine granite GRAVEL.		
			0.05		MADE GROUND: Medium dense multicoloured slightly clayey slightly silty sandy subangular fine to coarse granite, an occasional brick and concrete GRAVEL. Highly compacted.		
			(0.20)		ASPHALT		
			0.25		MADE GROUND: Blackish grey slightly clayey slightly silty sandy GRAVEL. Gravel is angular to subangular fine to coarse brick, concrete, ceramic, slate and flint. High cobble content of concrete and brick. Occasional wood fragments and rare other anthropogenic matter.		
			(0.05)				
			0.30				
	B	2.50	(1.00)				
			1				
			1.30		POSSIBLE MADE GROUND: Loose greyish brown SAND. Sand is predominantly medium.		
			(0.25)				
			1.55		Orangish brown silty sandy CLAY.		
			(0.25)				
		1.80		Becoming loose orangish brown slightly silty SAND. Sand is predominantly medium. Recovered wet.			
		2					
		(0.90)					
		2.70					
		3		End of Trial Pit at 2.70m			
		4					

Remarks

Terminated at 2.70m.

Pit Stability:	Partically unstable
-----------------------	---------------------

Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.

1.90m

0.45m

Final Depth	2.70m
-------------	-------

Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend	Well
Results	Type	Depth					
N=7 (1,1/1,2,2,2)	ES B SPT(C)	0.70 0.80 - 1.00 1.00		1	MADE GROUND: Grey subangular fine to medium granite gravel over: Grey slightly silty gravelly SAND. Gravel is angular to subangular fine to medium granite.		
					0.25 to 0.30m - Brick cobb e/ slab		
					MADE GROUND: Medium dense multicoloured slightly sandy gravelly SAND. Gravel is angular to subrounded fine to coarse brick, concrete and slate. Medium cobble content of brick and concrete. Occasionally as clay.		
					MADE GROUND: Firm to stiff brown slightly sandy slightly gravelly silty CLAY. Gravel is angular to subangular fine to medium flint and brick		
					Loose brown slightly clayey slightly gravelly silty SAND. Sand is predominantly fine to medium. Gravel is subangular to rounded fine to medium flint.		
					Loose yellow brown slightly silty SAND. Sand is predominantly fine.		
N=8 (2,1/2,2,2,2)	SPT(C) B	2.00 2.20 - 2.90		2	Orangish brown and yellowish brown slightly clayey silty SAND. Sand is predominantly fine to medium.		
					Firm reddish grey CLAY.		
N=6 (1,1/2,1,1,2)	SPT(C)	3.00		3	2.90 to 3.10m - Fine to medium red sand band		
					3.40 to 3.60m - Silty clay		
N=11 (1,2/2,3,3,3)	SPT(C)	4.00		4	4.00 to 5.00m - Poor recovery - wet		
N=15 (2,3/3,4,3,5)	SPT(C)	5.00		5	End of Borehole at 5.00m		
				6			

Remarks	Borehole Diameter		
	Base Depth	Diameter	Remarks
Terminated at 5.00m.			
Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.			



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Borehole No.

WS2

Sheet 1 of 1

Project Name Barwell			Project No. 6552		Date 18/02/2021 to 18/02/2021			Hole Type WLS	
Client Expedite PS			Co-ords E: N: L:		Water Strike Details Depth Str ke Time Elapsed Rose To			Logged By DW	
Contractor 360 Drilling Ltd			Plant Used Competitor Dart					Approved By	
								Scale 1:50	

Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend	Well
Results	Type	Depth					
N=10 (1,1/2,2,2,4)	ES	0.50 - 0.60	(0.25)	1	MADE GROUND: Grey subangular fine to medium granite gravel over: Grey slightly silty gravelly SAND. Gravel is angular to subangular fine to medium granite and flint.		
			0.25		MADE GROUND: Yellow grey sandy subangular fine to coarse granite GRAVEL		
			(0.25)				
			0.50				
			(0.25)				
N=10 (1,1/2,2,2,4)	SPT(C)	1.00	0.75	MADE GROUND: Dark brown slightly clayey slightly gravelly SAND. Sand is predominantly fine. Gravel is angular to subangular fine to coarse brick, slate, flint and rare glass. Medium cobble content of brick. Rare organic matter fragments.			
			(0.50)	Firm yellow slightly clayey slightly sandy S.L.T. Sand is predominantly fine. Rare black pockets.			
			1.25				
N=3 (2,0/0,1,1,1)	SPT(C)	2.00		Loose orangish brown SAND. Sand is predominantly medium. Occasional clayey bands.			
N=11 (0,0/1,3,3,4)	B SPT(C)	3.00 - 5.00	3.00				
N=8 (1,1/2,2,2,2)	SPT(C)	4.00					
N=10 (1,2/3,2,3,2)	SPT(C)	5.00					
End of Borehole at 5.00m							

Remarks

Terminated at 5.00m.

Borehole Diameter		
Base Depth	Diameter	Remarks

Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.

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Project Name Barwell				Project No. 6552	Date 18/02/2021 to 18/02/2021			Hole Type WLS			
Client Expedite PS				Co-ords E: N: L:	Water Strike Details			Logged By DW			
Contractor 360 Drilling Ltd		Plant Used Competitor Dart	Depth Str ke 2.00		Time Elapsed 0	Rose To 0.00	Approved By				
								Scale 1:50			
Samples and Results			Depth, (Thickness)	Level	Stratum Description				Legend	Well	
Results	Type	Depth									
N=11 (1,2/3,3,2,3)	SPT(C)	1.00	(0 25)	1	MADE GROUND: Grey subangular fine to medium granite gravel over: Grey slightly clayey silty sandy angular to subangular fine to medium granite and flint GRAVEL.						
			0 25		MADE GROUND: Light brown slightly clayey slightly silty sandy GRAVEL. Gravel is angular to subangular fine to coarse granite.						
			(0.15)		MADE GROUND: Dark brown gravelly SAND. Sand is predominantly fine to medium. Gravel is subangular fine to coarse brick, concrete and rare glass. Rare rubber fragments. Medium cobble content.						
			0.40								
			(0.40)								
N=14 (2,3/4,3,3,4)	SPT(C)	2.00	0 80	2	POSSIBLE MADE GROUND: Loose brown slightly silty clayey gravelly SAND. Sand is fine to medium. Gravel is angular to subangular fine to medium flint.						
			(0.15)		Loose brown to reddish brown slightly silty clayey SAND. Sand is fine to medium.						
			0 95								
			(0 55)								
			1 50		Soft light brown slightly sandy silty CLAY. Sand is fine to medium.						
N=0 (1,0/0,0,0,0)	SPT(C)	3.00	(0 50)	3							
			(3 00)								
			3 80 to 5.00m - Poor recovery - wet								
			3.80 to 3.80m - Black pocket								
			4.00 to 5.00m - Occasional lay bands								
N=6 (1,1/2,1,2,1)	SPT(C)	4.00	4	4							
			5								
			5 00								
			End of Borehole at 5.00m								
			6								
N=6 (1,1/2,1,1,2)	SPT(C)	5.00	5	5							
			6								
			6								
			6								
			6								

Remarks		Borehole Diameter		
Terminated at 5.00m.		Base Depth	Diameter	Remarks

Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.

 Consulting Geo-Technical & Geo-Environmental Engineers Site Investigation Contractors		The Slate Barn, Lower Lowley, Dunsford, Exeter, EX6 7BP 01647 252414 www.terrafirmasouth.co.uk			Borehole No. WS4 Sheet 1 of 1						
Project Name Barwell		Project No. 6552	Date 01/02/2021 to 18/02/2021			Hole Type WLS					
Client Expedite PS		Co-ords E: N: L:	Water Strike Details			Logged By DW					
Contractor 360 Drilling Ltd			Plant Used Competitor Dart	Depth Str ke 2.00	Time Elapsed 0	Rose To 0.00					
						Approved By					
						Scale 1:50					
Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend	Well				
Results	Type	Depth									
N=8 (1,2/2,2,2,2)	SPT(C)	1.00	(0 20)	1	MADE GROUND: Grey subangular fine to medium granite gravel over: Grey silty sandy GRAVEL. Gravel is angular to subangular fine to medium granite and flint.						
			0 20		MADE GROUND: Dark brown gravelly SAND. Sand is predominantly fine to medium. Gravel is subangular fine to coarse brick, concrete and rare clinker and glass. Rare rubber fragments. Medium cobble content. Low cobble content.						
			(0 25)								
			0.45								
			(0 25)								
0.70	MADE GROUND: Dark brown slightly silty slightly gravelly SAND. Gravel is subrounded to rounded fine to medium flint.										
N=13 (1,1/2,4,3,4)	SPT(C)		2.00	2	0.60 to 0.70m - Reddish brown						
					Loose brown to reddish brown slightly silty clayey SAND. Sand is fine to medium. Variable clayey and silty bands						
					N=3 (1,0/1,0,1,1)		SPT(C)	3.00	3	3.00 to 5.00m - Poor recovery - wet	
										N=12 (2,1/2,3,3,4)	
N=5 (2,2/1,1,1,2)	SPT(C)	5.00	5	5 00		UNKNOWN: Continuous CPT only - No recovery. Becoming loose to medium dense.					
					N=14 (3,3/3,4,4,3)		SPT(C)	5.50	(1 00)	End of Borehole at 6.00m	
N=19 (4,4/4,5,4,6)	SPT(C)	6.00	6	6 00							
Remarks Terminated at 5.00m. Continuous CPT to 6.45m.							Borehole Diameter				
							Base Depth	Diameter	Remarks		
Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.											



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Borehole No.
WS5
Sheet 1 of 1

Project Name Barwell			Project No. 6552		Date 18/02/2021 to 18/02/2021			Hole Type WLS							
Client Expedite PS			Co-ords E: N: L:		Water Strike Details			Logged By DW							
Contractor 360 Drilling Ltd					Plant Used Competitor Dart			<table> <tr> <th>Depth Str ke</th> <th>Time Elapsed</th> <th>Rose To</th> </tr> <tr> <td>0.90</td> <td>0</td> <td>0.00</td> </tr> </table>		Depth Str ke	Time Elapsed	Rose To	0.90	0	0.00
Depth Str ke	Time Elapsed	Rose To													
0.90	0	0.00													
								Scale 1:50							
Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend	Well								
Results	Type	Depth													
N=8 (1,2/1,2,2,3)	SPT(C)	1.00	(0.20)	1	MADE GROUND: Grey subangular fine to medium granite gravel over: Grey silty sandy GRAVEL. Gravel is angular to subangular fine to medium granite and flint.										
			0.20		MADE GROUND: Brown slightly silty slightly gravelly SAND. Sand is predominantly fine to medium. Gravel is angular to subrounded fine to coarse flint, brick and concrete.										
			(0.70)												
			0.90												
			(0.15)												
N=4 (2,2/1,1,1,1)	SPT(C)	2.00	1.05	2	POSSIBLE MADE GROUND: Light brown slightly silty SAND. Sand is fine to medium.										
			(0.40)		Light brown mottled grey slightly clayey slightly sandy SILT. Sand is fine.										
			1.45		Loose yellowish brown SAND. Sand is fine to medium. Rare clay and clayey bands.										
N=5 (0,0/1,1,1,2)	SPT(C)	3.00	(3.55)	3											
N=7 (1,1/2,2,1,2)	SPT(C)	4.00		4											
N=5 (1,2/1,1,2,1)	SPT(C)	5.00	5.00	5	UNKNOWN: Continuous CPT only - No recovery. Medium dense becoming dense.										
N=19 (4,3/4,4,5,6)	SPT(C)	5.50	(1.00)												
N=32 (8,8/8,9,7,8)	SPT(C)	6.00	6.00	6	End of Borehole at 6.00m										

Remarks
Terminated at 5.00m. Continuous CPT to 6.45m.

Borehole Diameter

Base Depth	Diameter	Remarks

Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.

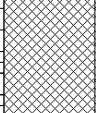


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Borehole No.
WS6
Sheet 1 of 1

Project Name Barwell			Project No. 6552		Date 18/02/2021 to 18/02/2021			Hole Type WLS									
Client Expedite PS			Co-ords E: N: L:		Water Strike Details			Logged By DW									
Contractor 360 Drilling Ltd					Plant Used Competitor Dart			<table> <tr> <th>Depth Str</th> <th>ke</th> <th>Time Elapsed</th> <th>Rose To</th> </tr> <tr> <td>2.00</td> <td></td> <td>0</td> <td>0.00</td> </tr> </table>		Depth Str	ke	Time Elapsed	Rose To	2.00		0	0.00
Depth Str	ke	Time Elapsed	Rose To														
2.00		0	0.00														
								Scale 1:50									

Samples and Results			Depth, (Thickness)	Level	Stratum Description	Legend	Well
Results	Type	Depth					
N=14 (1,3/4,4,3,3)	ES SPT(C)	0.80	(0 25) 0 25 (0 05) 0 30 (0 15) 0 45 (0 55)	1	MADE GROUND: grey subangular fine to medium granite gravel over: medium dense multicoloured slightly clayey slightly silty sandy subangular fine to coarse granite, an occasional brick and concrete GRAVEL. ASPHALT Bituminous Containing Material. Strong Hydrocarbon Odour. MADE GROUND: Medium dense multicoloured slightly clayey slightly silty sandy gravelly angular to subangular brick and concrete COBBLES. Gravel is angular to subangular fine to coarse brick, tile, slate and BCM. 0.75 to 0.80m - Black sand band 0.90 to 0.95m - Black sand band	  	
		1.00	(0 35) 1 35				
N=8 (1,2/2,3,2,1)	B SPT(C)	1 50 - 2.00	2	Very loose greyish orangish brown slightly silty fine to medium SAND. Variable clay and silt content throughout. 1.60 to 1.60m - Black sand band			
		2.00					
N=2 (0,0/1,0,0,1)	SPT(C)	3.00	3	3.00 to 5.00m - Poor recovery - wet			
N=2 (1,0/0,0,1,1)	SPT(C)	4.00	4				
N=2 (1,2/1,0,1,0)	SPT(C)	5.00	5	5 00	UNKNOWN: Continuous CPT only - No recovery. Becoming loose to medium dense		
N=20 (1,2/1,3,8,8)	SPT(C)	5.50		(1 00)			
N=11 (6,3/3,3,2,3)	SPT(C)	6.00	6	6 00	End of Borehole at 6.00m		

Remarks
Terminated at 5.00m. Continuous CPT to 6.45m.

Borehole Diameter

Base Depth	Diameter	Remarks

Notes: For all symbols and abbreviations please see key sheet. All depths and measurements in metres. Stratum thicknesses given in brackets.

Annex B: In-situ Test Results

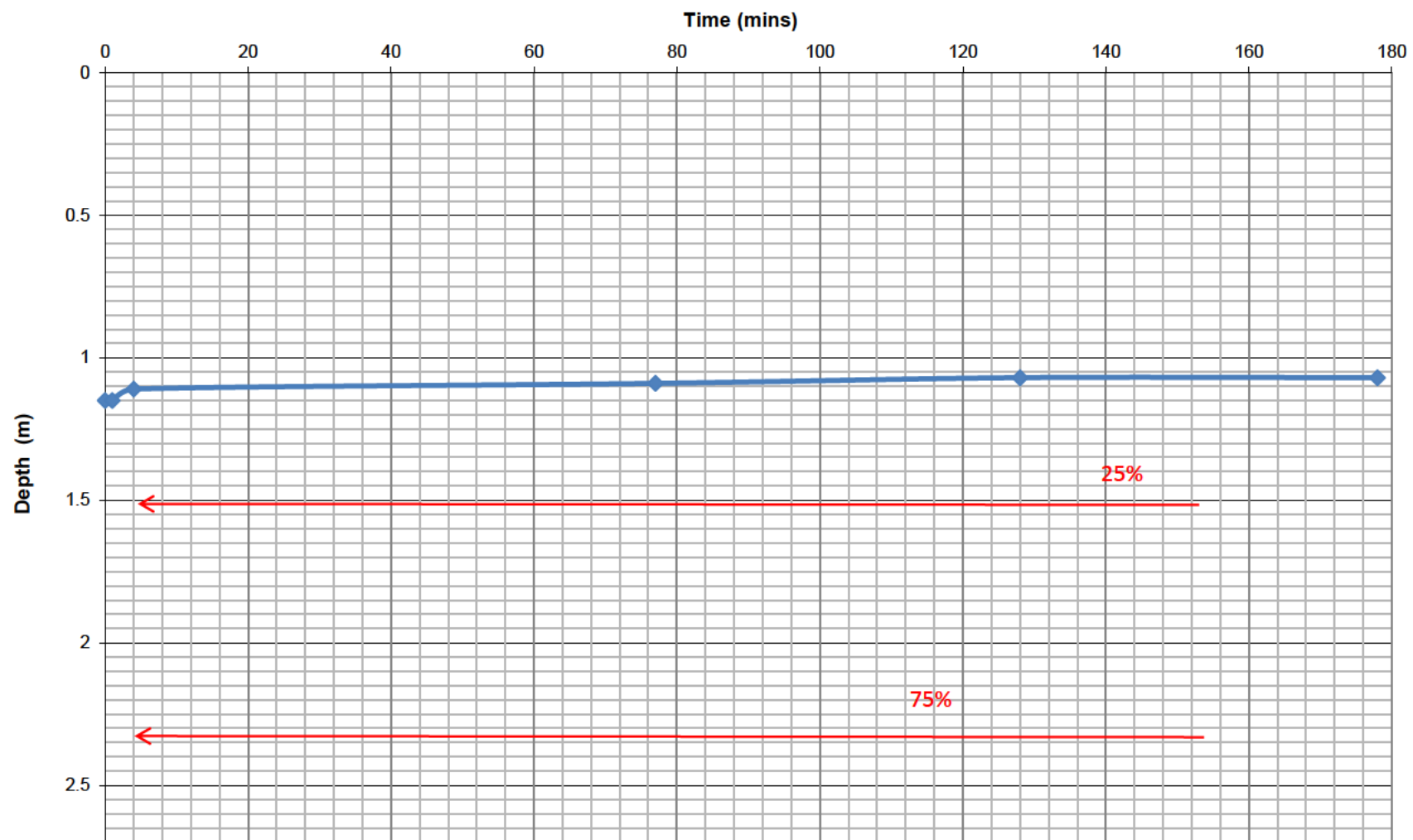
Site Name:	Barwell	Job No.:		Date Undertaken:	18/02/2021
Trial Pit No.:	TP2	Test No.:	1		

	Depth to Water (m)	Time (Mins)
(Top of test / effective depth - 100%)	1.15	0
	1.15	1
	1.11	4
	1.09	77
	1.07	128
	1.07	178
(Base of pit / effective depth - 0%)	2.700	

Length of Trial Pit (m)	1.9
Width of Trial Pit (m)	0.45
Depth of Trial Pit (m)	2.7
Effective Storage Depth (m)	1.550
Vp25	1.5375
Vp75	2.3125
Vp75-25	0.663
50% effective depth (m)	0.775
Mean Surface area ap50 (m2)	4.498
Time for 25% Outflow (tp25)	
Time for 75% Outflow (tp75)	
tp75 - 25	
Soil Infiltration Rate (m/s)	N/A

Soil Infiltration Worksheet: This worksheet has been produced in combination with the document 'BRE Digest 365- September 1991'. This worksheet can be used to determine soil infiltration rates from trial pit field measurements. Worksheet options are identified by a green background

Soil Infiltration Measurements - TP2, Test 1



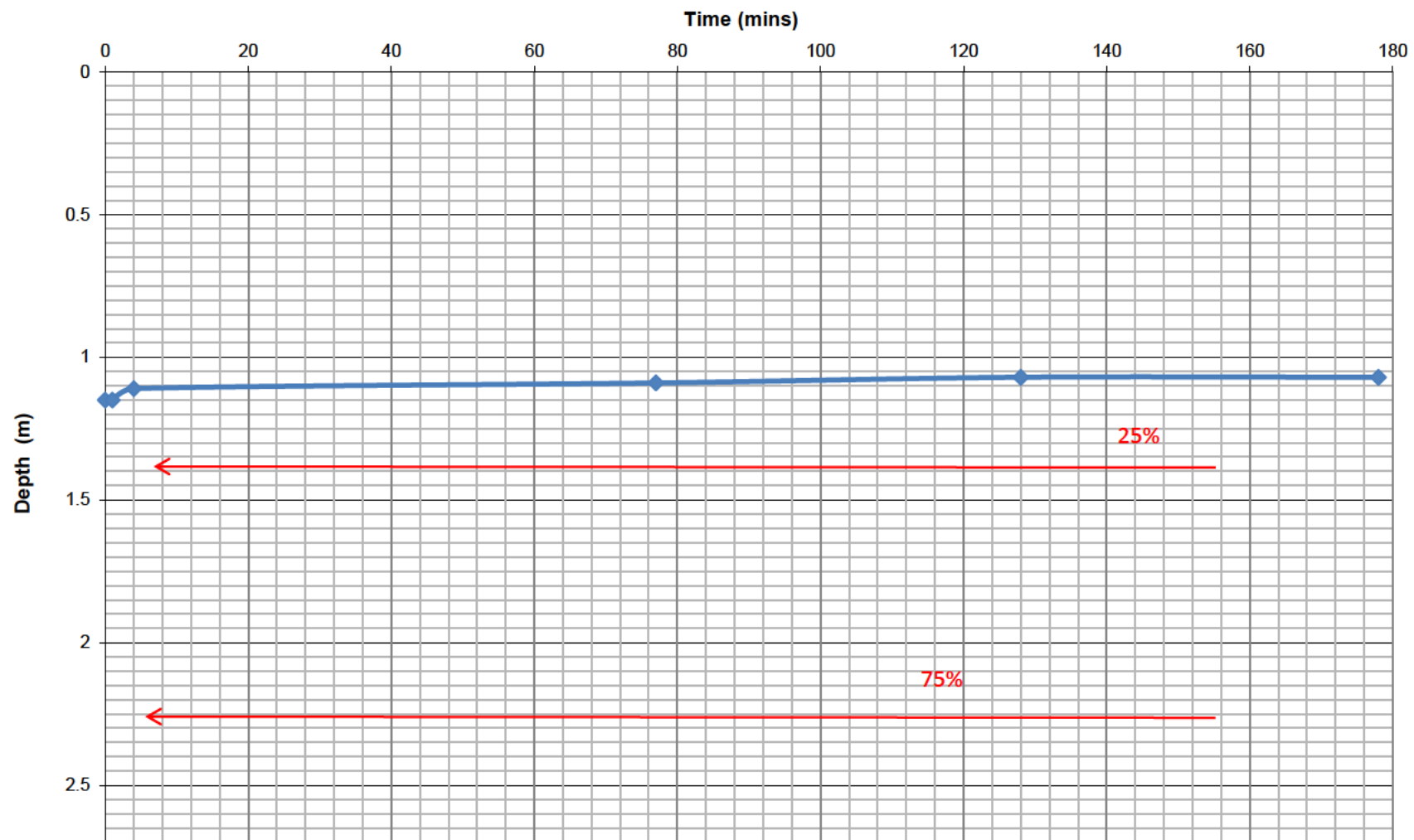
Site Name:	Barwell	Job No.:		Date Undertaken:	18/02/2021
Trial Pit No.:	TP1	Test No.:	1		

	Depth to Water (m)	Time (Mins)
(Top of test / effective depth - 100%)	0.94	0
	0.95	1
	0.94	91
	1	184
	1.03	237
	1.04	251
(Base of pit / effective depth - 0%)	2.700	

Length of Trial Pit (m)	1.9
Width of Trial Pit (m)	0.45
Depth of Trial Pit (m)	2.7
Effective Storage Depth (m)	1.760
Vp25	1.3800
Vp75	2.2600
Vp75-25	0.752
50% effective depth (m)	0.880
Mean Surface area ap50 (m2)	4.991
Time for 25% Outflow (tp25)	
Time for 75% Outflow (tp75)	
tp75 - 25	
Soil Infiltration Rate (m/s)	N/A

Soil Infiltration Worksheet: This worksheet has been produced in combination with the document 'BRE Digest 365- September 1991'. This worksheet can be used to determine soil infiltration rates from trial pit field measurements. Worksheet options are identified by a green background

Soil Infiltration Measurements - TP2, Test 1



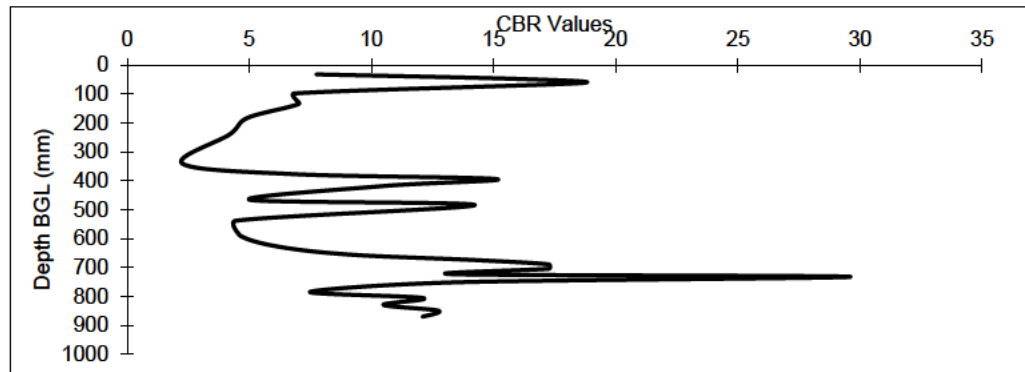
In-situ CBR by TRL DCP

TRRL Road Transport, Note 8

Project Name	Barwell	Date	18/02/2021	Soil Description	
Project No.	6552	Location/ Test No.	TRL1		

Depth of Test below ground level (mm): 0

CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)
7.7	32	32.0	1	162	17.3	689	15.0	1	819					
16.1	48	16.0	1	178	17.3	704	15.0	1	834					
18.6	62	14.0	1	192	13.4	723	19.0	1	853					
6.8	98	36.0	1	228	29.6	732	9.0	1	862					
7.0	133	35.0	1	263	13.4	751	19.0	1	881					
4.9	182	49.0	1	312	7.5	784	33.0	1	914					
4.2	239	57.0	1	369	12.1	805	21.0	1	935					
2.3	341	102.0	1	471	10.5	829	24.0	1	959					
6.8	377	36.0	1	507	12.7	849	20.0	1	979					
15.1	394	17.0	1	524	12.1	870	21.0	1	1000					
10.5	418	24.0	1	548										
5.0	466	48.0	1	596										
14.2	484	18.0	1	614										
4.5	538	54.0	1	668										
4.6	590	52.0	1	720										
6.3	629	39.0	1	759										
9.3	656	27.0	1	786										

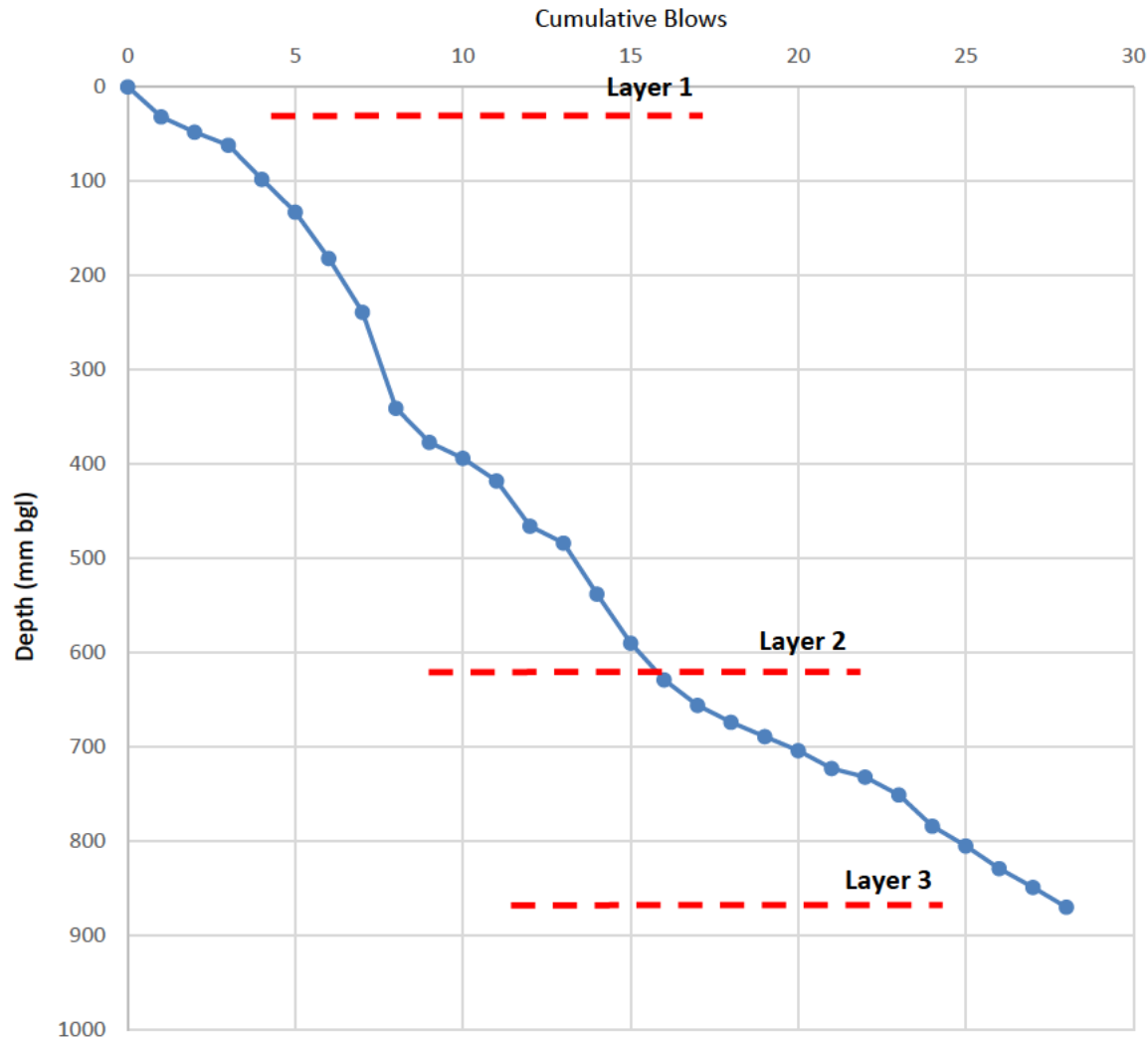



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In-situ CBR by TRL DCP

TRRL Road Transport, Note 8

Blows vs Depth



Layer Depth (mm bgl)	CBR Value
Layer 1 Base: 62	12.30
Layer 2 Base: 629	5.58
Layer 3 Base: 870	12.67

CBR value calculated from layers identified in cumulative blows per depth graph in accordance with CS229

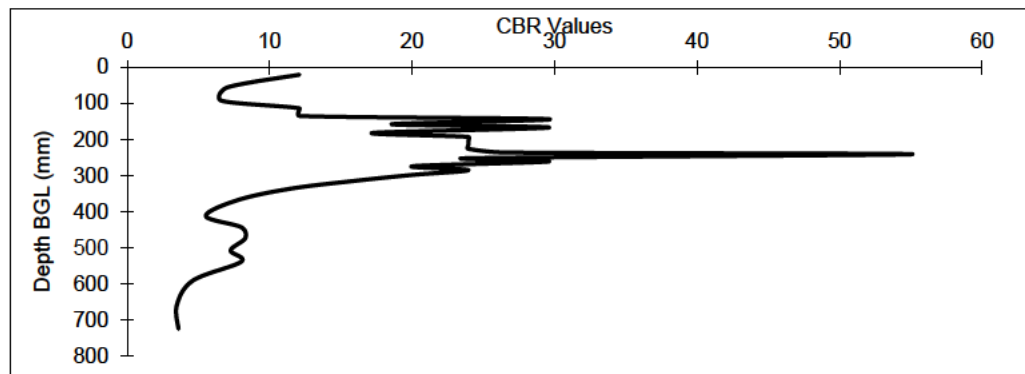


In-situ CBR by TRL DCP

TRRL Road Transport, Note 8

Project Name	Barwell	Date	18/02/2021	Soil	
Project No.	6552	Location/ Test No.	TRL2	Description	

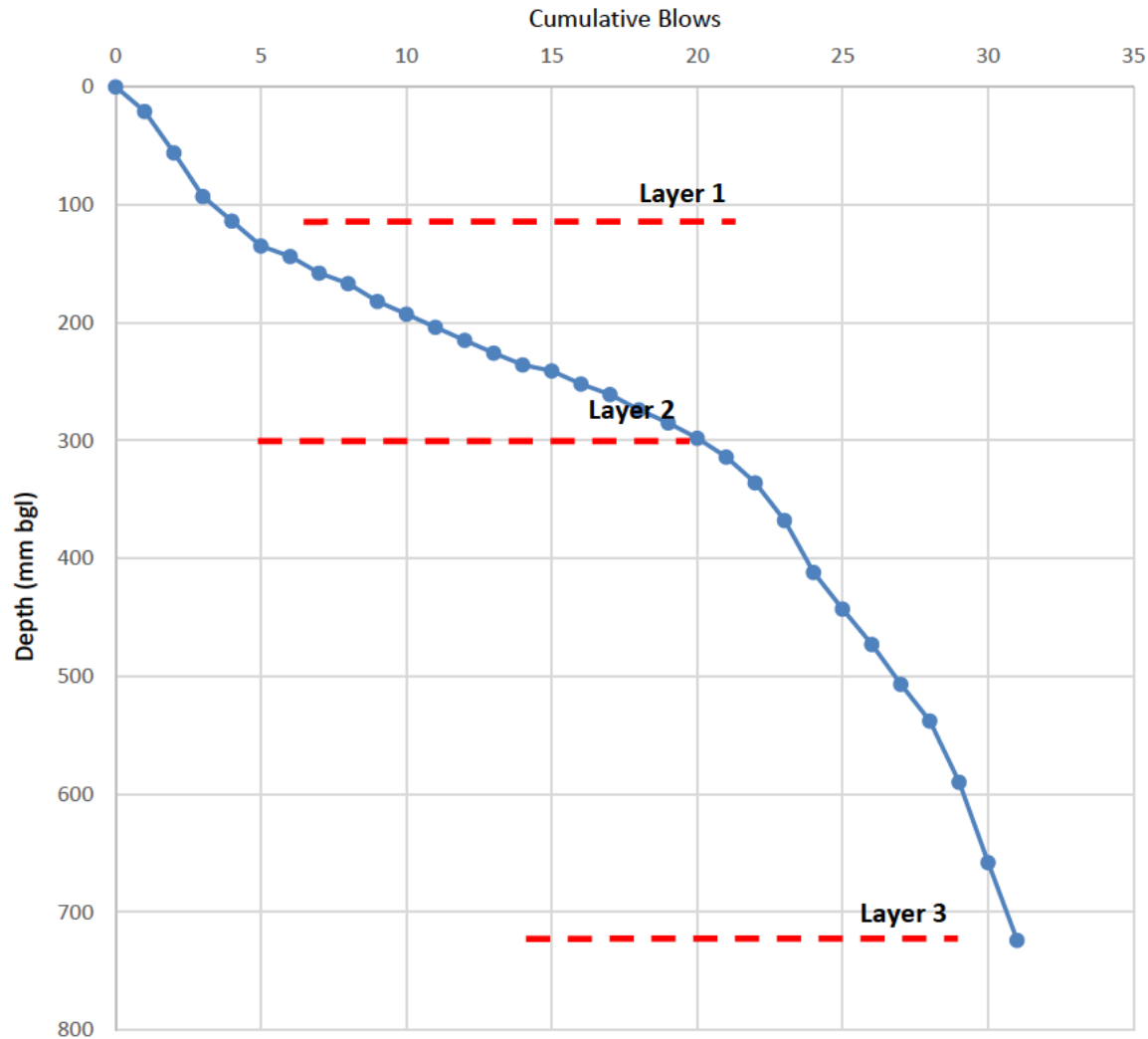
Depth of Test below ground level (mm): 0															
CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	
	0		0	130	20.1	274	13.0	1	404						
12.1	21	21.0	1	151	23.9	285	11.0	1	415						
7.0	56	35.0	1	186	20.1	298	13.0	1	428						
6.6	93	37.0	1	223	16.1	314	16.0	1	444						
12.1	114	21.0	1	244	11.5	336	22.0	1	466						
12.1	135	21.0	1	265	7.7	368	32.0	1	498						
29.6	144	9.0	1	274	5.5	412	44.0	1	542						
18.6	158	14.0	1	288	8.0	443	31.0	1	573						
29.6	167	9.0	1	297	8.3	473	30.0	1	603						
17.3	182	15.0	1	312	7.3	507	34.0	1	637						
23.9	193	11.0	1	323	8.0	538	31.0	1	668						
23.9	204	11.0	1	334	4.6	590	52.0	1	720						
23.9	215	11.0	1	345	3.5	658	68.0	1	788						
23.9	226	11.0	1	356	3.6	724	66.0	1	854						
26.5	236	10.0	1	366											
55.1	241	5.0	1	371											
23.9	252	11.0	1	382											
29.6	261	9.0	1	391											



In-situ CBR by TRL DCP

TRRL Road Transport, Note 8

Blows vs Depth



Layer Depth (mm bgl)	CBR Value
Layer 1 Base: 135	9.27
Layer 2 Base: 314	23.52
Layer 3 Base: 724	5.96

CBR value calculated from layers identified in cumulative blows per depth graph in accordance with CS229



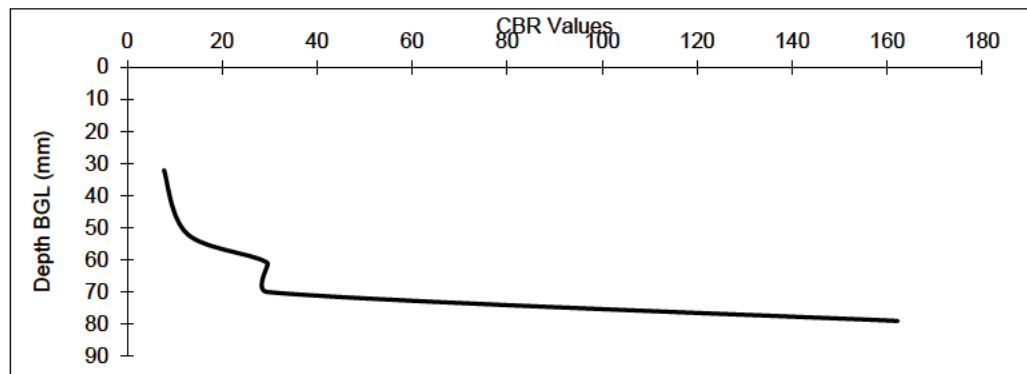
In-situ CBR by TRL DCP

TRRL Road Transport, Note 8

Project Name	Barwell	Date	18/02/2021	Soil Description	
Project No.	6552	Location/ Test No.	TRL3		

Depth of Test below ground level (mm): 0

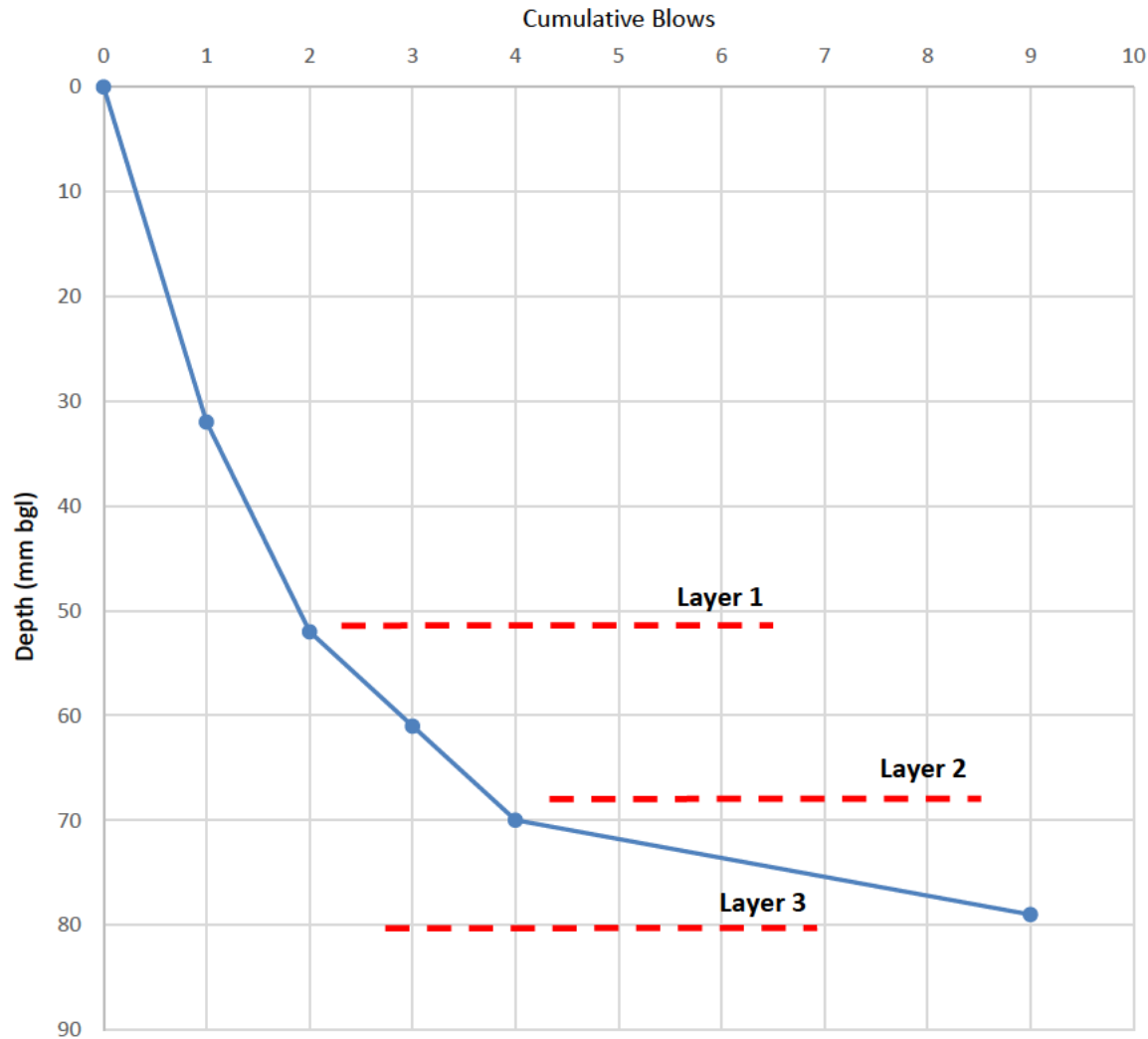
CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)
7.7	0		0	330										
12.7	32	32.0	1	362										
29.6	52	20.0	1	382										
29.6	61	9.0	1	391										
29.6	70	9.0	1	400										
162.2	79	1.8	5	409										



In-situ CBR by TRL DCP

TRRL Road Transport, Note 8

Blows vs Depth



Layer Depth (mm bgl)	CBR Value
Layer 1 Base: 52	9.65
Layer 2 Base: 70	29.61
Layer 3 Base: 79	162.25

CBR value calculated from layers identified in cumulative blows per depth graph in accordance with CS229

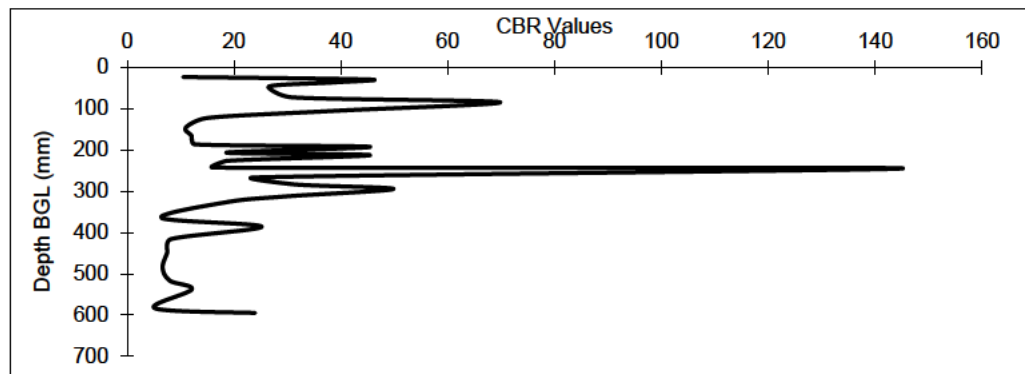


In-situ CBR by TRL DCP

TRRL Road Transport, Note 8

Project Name	Barwell	Date	18/02/2021	Soil Description	
Project No.	6552	Location/ Test No.	TRL4		

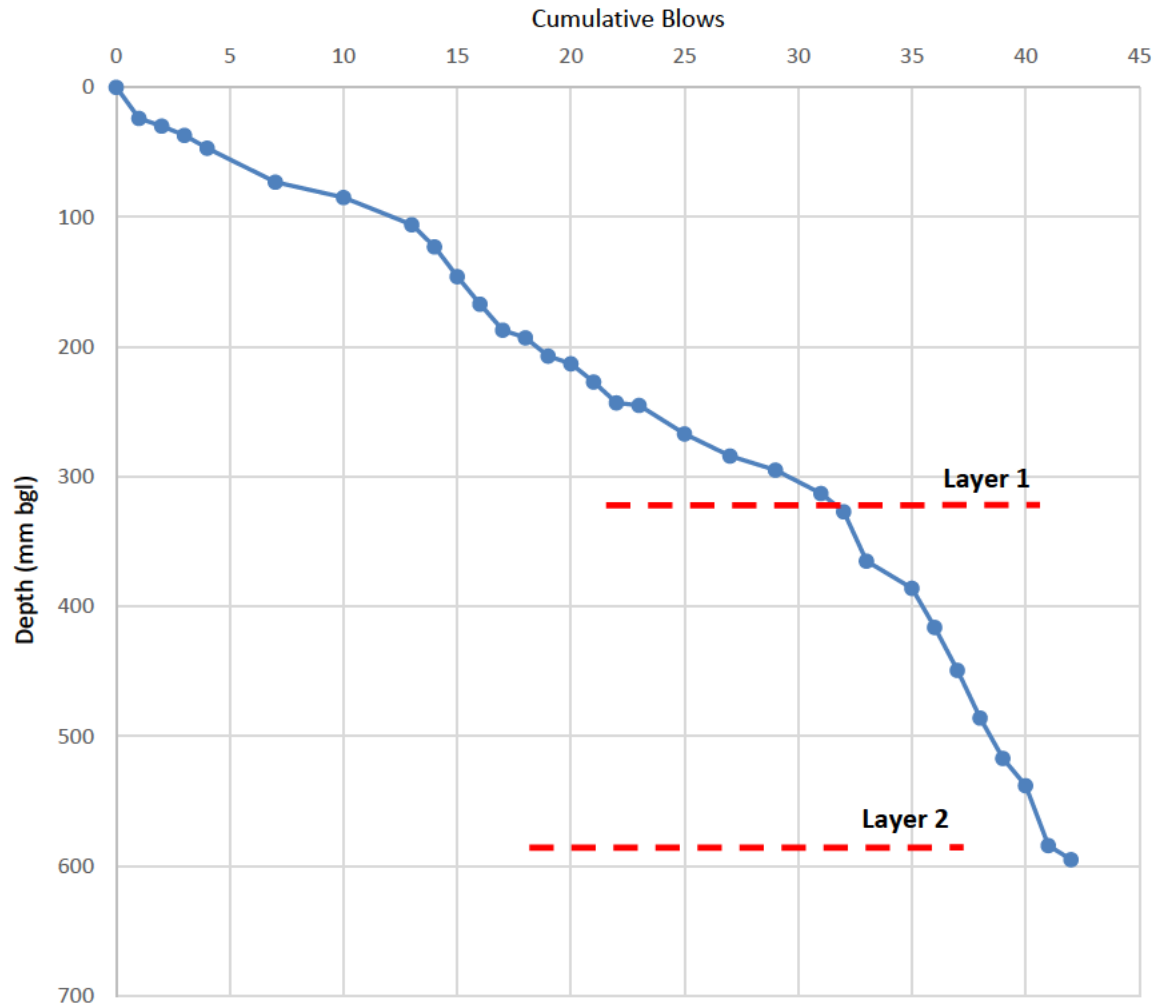
Depth of Test below ground level (mm): 0															
CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	
	0		0	405	23.9	267	11.0	2	672						
10.5	24	24.0	1	429	31.4	284	8.5	2	689						
45.4	30	6.0	1	435	49.8	295	5.5	2	700						
38.6	37	7.0	1	442	29.6	313	9.0	2	718						
26.5	47	10.0	1	452	18.6	327	14.0	1	732						
30.8	73	8.7	3	478	6.5	365	38.0	1	770						
69.8	85	4.0	3	490	25.2	386	10.5	2	791						
38.6	106	7.0	3	511	8.3	416	30.0	1	821						
15.1	123	17.0	1	528	7.5	449	33.0	1	854						
11.0	146	23.0	1	551	6.6	486	37.0	1	891						
12.1	167	21.0	1	572	8.0	517	31.0	1	922						
12.7	187	20.0	1	592	12.1	538	21.0	1	943						
45.4	193	6.0	1	598	5.3	584	46.0	1	989						
18.6	207	14.0	1	612	23.9	595	11.0	1	1000						
45.4	213	6.0	1	618											
18.6	227	14.0	1	632											
16.1	243	16.0	1	648											
145.1	245	2.0	1	650											



In-situ CBR by TRL DCP

TRRL Road Transport, Note 8

Blows vs Depth



Layer Depth (mm bgl)	CBR Value
Layer 1 Base: 327	25.89
Layer 2 Base: 595	9.34

CBR value calculated from layers identified in cumulative blows per depth graph in accordance with CS229

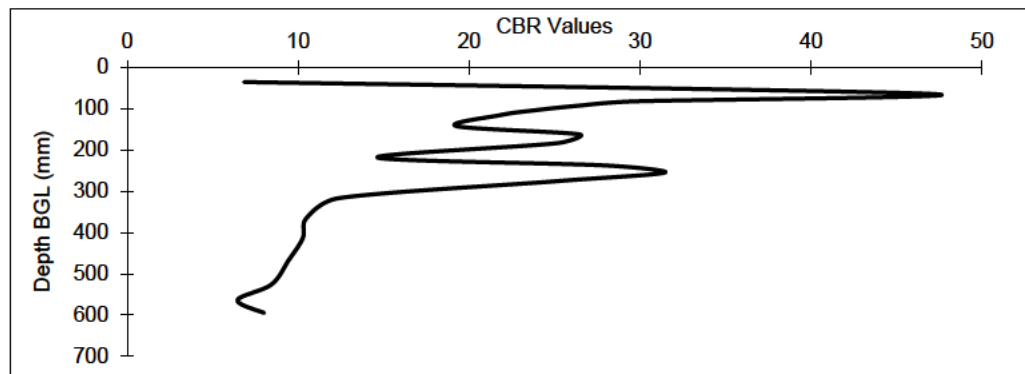


In-situ CBR by TRL DCP

TRRL Road Transport, Note 8

Project Name	Barwell	Date	18/02/2021	Soil Description	
Project No.	6552	Location/ Test No.	TRL5		

Depth of Test below ground level (mm): 0														
CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)
6.8	0		0	405	8.4	526	29.5	2	931					
47.1	36	36.0	1	441	6.5	564	38.0	1	969					
29.6	65	5.8	5	470	8.0	595	31.0	1	1000					
26.5	83	9.0	2	488										
23.9	93	10.0	1	498										
21.8	104	11.0	1	509										
19.3	116	12.0	1	521										
26.5	143	13.5	2	548										
25.2	163	10.0	2	568										
14.7	184	10.5	2	589										
28.0	219	17.5	2	624										
31.4	238	9.5	2	643										
25.2	255	8.5	2	660										
12.4	276	10.5	2	681										
10.5	317	20.5	2	722										
10.3	365	24.0	2	770										
9.5	414	24.5	2	819										
	467	26.5	2	872										

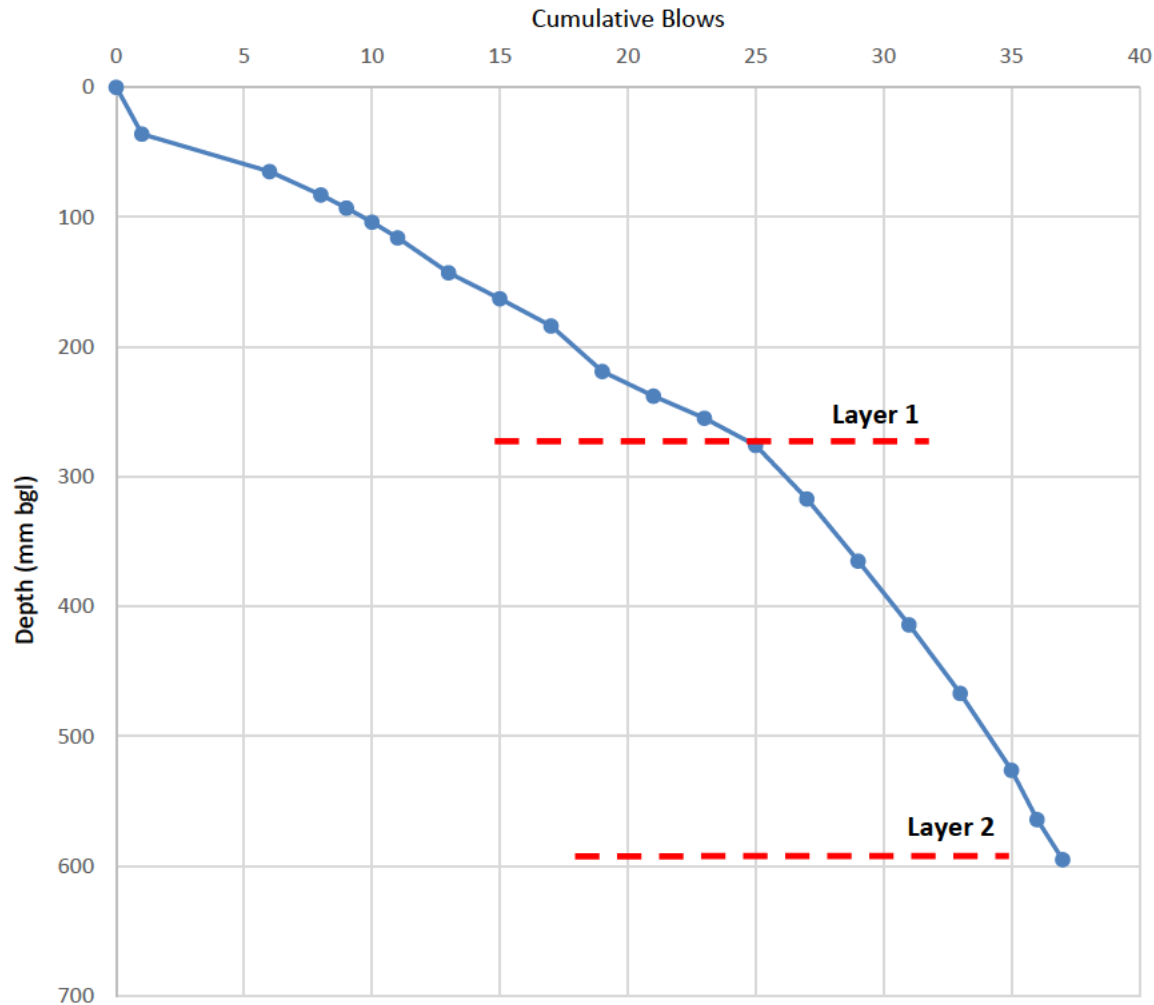



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In-situ CBR by TRL DCP

TRRL Road Transport, Note 8

Blows vs Depth



Layer Depth (mm bgl)	CBR Value
Layer 1 Base: 276	23.86
Layer 2 Base: 595	9.42

CBR value calculated from layers identified in cumulative blows per depth graph in accordance with CS229

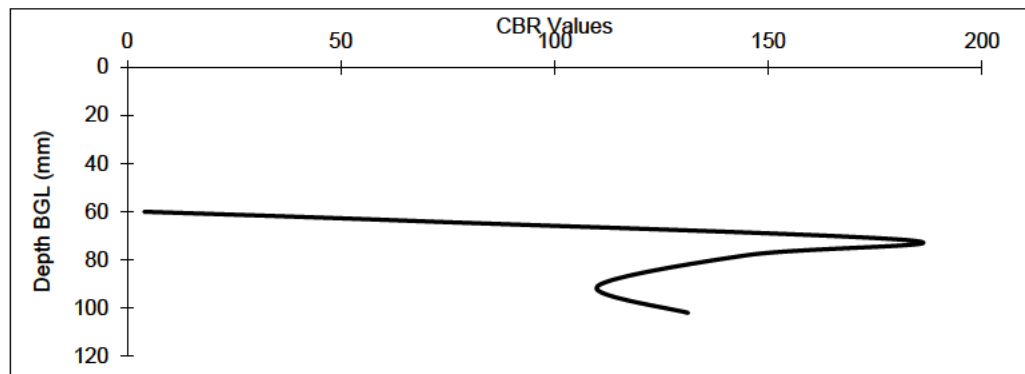


In-situ CBR by TRL DCP

TRRL Road Transport, Note 8

Project Name	Barwell	Date	18/02/2021	Soil	
Project No.	6552	Location/ Test No.	TRL5	Description	

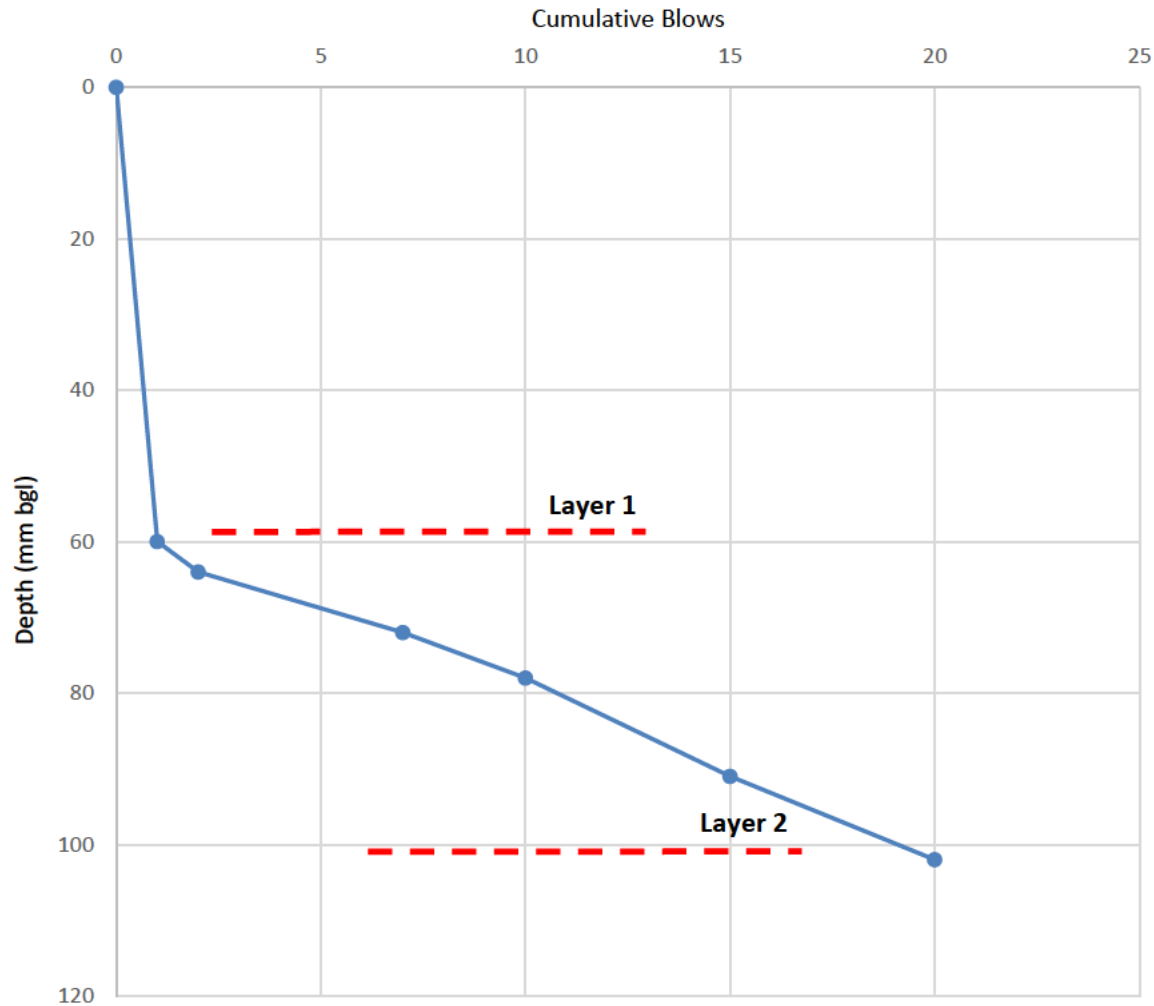
Depth of Test below ground level (mm): 0														
CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)	CBR Value %	Depth Below Ground Level (mm)	mm per blow	Blows	Reading on Scale (mm)
4.0 69.8 183.8 145.1 110.0 131.2	0		0	368										
	60	60.0	1	428										
	64	4.0	1	432										
	72	1.6	5	440										
	78	2.0	3	446										
	91	2.6	5	459										
	102	2.2	5	470										



In-situ CBR by TRL DCP

TRRL Road Transport, Note 8

Blows vs Depth



Layer Depth (mm bgl)	CBR Value
Layer 1 Base: 60	3.99
Layer 2 Base: 102	130.58

CBR value calculated from layers identified in cumulative blows per depth graph in accordance with CS229



Annex C: Chemical Test Results



2183

Final Report

Report No.:	21-05843-1		
Initial Date of Issue:	02-Mar-2021		
Client	Terra Firma		
Client Address:	The Slate Barn Lower Lowley Dunsford Devon EX6 7BP		
Contact(s):	Info		
Project	6552 Barnwell		
Quotation No.:		Date Received:	25-Feb-2021
Order No.:	6552	Date Instructed:	25-Feb-2021
No. of Samples:	6		
Turnaround (Wkdays):	5	Results Due:	03-Mar-2021
Date Approved:	02-Mar-2021		
Approved By:			

Details: Glynn Harvey, Technical Manager

Results - Soil

Project: 6552 Barnwell

Client: Terra Firma	Chemtest Job No.:		21-05843	21-05843	21-05843	21-05843	21-05843	21-05843	21-05843
Quotation No.:	Chemtest Sample ID.:		1148711	1148714	1148716	1148717	1148718	1148719	
Order No.: 6552	Client Sample Ref.:		1	1	1	1	1	1	1
	Sample Location:		HP1	TP2	WS2	WS3	WS4	WS5	
	Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
	Top Depth (m):		0.40	1.00	0.50	0.25	0.30	0.30	
	Bottom Depth (m):		0.40	1.00	0.60	0.50	0.40	0.50	
	Date Sampled:		18-Feb-2021	18-Feb-2021	18-Feb-2021	18-Feb-2021	18-Feb-2021	18-Feb-2021	
	Asbestos Lab:		DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	
Determinand	Accred.	SOP	Units	LOD					
ACM Type	U	2192		N/A	-	-	-	-	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-	-	-	-	-
Moisture	N	2030	%	0.020	3.8	11	12	9.9	6.4
pH	U	2010		4.0	9.8	9.0	8.5	8.5	8.6
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Sulphate (Total)	U	2430	%	0.010	0.026	0.46	0.21	0.091	0.11
Arsenic	U	2450	mg/kg	1.0	2.7	3.8	5.7	4.3	4.8
Cadmium	U	2450	mg/kg	0.10	0.30	< 0.10	0.30	0.31	0.41
Chromium	U	2450	mg/kg	1.0	15	9.9	13	12	13
Copper	U	2450	mg/kg	0.50	76	16	23	20	25
Mercury	U	2450	mg/kg	0.10	< 0.10	< 0.10	0.12	< 0.10	< 0.10
Nickel	U	2450	mg/kg	0.50	27	14	15	15	15
Lead	U	2450	mg/kg	0.50	29	24	71	45	120
Selenium	U	2450	mg/kg	0.20	< 0.20	0.25	0.23	< 0.20	< 0.20
Zinc	U	2450	mg/kg	0.50	140	56	120	99	110
Chromium (Trivalent)	N	2490	mg/kg	1.0	15	9.9	13	12	13
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Organic Matter	U	2625	%	0.40	< 0.40	0.53	1.5	1.9	1.5
Florisil Cleanup	N		-	N/A	Done	Done	Done	Done	Done
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C21-C35	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C21-C35	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Results - Soil

Project: 6552 Barnwell

Client: Terra Firma	Chemtest Job No.:				21-05843	21-05843	21-05843	21-05843	21-05843	21-05843
Quotation No.:	Chemtest Sample ID.:				1148711	1148714	1148716	1148717	1148718	1148719
Order No.: 6552	Client Sample Ref.:				1	1	1	1	1	1
	Sample Location:				HP1	TP2	WS2	WS3	WS4	WS5
	Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				0.40	1.00	0.50	0.25	0.30	0.30
	Bottom Depth (m):				0.40	1.00	0.60	0.50	0.40	0.50
	Date Sampled:				18-Feb-2021	18-Feb-2021	18-Feb-2021	18-Feb-2021	18-Feb-2021	18-Feb-2021
	Asbestos Lab:				DURHAM	DURHAM	DURHAM	DURHAM	DURHAM	DURHAM
Determinand	Accred.	SOP	Units	LOD						
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	< 10	< 10	< 10	< 10	< 10	< 10
Naphthalene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	U	2700	mg/kg	0.10	< 0.10	1.9	< 0.10	< 0.10	< 0.10	< 0.10
Pyrene	U	2700	mg/kg	0.10	< 0.10	1.5	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	U	2700	mg/kg	2.0	< 2.0	3.4	< 2.0	< 2.0	< 2.0	< 2.0
Benzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethy benzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
m & p-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Methyl Tert-Butyl Ether	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Phenols	U	2920	mg/kg	0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Al kaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazine.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Dichloromethane extraction / GCxGC FID detection
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenzo[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container
- E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

customerservices@chemtest.com

Annex D: Soil Property Test Results

SUMMARY OF LIQUID AND PLASTIC LIMIT TESTS

[illegible]

Test Type:

- 1 - 1 point 80g / 30° fall cone method.
- 2 - 4 point 80g / 30° fall cone method.
- 3 - Non plastic determination.

Sample condition:

- 1 - As Received
2 - Air Dried
3 - Washed & Air Dried

Checked and Approved by:

Project Number:

GEO / 32687

Project Name:

BARWELL

6552



SUMMARY OF CHEMICAL TESTS ON SOIL

Location	Depth m	Sample Ref	Sample Type	pH Value	Total Acid Soluble Sulphate as SO4	Water Soluble Sulphate as SO4 2:1 Water:Soil Extract	Total Sulphur	Water Soluble Chloride	Water Soluble Nitrate	Magnesium	Organic Content	Mass Loss on Ignition	Carbonate Content
					%	g/l	%	g/l	g/l	g/l	%	%	%
WS1	2.20-2.90	3	B	7.9	-	0.017	-	-	-	-	-	-	-
WS3	1.50-2.00	2	B	7.6	-	< 0.010	-	-	-	-	-	-	-
WS4	1.50-2.50	2	B	7.9	-	< 0.010	-	-	-	-	-	-	-
WS5	2.00-4.00	2	B	7.9	-	0.016	-	-	-	-	-	-	-
WS6	1.50-2.00	2	B	8.5	-	0.079	-	-	-	-	-	-	-

Tested by Chemtest Ltd : MCERTS / UKAS No 2183

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Project Number:

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Project Name:

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LIQUID AND PLASTIC LIMITS

Location WS1
 Sample Ref 3
 Depth (m) 2.20
 Sample Type B

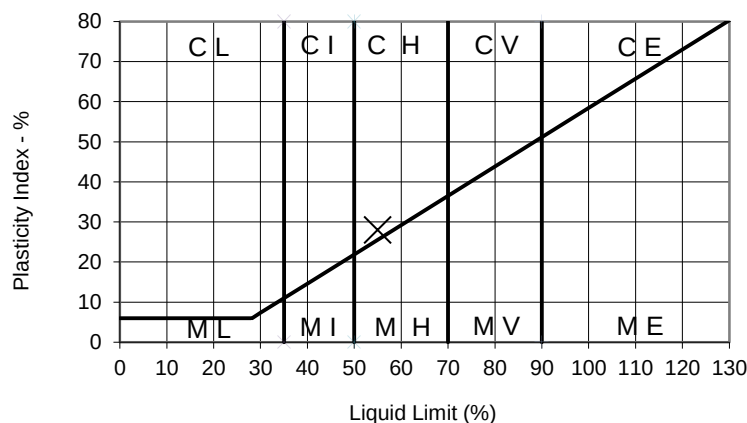
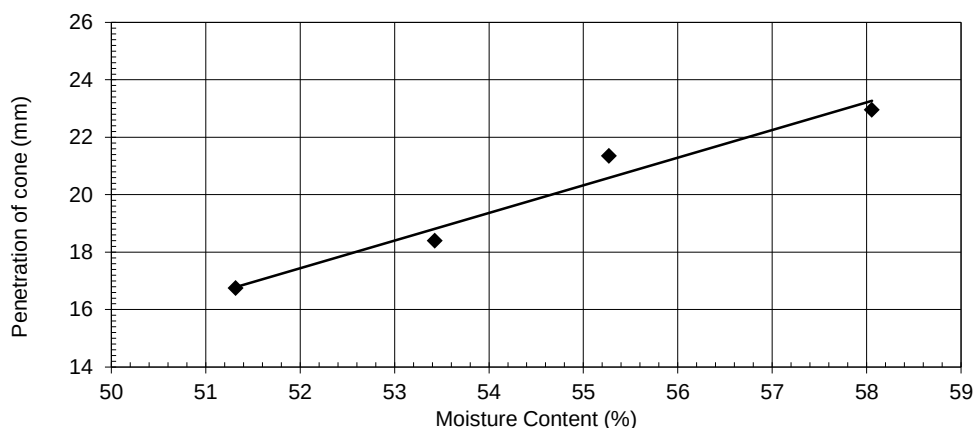
Description:

Reddish brown sandy CLAY.

Preparation : Sample as received.

Water Content : (BS EN ISO 17892-1:2014) 28.8 %
 Estimated percentage passing 425µm sieve : 100 %
 Liquid Limit - Fall Cone 4 point Method (cone angle 30°) with increasing water content : 55 %
 Plastic Limit : 27 %
 Plasticity Index : 28 %

Equivalent Water Content of material passing 425µm sieve : 28.8 %
 Liquidity Index : 0.06



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LIQUID AND PLASTIC LIMITS

Location WS3
 Sample Ref 2
 Depth (m) 1.50
 Sample Type B

Description:

Reddish brown mottled light brown clayey SAND.

Preparation : Sample as received.

Water Content : (BS EN ISO 17892-1:2014) 23.8 %

Estimated percentage passing 425µm sieve : 100 %

Liquid Limit - Fall Cone Method (cone angle 30°) : Not Determined

Plastic Limit : Non-Plastic

Equivalent Water Content of material passing 425µm sieve : 24 %

Sample was determined to be Non-Plastic after preparation

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Project Name:

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6552**

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05/03/2021

PARTICLE SIZE DISTRIBUTION

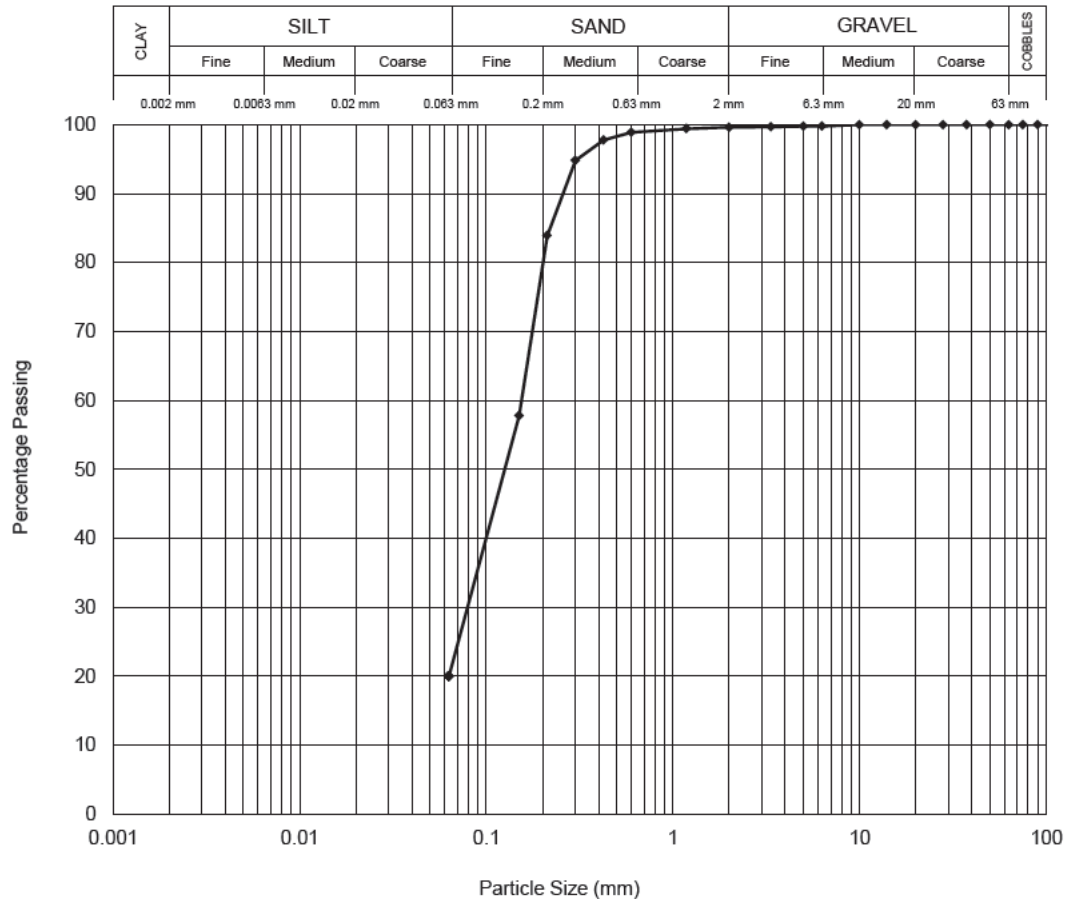
Location WS4
 Sample Ref 2
 Depth (m) 1.50-2.50
 Sample Type B

Description

Orangish brown clayey SAND.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
10.0 mm	100
6.30 mm	100
5.00 mm	100
3.35 mm	100
2.00 mm	100
1.18 mm	99
600 µm	99
425 µm	98
300 µm	95
212 µm	84
150 µm	58
63 µm	20



Particle Proportions	
Cobbles	0.0
Gravel	0.4
Sand	79.6
Silt & Clay	20.0

Processed by PK
 Checked and Approved by

Project Number:

GEO / 32687

Project Name:

BARWELL
 6552

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PARTICLE SIZE DISTRIBUTION

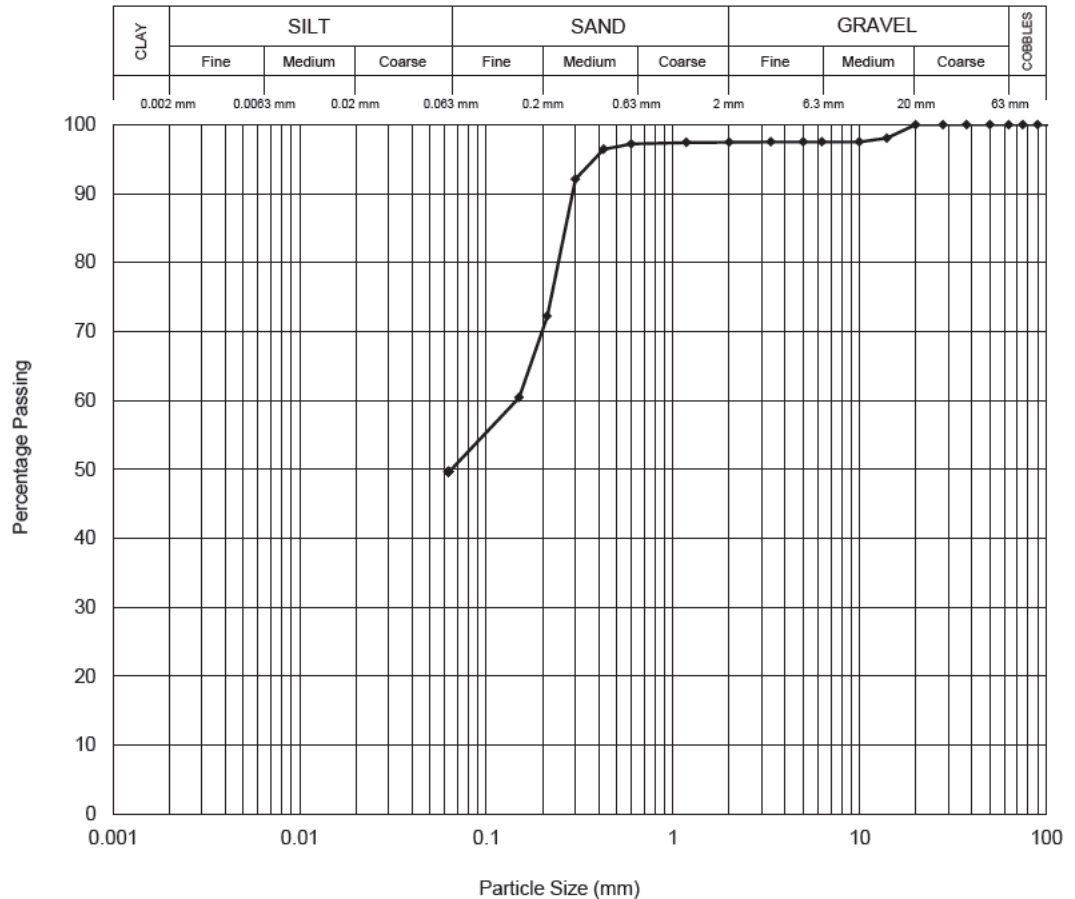
Location WS5
Sample Ref 2
Depth (m) 2.00-4.00
Sample Type B

Description

Orangish brown CLAY and SAND with rare fine to medium gravel.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	98
10.0 mm	98
6.30 mm	98
5.00 mm	98
3.35 mm	98
2.00 mm	97
1.18 mm	97
600 µm	97
425 µm	96
300 µm	92
212 µm	72
150 µm	60
63 µm	50



Particle Proportions	
Cobbles	0.0
Gravel	2.5
Sand	47.8
Silt & Clay	49.7

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Project Name:

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PARTICLE SIZE DISTRIBUTION

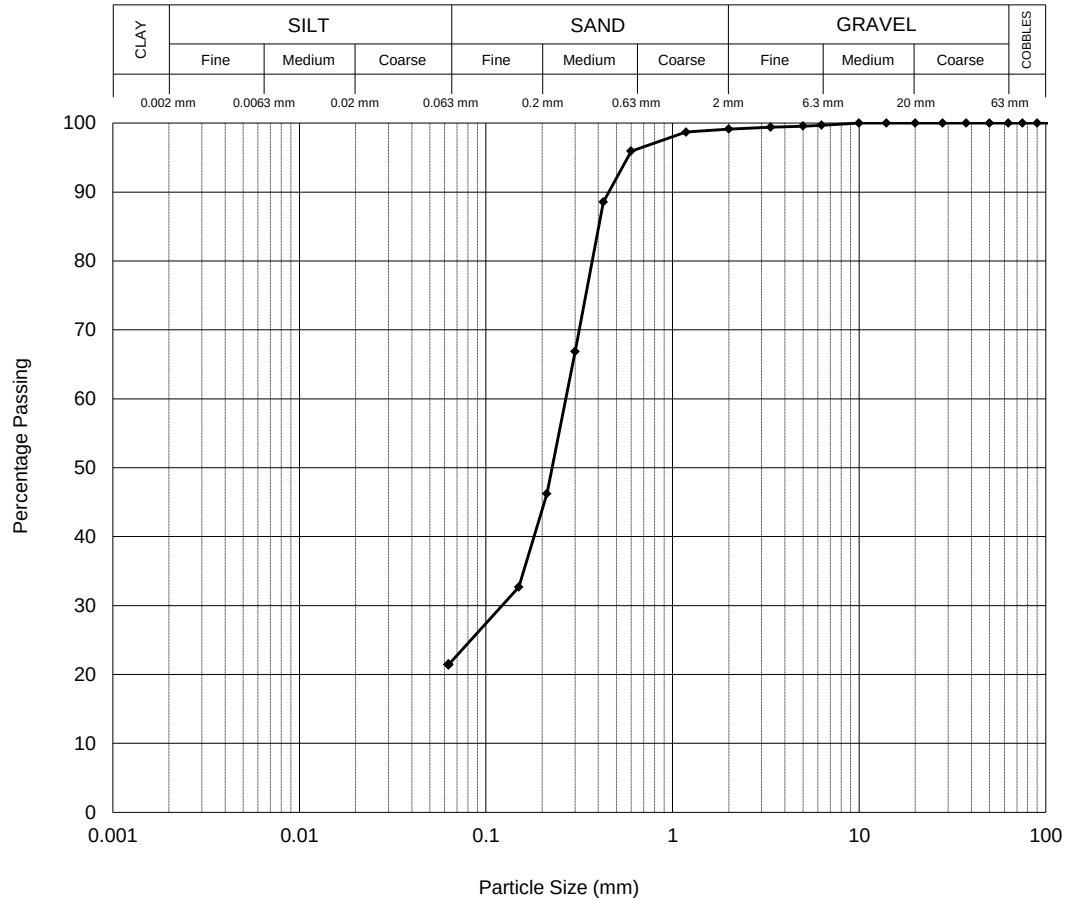
Location WS6
Sample Ref 2
Depth (m) 1.50-2.00
Sample Type B

Description

Orangish brown clayey SAND.

BS EN ISO 17892-4 : 2016 : Clause 5.2 - Wet Sieve

Sieve	
Size	% Pass
200.0 mm	100
125.0 mm	100
90.0 mm	100
75.0 mm	100
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
10.0 mm	100
6.30 mm	100
5.00 mm	100
3.35 mm	99
2.00 mm	99
1.18 mm	99
600 µm	96
425 µm	89
300 µm	67
212 µm	46
150 µm	33
63 µm	21



Particle Proportions	
Cobbles	0.0
Gravel	0.8
Sand	77.7
Silt & Clay	21.5

Processed by PK
Checked and Approved by

Project Number: -

GEO / 32687

Project Name:

**BARWELL
6552**