Appendix 10.2

GEOENVIRONMENTAL INTERPRETATIVE REPORT – BMD01-BHE-XX-XX-RP-YG-0003

CBRE

BUROHAPPOLD ENGINEERING

The People's Project

Geoenvironmental Interpretative Report

0040026

13 November 2019

Revision P03

BMD01-BHE-XX-XX-RP-YG-0003

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Revision	Description	Issued by	Date	Checked
P01	Issue	GS	21/01/2019	HM
P02	Update for planning	GS	08/10/2019	HM
P03	Update for planning	GS	13/11/2019	HM

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Author	**Georgina Sopp**
Reviewed	**Hugh Mallett**
Signature	
Date	**13/11/19**

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Executive Summary

Background and Objectives

BuroHappold Engineering (BuroHappold) was commissioned to carry out a geoenvironmental assessment of Bramley-Moore Dock (BMD), the application site. The overall aim of the geoenvironmental work was to carry out a ground investigation to inform understanding of potential ground-contamination related risks for the proposed future use.

Site Setting

The application site comprises BMD, on the River Mersey (centred on National Grid Reference (NGR) SJ3345292491). To the north of BMD is Wellington Dock, which has been infilled and houses the United Utilities Wastewater Treatment Works (UU WwTW) (Planning Ref: 11F/1581, approved 12/01/2012), whilst to the northwest lies Sandon Half-Tide Dock, which remains connected to BMD via a pair of dock gates. Sandon Half-Tide Dock lies within the operational Port. To the east of BMD, on the opposite side of Regent Road, lies a timber retailer, tyre retailer, and offices/residential uses. There is a public house, The Bramley Moore, across Regent Road from the southeast corner of the site. To the south lies Nelson Dock, the connective dock gate to which is sealed with hydraulic connectivity maintained via pipe works/sluice gates. The western boundary of the site is the elevated River Mersey wall, which forms a flood defence to the site. To the west of this boundary lies the River Mersey, beyond which is a mix of uses, predominantly residential dwellings fronting the river bank within the Wirral.

History

Based on the available historical maps, BMD has been present since at least the 1850s. Rail sidings were present at this time until the 1990s, in part labelled as the 'High Level Coal Railway'. A Hydraulic Engine House (Grade II listed) is located in the north-east corner of the application site and has been present since 1883 (shown on the 1890s map) and various shed / warehouse structures from 1850s until present. The north wharf was used for stockpiling of sediments until July 2019. The south wharf is currently used for storage and minor boat maintenance operations.

Geological Setting

The wharves are underlain by a downwards sequence of Made Ground, Tidal Flat Deposits, Glacial Till and sandstone of the Chester Formation. The stratigraphy within BMD comprises Dock Deposits (clays, silts, sands and gravels) over the Chester Formation. The hydrogeological and hydrological conditions are complex due to interactions between the River Mersey and wider dock system and permeability of BMD and River Mersey walls. A seepage regime exists between near-surface groundwater within Made Ground and the underlying water contained within BMD, with a design groundwater level of +5.50m AOD adopted. Groundwater within Glacial Till and the underlying sandstone shows a slight tidal influence.

Ground Investigation

Ground investigation was undertaken over two phases. The Phase 1 works were completed during June 2017 with contractor services provided by Geotechnical Engineering Ltd. The Phase 2 works were completed between December 2017 and January 2018 with contractor services provided by Structural Soils Ltd. The works included both geoenvironmental and geotechnical objectives.

Contamination Risk Assessment

A Generic Quantitative Risk Assessment has been carried out on the basis of the available data. Risks assessed to be greater than low are listed below:

- Moderate / low risk to construction / maintenance workers due to potential for presence of asbestos within Made Ground.
- Moderate risk to future site users due to potential vapour risk associated with localised hydrocarbon contamination (naphthalene) within Made Ground.
- Moderate risk to water supply pipes due to concentrations of contaminants in Made Ground and in the area of the former tar works.
- Moderate / low risk to construction / maintenance workers due to potential for contact with hydrocarbon contamination in area of former tar works.
- Moderate risk to future site users due to potential vapour risk associated with former tar works.
- Moderate risk to controlled waters due to concentrations of hydrocarbons in groundwater in vicinity of former tar works (originating from impacted ground).
- Moderate / low risk to construction / maintenance workers, future site users and stadium / buildings due to potential for ground gas generation from Dock Deposits (of which no monitoring has been undertaken to date).

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Geoenvironmental Condition

The ground investigation and risk assessment have shown that the general site condition in relation to contamination within soils and controlled waters is suitable for the proposed development of a stadium as planned and that the proposed development will not create any new pollution linkages when mitigation is put in place. The work has identified a need for some localised remediation of elevated hydrocarbon concentrations. In addition new water supply pipes are likely to need to be specified as barrier pipe if they are located on the dock wharves. It is unlikely that the application site would be determined as Contaminated Land (under the provisions of Part 2A of the Environmental Protection Act 1990) in its current status, or following the event of any redevelopment, provided the recommendations below are followed.

Outline Remedial Methodology

The following remedial measures are proposed on the basis of the Generic Quantitative Risk Assessment:

Source	Receptor	Mitigation Measures
Made Ground (asbestos)	Construction / maintenance workers	Good construction practice and adoption of standard health and safety precautions. Maintain watching brief for potential presence of asbestos containing materials.
Made Ground (hydrocarbons)	Future site users	Localised excavation and suitable off-site disposal of Made Ground impacted by hydrocarbon contamination (naphthalene) in the vicinity of BH04 and P102 (Figure 12-1). Allowance should be made for additional areas of contamination. If encountered, excavation and removal may be required and need for / scope of vapour protection measures should be reassessed.
Made Ground	Future site users	The majority of the proposed development will be covered by hard landscaping. There are very limited areas of soft-landscaping which include direct in-ground planting To mitigate the risk to future site users due to the potential for direct contact with contaminants in soils, soft landscaping should be isolated from underlying Made Ground by placement of a marker layer, with any planting in suitable imported soils.
Made Ground Former tar works	Water supply pipes	Selection of suitable materials and appropriate design once location of pipework is known. Confirm requirements for barrier pipe materials with the utility company.
Former tar works	Construction / maintenance workers	As part of enabling works (prior to construction / piling), localised excavation and suitable off-site disposal of ground impacted by operations of former tar works. Good construction practice and adoption of standard health and safety precautions.
Former tar works	Future site users	As part of enabling works (prior to construction / piling), localised excavation and suitable off-site disposal of ground impacted by operations of former tar works.
Former tar works	Controlled waters	Localised excavation and suitable off-site disposal of ground impacted by operations of former tars works (assumed source of hydrocarbon impact of groundwater in the vicinity). Adopt methodology to prevent runoff of impacted groundwater into BMD.
Dock Deposits	Construction / maintenance workers Future site users Stadium / buildings	Once building design is finalised, the need for ground gas monitoring and / or gas protection measures should be reassessed.

The following are also recommended:

- If the proposed installation methodology for the geotechnical membrane changes, a separate risk assessment should be conducted to assess risks to human health (not anticipated to change).
- A watching brief should be maintained during enabling works / construction for additional localised areas of hydrocarbon contamination arising from current or historical use of BMD. If encountered, the need for / scope of additional remediation will require further consideration.

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1. Introduction

1.1 General

On behalf of Everton Stadium Development Limited (hereafter referred to as Everton / The Club), BuroHappold Engineering Ltd. (BuroHappold) was commissioned to carry out a geoenvironmental assessment of Bramley-Moore Dock (BMD). The application site is located on the River Mersey within the district of Vauxhall and forms part of the Port of Liverpool. Combined geoenvironmental and geotechnical ground investigations were undertaken over two phases: Phase 1 during June 2017 and Phase 2 during December 2017 to January 2018.

1.2 Aims and objectives

The overall aim of the geoenvironmental work was to carry out a ground investigation of the application site to inform understanding of potential ground-contamination related risks for the proposed future use.

This report provides information relevant for the proposed future use of the application site in accordance with the requirements of the National Planning Policy Framework (NPPF) [1] and also with respect to potential liability under Part 2a of the Environmental Protection Act 1990. The work was carried out in general accordance with the Environment Agency (EA) / Department for Environment, Food and Rural Affairs (Defra) Model Procedures for the management of Contaminated Land [2], the relevant British Standards (BS) [3] [4], the EA Guiding Principles for Land Contamination [5], Groundwater Protection Policy [6] and other current good practice guidance.

The objectives of the report are to:

- Summarise the historical and current use of the application site and its surroundings;
- Provide an outline assessment of the nature of the ground conditions and the environmental sensitivity of the application;
- Provide an outline assessment of the potential location, nature and extent of ground and groundwater contamination;
- Assess the potential risks to people and the environment (natural and built) associated with potential ground contamination (solid, liquid or gas) associated with the proposed future uses;
- Construct an initial Conceptual Site Model and carry out a preliminary contaminated land risk assessment, in general accordance with the EA / Defra Model Procedures [2] and;
- Evaluate the potential need for and scope of further works such as further investigation and / or remedial action.

1.3 Information sources

The principal sources of information are the previous desk study [7], and Phase 1 [8] and Phase 2 [9] factual reports. This report is based upon information obtained from the above third party sources, together with observations from site walkover surveys. Data collected during the ground investigations is presented in this report. The third party data has been accepted at face value and has not been independently verified. BuroHappold can therefore give no warranty, representation or assurance as to the accuracy or completeness of such information.

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1.4 Planning Policy Framework / Statutory Legislation

Section 38(6) of the Planning and Compulsory Purchase Act 2004 [10] and Section 70(2) of the Town & Country Planning Act 1990 [11] requires planning applications should be determined in accordance with the statutory development plan, unless material considerations indicate otherwise. The statutory development plan for the City of Liverpool currently comprises the Unitary Development Plan (adopted 2002) [12] and Merseyside and Halton Joint Waste Local Plan (adopted July 2013) [13]. The Liverpool Local Plan (Submission Draft, May 2018) [14], National Planning Policy Framework (March 2012, updated in 2019) [15], and Liverpool City Council's Planning advice note for developers on developing contaminated land [16] are material considerations which also inform the assessment. A summary of the statutory development plan policies relevant to the application proposal and specifically matters relating to ground conditions are provided in Appendix A.

1.5 Limitations

The scope and design of the ground investigations has reflected the known history of site use, with the results of the Phase 1 ground investigation informing the design of the Phase 2 investigation. On this basis, the spacing of the exploratory holes and the sampling and analysis plan for this investigation are considered to have provided a reasonable level of certainty about the ground conditions. However, it is important to recognise that contamination can be both widespread and relatively localised, depending upon its source and nature etc.

No investigation, however comprehensive, can be expected to determine absolutely the nature and extent of all the contamination which could be present on any site. There will always be an element of uncertainty about the ground conditions, including contamination. This potential for currently undetected contamination to be present must therefore be taken into account not only in the risk assessment presented here but also in consideration of future development activities, for example, health and safety planning, financial planning and risk management and in the implementation of the below ground works during construction.

1.6 Competency

The work reported here was carried out by geoenvironmental scientists and engineers from BuroHappold. BuroHappold is a consulting engineering company that manages its work under various Quality Management Systems that are certified to ISO 9001. The work itself was carried out by staff with relevant qualifications, training and experience. This overall technical responsibility for the work was held by a Technical Director with substantial experience in the assessment of land affected by contamination who is a Chartered Geologist and registered SiLC (Specialist is Land Contamination) and SQP (Suitably Qualified Person).

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2. Site Setting

2.1 Site location

The application site comprises BMD, on the River Mersey (centred on National Grid Reference (NGR) SJ3345292491). The application site area is 8.62 ha., this is subject to agreement from the lawyers on the final redline boundary with Peel, the topo survey and potential for some expansion to cover construction laydown areas etc. A site location plan is shown in Figure 2-1. The application site redline boundary is shown in Figure 2-2.

Figure 2-1 –Location of BMD (Ordnance Survey, 2017)

To the north of BMD is Wellington Dock, which has been infilled and houses the United Utilities Wastewater Treatment Works (UU WwTW) (Planning Ref: 11F/1581, approved 12/01/2012), whilst to the northwest lies Sandon Half-Tide Dock, which remains connected to BMD via a pair of dock gates. Sandon Half-Tide Dock lies within the operational Port.

To the east of BMD, on the opposite side of Regent Road, lies a timber retailer, tyre retailer, and offices/residential uses. There is a public house, The Bramley Moore, across Regent Road from the southeast corner of the site.

To the south lies Nelson Dock, the connective dock gate to which is sealed with hydraulic connectivity maintained via pipe works/sluice gates.

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The western boundary of the site is the elevated River Mersey wall, which forms a flood defence to the site. To the west of this boundary lies the River Mersey, beyond which is a mix of uses, predominantly residential dwellings fronting the river bank within the Wirral.

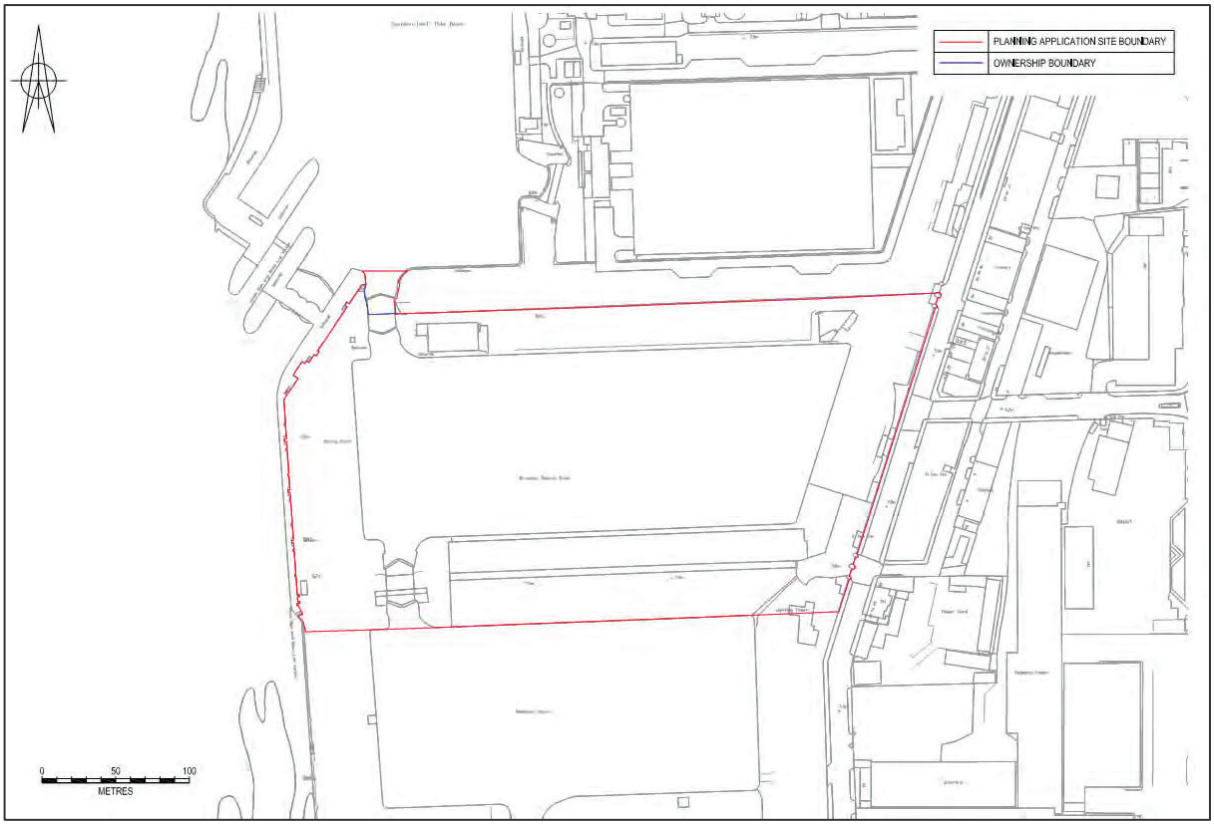

Figure 2-2 - Red line boundary of proposed development

2.2 Historical land use

The history of the application site and surrounding area has been determined from available historic Ordnance Survey maps from 1851 to 2014; this is summarised in Table 2-1.

Table 2-1 - History of application site and surrounding area.

Date	On Site History	History of the Surrounding Area
1851 (1:10,560)	BMD is present, with shed structures located on the northern, southern and western wharves. Rail sidings are present on the eastern side.	BMD is part of the Port of Liverpool system. To the north of the application site is Wellington Dock and the Wellington Half Tide Dock, and to the south is Nelson Dock. Rail sidings lead from wider Liverpool to the various docks. South-east of the Site is North Shore Mill and North Docks Station, labelled as 'Goods'. To the east are numerous unlabelled buildings.
1890 (1:10,560)	One of the shed structures on the northern wharf has been removed and is replaced by rail sidings	Expansion of shed structures on the northern wharf of Wellington Dock. Minor changes to unlabelled buildings located to the east of the application site.
1893 (1:2500)	Rail sidings located on the northern wharf and eastern perimeter are labelled as the 'High Level Coal Railway'. This was effectively a railway line on top of a brick viaduct with cranes to the south to load coal from ships into waiting railway trucks. Two small unlabelled buildings are present in the north-east corner of the application site, likely the Hydraulic Engine House (Grade II listed).	Buildings to the east of the application site are labelled to be hotels, public houses, an engine works, a foundry and a cattle shed. No discernible changes to the surrounding docks.

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Date	On Site History	History of the Surrounding Area
1906-1907 (1:10,560)	Rail sidings have extended onto the southern wharf.	The layout of Wellington Half Tide Dock has changed, and is renamed as Sandon Half-Tide Dock. A Goods Station is present to the north-east of the application site.
1908 (1:2500)	No discernible change.	Foundry to the east is no longer present.
1909 (1:10,560)	No discernible change.	No discernible change.
1925-1927 (1:10,560)	Minor extension of rail sidings on northern wharf.	No discernible change.
1927 (1:2500)	Cranes are labelled on the northern wharf and east side.	Shed on northern wharf of Wellington Dock is replaced with a larger structure.
1928 (1:10,560)	No discernible change.	No discernible change.
1938 (1:10,560)	No discernible change.	A Goods Station to the south-east of the application site has been removed and the land is unoccupied.
1954 (1:2500)	Rail sidings on the northern wharf (high level coal railway) have been scaled back and two small buildings are in their place. Rail sidings on the eastern edge of the application site have also been scaled back and a small shed has been constructed in the available space.	North Docks Goods Yard to the south-east of the application site is replaced by a Construction Engineering Works. A number of buildings labelled on the 1927 map as the North Docks Cattle Station have been removed and the land is unoccupied.
1967 (1:2500)	The shed on the northern wharf has been replaced by a larger structure. Two additional buildings are also present on this wharf. The shed on the southern wharf has been replaced by a larger structure.	The shed structure on the north and east sides of Nelson Dock have been removed, and two smaller buildings and two cranes are present in place. Castle Food Mill to south-east has been replaced by an oil refinery. A number of tanks are shown. A number of buildings to the east have been removed, others are now unlabelled and their uses unknown.
1973 (1:10,000)	Shed on northern wharf possibly replaced by larger shed taking up the entire wharf length.	Additional shed added on northern wharf of Nelson Dock.
1982 (1:10,000)	Large shed on northern wharf removed and replaced by two smaller buildings. Other shed on northern wharf removed.	Unlabelled buildings present on formerly unoccupied area of land to north-east.
1990 (1:10,000)	Rail sidings on northern wharf and eastern perimeter removed, land remains unoccupied.	Sandon Dock has been infilled and a Waste Water Treatment Works constructed in its place. Rail sidings to east of application site have been removed.
2002 (1:10,000)	Three small buildings on northern wharf removed.	All buildings present on perimeter of Nelson Dock have been removed. A pipeline is indicated in the south-east corner of Nelson Dock.
2010 (1:10,000)	No discernible change.	No discernible change.
2014 (1:10,000)	West wharf structure has been removed. Only shed on southern wharf, Hydraulic Tower and one other building remain.	Wellington Dock had been infilled and an extension to the waste water treatment facility was being constructed.

2.3 Proposed future use

It is proposed to construct a stadium of 52,888 seats. The stadium and surrounding area will be developed as follows:

- Infilling of BMD and construction of a sports stadium of 52,888 seats orientated north-south in the centre of the application site;

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- North-south orientated channel in the west of the application site maintaining connection through the wider dock network;
- Area to the east of the stadium (including eastern wharf) to be used as fan zones; and
- An at-grade car park located on the western wharf.
- The majority of the proposed development will be covered by hard landscaping. There are very limited areas of soft-landscaping which include direct in-ground planting.

Plans showing the proposed site layout (BMD01-MEI-A3-ZZ-DR-A-0020) and proposed softworks (BMD01-PLA-L1-00-DR-L-2000) at the end of this report.

2.4 Areas of unexpected contamination

During the ground investigation, a CEMEX employee based in a workshop on the northern wharf of BMD noted the historical presence of tar works on the northern wharf. This was located to the west of the workshop located on the western extent. The dates of operation and processes undertaken are unknown and were not identified during previous historic reviews [7]. This led to targeting of this area in the second phase of investigation. The presence of associated contamination is discussed in greater detail in Section 4.9.

2.5 Unexploded ordnance (UXO)

BuroHappold commissioned a UXO assessment from PLANIT UXB [17] (Appendix A). The assessment concluded that the Ordnance Threat Level varies across the application site:

- Volumes of ground within that have already been subjected to extensive redevelopment involving the displacement of earth are considered to have a negligible ordnance threat level;
- Volumes of ground within the areas covered by hardstanding (wharves, roadways and trackways are considered to have a negligible ordnance threat level; and
- The 'UXO Threat Zone' (i.e. the wet dock) is considered to have a medium ordnance threat level. The bomb penetration depth is estimated to be within a 1m safety margin of the dock's lining.

2.6 Radon

The Indicative Atlas of Radon for England and Wales [18] indicates that the application site is within an area where less than 1% of properties are at or above the Action Level for radon. The BRE Radon guidance document [19] indicates that no radon protection measures are required in this area.

2.7 Invasive species

No invasive species were identified during the site walkover or either phase of the ground investigation works.

2.8 Outline ground model

The following section provides an outline of the ground model as understood by BuroHappold prior to the investigation works undertaken during 2017 and 2018.

2.9 Geology

2.9.1 On-shore

The information presented in Table 2-2 summarises the expected on-shore ground model and has been inferred from the relevant BGS Map [20], BGS Geology of Britain Viewer [21] and historic borehole records [7].

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Table 2-2 - Expected geological sequence.

Stratum	Description	Thickness (m) (1)	Depth to Top (m bgl) (1)	Level of Top (m AOD) (1)
Made Ground (Demolition Rubble)	Dense to very dense, sandy (fine to coarse) angular fine to coarse GRAVEL. COBBLES of brick, concrete, pottery, ash and roof insulation.	2.4 to 3.4 (2.6)	0	+6.6
Tidal Flat Deposits	Not described on historical BGS boreholes.	-	-	-
Glacial Till	Firm to stiff, brown sandy silty CLAY with a little gravel of fine and medium sandstone and siltstone.	9.2 to 9.7 (9.4)	3.3 to 4.3 (3.8)	+3.3 to +2.3 (2.8)
Chester Formation	Weak red-brown moderately-weathered fine- and medium-grained SANDSTONE	Not proven	11.5 to 13.0 (12.3)	-4.9 to -6.4 (-5.7)

(1) Values presented are the range for the strata. Average BGS borehole values shown in brackets.

BGS Sheet 96 indicates presence of Tidal Flat Deposits, however this is not recorded in available historical borehole records. Tidal Flat Deposits of the River Mersey were observed off-site (south of Nelson Dock) by BuroHappold during the 2016 and 2017 site walkovers and comprised significant quantities of fine material, as expected given the depositional environment.

2.9.2 Off-shore (i.e. within BMD)

Information from adjacent docks (as reported in BMD01-BHE-ZX-XX-RP-CG-0001) suggests that BMD would have been excavated to bedrock and lined with a layer of puddle clay. A layer of soft sediment is also expected at the base, having settled out of the water over time. As such the expected strata within the dock are Dock Deposits (i.e. puddle clay or other soft sediments) overlying the Chester Formation. Very limited records of the construction of BMD remain.

2.10 Hydrogeology

The Tidal Flat Deposits are designated as an unproductive aquifer. The Glacial Till is a designated Secondary (undifferentiated) aquifer and the Chester Formation bedrock is a designated Principal Aquifer [7]. There are no active groundwater or potable water abstraction licenses within 2km of the Site.

BuroHappold projects in central Liverpool have shown two distinct groundwater tables, one in the shallow Made Ground and one in the deep Chester Formation, both of which have been observed to be influenced by the tidal fluctuations of the River Mersey.

Shallow groundwater conditions are likely to be complex at BMD, including a seepage regime dependent on the interactions of the River Mersey, bodies of water held in the dock system, permeability of BMD and River Mersey walls, permeability of backfill, and water tightness of the lock gates. Small variations in groundwater level are also expected to occur due to tidal influence of the River Mersey.

2.11 Hydrology

The application site is situated on the east bank of the estuary of the River Mersey. The Leeds and Liverpool Canal is situated approximately 500m east, running approximately north-south, with an exit through Stanley, Collingwood and Salisbury Docks via a series of locks 150m to the south of the application site. There are no surface water abstraction licenses within 2km.

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3. BuroHappold Ground Investigation

3.1 Aims and objectives

The overall aim of the geoenvironmental work undertaken was to inform an understanding of potential ground-contamination related risks for the proposed future use. A scope of work was designed to meet this aim and is described below.

3.2 Scope of ground investigation

The ground investigation was undertaken over two phases. The Phase 1 works were completed during June 2017 with contractor services provided by Geotechnical Engineering Ltd. The Phase 2 works were completed between December 2017 and January 2018 with contractor services provided by Structural Soils Ltd. The works included both geoenvironmental and geotechnical objectives. Only the geoenvironmental scope is discussed further in this report. The exploratory hole locations are shown on Figure 3-1 overleaf and drawing BMD01-BHE-ZX-LXX-DR-CG-0001 at the end of this report.

Phase 1:

- 8 dynamic sampling boreholes with rotary follow on to a minimum of 10m into Sandstone (BH01, BH01A, BH02 BH03, BH03A, BH03B, BH04 and BH05;
- Installation of 2 vibrating wire piezometers (BH01A and BH04), 2 standpipe piezometers (BH04 and BH05) and 1 slotted standpipe (BH02);
- 12 month programme of groundwater monitoring;
- Collection of grab samples of Dock Deposits;
- Geoenvironmental sampling from boreholes and of Dock Deposits; and
- Geoenvironmental laboratory testing.

Phase 2:

- 6 on-shore dynamic sampling boreholes with rotary follow on 15 to 30m into Sandstone (BH101, BH102, BH108, BH109, BH111 and BH114);
- 15 rotary probe boreholes at 6 locations to determine buried extent of BMD wall (P101A-P101C, P102A, P103A, P103B, P104A, P104B, P105A-P105C, P106A-P106C and P106D);
- 10 machine dug trial pits as part of site strip (SS1.1-SS1.5 and SS2.1-SS2.5), including targeted investigation of ground contamination in north-east;
- 3 areas of shallow surface strip trenches (shown as site strip on Figure 3-1) to look for near surface obstructions;
- Post fieldwork ground gas monitoring in three onshore borehole (BH101, BH109 and BH114) and three open hole locations (OH101 to OH103);
- Installation of 2 standpipe piezometers (BH102A and BH108A) in open hole locations;
- Collection of grab samples of Dock Deposits (PAC01 to PAC08);
- Geoenvironmental sampling from on-shore boreholes, probe locations and of Dock Deposits; and
- Geoenvironmental laboratory testing.

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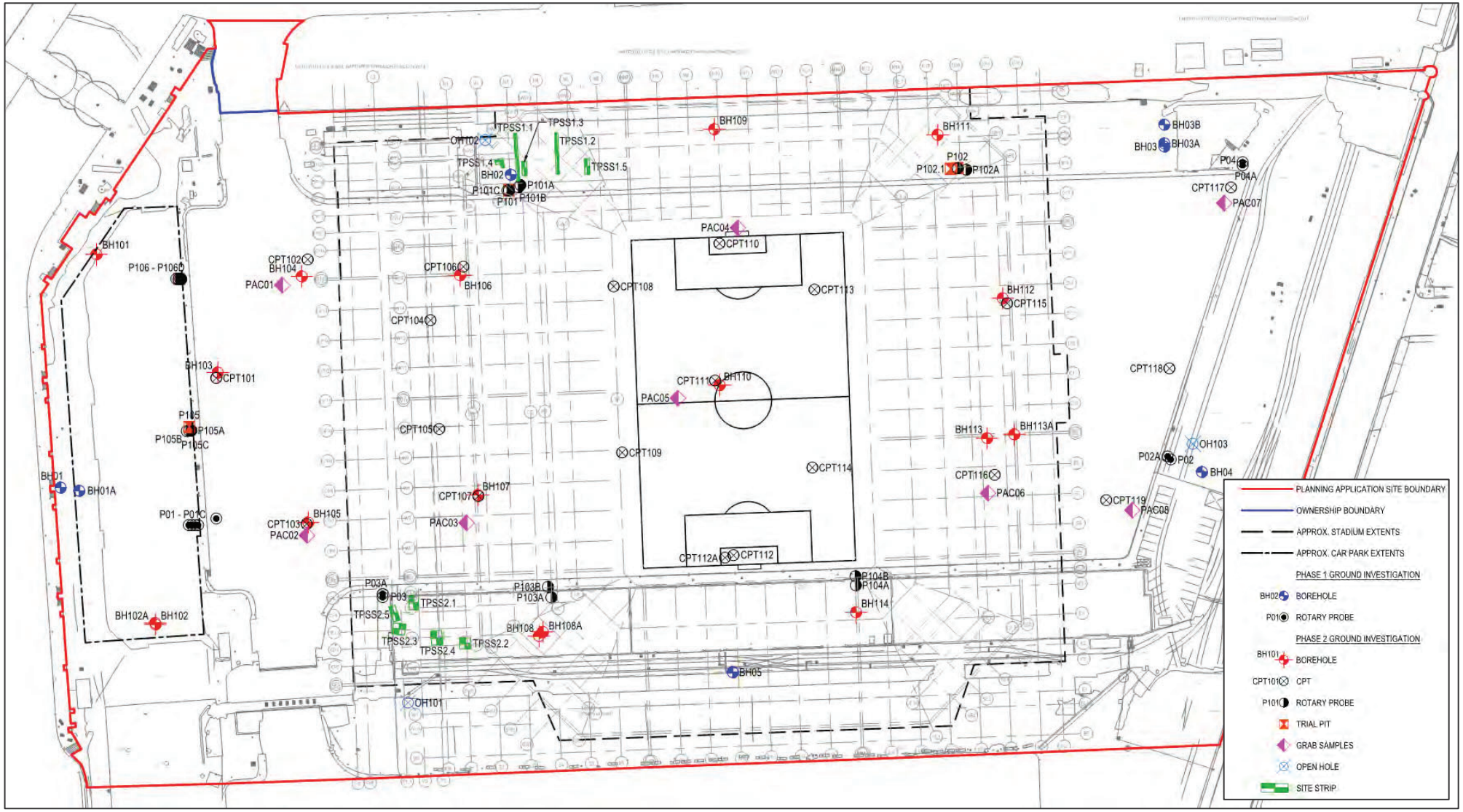

Figure 3-1 – Excerpt of Phase 1 and 2 exploratory hole location plan.

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4. Ground Conditions

4.1 On-Shore stratigraphy

The strata encountered on-shore during both phases of ground investigation are described in Table 4—1, with a more complete account provided in the following subsections. Due to the relative consistency in surface levels across the four wharves, the following subsections are discussed in terms of m bgl.

Table 4—1 - Summary of encountered strata

Stratum	Description
Made Ground	Northern wharf: gravelly clayey SAND to sandy clayey GRAVEL. Eastern wharf: very sandy GRAVEL. Southern wharf: sandy gravelly CLAY to gravelly clayey SAND; slightly sandy slightly clayey SILT to gravelly slightly silty SAND. Western wharf: gravelly clayey SAND to sandy clayey GRAVEL.
Tidal Flat Deposits	Very sandy slightly gravelly SILT. Slightly sandy slightly gravelly SILT.
Glacial Till	Slightly sandy slightly gravelly silty CLAY.
Chester Formation (weathered Sandstone)	Gravelly fine to coarse SAND. Extremely weak Sandstone recovered as non-intact core.
Chester Formation (intact Sandstone)	Medium grained Sandstone. Beds and laminations of fine grained Sandstone and Siltstone.

It was found that the ground conditions varied both across the application site and across each of the wharves e.g. each stratum listed above was not encountered at every location and the depth to weathered / intact sandstone was highly variable. It is believed this is a result of the historical development, where significant excavation was undertaking for the construction of BMD. As such, the ground conditions by wharf are summarised in Table 4—2 overleaf. Note that only one borehole was positioned on the eastern wharf.

4.2 Made Ground

Made Ground was encountered in all of the exploratory holes. The composition was found to be consistent with the construction of BMD and local historical industrial activity. Gravel and cobbles of sandstone are likely to have arisen from excavation of the dock basin, and presence of clinker, coal, slag etc. is likely to be associated with the operation of the railway and associated industrial activities in the area. Made Ground was found to be variable in composition both between and across each of the four wharves, and is discussed by wharf below.

Northern wharf

Four exploratory boreholes encountered highly variable Made Ground across the wharf, ranging from gravelly clayey sands to sandy clayey gravels, with occasional thin bands of slightly sandy slightly gravelly clay. At BH109 between 4.40m and 5.80m bgl, a dark bluish grey slightly sandy slightly gravelly silt was recorded. Further shallow investigation by means of a machine excavated site strip encountered contamination on the north-west of the wharf, comprising a layer of bitumen typically about 30cm thick from 0.15m bgl and bitumen cobbles encountered up to 2.20m bgl. Shallow obstructions were also found in this area, including buried brickwork, reinforced concrete and a steel girder.

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Table 4—2 - On-shore ground conditions by wharf

Wharf	Stratum	Thickness (m) [Average]	Depth to Top (m bgl) [Average]	Level of Top (m AOD) [Average]
Northern	Made Ground	4.6 to 7.2 [5.85]	0.0	6.6 to 6.75 [6.70]
	Tidal Flat Deposits	1.1 to 2.1 [1.6]	4.6 to 5.8 [5.2]	0.8 to 2.1 [1.5]
	Glacial Till	1.95 to 4.9 [3.4]	6.7 to 7.2 [6.95]	-0.45 to 0.0 [-0.25]
	Weathered Sandstone	0.5 to 1.8 [1.2]	9.15 to 11.6 [10.3]	-4.9 to -2.4 [-3.6]
	Intact Sandstone	Not proven	10.7 to 12.9 [11.5]	-6.2 to -4.1 [-4.8]
Eastern	Made Ground	5.5	0.0	6.85
	Tidal Flat Deposits	Not encountered	Not encountered	Not encountered
	Glacial Till	4.6	5.5	1.35
	Weathered Sandstone	2.6	10.1	-3.25
	Intact Sandstone	Not proven	12.7	-5.85
Southern	Made Ground	4.6 to 5.3 [4.9]	0.0	6.75 to 6.8 [6.8]
	Tidal Flat Deposits	1.05 to 1.85 [1.45]	4.6 to 4.8 [4.7]	2.0 to 2.2 [2.1]
	Glacial Till	Not encountered	Not encountered	Not encountered
	Weathered Sandstone	0.15 to 1.15 [0.65]	5.3 to 5.65 [5.5]	1.15 to 1.45 [1.3]
	Intact Sandstone	Not proven	5.8 to 6.6 [6.3]	0.2 to 1.0 [0.5]
Western	Made Ground	8.8 to 9.2 [9.0]	0.0	6.55 to 6.75 [6.65]
	Tidal Flat Deposits	1.2	8.0	-1.25
	Glacial Till	0.6	9.0	-2.3
	Weathered Sandstone	0.5 to 2.15 [1.5]	8.8 to 9.6 [9.2]	-2.9 to -2.25 [-2.55]
	Intact Sandstone	Not proven	9.7 to 11.75 [10.7]	-5.05 to -2.95 [-4.05]

Eastern wharf

One exploratory borehole was undertaken on the eastern wharf. Made Ground (0.2-3.1m bgl) was described as a dark brown very sandy gravel of sandstone, brick, slag, clinker and coal, with high brick and masonry cobble content in places. Brickwork and concrete were encountered at depth (3.1-3.85m bgl), indicating a potential for buried structures, with gravelly sand below. Due to the limited investigation in this area, it is not possible to correlate the encountered strata with the rest of the application site.

Southern wharf

Three exploratory boreholes were undertaken on the southern wharf, with Made Ground found on average to 4.9m bgl. Composition at BH05 and BH108 was fairly consistent, ranging from dark brown sandy gravelly clay to dark

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brown gravelly clayey sand. Made Ground at BH114 was distinctly different, comprising largely dark grey slightly sandy slightly clayey silt and some dark grey gravelly slightly silty sand. There is consequently no correlation of the Made Ground under the footprint of the existing warehouse. Across the wharf, gravel sized components are of mixed lithologies, including sandstone, siltstone, brick and concrete.

Western wharf

Three exploratory boreholes (BH01, BH101, BH102) were undertaken on the western wharf, with Made Ground found on average to 9.0m bgl. The composition at these locations was relatively consistent, predominantly ranging from reddish brown gravelly clayey sand to a sandy clayey gravel. Occasional to frequent cobbles were encountered comprising angular sandstone and brick. Gravel components are of mixed lithologies, including brick, clinker, sandstone, siltstone, concrete and coal. Two 0.7m thick clay bands were also described at BH102.

4.3 Tidal Flat Deposits

Tidal Flat Deposits were encountered in five of the exploratory boreholes in the northern and southern wharves. The deposits typically comprise a relatively thin layer (between 1.1 and 2.1m) of very soft to firm bluish to dark grey very sandy to slightly sandy slightly gravelly silt. The composition and properties of these deposits are broadly comparable with those encountered within the dock basin. Within BH109 and BH102, bands of dark grey medium sand were also recorded.

4.4 Glacial Till

Glacial Till was recorded in five of the exploratory boreholes located on the northern, eastern and western wharves. On three occasions, Glacial Till was recorded directly underlying Made Ground (Tidal Flat Deposits not present) at depths of between 5.5 and 9.0m bgl and over weathered / intact Sandstone of the Chester Formation. In two positions on the northern wharf (BH109 and BH111), Glacial Till was recorded beneath Tidal Flat Deposits. The thickness of the Till was highly variable, ranging from 0.6m at BH01A on the western wharf to 4.9m at BH111 on the northern wharf.

The Glacial Till was described as a stiff brown slightly sandy slightly gravelly silty clay, with gravel of sandstone and siltstone, and less commonly quartzite and shell fragments. In one instance on the western wharf, a 0.6m band of the Till was described as a soft clay. Occasional bands or pockets of yellowish brown to dark brown fine to coarse sand were also recorded.

4.5 Chester Formation

Weathered Sandstone

Weathered Sandstone of the Chester Formation was recorded at all but one of the exploratory borehole locations (BH108, southern wharf). It ranges in composition from a gravelly fine to coarse sand where the gravel is of sandstone lithorelicts, to an extremely weak sandstone recovered as non-intact core (predominantly recovered as fine to coarse gravel sized fragments).

The depth to the top of weathered Sandstone was between 8.8 and 11.6m bgl on the northern, eastern and western wharves whereas on the southern wharf it was between 5.3 and 5.65m bgl). Within three of the exploratory holes where weathered Sandstone was encountered (BH102, BH111 and BH114), a groundwater table was recorded within the zone of weathering. This suggests the presence of groundwater may contribute to the weathered profile.

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Intact Sandstone

Intact bedrock of the Chester Formation was recorded at between 5.8 and 12.7m bgl. As with the weathered Sandstone, there is a disparity in depth to intact Sandstone between the southern wharf and the northern, eastern and western wharves possibly owing to the construction of BMD.

In general, the intact Sandstone is described as a reddish brown medium grained Sandstone. The strength varies from very weak to medium strong, generally increasing with depth but with local bands or inclusions of contrasting strength. Within the rock profile, beds or laminations of light grey to yellowish brown predominantly fine grained Sandstone and more rarely of siltstone were also recorded. Beds were of thin to medium thickness, up to approximately 0.4m. Discontinuities between beds were mostly described as closely to very closely spaced, orientated at 0-20°, and planar rough clean locally infilled with soft reddish brown clay. Fractures were typically recorded between 50 to 80°, and ranging from planar to undulating.

4.6 Off-shore stratigraphy

The stratigraphy encountered within BMD reflected excavation down to bedrock during dock construction. The off-shore ground conditions are summarised in Table 4—3. The stratigraphy is discussed in terms of levels in m AOD due to the variation in ground level.

Table 4—3 - Off-shore ground conditions⁺.

Stratum	Description	Thickness (m) [Average]	Depth to Top (m bgl)* [Average]	Level of Top (m AOD) [Average]
Dock Deposits	Slightly sandy clayey SILT. Sandy gravelly SILT.	0.3 to 3.3 [1.2]	0.0	-4.3 to -1.3 [-3.15]
Chester Formation (weathered Sandstone)	Medium grained sandstone. Recovered as non-intact core (gravel and cobble sized fragments).	0.1 to 0.4 [0.3]	1.2 to 2.3 [1.7]	-4.75 to -4.05 [-4.35]
Chester Formation (intact Sandstone)	Medium grained Sandstone. Beds and laminations of fine grained Sandstone and Siltstone.	Not proven	0.3 to 3.3 [1.2]	-4.85 to -3.9 [-4.4]

⁺Data from CPT101, CPT106 and BH105 have been omitted due to discrepancies with the levels compared to adjacent boreholes; *Ground level is taken as the surface of the Dock Deposits.

4.7 Dock Deposits

Deposits were encountered at all exploratory locations. At each of the borehole positions, undisturbed samples of the deposits were obtained wherever possible, leaving limited material to be logged. However, where logged, the deposits were described as a very soft bluish grey to black slightly sandy clayey silt to a sandy clayey silt. In two of the borehole positions (BH104 and BH103), an underlying layer of sandy gravelly silt to gravelly silt was recorded, where gravel was comprised of Sandstone. Soil Organic Matter (SOM) ranged between 1.3 and 6.3%, with an average of 3.75%.

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CPT data have provided further insight to the components of the Dock Deposits, indicating that they are composed of bands of varying quantities of clays, silts and sands. Combining borehole, CPT and bathymetric survey data, it is broadly inferred that a layer of silt / clay deposits exist over the entire dock basin, over which – predominantly in the north and east of BMD – are sands and gravels. This reflects the dock use, where the northern and eastern wharves have historically been used for stockpiling and tipping of coal, and more recently for stockpiling of sand and gravels dredged from the River Mersey. Over much of the sands and gravels a further layer of silt is present – this would have settled out of the water on top of the sands and gravels over time. This profile is summarised below:

a) a) Silt deposit 0.25m to 0.7m thick; overlying.
b) Sands and Gravels 0.2m to 1.3m thick; overlying
c) Silt / Clay deposit 0.3m to 3.3m thick (bottom of which is assumed to be the bottom of the dock basin).

The thickness of Dock Deposits recorded at borehole and CPT positions ranges from 0.3m to 3.3m (average 1.2m). In general, the deposits are thicker in the north and east of BMD adjacent to the walls. Again, this likely reflects dock use and local currents within the dock system i.e. deposition is more likely around the perimeter where water flow is less significant.

4.8 Chester Formation

Weathered Sandstone

Weathered Sandstone was encountered in five of the eight off-shore boreholes; the CPT data do not allow for distinction between the weathered and intact Sandstone. The Weathered Sandstone comprises extremely weak to medium strong reddish brown to black sandstone, recovered as non-intact core of gravel and cobble sized fragments. In one instance a 0.1m band of dark grey to black gravel of mixed lithologies at BH112 was also inferred to be of the weathered basin. The weathered sandstone was consistently thin, ranging between 0.1m and 0.4m.

Intact Sandstone

Intact Sandstone was recorded between -3.9 and -4.9m AOD. The levels vary irregularly, likely reflecting combined effects of uneven excavation during construction and later weathering of the basin. The properties and composition of the Sandstone are as described for the on-shore locations.

4.9 Visual and olfactory evidence of contamination

Visual and olfactory evidence of contamination was encountered in a number of the exploratory hole locations:

- Clinker, ash, slag and / or coal were present within the Made Ground at selected locations on the northern (BH109 and BH111), eastern (BH04) and western wharves (BH01, BH101 and BH102);
- A strong hydrocarbon odour was noted within Made Ground at BH04 on the eastern wharf (black and grey clayey very sandy angular and subangular fine to coarse sandstone, brick, slag, clinker and coal GRAVEL) between 2.0-2.6m; and
- A moderate hydrocarbon odour was noted within Made Ground at BH109 on the northern wharf (dark bluish grey slightly gravelly silt. Sand is fine. Gravel is subangular fine to medium of sandstone siltstone and clinker) between 5.2-5.8m.

In addition, during investigation in the area of the former tar works located on the northern wharf (immediately west of the workshop, see Figure 4-1), the following evidence of contamination was noted:

- P101 – a strong hydrocarbon odour was noted by a BuroHappold Engineer during drilling;
- TPSS1.1 – very strong odour of 'tar' and coarse gravel to cobble size pieces of bitumen excavated between 0.15 and 2.2m;

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- TPSS1.2 – very strong smell of 'tar' and fine to coarse gravel sized bitumen pieces noted between 0.15m and 0.8m. Water ingress at 2.0m was strongly discoloured with a strong hydrocarbon odour (no free product observed);
- TPSS1.3 – fine to coarse fragments of bitumen, up to large cobble size noted between 0.9m and 2.2m, faint 'tar' odour';
- TPSS1.4 – layer of black bitumen present between 0.15m and 0.3m. Between 1.0m and 2.25m Made Ground included some coarse angular gravel of bitumen;
- TPSS1.5 – coarse gravel sized angular layer of bitumen present between 0.15m and 0.35m, with strong 'tar' odour; and
- OH102 - 0.5cm of LNAPL and hydrocarbon odour noted during first groundwater sampling round. Sulphate odour and oil sheen noted during the second groundwater sampling round.

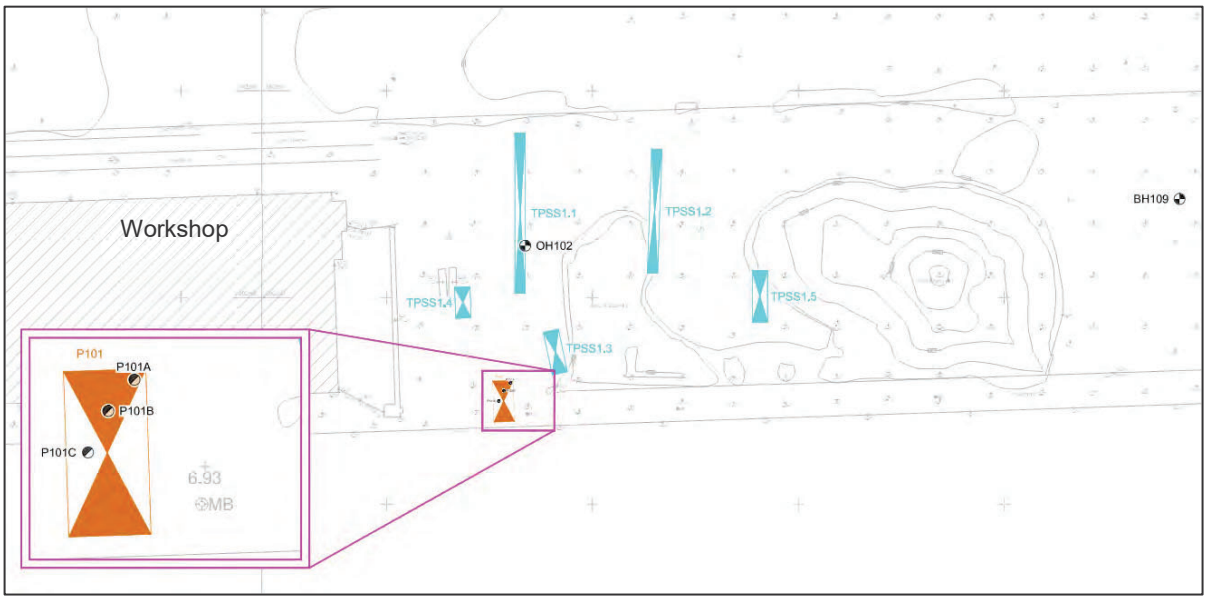

Figure 4-1 - Exploratory locations in vicinity of former tar works.

4.10 Groundwater

4.10.1 Manual groundwater monitoring

Groundwater levels within wells for groundwater and gas monitoring were determined using a hand-held dip-meter. Ground gas monitoring wells were dipped on eight or nine occasions between February and April 2018 and groundwater monitoring wells were dipped on three or four occasions during February and March 2018. A summary of the results is provided in Table 4—4 and shown graphically in Figure 4-2.

A near-surface groundwater body has been recorded within Made Ground on each of the fours wharves, with levels recorded between +5.1 and +3.5m AOD. Groundwater levels were not consistent between each of the wharves, likely indicating that the shallow groundwater is not in hydraulic continuity. Within Made Ground at each location there was a general slight decline in groundwater level between February and April. A limited number of measurements were taken at BH108 and BH108A where Sandstone was screened, therefore comment cannot be made on trends at these locations.

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Table 4—4 - Summary of groundwater levels.

Borehole	Screened strata	Location	Shallowest (m bgl)	Deepest (m bgl)	Shallowest (m AOD)	Deepest (m AOD)
BH101	Made Ground	Western wharf	2.8	3.05	3.8	3.5
BH102	Made Ground	Western wharf	2.8	2.8	3.9	3.9
BH102A	Made Ground	Western wharf	3.15	3.35	3.6	3.4
BH108	Sandstone	Western wharf	7.6	7.4	-0.55	-0.75
BH108A	Sandstone	Southern wharf	6.1	-7.5	0.7	-0.7
BH114	Made Ground	Southern wharf	2.3	3.3	4.5	3.5
OH101	Made Ground	Southern wharf	1.75	2.1	5.1	4.7
OH102	Made Ground	Northern wharf	1.7	2.15	5.0	4.55
OH103	Made Ground	Eastern wharf	2.05	2.3	4.8	4.5

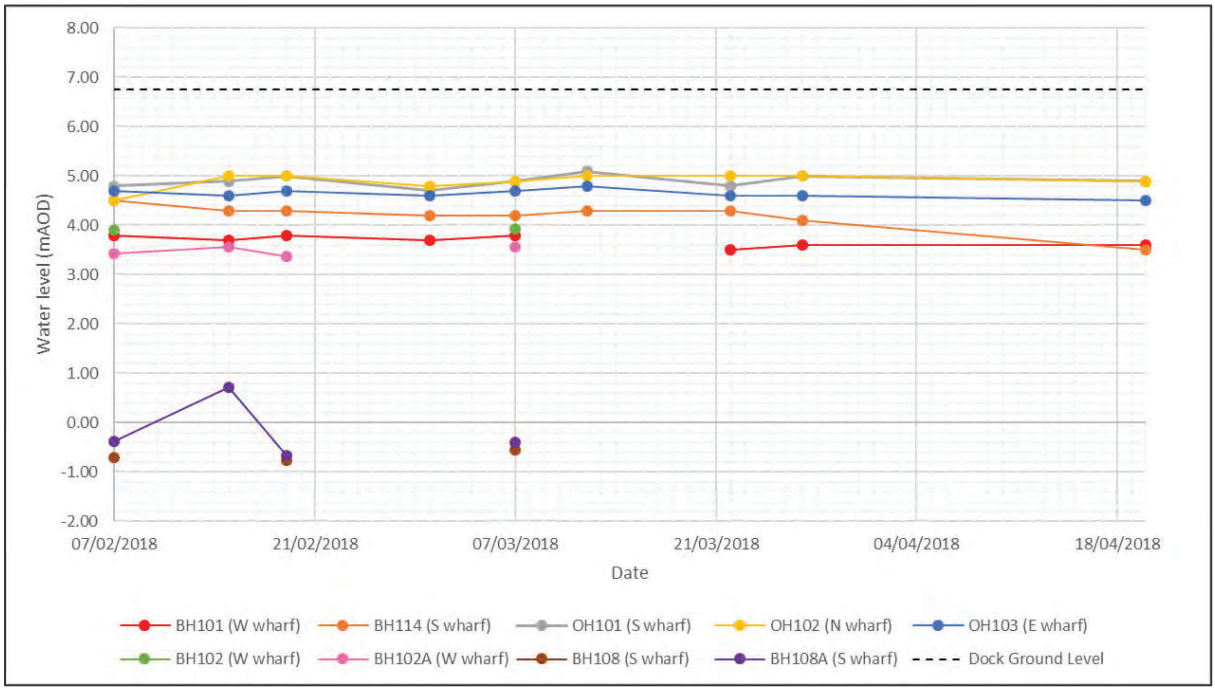

Figure 4-2 - Results of manual groundwater monitoring.

4.10.2 Data loggers

Seven groundwater data loggers were installed within six monitoring wells to monitor groundwater fluctuations over a 6 or 12 month period. Monitoring over this period allows seasonal fluctuation to be understood. The installations are summarised in Table 4—5. Water levels within BMD and of the River Mersey (at a position adjacent to BMD) were also monitored between July and September 2017 in attempt to understand the interactions between groundwater, water contained within BMD, and the River Mersey. Additional data for the River Mersey has also been obtained from the Environment Agency (data collected from Gladstone Dock, ~400m north) up to February 2018. Data collected up to March 2018 is presented in Figure 4-3.

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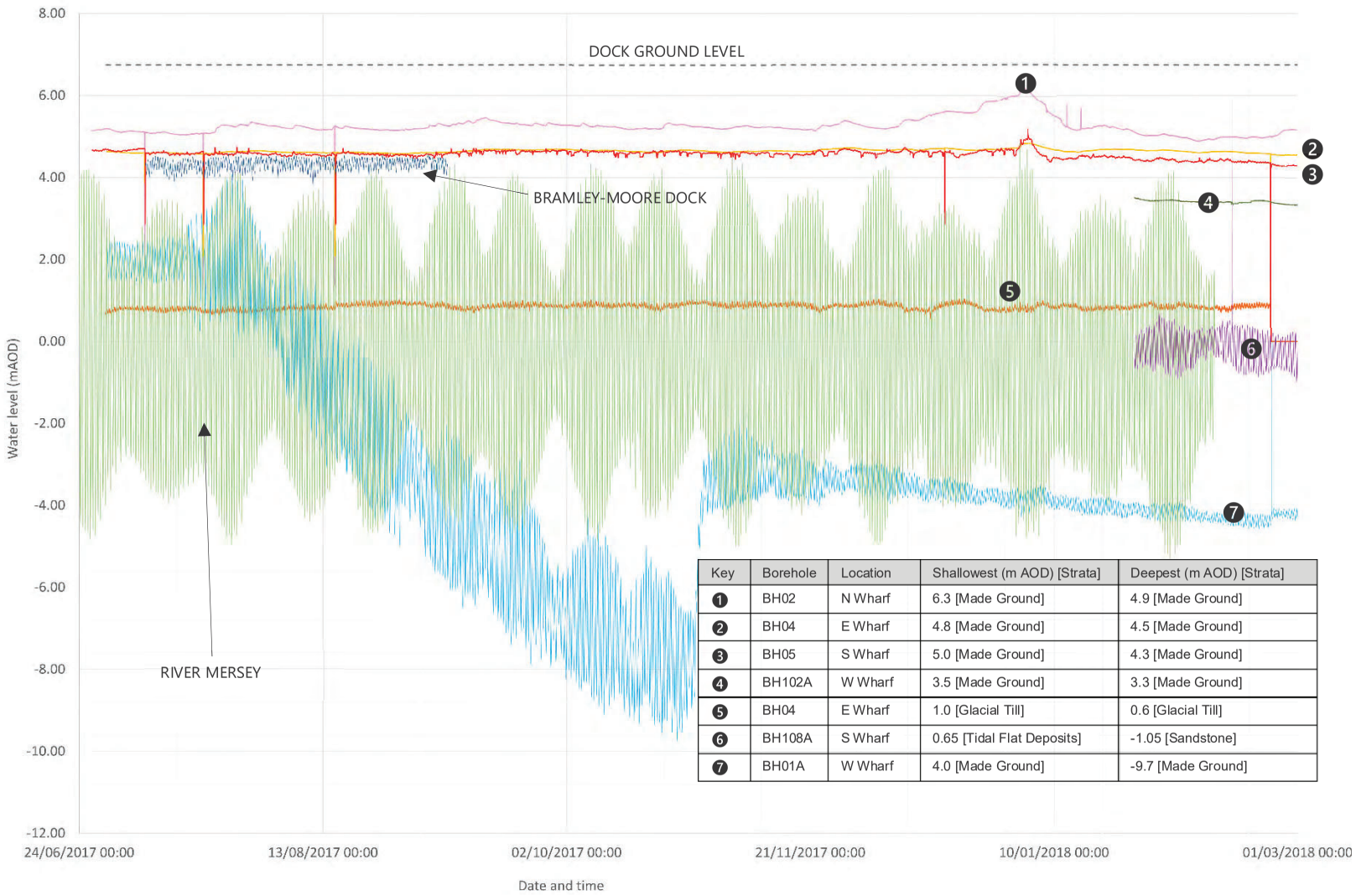

Key	Borehole	Location	Shallowest (m AOD) [Strata]	Deepest (m AOD) [Strata]
1	BH02	N Wharf	6.3 [Made Ground]	4.9 [Made Ground]
2	BH04	E Wharf	4.8 [Made Ground]	4.5 [Made Ground]
3	BH05	S Wharf	5.0 [Made Ground]	4.3 [Made Ground]
4	BH102A	W Wharf	3.5 [Made Ground]	3.3 [Made Ground]
5	BH04	E Wharf	1.0 [Glacial Till]	0.6 [Glacial Till]
6	BH108A	S Wharf	0.65 [Tidal Flat Deposits]	-1.05 [Sandstone]
7	BH01A	W Wharf	4.0 [Made Ground]	-9.7 [Made Ground]

Figure 4-3 – Plot of data logger results between June 2017 and March 2018.

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Table 4—5 - Summary of data logger installations.

Borehole [Location]	Duration [Months]	Installation		Results			
		Targeted Strata	Screen (m AOD)	Shallowest (m AOD)*	Strata	Deepest (m AOD)*	Strata
BH01A [western wharf]	12 months [June 2017 – June 2018]	Made Ground, weathered to intact Sandstone	6.5 to 5.4	4.0	Made Ground	-9.7	Sandstone
BH02 [northern wharf]		Made Ground	5.8 to 0.8	6.3	Made Ground	4.9	Made Ground
BH04 [eastern wharf]		Made Ground to Glacial Till	5.8 to -0.2	4.8	Made Ground	4.5	Made Ground
BH04 [eastern wharf]		Sandstone	-10.2 to -14.8	1.0	Glacial Till	0.6	Glacial Till
BH05 [southern wharf]		Tidal Flat Deposits	2.2 to 1.2	5.0	Made Ground	4.3	Made Ground
BH102A [western wharf]	6 months [January – June 2018]	Made Ground	1.0 to 5.5	3.5	Made Ground	3.3	Made Ground
BH108A [southern wharf]		Sandstone	12.0 to 15.0	0.65	Tidal Flat Deposits	-1.05	Sandstone
River Mersey	2 months [July – August 2017]	N/A	N/A	4.50	N/A	-5.0	N/A
BMD		N/A	N/A	4.60	N/A	3.8	N/A

*Up to 01/03/2018.

Key findings from analysis of groundwater data are summarised below:

- Data obtained from BH01A are considered erroneous, showing evidence of vibrating wire piezometer drift.
- A near-surface groundwater body (perched groundwater) within Made Ground has been recorded on each of the four wharves. This is found above BMD water level (except at BH102A), and as such varies without tidal influence.
- Groundwater level within Made Ground has been found to be relatively consistent, except for a peak in early January 2018 (likely in response to rainfall) followed by a decline back to approximate average levels by mid-January.
- There are differences in levels of groundwater in Made Ground on each of the four wharves, suggesting the water bodies are not in hydraulic continuity and that they relate to levels of impermeable materials on each of the wharves.
- A seepage regime is thought to exist between the near surface groundwater contained within the wharves and the lower water contained within BMD. Water staining of BMD walls provides evidence of this, as shown in Figure 4-4.
- BMD level shows a tidal influence, ranging over about 0.3m during a tidal cycle and with a 3 hour lag between high tide level of the River Mersey and maximum dock level. This indicates that the River Mersey wall and / or dock gates are not completely impermeable.
- Deeper groundwater bodies have been recorded within Glacial Till at BH04 and within Tidal Flat Deposits to Sandstone at BH108A.

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- Groundwater level within Glacial Till at BH04 shows tidal influence over a small range, fluctuating about 0.2m over each tide cycle.
- Greater tidal variation was recorded in Tidal Flat Deposits / Sandstone at BH108A, fluctuating about 1.0m over one tide cycle.

Figure 4-4 - BMD wall with evidence of staining on the right hand side, attributed to seepage of water contained within near surface Made Ground to the lower water contained within the dock.

4.11 Groundwater sampling

Groundwater samples were taken from OH101, OH102, OH103, BH101, BH102A, BH108, BH108A and BH114 on 15th February 2018 and 6th March 2018 and sent for laboratory analysis (see Section 8.1). Groundwater levels in the monitoring well and water quality indicator parameters (pH, temperature, electrical conductivity, redox potential and dissolved oxygen) were monitored during low-flow purging, with parameter stabilisation indicating that purging is complete and sampling can begin. As the flow rate used for purging is (in most cases) the same as or only slightly higher than the flow rate used for sampling, purging and sampling are conducted as one continuous operation in the field. A summary of the visual and olfactory signs of contamination of groundwater observed whilst sampling is presented in Table 4—6 below.

Table 4—6 - Groundwater sampling summary

Sample	Sample notes	
	15th February 2018	**6th March 2018**
OH101	No odour, clear.	-
OH102	Clear, small amount of sediment, hydrocarbon odour. 0.5cm LNAPL recorded.	Sulphate odour, clear with oil sheen on surface.
OH103	No odour, clear, small amount of sediment.	-
BH101	No odour, clear.	-
BH102A	No odour, clear, small amount of sediment.	No odour, translucent yellow tint.
BH108	No odour, translucent – yellowish reddish colour. Unable to stabilise due to low water level.	No odour, translucent yellow tint with sand sediment.
BH108A	No odour, clear.	-
BH114	No odour, clear.	-

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4.12 Free product

0.5cm of free product was noted at OH102 during the sampling round on 15th February 2018 and an oil sheen on 6th March 2018. However, this free product was too thin to be sampled.

4.13 Gas and vapour monitoring

Ground gas monitoring within five monitoring wells (BH101, BH114, OH101, OH102 and OH103) was undertaken over eight or nine monitoring rounds on between February and April 2018. Gas monitoring was carried out and recorded in accordance with guidance and protocols presented in relevant guidance [22] [23]. The monitoring data is presented and evaluated in Section 9.

During each round of monitoring, the gas and vapour concentrations and groundwater level for each borehole were recorded. An infrared gas meter was used to measure concentrations of carbon dioxide (CO_2), methane (CH_4) and oxygen (O_2) in percentage volume while carbon monoxide (CO) and hydrogen sulphide (H_2S) were recorded in parts per million (ppm). Initial and steady state conditions were recorded. An integral flow meter was used to measure gas flow in litres per hour. In addition, the atmospheric pressure before and during the monitoring together with the weather conditions were noted.-

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5. Contamination Risk Assessment Criteria

5.1 Outline approach

A risk-based approach is used for the assessment of contamination. This requires identification of a contaminant source, a receptor and a realistic pathway via which the contaminant may reach the receptor. The key receptors considered in this assessment are controlled waters (River Mersey, Secondary and Principal Aquifer, Port of Liverpool Dock System), people (construction / maintenance workers and future site users) and the built environment (buildings / services).

5.2 Risks to human health

In order to perform a Generic Quantitative Risk Assessment (GQRA), the soil test results have been compared with available Soil Guideline Values (SGVs), Category 4 Screening Values (C4SLs), BuroHappold and other industry Generic Assessment Criteria (GAC) details of which are presented in Appendix B.

Chronic: For human health risk assessment, soil results have been assessed using GACs, C4SLs and SGVs for the Contaminated Land Exposure Assessment (CLEA) residential without plant uptake and commercial land use scenarios [24]. These criteria were used to understand the liability and risk associated with the proposed future use. The residential without plant uptake scenario has been applied to give context to the data whereas the commercial industrial scenario is the most appropriate land use scenario.

Acute: There are no guidance values for assessing acute risk to human health from soil contamination. Because such risks are associated with short term exposure, consideration is required of maximum concentrations (not the average concentration which is relevant to chronic / long term risk). Comparison of maximum concentrations has been made with the various commercial land use GACs and other screening values which provides a conservative benchmark for such short term risks (as the values are based on long term exposure).

5.3 Plant health (phytotoxicity)

The majority of the proposed development will be covered by hard landscaping. There are very limited areas of soft-landscaping which include direct in-ground planting. Soil test results indicating phytotoxicity have therefore been assessed using the BS Specification for Topsoil (BS 3882) [25].

5.4 Risks to below ground structures

Soil samples have been assessed with reference to the UK Water Industry Research (UKWIR) Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites [26] to assess risks to below ground water supply pipework. The potential risks to below ground concrete structures associated with aggressive ground conditions are assessed in report BMD01-BHE-ZA-LXX-RP-CG-0002 [27].

5.5 Ground gas

Ground gas monitoring data has been used to assess the risks associated with the proposed development with reference to CIRIA report C665 [22], National Housing Building Council (NHBC) guidance [28] and BS 8485 [29]. Consideration to both CH_4 and CO_2 concentrations as well as flow rates has been given. The Gas Screening Value (GSV) is defined as the product of gas concentration multiplied by flow rate. The GSV is then considered with other parameters to define a Characteristic Situation (CS) which identifies the need for and scope of necessary gas protection measures.

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5.6 Controlled waters

5.6.1 Groundwater

Groundwater data have been assessed using the Saltwater EQS MAC and AA [30] values due to the nature of the application site adjacent to the tidal River Mersey. Data have also been assessed against Water Supply Regulations (Potable) values [31] and WHO DWS [32]. In most cases the Saltwater EQS are the most conservative screening values.

5.6.2 Soil leachate

Soil leachate data obtained from analysis of the off-shore Dock Deposits have also been screening against the Saltwater EQS MAC and AA values [30], Water Supply Regulations (Potable) values [31] and WHO DWS [32] to assess the risk posed to water within the Port of Liverpool Dock System and the adjacent River Mersey.

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6. Analytical Results for Soil – Onshore

6.1 Chemical analysis

The following chemical analysis for soil samples has been undertaken on the Made Ground and the Natural Ground.

Table 6-1 - Summary of chemical analysis undertaken

Determinands	Strata
CLEA metals suite (arsenic, barium, beryllium, cadmium, total chromium, copper, lead, nickel, selenium, vanadium and zinc)	Natural Ground and Made Ground
Total and free cyanide	
Total mercury	
Phenol	
Speciated PAHs	
Speciated TPH including BTEX	
pH	
Asbestos	Made Ground only
Glycol	
Soil Organic Matter (SOM)	
VOCs and SVOCs (a selection of samples only)	

6.2 Analytical results for soils

A total of 46 soil samples (20 during Phase 1 and 26 during Phase 2) were recovered and subject to chemical analysis during the investigation. This included 5 samples of Natural Ground and 41 samples of Made Ground. The complete analytical results for contaminants in soils are presented in full in Appendix C.

6.3 Chronic risks

6.3.1 Inorganic determinands

Asbestos was detected in one of the 41 samples of Made Ground that were analysed. This was recorded in BH01 (western wharf) at 1.0-1.2m depth and described as loose fibres and loose fibrous debris of Chrysotile. Potential ACMs were not noted on the exploratory hole log. No asbestos quantification was conducted.

Table 6-2 below summarises where exceedances of relevant screening thresholds were recorded. Commercial screening thresholds are the most appropriate screening threshold for the proposed development, however comparison is also made with residential without plant uptake thresholds to provide further context.

Table 6-2 - Summary of exceedances of screening thresholds for inorganic determinands (concentrations in mg/kg).

Contaminant (no. of samples)	Commercial threshold (no. of exceedances)	Residential w/out plant uptake (no. of exceedances)	Maximum concentration (sample location)
Lead (44)	2330 (0)	310 (5)	1700 (BH03, 0.1m, northern wharf)

The large majority of samples recorded concentrations of all determinands below both commercial and residential thresholds. Elevated concentrations of lead were detected, including in the shallow soil, however concentrations did not exceed commercial screening thresholds.

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6.3.2 Organic determinands

Table 6-3 summarises where exceedances of relevant screening thresholds were recorded. Analysis for VOCs and SVOCs was also conducted on a select range of samples based on observations during the ground investigation. This is discussed in more detail below.

Table 6-3 – Summary of exceedances of screening thresholds for organic determinands (concentrations in mg/kg).

Contaminant (no. of samples)	Commercial threshold (no. of exceedances)	Residential w/out plant uptake (no. of exceedances)	Maximum concentration (sample location)
Naphthalene (44)	190 (3)	2.3 (7)	1230 (P102, 0.5m, N wharf)
Benzo[a]anthracene (44)	170 (4)	11 (5)	390 (BH04, 1.0-1.2m, E wharf)
Chrysene (44)	350 (1)	30 (4)	420 (BH04, 1.0-1.2m, E wharf)
Benzo[b]fluoranthene (44)	44 (4)	3.9 (6)	410 (BH04, 1.0-1.2, E wharf)
Benzo[k]fluoranthene (44)	1200 (0)	110 (1)	200 (BH04, 1.0-1.2, E wharf)
Benzo[a]pyrene (44)	35 (4)	3.2 (7)	410 (BH04, 1.0-1.2, E wharf)
Ideno[123-cd]pyrene (44)	500 (0)	45 (4)	190 (BH04, 1.0-1.2, E wharf)
Dibenzo[ah]anthracene (44)	3.5 (4)	0.31 (9)	56 (BH04, 1.0-1.2, E wharf)
Aromatic C10-C12 (44)	16,000 (0)	250 (2)	590 (BH04, 1.0-1.2, E wharf)
Aromatic C12-C16 (44)	36,000 (0)	1800 (1)	1900 (BH04, 1.0-1.2, E wharf)
Aromatic C16-C21 (44)	28,000 (0)	1900 (3)	4700 (BH04, 1.0-1.2, E wharf)
Aromatic C21-C35 (44)	28,000 (0)	1900 (3)	6400 (BH04, 1.0-1.2, E wharf)
Total Aromatic (44)	28,000 (0)	1900 (4)	14,000 (BH04, 1.0-1.2, E wharf)
Total Aliphatic & Aromatic (44)	38,000 (0)	490 (6)	14,470 (BH04, 1.0-1.2, E wharf)

The majority of samples recorded concentrations of all organic determinands below relevant thresholds. All concentrations of glycols were below laboratory limits of detection. Occasional samples recorded concentrations of particular determinands above relevant thresholds:

- **BH01 (0.2-0.5m)** – marginal exceedance of the residential without plant uptake screening threshold for dibenzo[ah]anthracene recorded. No exceedances were recorded in the samples from 1.0-1.2m or 3.1m or BH01A (adjacent).
- **BH03 (0.1m)** – concentrations of four PAHs exceeded commercial screening thresholds (benzo[a]anthracene, benzo[b]fluoranthene, benzo[a]pyrene, dibenzo[ah]anthracene). Residential without plant uptake thresholds were exceeded for three other PAHs (naphthalene, chrysene, ideno[123-cd]pyrene) and TPH (speciated aromatics >C16, total aromatic, and total aliphatic and aromatic). No exceedances were recorded in the sample obtained from 0.5m at the adjacent BH03A.
- **BH04 (1.0-1.2m)** – six PAHs (naphthalene, benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[a]pyrene, dibenzo[ah]anthracene) exceeded commercial screening thresholds. Residential without plant uptake thresholds were exceeded for two other PAHs (benzo[k]fluoranthene, indeno[123-cd]pyrene) and TPH (speciated aromatics >C10, total aromatic, and total aliphatics and aromatics).
- **BH04 (2.0m)** – concentrations of five PAHs (naphthalene, benzo[a]anthracene, benzo[b]fluoranthene, benzo(a)pyrene, dibenzo[ah]anthracene) exceeded commercial screening thresholds. Residential without plant uptake thresholds were exceeded for two other PAHs (chrysene, ideno[123-cd]pyrene and TPH (aromatic C10-12, C16-21, C21-35, total aromatic, and total aliphatic and aromatic). All concentrations were below those recorded at 1.0-1.2m and no exceedances were recorded in the sample obtained from 5.0m or 5.6m.
- **P102 (0.1m)** – concentrations of four PAHs (naphthalene, benzo[b]fluoranthene, benzo[a]pyrene, dibenzo[ah]anthracene) exceeded residential without plant uptake screening thresholds.

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- **P102 (0.5m)** – concentrations of five PAHs (naphthalene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[a]pyrene, dibenzo[ah]anthracene) exceeded commercial screening thesholds. Exceedances of residential without plant uptake thresholds were recorded for two other PAHs (chrysene, indeno[123-cd]pyrene), total aromatics and total aliphatics and aromatics.
- **P102.1 (0.7m)** – exceedances of residential without plant uptake screening thresholds recorded for five PAHs (naphthalene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[a]pyrene, dibenzo[ah]anthracene).
- **P101 (1.0m)** – concentration of total aliphatic and aromatic exceeded the residential without plant uptake screening threshold. No exceedances were recorded in the sample obtained from 1.75m.
- **BH114 (0.5m)** – exceedances of residential without plant uptake thresholds recorded for two PAHs (benzo[a]pyrene and dibenzo[ah]anthracene). No exceedances recorded in sample obtained from 1.5m.
- **SS1.3 (1.5m)** – concentration of total aliphatic and aromatic exceeded residential without plant uptake threshold.
- **SS1.4 (0.0-1.0m)** – concentrations of residential without plant uptake thresholds exceeded for two PAHs (naphthalene and dibenzo[ah]anthracene).

Analysis for VOCs and SVOCs (in addition to speciated TPH and PAHs) was conducted for samples from P102.1 (0.7m), P102 (0.5m), SS1.3 (1.5m), SS1.4 (0.0-1.0m), BH109 (5.00m), P101 (1.0m) and P101 (1.75m). For each of the samples, concentrations of all or the vast majority of VOCs and SVOCs were below the laboratory limits of detection. Where detections of VOCs or SVOCs were recorded, the concentrations were low and are not considered to be significant.

In summary, some potentially significant areas of elevated concentrations of organics have been recorded. This includes:

1) **Former tar works** – elevated concentrations of TPH (total aliphatic and aromatics) and / or PAHs above residential without plant uptake screening thresholds. This corresponds with presence of bitumen, recorded to a maximum depths of 2.2m bgl (bottom of trial pit), and a strong tar odour in the area of TPSS1.3 and TPSS1.4 on the northern wharf.
2) **Remainder of site (on-shore)** – elevated concentrations of TPH bands and / or some PAHs above commercial screening thresholds were recorded at a number of locations across the wharves (including exceedances of commercial screening thresholds at P102 and P102.1; BH03 and BH04). Elevated concentrations commonly corresponded with presence of slag, clinker, coal, hydrocarbon odour etc. but the source is not distinct / well defined.

6.4 Acute risks

6.4.1 Inorganic determinands

The maximum concentrations of all inorganic determinands were not highly elevated, with no concentrations above commercial screening thresholds. Asbestos was only detected in one sample (2.4% of samples taken), described as loose fibres and loose fibrous debris of Chrysotile.

6.4.2 Organic determinands

The maximum concentrations of organic determinands within the samples analysed were highly elevated (above commercial thresholds) at the following locations:

- BH03 (0.1m) – four PAHs (benzo[a]anthracene, benzo[b]flouranthene, benzo[a]pyrene and dibenzo[ah]anthracene);
- BH04 (1.0-1.2m) – six PAHs (naphthalene, benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[a]pyrene, dibenzo[ah]anthracene). Naphthalene recorded at a concentration of 380 mg/kg;

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- BH04 (2.0m) – five PAHs (naphthalene, benzo[a]anthracene, benzo[b]fluoranthene, benzo(a)pyrene, dibenzo[ah]anthracene). Naphthalene recorded at a concentration of 250 mg/kg; and
- P102 (0.5m) – five PAHs (naphthalene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[a]pyrene, dibenzo[ah]anthracene). Naphthalene recorded at a concentration of 1230 mg/kg

Although the recorded concentrations of contaminants in the samples tested in the vicinity of the former tar works (i.e. P101, SS1.3, SS1.4) do not exceed commercial screening thresholds, based on the strong hydrocarbon odour noted during investigated in this area, there is a potential for acute risks associated with these vapours.

6.5 Risks to below ground structures

It is currently unknown where water supply pipes will be routed as part of the proposed development - i.e. on-shore within the existing dock wharves (addressed below) or through placed material used to fill BMD (addressed in Section 7.5).

Many samples of Made Ground present on the dock wharves had concentrations of determinands above the threshold values presented in the UKWIR Guidance [26]. Therefore, polyethylene (PE) and poly-vinyl chloride (PVC) pipes may not be appropriate for potable water supply in the proposed development. Accordingly, barrier pipe materials are likely to be required unless otherwise agreed with the utility company. This assumes the Made Ground remains in-situ as intended and the pipes are within the Made Ground.

6.6 Phytotoxicity

It is expected that planting as part of the proposed development will be limited to trees within tree planters (using imported soil). Nonetheless, samples have been assessed against the BS Specification for Topsoil (BS 3882) [25] for samples with a pH above 7 (average pH recorded was 9.2).

As shown in Table 6-4, occasional samples recorded concentrations above the phytotoxicity thresholds. Concentrations of nickel were below the thresholds for phytotoxicity in all of the samples analysed.

Table 6-4 - Phytotoxic determinands in Made Ground

Contaminant	BS 3882: 2007 threshold (no. of exceedances)	Locations (depth)	Strata
Copper (12)	200 mg/kg (3)	BH114 1.5m; BH04 1.0-1.2m; BH04 5.0m	Made Ground
Nickel (12)	110 mg/kg (0)	N/A	N/A
Zinc (12)	300 mg/kg (2)	BH03 0.1m; BH04 1.0-1.2m	Made Ground

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7. Analytical Results for Soil – Offshore

7.1 Chemical analysis

The following chemical analysis has been undertaken on Dock Deposits obtained from within BMD.

Table 7—1 - Summary of chemical analysis undertaken

Analysis	Determinands
Soil Analysis (Phases 1 and 2)	CLEA metals suite (arsenic, barium, beryllium, boron, cadmium, total chromium, copper, lead, nickel, selenium, vanadium and zinc)
	Total and free cyanide
	Total mercury
	Phenols
	Speciated PAHs
	Speciated TPH including BTEX
	pH
	Asbestos
	Glycols
	Soil Organic Matter
	VOCs and SVOCs (a selection of samples only)
	TBT and DBT (a selection of samples only)
Leachate Analysis (Phase 2 only)	CLEA metals suite (arsenic, barium, beryllium, boron, cadmium, total chromium, copper, lead, nickel, selenium, vanadium and zinc)
	Magnesium
	Speciated PAHs
	TPH total
	TBT

7.2 Analytical results for soils

A total of 15 samples of Dock Deposits contained within BMD (three during Phase 1 and 13 during Phase 2) were recovered and subject to chemical analysis during the investigation. Solid analysis was initially conducted on the Phase 1 and Phase 2 samples to assess risks to human health.

Based on the initial results, this was followed by leachate analysis on the Phase 2 samples for a select range of contaminants to allow assessment of risks to controlled waters. The complete analytical data for contaminants in Dock Deposits are presented in full in Appendix C.

7.3 Chronic risks to human health

7.3.1 Inorganic determinands

The large majority of samples recorded concentrations of inorganic determinands below both commercial and residential thresholds. A single exceedance of the residential threshold was recorded for lead, detailed in Table 7—3.

Asbestos was detected in one of the samples that were analysed. This was recorded at PAC01A, obtained from the surface of the Dock Deposits, and described as loose fibres of chrysotile at 0.002% w/w.

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Table 7—2 - Summary of exceedances for inorganic determinands (concentrations in mg/kg).

Contaminant (no. of samples)	Commercial threshold (no. of exceedances)	Residential w/out plant uptake (no. of exceedances)	Maximum concentration (sample location)
Lead (15)	2330 (0)	310 (1)	500 (PAC08A)

7.3.2 Organic determinands

The large majority of samples recorded concentrations of organic determinands below both commercial and residential thresholds. All concentrations of glycols were below laboratory limits of detection. A single exceedance of the residential threshold was recorded for total aliphatic and aromatic petroleum hydrocarbons, detailed in Table 7—3.

Table 7—3 - Summary of exceedances for organic determinands (concentrations in mg/kg).

Contaminant (no. of samples)	Commercial threshold (no. of exceedances)	Residential w/out plant uptake (no. of exceedances)	Maximum concentration (sample location)
Total Aliphatic and Aromatic (15)	38000 (0)	490 (1)	1090 (Location 6)

7.3.3 TBT and DBT

Analysis for TBT and DBT was undertaken on nine samples. In the absence of specific screening values, the sum of the concentrations of TBT and DBT have been assessed against Cefas Action Levels to provide context to the data in terms of risk to human health and to marine fauna. The large majority of samples recorded concentrations of DBT below the laboratory limits of detection. A detect marginally above the laboratory limit of detection was recorded on one occasion – a concentration of 0.014 mg/kg at PAC02A. Concentrations of TBT above laboratory limits of detection were recorded for 67% of the dataset. The Cefas Action Level 1 threshold was exceeded on one occasion (11% of dataset) – concentrations below this value are generally considered suitable for disposal at sea.

Table 7—4 - Summary of TBT and DBT data with respect to Cefas Action Levels (concentrations in mg/kg).

Contaminant (no. of samples)	cAL 1* (no. of exceedances)	cAL 2** (no. of exceedances)	Maximum concentration (sample location)
Tributyltin [TBT+DBT] (9)	0.1 (1)	1.0 (0)	0.23 (PAC05A)

*cAL 1 = Cefas Action Level 1 (generally suitable for disposal at sea).
**cAL 2 = Cefas Action Level 2 (considered unsuitable for uncontrolled disposal at sea without special handling or procedure).

The Dock Deposits will remain in-situ and a geotechnical membrane (to prevent mixing with the overlying fill material) installed on top prior to the infilling. As such, a pathway for human receptors to come into contact with the Dock Deposits only exists during installation of the membrane. This will be undertaken by suspending the geotechnical membrane over the dock surface, and lowering it to the dock basin using sand bags. Assuming this methodology, assessment of chronic risk to human health is not of relevance.

7.4 Acute risks to human health

7.4.1 Inorganic determinands

All concentrations of inorganic determinands were below the commercial screening thresholds and are therefore unlikely to pose an acute risk to human health.

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Asbestos was detected in one of the samples that were analysed. This was recorded in PAC01A, obtained from the surface of the Dock Deposits, at 0.002% w/w.

7.4.2 Organic determinands

All concentrations of organic determinands were below the commercial screening thresholds.

7.5 Risks to below ground structures

Water supply pipes will be routed on-shore within the existing dock wharves (addressed in Section 6.5) and through the infilled dock (addressed below).

BMD will be infilled using material chosen such that concentrations of determinands do not exceed the threshold values presented in the UKWIR Guidance [26]; therefore, polyethylene (PE) and poly-vinyl chloride (PVC) may be suitable for potable water supply in this area. If the chosen fill material has concentrations above the UKWIR Guidance values, the choice of materials will have to be revised.

7.6 Risks to controlled waters

7.6.1 Inorganic determinands

All leachate concentrations of mercury, beryllium, cadmium, selenium and tributyltin were below the laboratory limits of detection. However, it should be noted that the EQS AA and MAC values for cadmium are below the laboratory limits of detection (although the WHO DWS and Water Supply Regulation values are higher). Leachate concentrations of chromium, copper and nickel were above laboratory limits of detection but below relevant screening thresholds. Exceedances of the chosen screening thresholds were recorded for arsenic, boron, lead and zinc, summarised in Table 7—5 below.

Table 7—5 – Summary of samples exceeding screening thresholds for inorganic determinands, concentration in µg/l.

Contaminant (no. of samples)	EQS Salt AA (no. of exceedances)	EQS Salt MAC (no. of exceedances)	UK DWS (no. of exceedances)	WHO DWS (no. of exceedances)	Average concentration	Max. concentration (location)
Arsenic (12)	25 (8)	N/A	10 (10)	10 (10)	32	64 (PAC02A)
Boron (12)	N/A	N/A	1000 (2)	2400 (0)	756	1080 (PAC02A)
Zinc (12)	6.8 (9)	N/A	N/A	N/A	10	16 (PAC01A)
Lead (12)	1.3 (1)	14 (0)	10 (0)	10 (0)	1.25	2 (PAC04B)

Leachate concentrations of arsenic and zinc exceeded the EQS Salt AA thresholds in most of the samples analysed and were distributed throughout BMD. No maximum allowable concentration screening thresholds are available for these determinands. It is therefore considered likely that these metals will be present in sediments throughout the Port of Liverpool Dock System.

Exceedances of relevant screening thresholds for boron and lead were less frequent, with the average concentrations of both contaminants being below all relevant screening thresholds. In addition, the maximum allowable concentration for lead was not exceeded. Concentrations of boron can likely be attributed to presence within brackish water.

For magnesium, barium and vanadium, leachate concentrations above laboratory limits of detection were recorded in the vast majority of samples; however, there are no applicable screening values. Concentrations of magnesium can likely be attributed to presence within brackish water. No source of barium or vanadium has been identified – it is therefore considered likely that these contaminants will be present in sediments throughout the Port of Liverpool Dock System.

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7.6.2 Organic determinands

A number of samples recorded leachate concentrations of organic contaminants above the screening thresholds as outlined in Table 7—6. Concentrations of acenaphthylene were below laboratory limits of detection in all samples (although there are no relevant screening thresholds for this determinand). In all samples analysed, leachate concentrations of naphthalene were above laboratory limits of detection, but below relevant screening thresholds. For fluoranthene, benzo[b]flouranthene, benzo[k]flouranthene, benzo[a]pyrene and benzo[g,h,i]perylene, the laboratory limits of detection are above some of the screening values.

Table 7—6 - Summary of samples exceeding screening thresholds for organic determinands, concentrations in µg/l.

Contaminant (no. of samples)	EQS Salt AA (no. of exceedances)	EQS Salt MAC (no. of exceedances)	UK DWS (no. of exceedances)	WHO DWS (no. of exceedances)	Max. concentration (location)
Fluoranthene (12)	0.0063 (4)	0.12 (1)	N/A	N/A	0.18 (PAC07A)
Anthracene (12)	0.1 (1)	0.1 (1)	N/A	N/A	0.16 (PAC07A)
Benzo[b]flouranthene (12)	N/A	0.017 (1)	N/A	N/A	0.1 (PAC07A)
Benzo[k]flouranthene (12)	N/A	0.017 (1)	N/A	N/A	0.09 (PAC07A)
Benzo[a]pyrene (12)	0.007 (1)	0.027 (1)	0.01 (1)	0.7 (0)	0.12 (PAC07A)
Benzo[g,h,i]perylene (12)	N/A	0.0082 (1)	N/A	N/A	0.07 (PAC07A)
TPH total (12)	N/A	N/A	10 (12)	N/A	418 (PAC04B)

Detections of fluoranthene were recorded in four samples. All detected concentrations exceeded the EQS annual average screening threshold (as the laboratory limit of detection exceeds this value). The EQS maximum allowable concentration was exceeded in once instance – PAC07A located in the north-east corner of BMD.

All other exceedances of screening thresholds for PAHs were recorded at PAC07A, suggesting that presence of PAHs within the Dock Deposits may be relatively localised.

The leachable concentrations of TPH total exceeded the UK DWS screening thresholds for Total Aliphatics & Aromatics >C5-35 in all samples, with an average concentration of 288 µg/l. Qualitative analysis of the ratio of Aromatic >C21-C35 to Aliphatic >C21-C35 bands from TPH CWG solid analysis indicates that humic and fulvic acids are likely to be contributing to the TPH total leachate concentrations in the majority of samples.

Detections were recorded for phenanthrene, fluorine, chrysene, pyrene, benzo[a]anthracene, didenzo[a,h]anthracene, ideno[1,2,3-cd]pyrene and acenaphthylene in some samples. There are no screening values for these determinands; however, concentrations were only marginally above laboratory limits of detection.

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8. Analytical Results for Groundwater

8.1 Chemical analysis

Chemical analysis for groundwater samples has been undertaken as detailed in Table 8—1.

Table 8—1 - Groundwater Chemical Analysis Suite

Chemical Analysis
pH
Hardness
CLEA metals suite (arsenic, barium, beryllium, cadmium, total chromium, copper, lead, nickel, selenium, vanadium and zinc)
Total cyanide
Speciated PAHs
Speciated TPH, including BTEX
Chloride
Sulphide
Ammoniacal nitrogen
VOCs and SVOCs (a selection of samples only)

8.2 Analytical results for waters

A total of 14 groundwater samples have been taken during two rounds of sampling in seven monitoring wells – OH101, OH102, OH103, BH101, BH102A, BH108A and BH114. Groundwater data have been assessed using the Saltwater EQS due to the nature of the application site adjacent to the tidal River Mersey. Data have also been assessed against UK DWS values and WHO DWS. The analytical test results for contaminants in groundwater are presented in full in Appendix C.

8.2.1 Inorganic determinands

All concentrations of beryllium and cadmium were below laboratory limits of detection. There are no relevant screening thresholds for barium or beryllium. Concentrations above laboratory limits of detection but below relevant screening thresholds were recorded for chromium, lead, nickel and selenium. A number of samples contained concentrations of inorganic contaminants above the screening thresholds as outlined in Table 8—2**.**

Table 8—2 - Summary of samples exceeding screening thresholds for inorganic determinands (concentrations in µg/l).

Contaminant (no. of samples)	EQS Salt AA (no. of exceedances)	EQS Salt MAC (no. of exceedances)	UK DWS (no. of exceedances)	WHO DWS (no. of exceedances)	Average concentration	Max. concentration (location)
Cyanide (14)	1 (5)	5 (5)	50 (2)	70 (2)	35	181 (OH101)
Mercury (14)	-	0.07 (3)	1 (0)	6 (0)	-	0.2 (BH101, BH102A)
Arsenic (14)	25 (2)	-	10 (2)	10 (2)	7	30 (BH114)
Boron (14)	-	-	1000 (8)	2400 (1)	1317	2860 (BH101)
Copper (14)	3.76 (2)	-	2000 (0)	2000 (0)	2.1	7 (OH101)
Zinc (14)	6.8 (8)	-	-	-	150	1135 (BH108A)

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Marginal exceedances of relevant screening thresholds were recorded as follows:

- Concentrations of arsenic marginally exceeding the EQS Salt AA, UK DWS and WHO DWS values were recorded at BH101 and BH114 during one sampling round. No EQS Salt MAC values are available.
- Copper was reported at concentrations marginally in excess of the EQS AA Salt value on two occasions (14% of samples tested) at OH101. No EQS MAC Salt value is available. The UK DWS and WHO DWS values are significantly higher and were not exceeded.
- Boron was reported at concentrations in excess of the UK DWS values in eight samples (57% of samples tested). The slightly higher WHO DWS value was marginally exceeded in one sample.
- Mercury was reported at concentrations marginally exceeding the EQS MAC Salt values in three samples (21% of samples tested); however, no exceedances of the UK DWS or WHO DWS values were recorded.
- Concentrations of cyanide in excess of the EQS AA Salt value were recorded on five occasions; however, the laboratory limit of detection is above this value and as such there may be further exceedances (30% of samples tested). The UK DWS and WHO DWS values were exceeded at OH101 only during both sampling rounds.
- Concentrations of zinc in excess of the EQS AA Salt values were recorded in eight samples (57% of samples tested). Exceedances were marginal, except for at BH102A and BH114 during both sampling rounds.

8.2.2 Organic determinands

Concentrations of acenaphthylene, dibenzo(a,h)perylene, BTEX compounds, and some light-end hydrocarbons (aliphatics >C6-C8, aromatics >EC5-EC7 and aromatics >EC7-EC8) were below laboratory limits of detection. For fluoranthene, benzo(a)pyrene, benzo(g,h,i)perylene and aromatics >EC10-EC12, the laboratory limits of detection are above some of the chosen screening values. A small number of samples contained concentrations of organic contaminants above the screening thresholds as outlined in Table 8—3.

Table 8—3 - Summary of samples exceeding screening thresholds for inorganic determinands (concentrations in µg/l).

Contaminant (no. of samples)	EQS Salt AA (no. of exceedances)	EQS Salt MAC (no. of exceedances)	UK DWS (no. of exceedances)	WHO DWS (no. of exceedances)	Max. concentration (location)
Naphthalene	2 (1)	130 (0)	-	-	1.43 (OH102)
Fluoranthene	0.0063 (7)	0.12 (2)	-	-	0.81 (OH102)
Anthracene	0.1 (2)	0.1 (2)	-	-	0.39 (OH102)
Benzo(b)fluoranthene	-	0.017 (4)	-	-	0.03 (OH102)
Benzo(k)fluoranthene	-	0.017 (1)	-	-	0.02 (OH103)
Benzo(a)pyrene	0.007 (4)	0.027 (0)	0.01 (4)	0.7 (0)	0.02 (OH102, OH103)
Benzo(g,h,i)perylene	-	0.0082 (2)	-	-	0.01 (OH102, OH103)
Aromatics >EC10-EC12	0.4 (2)	1.4 (2)	-	-	106 (OH102)
Total Aliphatics & Aromatics >C5-35	-	-	10 (4)	-	25543 (OH102)

Concentrations of organic determinands in excess of the chosen screening thresholds were predominantly recorded at OH102 and OH103. At OH102:

- Concentrations of five PAHs during the first sampling round and three PAHs during the second sampling round exceeded the EQS MAC Salt values.
- Concentrations of naphthalene during each round exceeded the EQS AA Salt value but not the MAC value.
- EQS AA and MAC Salt values for Aromatics >EC10-EC12 and UK DWS values for Total Aliphatics and Aromatics were exceeded during both sampling rounds.
- Detections of all other PAHs (except acenapthylene and dibenzo(a,h)anthracene) and TPH aromatic and aliphatic fractions >C8 were recorded; however, there are no screening values for these determinands.

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- OH102 is located in the vicinity of the former tar works. During the first sampling round 0.5cm of LNAPL was noted and during the second sampling round only an oil sheen.
- The analytical results for groundwater correspond with that for soils in the area, where presence of bitumen and a 'tar' odour were noted within the shallow Made Ground down to the groundwater interface.

At OH103:

- During the first sampling round, concentrations of five PAHs exceeded relevant screening thresholds. There were two exceedances of screening thresholds for PAHs during the second round. Detections of most other PAHs were recorded (except naphthalene, acenapthylene, fluorine, dibenzo(a,h)anthracene and benzo(g,h,i)perylene); however, there are no screening values for the majority of these determinands.
- All concentrations of speciated TPH were below laboratory limits of detection.
- Detections of PAHs in groundwater may be attributed to presence of PAHs in Made Ground in the vicinity. This is based on the analytical results for soils at nearby BH04 which found concentrations of some PAHs in excess of commercial screening thresholds.

In addition, the EQS AA Salt value for fluoranthene was marginally exceeded on one occasion at BH102A and on both occasions at BH108A. However, the concentrations detected were below the EQS MAC Salt. Concentrations of Total Aliphatics and Aromatics marginally exceeded the UK DWS values on one occasion at BH101 and BH102A.

In summary, the two main locations where hydrocarbon-impacted groundwater has been recorded are OH102 and OH103.

8.3 Product samples

0.5cm of LNAPL was noted at OH102 during the first groundwater sampling round; however, this was not sampled because the layer was too thin. During the second groundwater sampling round only an oil sheen was noted at this location. No other evidence of free product was noted.

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9. Ground Gas Assessment

9.1 Programme

Ground gas monitoring was undertaken at five locations (BH101, BH114, OH101, OH102, OH103) across the four wharves on eight or nine separate occasions between February and April 2018. Visits were undertaken during both high and low atmospheric pressure episodes. The complete results are provided in Appendix C. No ground gas monitoring of the Dock Deposits has been undertaken.

9.2 Ground gas field monitoring results

A summary of the ground gas field monitoring results are provided in Table 9—1 below.

Table 9—1 -Ground gas field monitoring results

Borehole	Response Zone Flooded?	Max. Flow rate (l/hr)	Peak CH_4 (% v/v)	Peak CO_2 (% v/v)	Min. O_2 (% v/v)	Peak CO (ppm)	Peak H_2S (ppm)
BH101	Partially	0.2	0	0.4	18.2	0	0
BH114	Partially	0.4	0	4.8	9.7	0	0
OH101	Partially	0.3	0	1.3	17.7	0	0
OH102	Partially	0.1	0	3.7	3.1	1	0
OH103	Partially	0.4	0	1.5	20.1	0	0
Worst Case Example+	Partially	0.4	0	4.8	3.1	1	0

Concentrations of carbon dioxide above the detection limit were detected in each of the five monitoring wells. These were slightly elevated, up to 4.8% v/v at BH114. Methane and hydrogen sulphide were not recorded above detection limits in any of the locations over the entire monitoring period. Consistently low flow rates were recorded; up to 0.4 l/hr. Carbon monoxide was detected on one occasion, at a concentration of 1ppm at OH102.

Elevated carbon dioxide (3.7% v/v), minimum oxygen concentrations (3.1% v/v), and the only detect of carbon monoxide (1ppm) were recorded at OH102. The response zone of this well was within Made Ground (0.5-4.5m bgl) and located in the area of the former tar works where, in the vicinity, presence of bitumen (~0.15-2.2m bgl) and a hydrocarbon odour were noted during ground investigation works. A thin layer of LNAPL / an oil sheen were also noted at OH102 during the two groundwater monitoring rounds.

Maximum concentrations of carbon dioxide of 4.8% v/v and minimum concentrations of oxygen of 9.7% v/v were recorded at BH114. The response zone for this well was within Made Ground from 0.5 to 4.5m bgl. It is possible that these slightly elevated carbon dioxide and depleted oxygen concentrations are the result of microbial activity relating to hydrocarbon contamination.

Ground gas monitoring was conducted during times of both high and low atmospheric pressure, ranging from 993mb to 1025mb. Monitoring wells were partially flooded over the duration of monitoring. It is therefore likely that conditions approaching worst case have been realised.

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9.3 Assessment of the ground gas regime

The main potential sources of ground gas are considered to be Made Ground distributed across the application site and localised hydrocarbon contamination. The gas data have been assessed with reference to CIRIA report C665 [22] and British Standards BS8485 [29]. Consideration has therefore been given to both methane and carbon dioxide concentrations as well as flow rates. The Gas Screening Value (GSV) is defined as the product of gas concentration multiplied by flow rate. The GSV is then considered with other parameters / limiting conditions to define a Characteristic Situation. The Characteristic Situation in turn identifies the need for and scope of any necessary gas protection measures.

The highest concentration of carbon dioxide (4.8% v/v) and the highest flow rate (0.4 l/hr) recorded produce a GSV for carbon dioxide of 0.0192, indicating that the ground gas regime falls within Characteristic Situation 1 (CS1). No concentrations of methane were detected and as such the GSV is 0, also CS1. The maximum recorded concentration of carbon dioxide is marginally below the typical maximum for CS1 (5% v/v), i.e. the point above which consideration should be given to increasing classification to Characteristic 2, and as such a CS1 designation is considered suitable.

There is potential for ground gas to evolve from Dock Deposits when the fill is placed and the Dock Deposits are compressed. The Dock Deposits recorded an average soil organic matter of 3.75%. Detects of heavier end TPH recorded, concentrations below residential without plant uptake thresholds in the vast majority of samples. Qualitative analysis of the ratio of Aromatic >C21-C35 to Aliphatic >C21-C35 bands from TPH CWG solid analysis indicates that humic and fulvic acids are likely to contribute to the TPH total leachate concentrations in the majority of samples. There is therefore potential for gas to evolve from these deposits but given their extent the quantity of ground gas that could evolve would be limited.

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10. Geoenvironmental Risk Assessment

10.1 General approach

In the UK, the assessment of risk from contamination follows the source-pathway-target approach. If one of these three elements is absent it is considered that there is no risk of harm. If, however, there is considered to be a linkage between any given source and any given target / receptor then a risk-based approach is used to assess the significance or impact of any such linkage.

Source	The contaminants that have the potential to negatively affect human health and/or the health of the environment (i.e. the hazard).
Pathway	The potential route by which a receptor may come into contact with the source.
Receptor	The specific group of human beings or aspect of the environment (e.g. controlled waters) that could be affected by the source.

Risks are defined as the probability of an event occurring combined with the severity of the consequence of that event occurring. Particularly, to assess the risk to end users posed by any given source, the sensitivity of each receptor is considered. For example, the concentration of contamination acceptable at a site to be developed as a residential property, with a garden used to grow vegetables and accessible to young children, is set lower than that for a commercial site where soil is exposed in minor areas of landscaping and the only long-term users of the site are adults. Similarly, a site overlying a major aquifer supplying potable water to a large population will be considered more stringently than a site overlying an impermeable geology with only minor seepages of groundwater.

10.2 Conceptual Site Model (CSM)

The potential risks posed to the River Mersey, groundwater, human health and the environment by ground contamination have been evaluated by a generic quantitative risk assessment which incorporates the 'source-pathway-receptor' identification and assessment methodology in accordance with the Model Procedures. The risk assessment process therefore involves the identification of each source based on the site setting information and ground investigation results and the identification of the relevant exposure pathway and each potential receptor. The potential risks to the receptors are then assessed by considering the potential effect of the source on the receptor as well as the likelihood of a pathway linking the two, i.e. a contaminant linkage, as discussed above.

10.3 Contamination sources

Potential contamination sources from former uses of the application site have been identified following a review of site setting and desk study information and from information gained during the ground investigation. The potential sources of contamination and associated contaminants of concern are listed in Table 10—1 overleaf.

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Table 10—1 - Principal potential sources of contamination

Potential Source	Location	Likely Age	Potential contaminants of concern
Made Ground – reworked natural material, brick, concrete, coal, clinker, wood fragments, slag etc. Also localised presence of hydrocarbon contamination.	On Site (site-wide)	Up to ~170 years	Ground gas (carbon dioxide, methane). Asbestos, heavy metals, PAHs, TPH, VOCs, SVOCs.
Former tar works	On Site (northern wharf)	Unknown	Ground gas (carbon dioxide, methane). PAHs, TPH, VOCs, SVOCs.
Dock Deposits	On Site (Off-shore)	Up to ~170 years	Ground gas (carbon dioxide, methane). Heavy metals, PAHs, TPH, TBT, DBT.

10.4 Pollution linkages

Site specific pathway receptor linkages have been identified with respect to the sources outlined above and the anticipated future use, summarised in Table 10—2 below.

The proposed development includes infilling of BMD. The Dock Deposits will remain in-situ and a geotechnical membrane (to prevent mixing with the overlying fill material) installed on top prior to the infilling. As such, a pathway for human receptors to come into contact with the Dock Deposits only exists during installation of the membrane. This will be undertaken by suspending the geotechnical membrane over the dock surface, and lowering it to the dock basin using sand bags. By adopting this process, there is no pathway by which human receptors could be exposed to the Dock Deposits. Therefore, assessment of risks to human health has not been undertaken.

Table 10—2 Potential receptors and pathways

Receptor		Pathway
Human Health	Construction / maintenance workers	Direct contact, ingestion, inhalation
	Future site users	Direct contact, ingestion, inhalation. Migration of hazardous gas / vapour via granular strata, accumulation in enclosed spaces, explosion, asphyxiation.
Controlled Waters	Principal Aquifer (Chester Formation)	Leaching and migration through granular strata.
	River Mersey	Surface water run-off / leaching and migration through granular strata.
	Port of Liverpool Dock System	
Ecology	Flora and fauna	Root uptake
Built Environment	Water supply pipes / building fabric	Direct contact
	Stadium / buildings	Migration of hazardous gas / vapour via granular strata, accumulation in enclosed spaces, explosion, asphyxiation.

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Table 10—3 Results of Geoenvironmental Risk Assessment

Pollutant Linkage			**Risk Assessment (following CIRIA C552)**			**Description of source.**
Source	**Contaminants of concern**	Receptor **/ Pathway**	**Consequence**	**Probability**	**Risk**	Comment on hazard realisation.
Made Ground – reworked natural material, brick, concrete, coal, clinker, wood fragments, slag etc. Also localised presence of hydrocarbon contamination.	Asbestos, heavy metals, PAHs, TPH, VOCs, SVOCs.	**Made Ground present on BMD wharves. Made Ground comprised various quantities of reworked natural material, brick, concrete, coal, ash, clinker, wood fragments, slag etc., likely arising due to various phases of redevelopment. BMD previously used for export and storage of coal, with railway historically present. Minor boat maintenance and storage of fuels also likely, with potential for contamination due to spillages. Groundsure report suggests tanks historically present on site, though no evidence encountered during ground investigation.** **All concentrations of inorganics in Made Ground below commercial screening thresholds and majority below residential without plant uptake thresholds. Asbestos occasionally detected. Localised elevated concentrations of organics recorded. PAHs in excess of commercial screening thresholds and / or speciated TPH in excess of residential without plant uptake thresholds at: BH03 (0.1m), BH04 (1.0-1.2 and 2.0m bgl), P102 (0.1 and 0.5m bgl) and P102.1 (0.7m). Ground investigation logs note a strong hydrocarbon odour at 2.0-2.6m at BH04 and moderate hydrocarbon odour at 5.2-5.8m at BH109, free phase not identified.**				
		Construction / maintenance workers Direct contact, ingestion, inhalation	Severe (asbestos) Mild (other determinands)	Unlikely (asbestos) Low likelihood (other determinands)	Moderate / low (asbestos) Low (other determinands)	Ground engineering aspects of construction will involve partial excavation and uncovering of Made Ground – largely limited to areas within stadium footprint. Localised removal of near-surface Made Ground likely within stadium footprint as part of enabling works. Exposure time will be relatively limited. Good construction practice and standard health and safety precautions to be implemented.
		Future site users Direct contact, ingestion, inhalation. Migration of hazardous gas / vapour via granular strata, accumulation in enclosed spaces, explosion, asphyxiation.	Medium	Likely	Moderate	The majority of the proposed development will be covered by hard landscaping. There are very limited areas of soft-landscaping which include direct in-ground planting. Limited potential for direct contact with contaminants in soils. Potential for elevated concentrations of naphthalene to impact future site users. Concentrations of naphthalene in excess of commercial screening criteria recorded, posing potential vapour risk. Concentrations of other VOCs / SVOCs low or below limits of detection. Potential for accumulation of vapours within enclosed spaces. Localised removal of near-surface Made Ground on wharf areas likely within stadium footprint as part of enabling works.
		Principal Aquifer (Chester Formation) **River Mersey** **Port of Liverpool Dock System** Surface water run-off / leaching and migration through granular strata.	Mild	Low	Low	Except for OH102 (addressed below), groundwater data do not indicate significant impact by contamination. Free phase contamination not encountered. Most mobile contamination likely to have migrated historically. Seepage regime exists between groundwater in Made Ground and dock water below. BMD and River Mersey walls relatively impermeable. No active groundwater, surface water, or potable water abstraction licenses within 2km. Localised removal of near-surface Made Ground on wharf areas likely within stadium footprint as part of enabling works. Limited potential for mobilisation of unforeseen contamination during piling works. BMD to be infilled, increasing distance to surface waters. Good construction practices to be implemented. Hardstanding finishes across majority of proposed development will prevent infiltration and mobilisation.
		Flora and fauna Root uptake	Minor	Likely	Low	The majority of the proposed development will be covered by hard landscaping. There are very limited areas of soft-landscaping which include direct in-ground planting. Exceedances of phytotoxicity thresholds recorded in five instances, one within near-surface (BH03 at 0.10m). Localised removal of near-surface Made Ground likely within stadium footprint as part of enabling works.
		Water supply pipes Direct contact	Medium	Likely	Moderate	Some concentrations of contaminants above criteria for use of polyethylene or PVC pipes. Localised removal of near-surface Made Ground on wharf areas likely within stadium footprint as part of enabling works. Barrier pipe materials likely to be required unless otherwise agreed with utility company. Further assessment will be required prior to Stage 5 design.
Former tar works	PAHs, TPH, VOCs, SVOCs.	**Historical presence of a tar works recorded on northern wharf. Within area, bitumen layer found from ~0.15-0.35m bgl and bitumen cobbles / gravel up to 2.2m bgl. Strong tar odour noted during shallow excavation. Groundwater ingress in trial pits had strong hydrocarbon odour but no evidence of free phase contamination. Isolated exceedances of residential without plant uptake thresholds recorded for total aliphatics, naphthalene and dibenzo[ah]anthracene. Concentrations of VOCs / SVOCs are low or below laboratory limits of detection. 0.5cm of LNAPL recorded at nearby OH102 during first sampling round, oil sheen during second sampling round. Groundwater data show elevated concentrations of heavier-end TPH and some PAHs (up to 26 mg/l total TPH).**				
		Construction / maintenance workers Direct contact, ingestion, inhalation	Mild	Likely	Moderate / low	Ground engineering aspects of construction will involve partial excavation and uncovering of Made Ground. Former tar works within stadium footprint / location of likely piling. Some elevated concentrations of organics recorded in the near surface. Exposure time will be relatively limited. Mitigation can be achieved by localised excavation and suitable off-site disposal of ground impacted by operations of former tar works during enabling works. Good construction practice and standard health and safety precautions to be implemented.
		Future site users Direct contact, ingestion, inhalation. Migration of hazardous gas / vapour via granular strata, accumulation in enclosed spaces, explosion, asphyxiation.	Medium	Likely	Moderate	The majority of the proposed development will be covered by hard landscaping. There are very limited areas of soft-landscaping which include direct in-ground planting. Limited potential for direct contact with contaminants in soils. Strong hydrocarbon odour noted. Concentrations of volatile / light-end organics do not exceed relevant screening thresholds, however potential for areas of higher concentrations to be present. Potential for accumulation of vapours within enclosed spaces. Mitigation can be achieved by localised excavation and suitable off-site disposal of ground impacted by operations of former tar works during enabling works. Good construction practice and standard health and safety precautions to be implemented.
		Principal Aquifer (Chester Formation) **River Mersey** **Port of Liverpool Dock System**	Medium	Likely	Moderate	Groundwater at OH102 impacted by TPH and PAHs, likely originating from bitumen / hydrocarbons present in Made Ground. Potential for migration of dissolved / free phase contamination. Potential for mobilisation of unforeseen contamination during piling works. Seepage regime exists between groundwater in Made Ground and dock water below. BMD and River Mersey walls relatively impermeable. No active groundwater, surface water, or potable water abstraction licenses within 2km.

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Pollutant Linkage			Risk Assessment (following CIRIA C552)			Description of source.
Source	**Contaminants of concern**	Receptor / **Pathway**	**Consequence**	**Probability**	**Risk**	Comment on hazard realisation.
		Surface water run-off / leaching and migration through granular strata.				Mitigation can be achieved by localised excavation and suitable off-site disposal of ground impacted by operations of former tar works during enabling works. BMD to be infilled, decreasing connectivity to surface waters. Good construction practices to be implemented. Hardstanding finishes across majority of proposed development will prevent infiltration and mobilisation.
		Flora and fauna Root uptake	Minor	Likely	Low	The majority of the proposed development will be covered by hard landscaping. There are very limited areas of soft-landscaping which include direct in-ground planting. . Exceedances of phytotoxicity thresholds recorded in five instances, none within vicinity of former tar works. Localised removal of near-surface Made Ground likely within stadium footprint as part of enabling works.
		Water supply pipes Direct contact	Medium	Likely	Moderate	Some concentrations of contaminants above criteria for use of polyethylene or PVC pipes. Localised removal of near-surface Made Ground on wharf areas likely within stadium footprint as part of enabling works. Barrier pipe materials likely to be required unless otherwise agreed with utility company. Further assessment will be required prior to Stage 5 design. Mitigation can be achieved by localised excavation and suitable off-site disposal of ground impacted by operations of former tar works during enabling works.
Dock Deposits	Heavy metals, PAHs, TPH, TBT, DBT.	**BMD contains deposits of clay, silt, sand and gravels which have settled out over time or arise from activities at the dock i.e. stockpiling of dredged material from River Mersey. Material present for up to 170 years, although dredging likely to have occurred historically. Potential for contamination to arise from tipping of material into BMD, boat maintenance operations or spillages of fuels etc. Asbestos was detected in one sample. One exceedance of residential without plant uptake criteria recorded for lead and total aliphatic and aromatic. Leachate data showed exceedances of relevant screening criteria for arsenic, boron, lead, zinc, PAHs and TPH total.**				
		Principal Aquifer (Chester Formation) **River Mersey** **Port of Liverpool Dock System** Leaching and migration through granular strata.	Mild	Unlikely	Very low	Where leachate data from Dock Deposits showed exceedances of screening thresholds, concentrations were marginal, recorded in a limited number of samples, or inferred to be a property of deposits throughout the dock system. No active groundwater, surface water, or potable water abstraction licenses within 2km. Significant dilution effect will occur.
Made Ground - reworked natural material, brick, concrete, coal, clinker, wood fragments, slag etc. Also localised presence of hydrocarbon contamination. Former tar works	Carbon dioxide, methane	**Ground gas monitoring conducted over seven to eight rounds. Putrescible materials not recorded during ground investigation. Maximum carbon dioxide concentration (4.8% v/v) recorded at BH114 with oxygen concentration of 9.7% v/v. Consistently slightly elevated concentrations of carbon dioxide and depleted oxygen concentrations recorded at OH102 in vicinity of former tar works (worst case 3.7% v/v CO_2 and 3.1% v/v O_2). Worst-case concentration of carbon dioxide (4.8% v/v) and highest flow rate (0.4 l/hr) produce GSV of 0.0192 – CS1. No concentrations of methane detected, as such GSV is 0 – also CS1. CS1 designation means no gas protection measures are required.**				
		Construction / maintenance workers Inhalation	Mild	Unlikely	Very low	Limited potential for exposure to ground gases due to likely attenuation / dilution in outdoor air. No enclosed spaces proposed. Localised removal of near-surface Made Ground likely within stadium footprint as part of enabling works. Exposure time will be relatively limited. Standard health and safety precautions to be implemented.
		Future site users Inhalation. Migration of hazardous gas / vapour via granular strata, accumulation in enclosed spaces, explosion, asphyxiation.	Mild	Low	Low	Slightly elevated concentrations of carbon dioxide recorded at locations inside proposed building footprint. Potential for gas ingress into enclosed spaces within the proposed buildings. Limited potential for exposure to ground gases outside of buildings due to attenuation / dilution in outdoor air. Localised removal of near-surface Made Ground likely within stadium footprint as part of enabling works.
		Stadium / buildings Migration via granular strata, accumulation in enclosed spaces, explosion, asphyxiation.	Mild	Low	Low	Slightly elevated concentrations of carbon dioxide recorded at locations inside proposed building footprint. Potential for gas ingress into enclosed spaces within the proposed buildings. Localised removal of near-surface Made Ground likely within stadium footprint as part of enabling works.
Dock Deposits	Carbon dioxide, methane	**BMD contains deposits of clay, silt, sand and gravels which have settled out over time or arise from activities at the dock i.e. stockpiling of dredged material from River Mersey. Material present for up to 170 years, although dredging likely to have occurred historically. Recorded thickness ranged between 0.30 to 3.30m, Average SOM of 3.75% recorded. Detects of heavier end TPH recorded, concentrations below residential without plant uptake thresholds in the vast majority of samples. Qualitative analysis of the ratio of Aromatic >C21-C35 to Aliphatic >C21-C35 bands from TPH CWG solid analysis indicates that humic and fulvic acids are likely to contribute to the TPH total leachate concentrations in the majority of samples.**				
		Construction / maintenance workers Inhalation	Severe	Unlikely	Moderate / low	No ground gas monitoring of Dock Deposits undertaken (not possible). Deposits to remain in-situ. Construction methodology will comprise installation of geotechnical membrane on top of deposits with subsequent infilling using natural imported fill to top of dock level. Dock Deposits will remain saturated. Working in poorly ventilated, enclosed space unlikely as part of construction. Low accumulation rates likely.
		Future site users Inhalation. Migration of hazardous gas / vapour via granular strata, accumulation in enclosed spaces, explosion, asphyxiation.	Severe	Unlikely	Moderate / low	No ground gas monitoring of Dock Deposits undertaken (not possible). Deposits to remain in-situ. Construction methodology will comprise installation of geotechnical membrane on top of deposits with subsequent infilling using natural imported fill to top of dock level. Dock Deposits will remain saturated. DPM installed within building. The final building design (Stage 5) will consider the potential for gas ingress i.e. the penetrations through the slab will be minimised, and where present, appropriately sealed.
		Stadium / buildings Migration via granular strata, accumulation in enclosed spaces, explosion, asphyxiation.	Severe	Unlikely	Moderate / low	No ground gas monitoring of Dock Deposits undertaken (not possible). Deposits to remain in-situ. Construction methodology will comprise installation of geotechnical membrane on top of deposits with subsequent infilling using natural imported fill to top of dock level. Dock Deposits will remain saturated. DPM installed within building. The final building design (Stage 5) will consider the potential for gas ingress i.e. thepenetrations through the slab will be minimised, and where present, appropriately sealed.

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11. Conclusions

11.1 Geoenvironmental risk summary

The risk assessment undertaken has found the following risks to be above low:

- Moderate / low risk to construction / maintenance workers due to potential for presence of asbestos within Made Ground.
- Moderate risk to future site users due to potential vapour risk associated with localised hydrocarbon contamination (naphthalene) within Made Ground.
- Moderate risk to water supply pipes due to concentrations of contaminants in Made Ground and in the area of the former tar works.
- Moderate / low risk to construction / maintenance workers due to potential for contact with hydrocarbon contamination in area of former tar works.
- Moderate risk to future site users due to potential vapour risk associated with former tar works.
- Moderate risk to controlled waters due to concentrations of hydrocarbons in groundwater in vicinity of former tar works (originating from impacted ground).
- Moderate / low risk to construction / maintenance workers, future site users and stadium / buildings due to potential for ground gas generation from Dock Deposits (of which no monitoring has been undertaken to date).

11.2 Site geoenvironmental condition

The ground investigation and risk assessment has shown that the general site condition in relation to contamination within soils and controlled waters is suitable for the proposed development of a football stadium as planned and that the proposed development will not create any new pollution linkages when mitigation is put in place. The work has however identified a need for some localised remediation of elevated hydrocarbon concentrations, one area on the north wharf, one area on the east wharf, and the former area of the tar works on the north wharf. In addition new water supply pipes are likely to need to be specified as barrier pipe if they are located in the wharf areas. It is unlikely that the application site would be determined as Contaminated Land (under the provisions of Part 2A of the Environmental Protection Act 1990) in its current status, or following the event of any redevelopment, provided the recommendations below are followed.

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12. Outline Remedial Methodology

The identified risks in Section 11.1 can be mitigated by adopting the remedial methodology detailed in Table 12—1.

Table 12—1 – Remedial Methodology

Source	Receptor	Mitigation Measures
Made Ground (asbestos)	Construction / maintenance workers	Good construction practice and adoption of standard health and safety precautions. Maintain watching brief for potential presence of asbestos containing materials.
Made Ground (hydrocarbons)	Future site users	Localised excavation and suitable off-site disposal of Made Ground impacted by hydrocarbon contamination (naphthalene) in the vicinity of BH04 and P102 (Figure 12-1). Allowance should be made for additional areas of contamination. If encountered, excavation and removal may be required and need for / scope of vapour protection measures should be reassessed.
Made Ground	Future site users	The majority of the proposed development will be covered by hard landscaping. There are very limited areas of soft-landscaping which include direct in-ground planting To mitigate the risk to future site users due to the potential for direct contact with contaminants in soils, soft landscaping should be isolated from underlying Made Ground by placement of a marker layer, with any planting in suitable imported soils.
Made Ground Former tar works	Water supply pipes	Selection of suitable materials and appropriate design once location of pipework is known. Confirm requirements for barrier pipe materials with the utility company.
Former tar works	Construction / maintenance workers	As part of enabling works (prior to construction / piling), localised excavation and suitable off-site disposal of ground impacted by operations of former tar works. Good construction practice and adoption of standard health and safety precautions.
Former tar works	Future site users	As part of enabling works (prior to construction / piling), localised excavation and suitable off-site disposal of ground impacted by operations of former tar works.
Former tar works	Controlled waters	Localised excavation and suitable off-site disposal of ground impacted by operations of former tars works (assumed source of hydrocarbon impact of groundwater in the vicinity). Adopt methodology to prevent runoff of impacted groundwater into BMD.
Dock Deposits	Construction / maintenance workers Future site users Stadium / buildings	Once building design is finalised, the need for ground gas monitoring and / or gas protection measures should be reassessed.

The following are also recommended:

- If the proposed installation methodology for the geotechnical membrane changes, a separate risk assessment should be conducted to assess risks to human health.
- A watching brief should be maintained during enabling works / construction for additional localised areas of hydrocarbon contamination arising from current or historical use of BMD. If encountered, the need for / scope of additional remediation will require further consideration.

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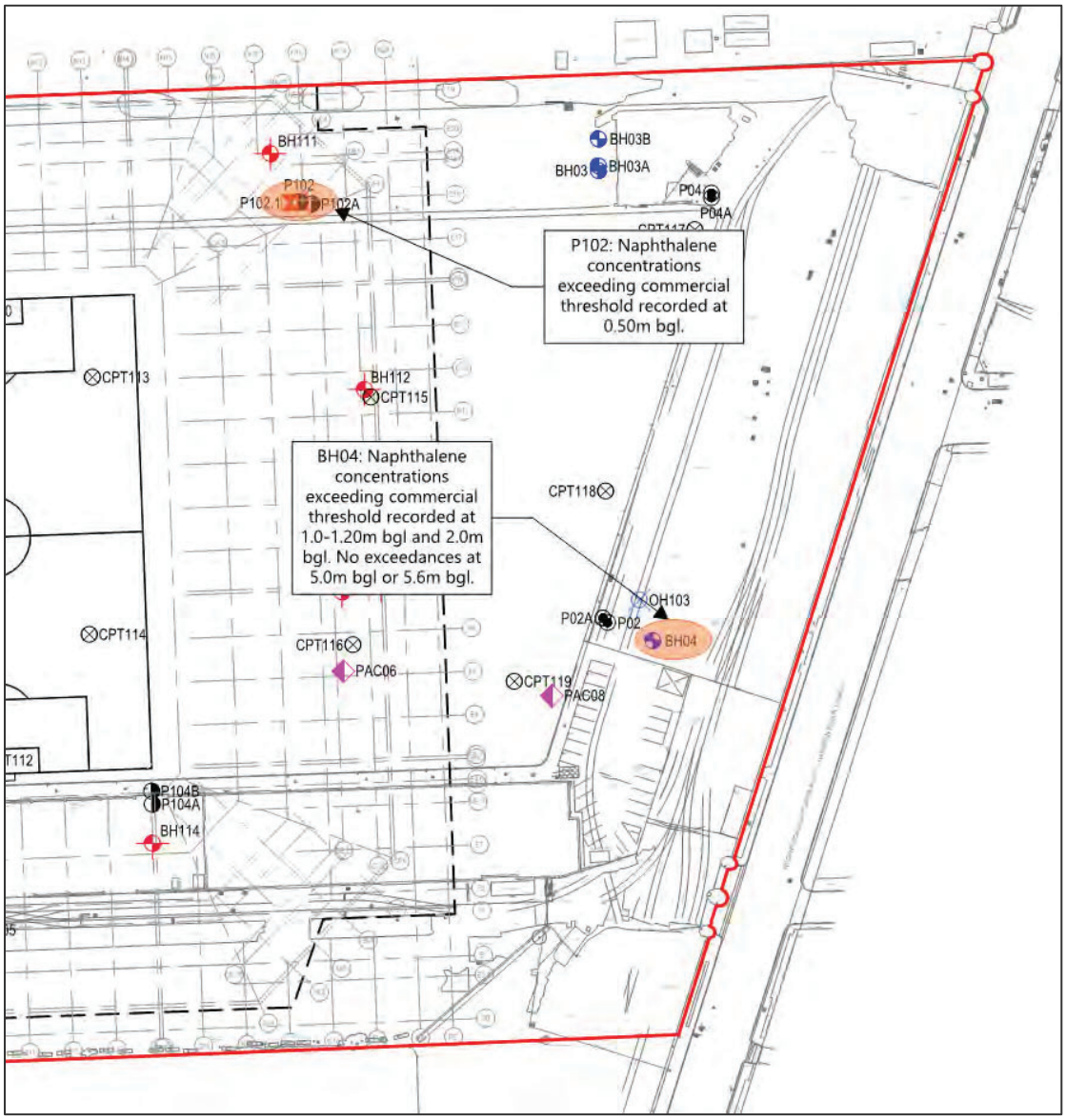

Figure 12-1- Locations where naphthalene concentrations exceed commercial screening values.

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[29] British Standards Institute, "BS8485:2015 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings," British Standards Institute, London, 2015.

[30] Environment Agency, "Non Statutory (Operational) Environmental Quality Standards".

[31] UK Drinking Water Inspectorate, "The Water Supply (Water Quality) Regulations 2000 (England and Wales)," 2000.

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Figures

- Proposed Site Layout Plan - BMD01-MEI-A3-ZZ-DR-A-0020
- GA Plan – Softworks - BMD01-PLA-L1-00-DR-L-2000
- Exploratory Hole Location Plan – BMD01-BHE-ZX-LXX-DR-CG-0001

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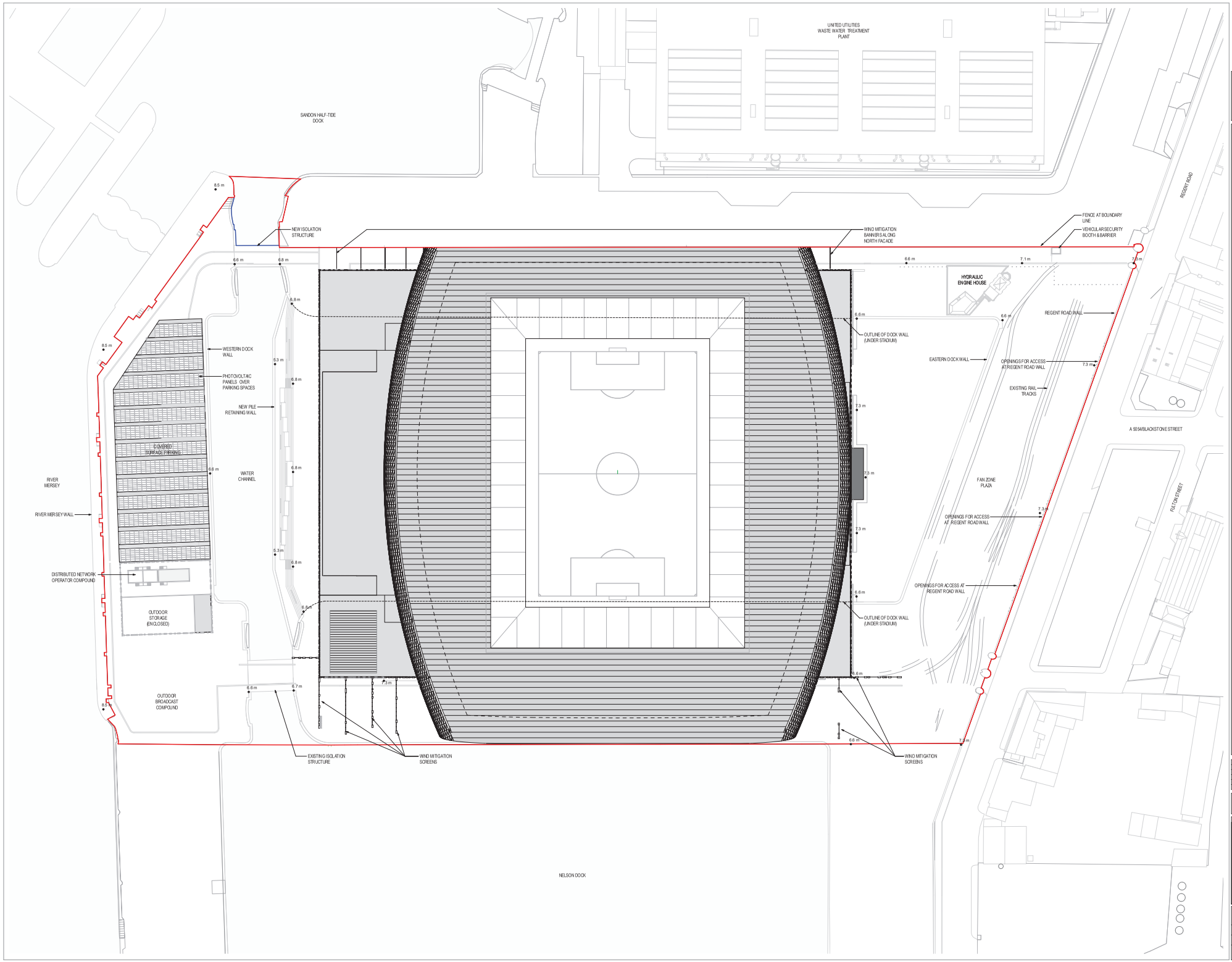


MEIS ARCHITECTS

EVERTON STADIUM DEVELOPMENT LTD.

OWNER
Everton Football Club
Goodison Park
Liverpool, L4 4EL
United Kingdom
T: +44 (0) 151 556 1878

PROJECT MANAGER
Gardiner & Theobald
Merchant Exchange
17-19 Whitworth Street West
Manchester, M1 5WG, United Kingdom
T: +44 (0) 207 209 3000

ARCHITECT
MEIS Architects
1140 Broadway
New York, NY 10001
United States of America
T: +1 646 823 9102

TECHNICAL ARCHITECT
Pattern
222 Gray's Inn Road
London, WC1X 8HB
United Kingdom
T: +44 (0) 207 993 9400

STRUCTURAL / MEP / INFRASTRUCTURE
Buro Happold
Camden Mill, 230 Lower Bristol Road
Bath, BA2 3DQ
United Kingdom
T: +44 (0) 122 532 0600

LANDSCAPE ARCHITECT
Plan1-4E
Liverpool Studio; No. 8 Princes Parade
Princes Dock, Liverpool, L3 1DL
United Kingdom
T: +44 (0) 151 363 1230

PLANNING
CBRE
10th Floor, One St Peter's Square, Manchester, M2 3DE
United Kingdom
T: +44 (0) 161 445 7666

HERITAGE CONSULTANTS
KM Heritage
72 Pymer's Mead
London SE21 8NJ
United Kingdom
T: +44 (0) 208 670 9057

TRANSPORT CONSULTANT
Matt MacDonald
Ground floor, Royal Liver Building
Pier Head, Liverpool L3 1JH
United Kingdom
T: +44 (0) 151 482 9945

LEGEND:

- SITE BOUNDARY
- OWNERSHIP BOUNDARY

NOT FOR CONSTRUCTION / PLANNING APPLICATION SET - FOR REFERENCE

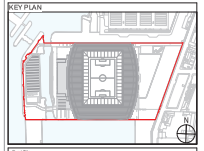
NOTE
FOR DETAILED LANDSCAPE
PROPOSALS SEE SUBMITTED
LANDSCAPING PLANS

No.	Description	Date

BRAMLEY-MOORE DOCK

LIVERPOOL, ENGLAND

KEY PLAN



Drawing Title
PROPOSED SITE LAYOUT PLAN

Date	Scale
01 NOV 2019	1 : 500@A0
MEIS Project Number	Status
14006.03_EV	PLANNING

Drawing Number
BMD01-MEI-A3-ZZ-DR-A-0020-P00

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TREE SCHEDULE								
Species		Common name	Pot	Size: height (mm)	Density (m2)	Girth	Clear Stem	Quantity
Metasequoia Glyptostrobodies	Non-native	Dawn Redwood	Rootballed	7.0+	As shown	40-45cm	Min 2.5m	5
Pinus sylvestis	Native	Scot's Pine	Rootballed	7.0+	As shown	Strong stems and bushy	Min 2.5m	23
Alnus cordata	Non-native	Italian Alder	Rootballed	6.0-6.5m	As shown	30-35	Min 2.5m	12
Ulmus 'Columella'	Non-native	Elm 'Columella'	Rootballed	5.5-6.0m	As shown	25-30	Min 2.2m	13

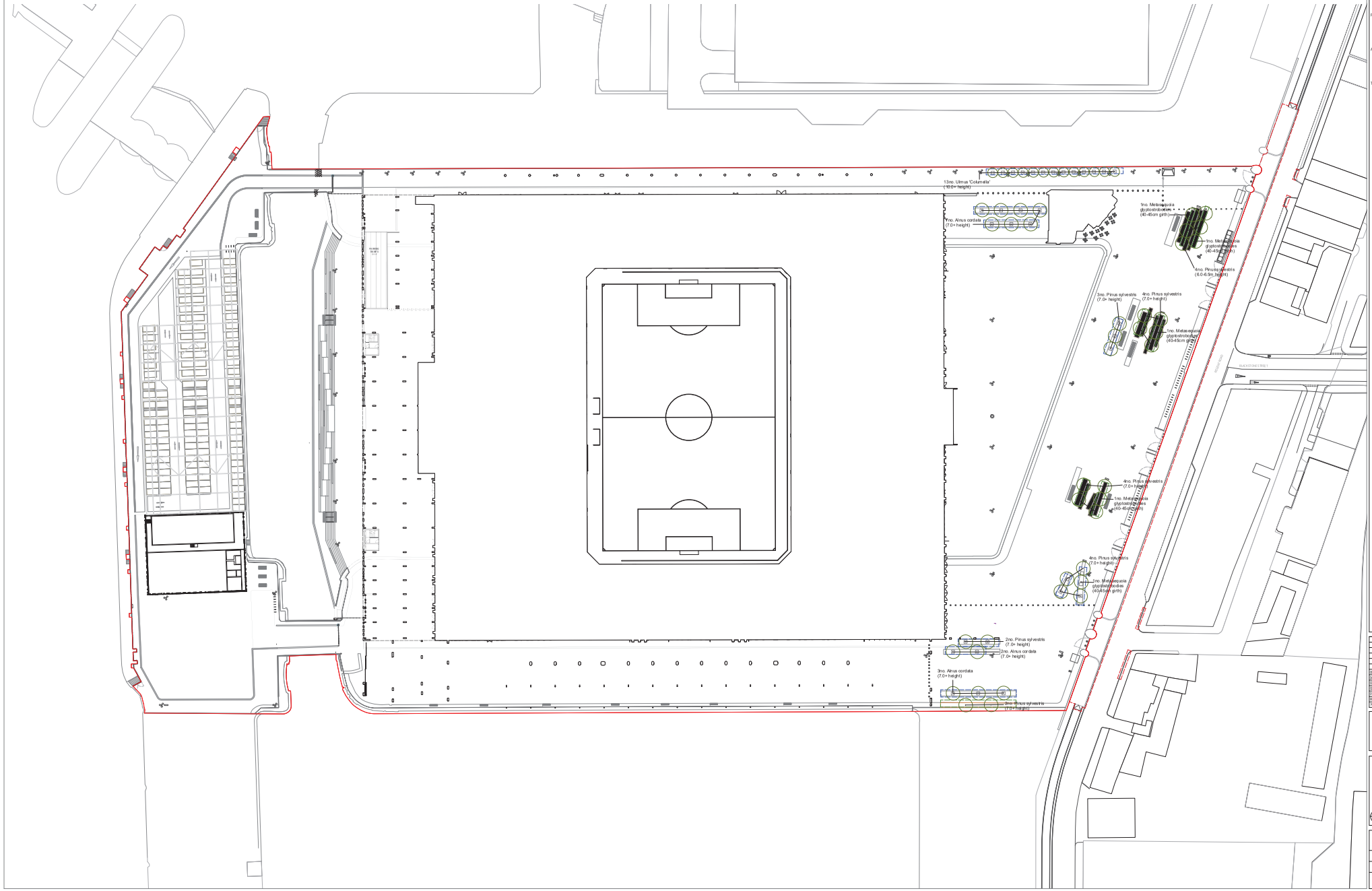
PLANT SCHEDULE					
Species		Pot	Density (m2)	Quantity	Total Area (m2)
Stipa tenuissima	Non-native	8L	5	625	125
Calamagrostis × acutiflora 'Karl Foerster'	Non-native	8L	5	375	75
Helictotrichon sempervirens	Native	8L	5	425	85
Salix lapponum	Native	5L	8	424	53

Maintenance Recommendations for Pinus sylvestris:

The overhead guying cables should be inspected annually for tightness and chafe on the tree trunk.
Pines typically pull on a considerable increase in girth in the Autumn after transplanting so it will be important to relax the cabling around the tree trunk as necessary.
The cabling is fitted with bulldog wire grips which can be manually adjusted.
After two summers the trees should be fully established in the ground and the cabling should be removed.
Pines have a low demand for soil nutrition but maintaining a cover of soil or bark mulch is important so top dress as necessary.
Do not use green waste based composts.
Pests and disease are limited to Adelges and Pine Bark Beetle. Isolated trees in city centres are seen as being at very low risk so there is little likelihood of needing preventative action.

KEY

- Site Bound ary
- Extent of Proposed Black Box High way
- Level Mat ion Deviation w/ Tree Level Mat ion Deviation w/ Tree Contour Gap at 2.5m clear stem for ease by mowers.
- Edge transition a Edge to plan ting cab ceiling.
- Columns guyed to avoid the root ball area w/ Edge to plan ting cab ceiling.
- Indicat ed clear cane per mission a Edge to plan ting cab ceiling.
- Salix lapp onum Edge to plan ting cab ceiling.
- Tree Pit in paving Location: Footf lat
  Tree will be set flat with the surrounding hard surf ace
- Tree Pit in plan ting Location: Footf lat



MEIS ARCHITECTS

EVERTON STADIUM DEVELOPMENT LIMITED.
BRAMLEY-MOORE DOCK

OWNER
Everton Football Club
Goodison Park
Liverpool, L4 4EL
United Kingdom
T: +44 (0) 151 556 1878

PROJECT MANAGER
Gardiner & Theobald
Merchant Exchange
17-19 Whitworth Street West
Manchester, M1 5WQ, United Kingdom
T: +44 (0) 207 209 3000

ARCHITECT
MEIS Architects
1140 Broadway
New York, NY 10001
United States of America
T: +1 646 823 9102

TECHNICAL ARCHITECT
Pattern
222 Grey's Inn Road
London, WC1X 8HB
United Kingdom
T: +44 (0) 207 993 9400

STRUCTURAL / MEP / INFRA STRUCTURE
Buro Happold
Camden Mill, 230 Lower Bristol Road
Bath, BA2 3DQ
United Kingdom
T: +44 (0) 122 532 0600

LANDSCAPE ARCHITECT
Planit-IE
Tempest S.3, 12 Tithebarn Street
Liverpool
L2 2DT
T: +44 (0) 151 363 1230

PLANNING
CBRE
One St. Peter's Square,
Manchester, M2 3DE
United Kingdom
T: +44 (0) 161 223 5469

HERITAGE CONSULTANTS
KM Heritage
72 Pymer's Mead
London SE21 8NJ
United Kingdom
T: +44 (0) 208 670 9057

TRANSPORT CONSULTANT
Mott MacDonald
Ground floor, Royal Liver Building
Pier Head, Liverpool L3 1JH
United Kingdom
T: +44 (0) 151 482 9945

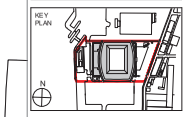
NOT FOR CONSTRUCTION / PLANNING

APPLICATION SET - FOR REFERENCE

No.	Description	Date
06	Planning	12.11.19
04	Draft Planning Issue	18.10.19
03	Stage 3A Design	06.09.19
02	Stage 2A	21.08.19
01	Draft Employers Requirements	15.08.19
00.1	INIT IAL ISSUE - DRAWINGS	01.08.19

EVERTON FC
NEW STADIUM
LIVERPOOL, ENGLAND

KEY PLAN



Drawing Title
GA Plan - Softworks

Date: 4 SEPT 2019
Scale: 1:500 @ A0
MEIS Project Number: 14006.03_EV
Status: PLANNING
Drawing Number: BMD01-PLA-L1-00-DR-L-2000

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CONSTRUCTION.

MAINTENANCE/CLEANING/OPERATION.

DECOMMISSIONING/DEMOLITION.

Notes

Rev	Description	Date	Drn	Ch'd
01	SITE BOUNDARIES UPDATED. GRAB SAMPLES AND OPEN HOLES ADDED. ISSUED FOR INFORMATION.	13.11.19	NG	JR
D0	INFORMATION	05.08.19	NG	JR

INFORMATION

Status of drawing

BUROHAPPOLD ENGINEERING

Camden Mill
Lower Bristol Road
Bath BA2 3DQ
UK

Tel: +44 (0)1225 320600
Fax: +44 (0)870 787 4148
Email: 0040026@burohappold.com
Web: www.burohappold.com

Architect: MEIS

Project: THE PEOPLE'S PROJECT

Drg Title: EXPLORATORY HOLE LOCATION PLAN

Scales @A1 1:1000
Drawn by NG
Checked by JR

Job No. 0040026
Date AUGUST 2019
Rev 01

Drawing No. BMD01-BHE-ZX-LXX-DR-CG-0001

Appendix A - Planning Policy Framework / Statutory Legislation

Section 38(6) of the Planning and Compulsory Purchase Act 2004 and Section 70(2) of the Town & Country Planning Act 1990 requires planning applications should be determined in accordance with the statutory development plan, unless material considerations indicate otherwise.

The statutory development plan for the City of Liverpool currently comprises:

- Unitary Development Plan (adopted 2002); and
- Merseyside and Halton Joint Waste Local Plan (adopted July 2013).

A summary of the statutory development plan policies relevant to the application proposal and specifically matters relating to ground conditions are provided below.

The following policies and guidance are material considerations which also inform the assessment:

- Liverpool Local Plan (Submission Draft, May 2018);
- National Planning Policy Framework (March 2012, updated in 2019); and
- Planning advice note for developers on developing on contaminated land.

Statutory Development Plan

Liverpool Unitary Development Plan (UDP)

The key policies within the adopted UDP are as follows:

- **Policy EP1 (Vacant, Derelict and Neglected Land)** promotes and encourages the reclamation of derelict land and the restoration of neglected land and encourages the development of these for other appropriate uses. In determining priorities for derelict land, particular attention will be given to:
    - The contribution the reclamation of the site would make to achieving the aims of urban regeneration and to aiding the implementation of policies in this Plan
    - The need to facilitate inward investment opportunities and create jobs
    - The degree of contamination, dereliction or danger posed by the site; and
    - The need to integrate with, and support, other regeneration initiatives and agencies in order to maximise the benefits of reclamation.
- **Policy EP2 (Contaminated Land)** before determining any application for planning consent on land which the City Council considers is seriously contaminated, the Council will require the applicant: to submit details of a site survey identifying the type, degree and extent of any contamination; and submit details to the City Council of specific remedial measures required to deal satisfactorily with any hazard, together with the proposed timescale for the implementation of the measures. Planning permission will only be granted prior to a full site investigation, where the Council considers that any known or suspected contamination is unlikely to adversely affect the proposed redevelopment. This permission may be subject to conditions requiring a site investigation together with the remediation of any contamination.

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- **Policy EP3 (Landfill Gas)** planning permission will not be granted for development on former landfill sites, or within 250m of current or former landfill sites, unless the applicant can clearly demonstrate that there is no risk from the generation or migration of landfill gas, or that satisfactory measures can be taken to counter any possible hazard.
- **Policy EP12 (Protection of Water Resources)** planning permission will not be granted for development which, in the opinion of the City Council following consultation with the Environment Agency, would adversely affect the quality or supply of surface water or groundwater as a result of: the nature of the surface or waste water discharge; unsatisfactory arrangements for the disposal of foul sewage, trade effluent of surface water; the disturbance of contaminated land; or the spillage or leakage of stored oil or chemicals.

Material Considerations

Emerging Local Plan (Submission Draft May 2018)

A new local plan is presently awaiting formal public examination and when ultimately adopted will replace the Unitary Development Plan (UDP). In accordance with NPPF para. 48, the current submission draft has substantive but not full weight in decision-taking given that whilst it has been submitted for examination it is not clear at present as to the extent to which there are 'unresolved' objections to the overarching plan strategy or individual policies (whether allocations or development management policies).

The relevant policy for ground conditions is set out in part a of Policy STP2 -*Sustainable Growth Principles and Managing Environmental Impacts* which states that as a priority, new development should be located on previously developed land and/or re-use an existing building; seek to use secondary materials such as recycled aggregates; and where appropriate aim to secure the remediation of contaminated sites.

National Planning Policy Framework (NPPF, February 2019)

Paragraph 170 details that planning decisions should contribute to and enhance the natural and local environment by, amongst others:

- Clause E - prevent new development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil pollution or land instability; and
- Clause F - remediate degraded, derelict, contaminated and unstable land where appropriate.

Paragraph 178 thereafter details that in relation ground conditions and pollution, planning decisions should ensure that:

A. A site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation).
B. After remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and
C. Adequate site investigation information, prepared by a competent person, is available to inform these assessments.

Paragraph 179 ultimately draws the policy guidance together detailing that where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.

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Planning advice note for developers on developing on contaminated land

The guide, produced by Liverpool City Council Environmental Protection Unit (EPU), comprises general advice to developers and requirements for planning application submissions on potentially-contaminated land. The note details that sufficient investigatory works should be undertaken for the purposes of assessing all 'site-specific' risks posed at, and from, a proposed development site.

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Appendix B – Supporting Ground Investigation Information

- Geotechnical Engineering - Factual Report (Phase 1)
- Structural Soils - Factual Report (Phase 2)
- PLANIT UXB Ltd – Explosive Ordnance Threat Assessment

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PROJECT BLUE

FACTUAL REPORT ON GROUND INVESTIGATION

Prepared for BUROHAPPOLD

Report Ref: 33138

Geotechnical Engineering Ltd
Centurion House, Olympus Park
Quedgeley, Gloucester. GL2 4NF

01452 527743
www.geoeng.co.uk

PROJECT BLUE

FACTUAL REPORT ON GROUND INVESTIGATION

Prepared for BUROHAPPOLD

Report Ref: 33138

PROJECT: Proposed Development

VOLUME - VERSION	STATUS	ORIGINATOR	CHECKER	APPROVED	DATE
1 of 1 – A	PRELIM	PS	ELe	-	24/08/2017
1 of 1 – B	DRAFT	PS	CT	-	07/09/2017
1 of 1 – C	FINAL	PS	CT	JH	22/09/2017
1 of 1 – D	FINAL	PS	CT	JH	22/09/2017
1 of 1 – E	FINAL	PS	CT	JH	07/11/2017

ORIGINATOR	APPROVER
P SPEAR Senior Engineering Geologist	J HANSON Director

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The report has been prepared for the sole use and reliance by Buro Happold. GEL accepts no liability as a result of the use or reliance of this report by any other parties.

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2. SITE LOCATION AND GEOLOGY 1

3. GROUND INVESTIGATION 1

3.1 Fieldwork 1

3.2 Logging 6

3.3 Laboratory Testing 7

4. REFERENCES 10

FIGURES **Nos.**

EXPLORATORY HOLE LOCATION PLAN 1

APPENDICES

APPENDIX A FIELDWORK DATA

APPENDIX B LABORATORY TESTING

APPENDIX C CHEMICAL ANALYSES

1. INTRODUCTION

It is proposed to develop the site at Bramley-Moore Dock, Liverpool. Geotechnical Engineering Limited (GEL) was instructed by BuroHappold (the Client) to carry out an investigation to determine the ground conditions.

The scope of works and terms and conditions of appointment were specified by the Client and GEL correspondence reference T26066 dated 23rd May 2017. The investigation was carried out under direction and supervision of the Client.

This report describes the investigation and presents the findings.

2. SITE LOCATION AND GEOLOGY

The site is situated at Bramley-Moore Dock in Vauxhall, Liverpool and may be located by its National Grid co-ordinates SJ 334 924.

British Geological Survey (BGS) England and Wales (Sheet No. 96, 1:50,000, 2006) and the BGS online geology (1:50,000) indicate the site is underlain by Tidal Flat Deposits (clay, silty, sandy). The underlying solid geology comprises Sandstone of the Chester Pebble Beds Formation. Made Ground was also anticipated due to construction of the Dock.

3. GROUND INVESTIGATION

3.1 Fieldwork

The fieldwork was carried out in general accordance with BS5930:2015 during the period 12th to 28th June 2017 and comprised eight rotary boreholes for geotechnical purposes, ten rotary

boreholes to identify the dock wall, and seven bathymetric survey samples (obtained by others).

The exploratory hole locations were selected by the Client and set out by GEL and are shown on Figure 1. The ground level and co-ordinates at each exploratory hole were established by GEL using GPS techniques.

Boreholes for Geotechnical Purposes

The boreholes, referenced BH01, BH01A, BH02, BH03, BH03A, BH03B, BH04 and BH05 (Appendix A), were formed using a track-mounted Geotechnical Pioneer Rig. Initially, the surface hardstanding at each location (except BH01 and BH04) was penetrated using waterflush rotary coring techniques. Thereafter, an inspection pit was hand excavated at each borehole location (except BH03B, and from the surface at BH01 and BH04) to a maximum depth of 1.20m to check for buried services. Disturbed samples were taken and retained in a combination of plastic tubs, bags and glass jars. Borehole BH03 was abandoned after coring the surface hardstanding due to the presence of re-enforced concrete. In boreholes BH01, BH01A, BH02, BH04 and BH05 heavy duty dynamic sampling techniques were then employed to produce a continuous disturbed sample of 112mm nominal diameter. The samples were recovered in semi-rigid plastic liner.

In boreholes BH01A, BH03A and BH04, on refusal to dynamic sampling, and from the surface in BH03B, the boreholes were continued by rotary core drilling techniques utilising a water or polymer flush. A double-tube swivel core barrel with semi-rigid plastic liner was utilised to recover a continuous sample of 120mm diameter.

In boreholes BH02 and BH05, on refusal to dynamic sampling the boreholes were continued by Geobor S wireline rotary drilling techniques utilising a polymer flush. An inner barrel assembly, incorporating a semi-rigid plastic liner, is deployed down the borehole and is

latched onto the outer barrel/casing to recover continuous cores of 102mm diameter. The outer barrel acts as the casing ensuring the hole is fully cased at all times. Where appropriate, dynamic sampling techniques were carried out to recover dropped core or where rotary core drilling was not suitable.

The dynamic samples and rotary core were extracted horizontally from the sampler and core barrel respectively, the semi-rigid liner was cut to length and caps placed at each end to retain moisture content. All samples and core were retained in sequence in labelled, wooden coreboxes.

Undisturbed samples of 100mm nominal diameter were taken in suitable cohesive soils using a thin walled, open drive sampler (UT100). Samples were wax sealed and capped on site to prevent moisture loss.

Standard penetration tests (SPT) were carried out in general accordance with BS EN ISO 22476-3:2005+A1:2011. A split barrel or a solid cone was used depending upon the materials encountered and the split barrel samples retained in airtight jars. The SPT N value was taken as the number of blows to penetrate the 300mm test drive following a 150mm seating drive. Where low penetration was recorded the seating drive was terminated at 25 blows and the test drive completed after a further 50 blows. Detailed SPT results, together with the energy ratio (E_r), are presented in Appendix A and summarised as uncorrected N values on the borehole logs.

The boreholes BH01, BH01A, BH02, BH03, BH03A, BH03B, BH04 and BH05 were monitored for groundwater ingress as dynamic sampling proceeded. Upon encountering water, sampling was temporarily stopped to allow the level to stabilise. Water levels were also recorded at the start and finish of each day's work and on completion of the borehole and are presented on the relevant log.

Packer tests were carried out in boreholes BH01A and BH04 in general accordance with BS EN ISO 22282-3:2012. Double pneumatic packers were used to isolate the test section and connected to the surface via 46mm diameter BQ internally flush coupled rods. The water pressure and flow rate was measured at the surface. The tests were carried out under five stages at up to four different pressures (a-b-c-d-c-b-a) with each pressure maintained for 10 to 15 minutes. Packer test results together with Lugeon and permeability values have been presented in Appendix A.

On completion, vibrating wire piezometers were installed in boreholes BH01A and BH04. Each piezometer consisted of a cabled, prepared porous tip element connected to a pressure transducer set in a cementitious grout. The response zone was sealed above and below with a bentonite plug. The piezometer cable was protected at the surface within a dedicated terminal block. A second standpipe piezometer was installed in BH04 (detailed below). Installation details are given on the relevant borehole log. Subsequent water pressure readings are plotted in Appendix A.

On completion standpipe piezometers were installed in boreholes BH04 and BH05. Each standpipe piezometer consisted of a 19mm ID PVC access tube with a porous tip set in a granular filter medium. The response zone was sealed above and below with a bentonite plug. The installations were protected at the surface by a lockable stopcock cover set in concrete. Installation details are given on the relevant borehole log. Subsequent water level readings are plotted in Appendix A.

On completion, a slotted standpipe was installed in borehole BH02. The standpipe consisted of a 50mm ID HDPE slotted tube set in a granular filter medium and sealed above with a bentonite plug. The installation was protected at the surface by a lockable, steel borehole helmet. Installation details are given on the relevant borehole log. Subsequent water level readings are plotted in Appendix A.

On completion, borehole BH01 was backfilled with bentonite pellets and arisings. and borehole BH03 was backfilled with concrete.

On completion, an inflatable rubber bladder was installed above the possible voids in boreholes BH03A and BH03B. The boreholes were then backfilled with concrete and bentonite pellets.

Variable head permeability tests were carried out in boreholes BH01, BH01A, BH02, BH04 and BH05 in general accordance with the procedures given in BS EN ISO 22282-2:2012. Falling head tests were carried out by topping up the standpipe or borehole with clean water. Where possible, coefficients of permeability were calculated using the BS EN ISO 22282-2:2012 Hvorslev method and the Velocity Graph method. Intake factors have been derived from Hvorslev and are presented along with the results in Appendix A.

Prior to water sampling, the water monitoring standpipes were purged until at least three well volumes of water had been removed. Temperature, dissolved oxygen levels, pH, resistivity, conductivity, dissolved solids, salinity and redox potential readings were also taken at various levels during well development and the readings are presented in Appendix A.

Boreholes for Dock Wall

At four locations, a series of boreholes were drilled perpendicular to the dock wall in an attempt to define the dock wall structure. A graphical section for each series of boreholes is presented in Appendix A.

The boreholes, referenced P01, P01A, P01B, P01C, P02, P02A, P03, P03A, P04 and P04A (Appendix A), were formed using a track-mounted Geotechnical Pioneer Rig. Initially, the surface hardstanding was drilled using waterflush rotary coring techniques of 300mm

diameter. Thereafter, an inspection pit was hand excavated at each borehole location to a maximum depth of 1.20m to check for buried services.

The boreholes P04 and P04A were terminated within the inspection pit due to encountering a concrete structure / foundation at 0.50m (P04) and buried cable and pipe at 0.50m (P04A).

The boreholes P01, P01A, P01B, P01C, P02, P02A, P03 and P03A, were then advanced by a combination of flushing the casing using water (168mm, no samples were recovered) and rotary coring using a water flush. During the coring, a double-tube swivel core barrel with semi-rigid plastic liner was utilised to recover a continuous sample of 120mm diameter.

On completion, boreholes P01, P01A, P01B, P01C, P02, P03 and P03A were backfilled with bentonite pellets and the surface reinstated with concrete. On completion, boreholes P02A, P04 and P04A were backfilled with arisings and the surface reinstated with concrete.

General

Samples for chemical analyses were dispatched from site directly to i2 Analytical UK Ltd under a Chain of Custody. The remaining samples were brought to GEL's laboratory for testing and storage.

A Bathymetry survey of the dock basin was arranged by the Client and undertaken by a third party. The samples obtained, referenced 1 to 7, were collected from site by GEL and brought GEL’s laboratory for testing and storage.

3.2 Logging

The logging of soils and rocks was carried out by an Engineering Geologist in general accordance with BS5930:2015. A key to the exploratory hole logs is presented in Appendix A.

Detailed descriptions of the core and samples are given in the borehole logs, Appendix A, along with details of sampling, in situ testing, groundwater ingress, installations and relevant comments on drilling techniques.

Suitable core subsamples were selected by the Client. The core was carefully logged and prepared prior to preserving the subsample by wrapping in clingfilm and tinfoil and coating with at least three layers of wax. The sample was further protected by a covering of waxed cheesecloth, labelled and transported horizontally in padded, wooden coreboxes.

Prior to logging, photographs of the core were taken and are presented separately.

3.3 Laboratory Testing

A schedule of laboratory tests was prepared by the Client, the following tests being carried out in accordance with BS1377:1990, unless stated otherwise. The number in brackets refers to the test number given in that standard. The results are presented in Appendix B.

The natural water content was determined on twenty-six selected samples in accordance with BS EN ISO 17892-1:2014.

Liquid limit, plastic limit and plasticity index tests [Part 2:4.3, 5.3 and 5.4] were carried out on fifteen selected samples. Atterberg line plots have also been presented.

Particle size distributions were determined in accordance with BS EN ISO 17892-4:2016 for thirteen samples by wet sieving [Part 5.2]. The fine fractions of all of these samples were further analysed by sedimentation using the pipette method [Part 5.4]. The results are presented as grading curves.

The compaction characteristics of one selected soil sample were investigated using a 2.5kg rammer [Part 4:3.2 and 3.3/3.4]. The results are presented as a plot of dry density against moisture content.

The one-dimensional consolidation properties [Part 5:3] were determined in the oedometer on two 63.5mm or 50mm diameter by 19mm or 20mm thick specimens prepared from UT100 samples. The results are presented in tabular form and also as graphs of void ratio versus log (effective pressure).

Unconsolidated undrained triaxial compression tests were carried out under a single cell pressure on two specimens prepared from full diameter UT100 samples [Part 7:8]. A cell pressure specified by the Consultant was used. Fully saturated, ϕ_u = 0, conditions were assumed and the undrained cohesion, c_u was taken as half the deviator stress at failure.

The following tests on rock samples were carried out in accordance with ISRM (2007) unless stated otherwise. Test results are presented in Appendix B.

Fifteen rock cores were tested for their unconfined compressive strength. In addition, for four of these samples, axial and radial strain measurements were made using strain gauges to enable Young's modulus and Poisson's ratio to be calculated.

Point load index tests were carried out on fifteen selected lengths of core.

The BRE SD1 (2005) suite of tests was carried out on four samples by Chemtest UK Ltd using in-house methods.

Selected samples were despatched to i2 Analytical Ltd where chemical analyses were carried out to in-house methods for a suite of contaminants. The results are presented in Appendix C.

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4. REFERENCES

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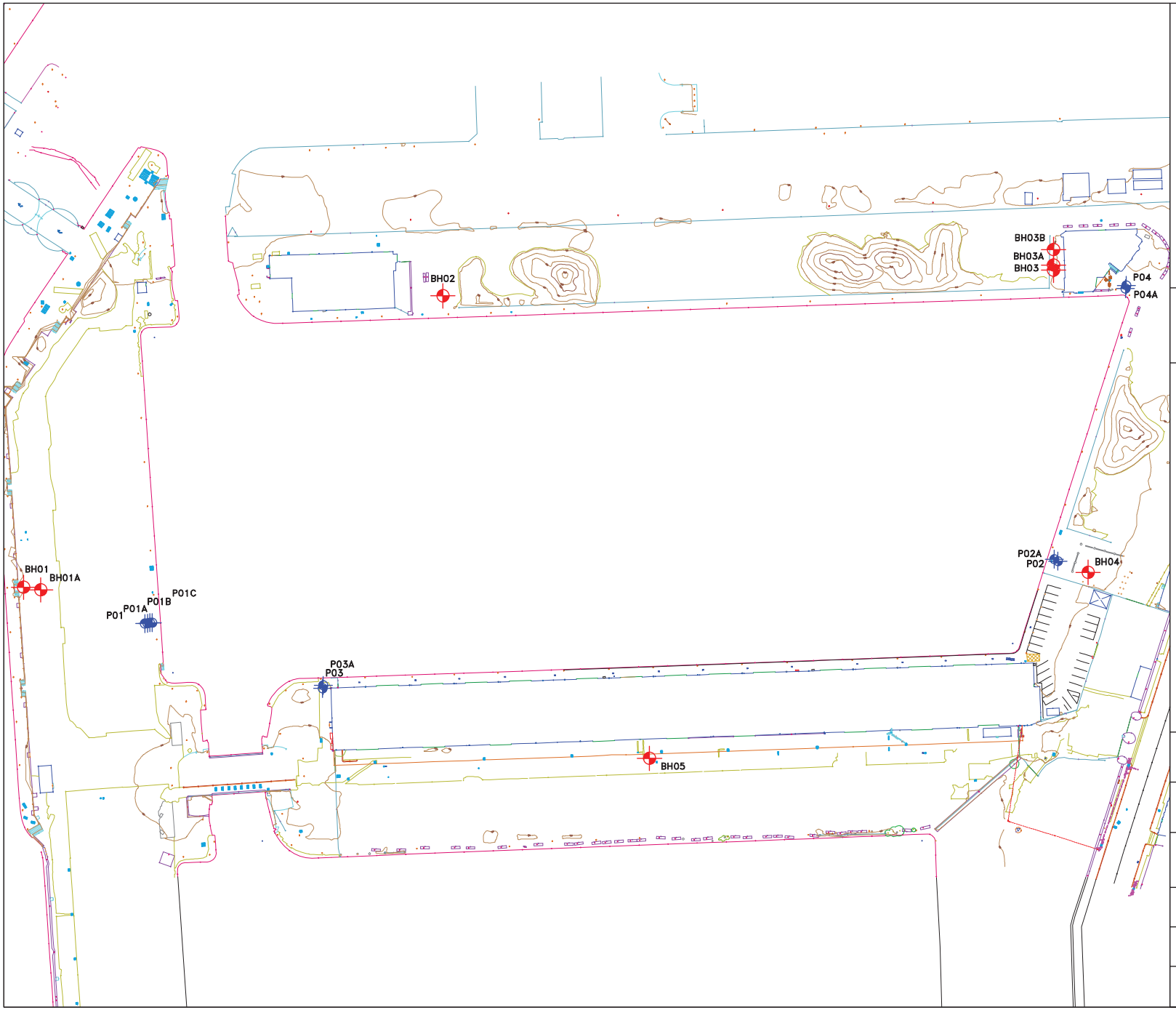

Key.

Borehole Location

Probehole Location

N

Notes:

Drawing supplied by the Client

geotechnical

Geotechnical Engineering Ltd

Centurion House, Olympus Park, Quedgeley, Gloucester GL2 4NF

Telephone: (01452) 527743 Facsimile: (01452) 729314

E-mail: geotech@geoeng.co.uk Web: www.geoeng.co.uk

Client: BURO HAPPOLD

Site: PROJECT BLUE

Title: EXPLORATORY HOLE LOCATION PLAN

Drawn By:	Checked By:	Paper Size:
PS	CT	A3

Scale:	Date:
1:1500	SEPTEMBER 2017

Contract:	Figure:
33138	01

APPENDIX A

FIELDWORK DATA

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KEY TO EXPLORATORY HOLE LOGS

Sample type

D	Small disturbed	U	Undisturbed	X/L	Dynamic	D*/ES	Environmental - soil	Cs	Core subsample (prepared)
B	Bulk disturbed	UT	Undisturbed thin wall	C	Core	EW	Environmental - water	Xs/Ls	Dynamic subsample (prepared)
LB	Large bulk disturbed	P	Piston	W	Water				

Test type

S SPT - Split spoon sampler followed by uncorrected SPT 'N' Value
C SPT - Solid cone followed by uncorrected SPT 'N' Value
(*250 - Where full test drive not completed, linearly extrapolated 'N' value reported, ** - Denotes no effective penetration)
H Hand vane - direct reading in kPa - not corrected for BS1377 (1990). Re* denotes refusal
M Mackintosh probe - number of blows to achieve 100mm penetration
PP Pocket penetrometer - direct reading in kg/sq.cm
Vo Headspace vapour reading, uncorrected peak values in ppm, using a PID (calibrated with Isobutylene, using a 10.6eV bulb)

Sample/core range/l_f

Dynamic sample

Undisturbed sample - open drive including thin wall. Symbol length reflects recovery

x x = Total Core Recovery (TCR) as percentage of core run

y y = Solid Core Recovery (SCR) as percentage of core run. Assessment of core is based on full diameter.

z z = Rock Quality Designation (RQD). The amount of solid core greater than 100mm expressed as percentage of core run.

Where SPT has been carried out at beginning of core run, disturbed section of core excluded from SCR and RQD assessment.

l_f - fracture spacing - the modal fracture spacing (mm) over the indicated length of core. Where spacing varies significantly, the minimum, mode and maximum values are given. NI = non-intact core NA = not applicable

Instrumentation

Porous tip | Perforated standpipe | Granular response zone | Bentonite seal | Cement/ bentonite grout | Soil Backfill | Concrete

Stratum boundaries

Estimated boundary

Grading boundary

Logging

The logging of soils and rocks has been carried out in general accordance with BS 5930:2015.

Chalk is logged in general accordance with Lord et al (2002) CIRIA C574. Where possible, dynamic samples in chalk have been logged in accordance with CIRIA C574; descriptions and gradings (if presented) should be treated with caution given the potential for sample disturbance.

For rocks the term fracture has been used to identify a mechanical break within the core. Where possible incipient and drilling induced fractures have been excluded from the assessment of fracture state. Where doubt exists, a note has been made in the descriptions. All fractures are considered to be continuous unless otherwise reported.

Made Ground is readily identifiable when, within the material make up, man made constituents are evident. Where Made Ground appears to be reworked natural material the differentiation between in situ natural deposits and Made Ground is much more difficult to ascertain. The interpretation of Made Ground within the logs should therefore be treated with caution.

The descriptors "topsoil" and "tarmacadam" are used as generic terms and do not imply conformation to any particular standard or composition.

Rootlets are defined as being less than 2mm in diameter, roots are defined as in excess of 2mm diameter.

General Comments

The process of drilling and sampling will inevitably lead to disturbance, mixing or loss of material in some soil and rocks.

Indicated water levels are those recorded during the process of drilling or excavating exploratory holes and may not represent standing water levels.

All depths are measured along the axis of the borehole and are related to ground level at the point of entry. All inclinations are measured normal to the axis of the core.

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BOREHOLE LOG

BH01

CLIENT	BUROHAPPOLD					Sheet	1 of 1
SITE	PROJECT BLUE					Scale	1 : 50
Start Date	19 June 2017	Easting	333248.0				
End Date	21 June 2017	Northing	392455.0	Ground level	6.55mOD	Depth	5.65 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
19/06/17 1130hrs	1B	0.20 - 0.50						Brown silty very gravelly (ashy) fine to coarse SAND with frequent subangular cobble sized concrete blockwork. Gravel is angular to rounded fine to coarse brick, concrete, coal and clinker. (MADE GROUND) 0.40m: Granite wall on east side of pit (base not proven).			
	1ES	0.20 - 0.50		Vo 0.0							
19/06/17 1600hrs Dry	2B	1.00 - 1.20									
	2ES	1.00 - 1.20		Vo 0.0							
		1.20 - 1.65	Nil	C 4							
20/06/17 0700hrs Dry	3L	1.20 - 2.20									
	4D	2.00									
	3ES	2.10		Vo 0.0					2.10	4.45	
		2.20 - 2.65	Nil	C 8				Loose locally medium dense reddish brown locally yellowish brown slightly clayey very sandy subangular to rounded fine to coarse sandstone, siltstone and clinker GRAVEL with medium rounded sandstone cobble content. (MADE GROUND)			
	5L	2.20 - 3.20									
	6D	3.00									
	4ES	3.10		Vo 0.0							
		3.20 - 3.65	Nil	C 12							
	7L	3.20 - 4.20									
	8D	4.00									
	5ES	4.10		Vo 0.0							
		4.20 - 4.65	3.20	C8							
	9L	4.20 - 5.20									
	10D	5.00									
20/06/17 1600hrs 0.00m	6ES	5.10		Vo 0.0							
	11D	5.20 - 5.65	3.20	S 15							
21/06/17 0700hrs 3.72m								Borehole completed at 5.65m.	5.65	0.90	
									{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-1.20m. Dynamic sampled (128mm) 1.20-5.20m.

CASING: 168mm diam to 5.20m.

BACKFILL: On completion, hole backfilled with bentonite pellets 5.65-1.00m and arisings 1.00-0.00m.

REMARKS: Falling head permeability test undertaken at 5.20m (reported separately). Casing flushed to 5.50m following SPT at 5.20m in attempt to re-align borehole. Borehole abandoned at 5.65m on Client's instruction as unable to straighten casing. Borehole reattempted approximately 1m to the north as BH01A.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
5.20	3.20	4.90	20	Slow

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BOREHOLE LOG

BH01A

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 3
Start Date	21 June 2017	Easting	333254.0			Scale	1 : 50
End Date	22 June 2017	Northing	392454.0	Ground level	6.70mOD	Depth	21.20 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	I_f	instru -ment	description	depth (m)	reduced level (m)	legend
21/06/17 1000hrs	1C	0.00 - 0.15						NO RECOVERY. Casing used to advance borehole (refer to BH01).			
									5.50	1.20	
	2L	5.50 - 7.00	5.50					Medium dense reddish brown locally yellowish brown and greyish brown clayey very gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse sandstone, siltstone and clinker. (MADE GROUND)			
	3D	6.00									
	1ES	6.10		Vo 0							
		7.00 - 7.45	7.00	C 11							
	4L	7.00 - 8.50									
	5D	7.50									
	2ES	7.60		Vo 0							
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Waterflush rotary core drilled (300mm) 0.00-0.15m. Casing used to advance borehole (200mm) 0.15-1.50m and (168mm) 1.50-5.50m. Dynamic sampled (128mm) 5.50-9.80m. Rotary core drilled (146mm) 9.80-21.20m using a polymer flush.

CASING: 200mm diam to 1.50m and 168mm diam to 11.30m.

BACKFILL: On 26/06/17, borehole backfilled with bentonite pellets 21.20-12.00m. A vibrating wire piezometer (Serial No. 343611) was installed at 10.00m, cement:bentonite grout 12.00-1.00m, bentonite pellets 1.00-0.50m, concrete and stopcock cover 0.50-0.00m.

REMARKS: Driller notes reduced flush returns 9.80-21.20m (60-80% returned). Falling head permeability tests undertaken between 11.30-15.40m and 11.30-21.20m. Packer infiltration tests undertaken on 23/03/17 at 13.90-15.80m and 17.50-19.40. Results presented separately.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

BH01A

CLIENT	BUROHAPPOLD					Sheet	2 of 3
SITE	PROJECT BLUE					Scale	1 : 50
Start Date	21 June 2017	Easting	333254.0				
End Date	22 June 2017	Northing	392454.0	Ground level	6.70mOD	Depth	21.20 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	I_f	instru -ment	description	depth (m)	reduced level (m)	legend
								7.80 - 8.10m: Locally tending to clayey very sandy fine to coarse subangular sandstone, siltstone and clinker gravel.			
		8.50 - 8.95	8.50	C 24							
	6L	8.50 - 9.80									
									9.00	-2.30	
	7D	9.00						Soft brown slightly gravelly sandy CLAY with frequent pockets (up to 50mm) of grey, black and yellowish brown fine to coarse sand. Gravel is subangular and subrounded fine to coarse sandstone.			
	3ES	9.10		Vo 0					9.60	-2.90	
		9.80 - 9.91	9.80	C*214		NA					
	8C	9.80 - 11.30			60			Very dense reddish brown gravelly fine to coarse SAND. Gravel is subrounded fine to coarse lithorelicts of extremely and very weak sandstone. COMPLETELY WEATHERED SANDSTONE?. 9.60m: Band (30mm) of frequent shell fragments (up to 3mm diam).			
	9D	10.50									
	4ES	10.60		Vo 0							
21/06/17 1630hrs 2.94m											
		11.30 - 11.40	11.30	C*500							
22/06/17 0700hrs 3.77m	10C	11.30 - 12.80			100 70 60						
								11.60 - 11.75m: Yellowish brown.	11.75	-5.05	
						90 250 500		Very weak locally weak reddish brown fine and medium SANDSTONE with closely to widely spaced thin beds of fine yellowish brown locally greenish brown sandstone. Fractures are subhorizontal to 30° rarely 60° closely and medium spaced planar and undulating smooth locally stained black. 12.15m: Frequent 30° subhorizontal black wisps.			
	11Cs	12.00 - 12.20									
	12C	12.80 - 14.30	11.30		100 100 90						
	13Cs	13.95 - 14.15									
	14C	14.30 - 15.40	11.30		100 100 81						
	15Cs	14.70 - 14.90						14.90m: Band (30mm) of coarse sandstone.			
	16C	15.40 - 16.90	11.30		96 96 82						
	17Cs	15.90 - 16.10						16.10 - 16.70m: Fine sandstone.			
						50 90 150		16.80 - 17.75m: Fractures are subhorizontal to 30°, 60° and subvertical very closely and closely spaced undulating smooth.			
	18C	16.90 - 18.40	11.30		92 80 43						
						90 250					
								Continued Next Page	{18.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks
				Groundwater not encountered prior to use of water flush.

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BOREHOLE LOG

BH01A

CLIENT	BUROHAPPOLD					Sheet	3 of 3
SITE	PROJECT BLUE					Scale	1 : 50
Start Date	21 June 2017	Easting	333254.0				
End Date	22 June 2017	Northing	392454.0	Ground level	6.70mOD	Depth	21.20 m

progress date/time water depth	sample no & type	depth (m) from	to	casing depth (m)	test type & value	samp. /core range	I_f	instru -ment	description	depth (m)	reduced level (m)	legend
							500		17.75 - 18.00m: Subhorizontal to 20° thick lamination of yellowish brown and yellowish grey fine sandstone.			
	19C 20Cs	18.40 18.50	19.70 18.90	11.30		100 100 93			18.40 - 19.50m: Medium and coarse sandstone.			
	21C	19.70	21.20	11.30		100 100 96						
22/06/17 1630hrs 3.60m	22Cs	21.00	21.20							21.20	-14.50	
									Borehole completed at 21.20m.			
										{28.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

BH02

CLIENT	BUROHAPPOLD					Sheet	1 of 3
SITE	PROJECT BLUE					Scale	1 : 50
Start Date	14 June 2017	Easting	333392.0				
End Date	15 June 2017	Northing	392555.0	Ground level	6.75mOD	Depth	25.40 m

progress date/time water depth	sample no & type	depth (m) from	to	casing depth (m)	test type & value	samp. /core range	I_f	instru -ment	description	depth (m)	reduced level (m)	legend
14/06/17 1300hrs	1D	0.10							MADE GROUND comprising light grey locally black TARMACADAM.	0.10	6.65	
	2B	0.50								0.40	6.35	
	3D	0.50							Dark grey slightly clayey gravelly fine to coarse SAND. Gravel is angular and subangular fine to coarse concrete, tarmacadam and rare sandstone. (MADE GROUND)			
	1ES	0.50			Vo 0.0							
	4B	1.00										
	5D	1.00										
	2ES	1.00			Vo 0.0				Reddish brown slightly clayey gravelly fine to coarse SAND. Gravel is angular and subangular fine to coarse sandstone. (MADE GROUND) 1.20m: Loose.			
	6D	1.20 - 1.65		Nil	S 9							
	7L	1.20 - 2.20										
	8D	1.50										
	3ES	1.50			Vo 0.0					1.75	5.00	
	9D	2.00							Grey locally mottled reddish brown clayey gravelly fine to coarse SAND with frequent shell fragments (up to 18mm). Gravel is subrounded and rounded fine to coarse sandstone. (MADE GROUND)			
	4ES	2.00			Vo 0.0							
	10D	2.20 - 2.65		Nil	S 7							
	11L	2.20 - 3.20								2.50	4.25	
									Loose reddish brown clayey very gravelly fine to coarse SAND with frequent pockets (120mm) of soft brownish grey slightly gravelly sandy clay. Gravel is subrounded and rounded fine to coarse sandstone. (MADE GROUND) 3.00 - 3.10m: Low subangular sandstone cobble content. 3.10 - 3.80m: Frequent pockets (up to 35mm) of firm grey slightly sandy clay.			
	5ES	3.00			Vo 0.0							
	12D	3.20 - 3.65		Nil	S 7							
	13L	3.20 - 4.20										
	14D	3.50								3.80	2.95	
14/06/17 1615hrs 0.00m									Firm brownish grey slightly sandy slightly gravelly CLAY. Gravel is subrounded and rounded fine to coarse sandstone. (MADE GROUND)	4.05	2.70	
	6ES	4.00			Vo 0.0					4.20	2.55	
15/06/17 0800hrs 0.40m	15UT	4.20 - 4.65		4.20					Firm becoming stiff grey slightly sandy gravelly CLAY. Gravel is subangular to rounded fine to coarse sandstone and rare siltstone. (MADE GROUND)			
	16L	4.20 - 5.20										
	17D	4.65 - 4.70										
	18D	5.00							Reddish brown and grey clayey very gravelly fine to coarse SAND. Gravel is subrounded and rounded fine to coarse sandstone. (MADE GROUND) 4.95 - 5.10m: Low subangular sandstone cobble content.			
	7ES	5.00			Vo 0.0							
	19UT	5.20 - 5.65		5.20								
	20L	5.20 - 6.70								5.60	1.15	
									Dark reddish brown, reddish brown and grey angular to subrounded fine to coarse sandstone with rare brick, concrete and crystalline GRAVEL. (MADE GROUND)			
	8ES	6.00			Vo 0.0							
										6.35	0.40	
	21D	6.50							Dark reddish brown and dark brown slightly clayey slightly gravelly fine to coarse SAND. Gravel is angular and subangular fine sandstone and rare fine brick. (MADE GROUND)			
	22UT	6.70 - 7.15		6.70								
	23L	6.70 - 8.20										
	9ES	7.00			Vo 0.0				7.00 - 7.20m: Gravelly. Gravel is angular to subrounded fine to coarse sandstone with rare brick and concrete.	7.20	-0.45	
									Stiff locally firm fissured brown slightly gravelly slightly sandy silty CLAY with rare shell fragments (up to 2mm). Fissures are subhorizontal extremely closely spaced planar smooth.			
	24D	8.00										
	10ES	8.00			Vo 0.0							
									Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Waterflush rotary core drilled (300mm) 0.00-0.10m. Hand dug inspection pit 0.10-1.20m. Dynamic sampled (128mm) 1.20-9.20m. Rotary core drilled (146mm wireline) 9.20-25.40m using a polymer flush.

CASING: 167mm diam to 8.20m, 146mm to 25.40m.

BACKFILL: On completion, hole backfilled with bentonite pellets 25.40-6.00m. A slotted standpipe (50mm) was installed to 6.00m, granular response zone 6.00-0.50m, concrete and raised cover 0.50- 0.00m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
3.20	Nil	1.70	20	Encountered following run 2.20-3.20m.

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BOREHOLE LOG

BH02

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	2 of 3
Start Date	14 June 2017	Easting	333392.0			Scale	1 : 50
End Date	15 June 2017	Northing	392555.0	Ground level	6.75mOD	Depth	25.40 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	I_f	instru -ment	description	depth (m)	reduced level (m)	legend
		8.20 - 8.65	8.20	S 15							
	25L	8.20 - 9.20									
	26Cs	8.40 - 8.80									
	11ES	9.00		Vo 0.0				8.90 - 9.05m: Frequent pockets (up to 60mm) of brown slightly clayey gravelly fine to coarse sand. Gravel is subangular to rounded fine and medium sandstone and rare siltstone.	9.15	-2.40	
	27D	9.20 - 9.63	9.20	S*55							
	28C	9.20 - 9.80			100 5 0						
	29D	9.50				NI 100 190		Very dense reddish brown slightly gravelly clayey fine to coarse SAND. Gravel is subangular to rounded fine and medium sandstone.	9.65	-2.90	
	30C	9.80 - 9.90	9.80		100						
	31C	9.90 - 10.40	9.90		100 82 48			Weak locally very weak reddish brown locally grey fine and medium SANDSTONE. Fractures are subhorizontal locally randomly orientated very closely and closely spaced planar smooth locally planar rough. 9.90 - 10.15m: Fractures are 50° closely spaced planar smooth stained black.	10.40	-3.65	
	32C	10.40 - 11.90	10.40		100 64 21	NA					
						NI 90 200		Reddish brown very clayey fine to coarse SAND.	10.95	-4.20	
	33D	11.10						Weak locally very weak reddish brown, dark reddish brown and grey fine and medium SANDSTONE. Fractures are subhorizontal to 20° very closely to medium spaced planar smooth locally planar rough locally stained black. 10.95 - 11.20m: Subvertical extremely closely spaced undulating smooth fractures. 11.10 - 11.40m: Light grey fine to coarse sandstone. 11.90 - 12.50m: Yellow, orangish brown and light grey fine to coarse sandstone. 12.50 - 12.70m: Dark grey and black. Fractures are 30° extremely closely to closely spaced planar smooth locally planar rough. 12.70 - 12.85m: Light grey fine to coarse sandstone. 13.00 - 14.10m: Black and dark grey mottled dark reddish brown.			
	34C	11.90 - 13.40	11.90		99 97 37						
	35Cs	13.05 - 13.20									
	36C	13.40 - 14.90	13.40		100 94 48						
	37Cs	13.75 - 13.95									
	38C	14.90 - 16.40	14.90		100 99 71						
	39Cs	15.15 - 15.60				110 200 430		15.75 - 15.80m: Light grey fine to coarse sandstone.			
						20 90 130					
	40C	16.40 - 17.90	16.40		97 97 58	290					
	41Cs	16.55 - 16.85						16.55 - 16.90m: Light grey fine to coarse sandstone.			
						5 50 120					
						350					
						40 70					
								Continued Next Page	{18.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	AGS	CONTRACT	CHECKED
						33138	JH

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BOREHOLE LOG

BH02

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	3 of 3
Start Date	14 June 2017	Easting	333392.0			Scale	1 : 50
End Date	15 June 2017	Northing	392555.0	Ground level	6.75mOD	Depth	25.40 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	I_f	instru -ment	description	depth (m)	reduced level (m)	legend
	42C	17.90 - 19.40	17.90		99 97 67	90		17.90 - 18.00m: Light yellowish grey.			
						130 300 310		18.30 - 18.45m: Reddish brown mottled yellowish brown and light grey.			
	43Cs	18.70 - 18.90						18.85 - 19.00m: Light grey fine to coarse sandstone.			
						20 130 285					
	44C	19.40 - 20.90	19.40		94 81 48						
	45Cs	20.20 - 20.50						20.20 - 20.80m: Medium strong. Yellowish grey, reddish brown, yellowish brown and dark grey.			
						NI 50 90		20.60 - 20.75m: Laminations are 30° extremely closely spaced planar rough.			
	46C	20.90 - 22.40	20.90		99 98 58	80 160 270					
								21.40 - 21.55m: 50° planar rough fracture.			
						NI 80 130					
	47C	22.40 - 23.90	22.40		100 100 91						
	48Cs	22.65 - 23.00				370 500		22.60 - 22.80m: Yellowish grey, dark reddish brown locally orangish brown.			
								23.15m: Subhorizontal stepped rough insipient fracture.			
						60 140 180					
	49C	23.90 - 25.40	23.90		80 80 60						
						320		24.05m: Band (25mm) of yellowish grey fine to coarse sandstone.			
						40 100 140		24.30 - 24.55m: Yellowish grey, reddish brown locally orangish brown.			
15/06/17 1700hrs 3.33m									25.10	-18.35	
								25.10 - 25.40m: Assessed zone of core loss. No recovery.	25.40	-18.65	
								Borehole completed at 25.40m.			
									{28.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	AGS	CONTRACT	CHECKED
						33138	JH

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BOREHOLE LOG

BH03

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 1
Start Date	19 June 2017	Easting	333601.0			Scale	1 : 50
End Date	19 June 2017	Northing	392564.0	Ground level	6.95mOD	Depth	0.30 m

progress date/time water depth	sample no & type	depth (m) from	to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
	C	0.00	0.30						Dark brown mottled black slightly clayey gravelly fine to coarse SAND with a low subangular brick cobble content. Gravel is angular and subangular fine to coarse brick, concrete and sandstone with rare crystalline, ceramic and wood fragments. (MADE GROUND) 0.10 - 0.20m: Rare metal fragments (up to 150mm).	0.20	6.75	
	1D	0.10							MADE GROUND comprising light grey CONCRETE.	0.30	6.65	
19/06/17 1230hrs	1ES	0.10			Vo 0.0				Borehole completed at 0.30m.			
19/06/17 1300hrs Dry										{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Waterflush rotary core drilled (300mm) 0.00-0.30m.

CASING: None used.

BACKFILL: On completion, borehole backfilled with concrete 0.30-0.00m.

REMARKS: Surface concrete too hard to penetrate below 0.30m. Borehole terminated at 0.30m on Client's instruction and reattempted approximately 1m to the north as BH03A.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	CONTRACT	CHECKED
				Groundwater not encountered.	33138	JH

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BOREHOLE LOG

BH03A

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 1
Start Date	19 June 2017	Easting	333601.0			Scale	1 : 50
End Date	20 June 2017	Northing	392565.0	Ground level	6.90mOD	Depth	3.50 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
		0.00 - 0.20						Dark brown mottled black slightly clayey gravelly fine to coarse SAND. Gravel is angular and subangular fine to coarse brick, concrete, rare sandstone and wood fragments. (MADE GROUND)	0.20	6.70	
19/06/17 1530hrs Dry	1C	0.20 - 2.20	Nil		100						
	1ES	0.50		Vo 0.0							
20/06/17 0830hrs Dry								MADE GROUND comprising light grey and light brownish grey CONCRETE.	2.20	4.70	
	C	2.20 - 3.20	Nil		0			No recovery. Driller notes void.			
20/06/17 0915hrs Dry									3.50	3.40	
								Borehole completed at 3.50m.	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Waterflush rotary core drilled (300mm) 0.00-0.20m and (146mm) 0.20-3.50m.

CASING: None used.

BACKFILL: On 23/06/2017 an expandable rubber bladder was installed at 1.50m. Borehole backfilled with concrete 1.50-1.30m, bentonite pellets 1.30-0.20m and concrete 0.20-0.00m.

REMARKS: A void was encountered between 2.20-3.50m. Borehole terminated at 3.50m on Client's instruction and redrilled approximately 6m to the north as BH03B.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	CONTRACT	CHECKED
				Groundwater not encountered.	33138	JH

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BOREHOLE LOG

BH03B

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 1
Start Date	20 June 2017	Easting	333601.0			Scale	1 : 50
End Date	20 June 2017	Northing	392571.0	Ground level	6.85mOD	Depth	3.20 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
20/06/17 1100hrs	1C	0.00 - 2.80	Nil		88			MADE GROUND comprising light grey and light brownish grey CONCRETE.	1.40	5.45	
								Light grey angular to rounded fine to coarse concrete, crystalline, brick and rare sandstone GRAVEL. (MADE GROUND)	1.50	5.35	
								MADE GROUND comprising red BRICKWORK. Bricks (70mm) are dark red and dark reddish brown with rare yellow inclusions and less than 5% voids (up to 5mm). Mortar (up to 20mm thick) is dark grey well bonded with rare inclusions (up to 2mm) of red brick and up to 10% voids (up to 8mm). 2.45 - 2.80m: Metal fragment (350mm).	2.55	4.30	
20/06/17 1145hrs Dry	C	2.80 - 3.20	Nil		0			MADE GROUND comprising grey and dark grey CONCRETE.	2.80	4.05	
								No recovery. Driller notes void.	3.20	3.65	
								Borehole completed at 3.20m.	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.
METHOD: Waterflush rotary core drilled (146mm) 0.00-3.20m.
CASING: None used.
BACKFILL: On 23/06/2017 an expandable rubber bladder was installed at 2.80m. Hole backfilled with concrete 2.80-2.60m, bentonite pellets 2.60-0.20m and concrete 0.2-0.00m.
REMARKS: A void was encountered between 2.80-3.20m. Borehole abandoned on Client's instruction.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	CONTRACT	CHECKED
				Groundwater not encountered.	33138	JH

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BOREHOLE LOG

BH04

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 3
Start Date	12 June 2017	Easting	333613.0			Scale	1 : 50
End Date	14 June 2017	Northing	392460.0	Ground level	6.85mOD	Depth	24.50 m

progress date/time water depth	sample no & type	depth (m) from	to	casing depth (m)	test type & value	samp. /core range	I_f	instru -ment	description	depth (m)	reduced level (m)	legend
12/06/17 1315hrs	1C	0.10	0.20	Nil		100			Light grey slightly clayey sandy (ashy) angular and subangular fine to coarse sandstone GRAVEL. (MADE GROUND)	0.10	6.75	
	2B	0.20	0.50							0.20	6.65	
	1ES	0.20	0.50		Vo 341				MADE GROUND comprising light grey CONCRETE.			
	3B	1.00	1.20						Black and grey clayey very sandy angular and subangular fine to coarse sandstone, brick, slag, clinker and coal GRAVEL. (MADE GROUND)			
	2ES	1.00	1.20		Vo 82							
		1.20	1.65	Nil	C 3							
	4L	1.20	2.00						0.40 - 0.60m: High subangular brick and masonry cobble content. 0.90m: Single cobble sized fragment of nodular slag and fragments of timber (300x40x20mm). 1.20 - 3.10m: Very loose.			
		2.00	2.45	Nil	C 5							
	5L	2.00	2.60						2.00 - 2.60m: Strong hydrocarbon odour.			
12/06/17 1730hrs 2.07m	3ES	2.00			Vo 121							
13/06/17 0900hrs 2.10m	6C	2.60	4.00	2.60		89	NA		2.60 - 2.80m: High subangular brick and masonry cobble content.			
										3.10	3.75	
									MADE GROUND comprising dark red BRICKWORK.	3.35	3.50	
									MADE GROUND comprising strongly cemented light grey CONCRETE composed of 70% subangular to rounded fine to coarse gravel sized aggregate of sandstone with up to 2% voids (up to 3mm).	3.85	3.00	
	C	4.00	5.00	2.60		0	NR		NO RECOVERY.			
										5.00	1.85	
	7L	5.00	6.00	2.60			NA		Dark grey gravelly fine to coarse SAND. Gravel is angular to rounded fine to coarse sandstone, siltstone, brick and coal. (MADE GROUND)			
	4ES	5.00			Vo 6.2					5.50	1.35	
	5ES	5.60			Vo 0.0				Stiff brown slightly sandy slightly gravelly silty CLAY. Gravel is subangular to rounded fine and medium, rarely coarse sandstone and siltstone.			
	8D	6.00	6.45	2.60	S 21							
	9L	6.00	7.10	6.00					5.50 - 5.80m: Firm.			
	6ES	6.60			Vo 0.0							
	10UT	7.10	7.60	7.10		92	NA		7.60m: Pocket (50mm) of yellowish brown silty fine sand. 7.60 - 10.10m: Gravel is fine to coarse.			
	11C	7.10	8.60									
	12D	7.40										
	13D	7.50										
									Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Hand dug inspection pit 0.00-0.10m and 0.20-1.20m. Dynamic sampled (128mm) 1.20-2.60m and 5.00-7.10m. Waterflush rotary core drilled (300mm) 0.10-0.20m, (146mm) 2.60-5.00m and 7.10-24.50m.

CASING: 168mm diam to 11.60m.

BACKFILL: On 15/06/17 the borehole collapsed 24.50m to 21.60m. A vibrating wire piezometer (Serial No. 343611) was installed at 21.00m, cement:bentonite grout 21.60-17.00m and bentonite seal 17.00-7.00m. On 19/06/17, a standpipe piezometer (19mm) was installed with tip at 6.00m, granular response zone 7.00-1.00m, bentonite seal 1.00-0.50m, concrete and stopcock cover 0.30- 0.00m.

REMARKS: Driller notes loss od flush returns 2.60-5.00m and reduced flush returns (60-70% returned) 14.00-24.50m. Packer infiltration tests undertaken 15/06/17 at 14.10-16.00m and 18.90-20.80m (reported separately).

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
2.60	Nil	2.05	20	Rapid inflow following dynamic sample run 2.00-2.60m.

CONTRACT	CHECKED
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BOREHOLE LOG

BH04

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	2 of 3
Start Date	12 June 2017	Easting	333613.0			Scale	1 : 50
End Date	14 June 2017	Northing	392460.0	Ground level	6.85mOD	Depth	24.50 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	I_f	instru -ment	description	depth (m)	reduced level (m)	legend
	14D 15C	8.60 - 9.05 8.60 - 10.10	7.10	S 41	100	NA		8.55m: Pocket (50mm) of yellowish brown silty fine sand. Stiff brown slightly sandy slightly gravelly silty CLAY. Gravel is subangular to rounded fine and medium, rarely coarse sandstone and siltstone. 9.20 - 9.45m: Rare reddish brown staining. 9.45 - 10.10m: Sandy.	8.60	-1.75	
	16D 17C	10.10 - 10.48 10.10 - 11.60	7.10	S*67	28	NA		Limited recovery. Recovered as reddish brown slightly gravelly clayey fine to coarse SAND. Gravel is subangular fine to coarse sandstone.	10.10	-3.25	
	18C	11.60 - 12.50	11.60		89 0 0	NI		Extremely weak thinly laminated poorly cemented reddish brown fine and medium SANDSTONE frequently tending to weakly cemented fine and medium sand. Fractures are subhorizontal to 20° and 80° to subvertical very closely and closely spaced planar smooth.	11.30	-4.45	
	19D 20C	12.45 12.50 - 12.59 12.50 - 14.00	11.60	C*375	100 73 50	250 900 1000		Very weak thinly laminated poorly cemented reddish brown fine and medium SANDSTONE with closely to widely spaced bands (up to 80mm) of light grey fine sandstone. Fractures are subhorizontal to 20° rarely 60° medium to widely spaced planar smooth frequently with fine and medium reddish brown sand on fracture face.	12.70	-5.85	
13/06/17 1700hrs 4.53m	21Cs 22D	13.70 - 13.95 13.95 14.00 - 14.06	11.60	C*750							
14/06/17 0800hrs 3.77m	23C	14.00 - 15.50	11.60		100 93 93						
	24Cs	15.10 - 15.32									
	25D 26C	15.45 15.50 - 17.00	11.60		100 97 97	60 150 400		15.40 - 19.20m: Fractures are subhorizontal to 20°, rarely 60° closely and medium spaced planar smooth.			
	27Cs	16.60 - 16.80									
	28C	17.00 - 18.50	11.60		100 100 100	60 400 800		17.00 - 19.20m: Fractures are subhorizontal to 20°, rarely 60° closely to widely spaced planar smooth. 17.30 - 17.90m: Frequent very closely spaced bands (up to 80mm) of light grey fine sand.			
								Continued Next Page	{18.00}		

water strike (m) casing (m) rose to (m) time to rise (m) remarks

AGS

CONTRACT	CHECKED
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BOREHOLE LOG

BH04

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	3 of 3
Start Date	12 June 2017	Easting	333613.0			Scale	1 : 50
End Date	14 June 2017	Northing	392460.0	Ground level	6.85mOD	Depth	24.50 m

progress date/time water depth	sample no & type	depth (m) from	to	casing depth (m)	test type & value	samp. /core range	I_f	instru -ment	description	depth (m)	reduced level (m)	legend
	29D	18.30										
	30C	18.50	20.00	11.60		100 100 73						
	31Cs	19.05	19.20				70 100 180		19.20 - 19.95m: Fractures are subhorizontal to 20° very closely and closely spaced planar smooth.			
	32C	20.00	21.50	11.60		100 100 82	90 200 280		19.95 - 21.00m: Fractures are subhorizontal to 20° closely and medium spaced planar smooth.			
	33D	21.10					50 120 200		21.00 - 21.50m: 30° planar smooth fracture. 21.00 - 24.50m: Fractures are subhorizontal to 20° very closely and closely spaced planar smooth.			
	34C	21.50	23.00	11.60		100 89 59						
	35D	22.20										
	36C	23.00	24.50	11.60		100 99 73			23.00m: PLT suggests weak.			
	37Cs	23.00	23.27									
14/06/17 1700hrs 3.14m										24.50	-17.65	
									Borehole completed at 24.50m.			
										{28.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	AGS	CONTRACT	CHECKED
						33138	JH

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BOREHOLE LOG

BH05

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 2
Start Date	21 June 2017	Easting	333463.0			Scale	1 : 50
End Date	22 June 2017	Northing	392396.0	Ground level	6.80mOD	Depth	16.20 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range	I_f	instru -ment	description	depth (m)	reduced level (m)	legend
21/06/17 1200hrs	C	0.00 - 0.40			100			MADE GROUND comprising light grey CONCRETE.			
	1D	0.00 - 0.10									
	1ES	0.50		Vo 0.0					0.45	6.35	
	2B	0.50						Brown clayey gravelly fine to coarse SAND with a low subangular concrete cobble content. Gravel is angular to subrounded fine to coarse brick, concrete and rare sandstone. (MADE GROUND)	0.65	6.15	
	3D	0.50									
	2ES	1.00		Vo 0.0							
	4B	1.00									
	5D	1.00							1.25	5.55	
	6D	1.20 - 1.65	Nil	S 4				Soft locally firm dark brown mottled dark reddish brown sandy gravelly CLAY. Gravel is angular to subrounded fine to coarse brick, concrete, rare sandstone and plastic. (MADE GROUND)			
	7L	1.20 - 2.20									
	8D	1.50									
	3ES	1.50		Vo 0.0					1.90	4.90	
	9D	2.00						Loose orangish brown clayey gravelly fine to coarse SAND with a low subangular sandstone cobble content. Gravel is subangular fine to coarse sandstone. (MADE GROUND) 1.60 - 1.90m: Dark brown and dark reddish brown mottled brown and orangish brown.			
	4ES	2.00		Vo 0.0							
	10D	2.20 - 2.65	Nil	S 6							
	11L	2.20 - 3.20									
	5ES	3.00		Vo 0.0					2.90	3.90	
	12D	3.20 - 3.65	Nil	S 6				Loose greyish brown gravelly very clayey fine SAND with rare grey laminae of clay and rare fine gravel sized shell fragments. Gravel is subangular fine to coarse sandstone. (MADE GROUND)			
	13L	3.20 - 4.20									
	14D	3.50						Soft locally very soft dark grey slightly gravelly very sandy silty CLAY. Gravel is angular to rounded fine to coarse brick with rare concrete and sandstone. (MADE GROUND)			
	6ES	4.00		Vo 0.0							
	15D	4.20 - 4.65	4.20	S 5				2.90 - 3.30m: Gravelly, very sandy. 3.50m: Locally tending to dark grey slightly sandy slightly gravelly clayey silt.			
	16L	4.20 - 5.20							4.60	2.20	
								Very soft black mottled dark grey slightly sandy clayey SILT.			
	17D	5.00									
	7ES	5.00		Vo 0.0							
	18UT	5.20 - 5.65	4.20								
	19D	5.65 - 5.70							5.65	1.15	
	20C	5.70 - 7.20	5.70		100 86 21	NI 70 120		Extremely weak and very weak reddish brown fine to coarse SANDSTONE recovered as sandy gravelly clay. Gravel is angular to subrounded fine to coarse sandstone.	5.80	1.00	
	8ES	6.00		Vo 0.0				Very weak locally weak reddish brown fine and medium locally fine to coarse SANDSTONE. Fractures are 20° very closely and closely spaced planar rough locally planar smooth stained dark reddish brown and black locally infilled (up to 2mm) with reddish brown silty clay. 5.85 - 5.95m: 50° planar rough fracture. 6.00 - 6.10m: Recovered as clayey sandy angular and subangular fine to coarse sandstone gravel. 6.05 - 6.15m: 50° planar rough fracture. 7.20 - 7.30m: Subvertical planar smooth fracture.			
21/06/17 1600hrs 2.10m		7.20 - 7.30	7.20	C*250							
22/06/17 0700hrs 2.40m	21C	7.20 - 8.70			100 91 51						
									8.00	-1.20	
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Waterflush rotary core drilled (300mm) 0.00-0.40m. Hand dug inspection pit 0.40-1.20m. Dynamic sampled (128mm) 1.20-5.70m. Rotary core drilled (146mm wireline) 5.70-16.20m using a polymer flush.

CASING: 168mm diam to 5.70m, 146mm 16.20m.

BACKFILL: On completion, borehole backfilled with bentonite pellets 16.20-6.50m. A standpipe piezometer (19mm) was installed with tip at 5.10m, granular response zone 5.60-4.60m, bentonite seal 4.60-0.50m, concrete and stopcock cover 0.50-0.00m.

REMARKS: Falling head test undertaken at 13.20m (results presented separately).

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

BH05

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	2 of 2
Start Date	21 June 2017	Easting	333463.0			Scale	1 : 50
End Date	22 June 2017	Northing	392396.0	Ground level	6.80mOD	Depth	16.20 m

progress date/time water depth	sample no & type	depth (m) from	to	casing depth (m)	test type & value	samp. /core range	I_f	instru -ment	description	depth (m)	reduced level (m)	legend
	22Cs	8.40	8.55				NI 90 180		Very weak to weak reddish brown and yellowish brown fine and medium SANDSTONE. Fractures are subhorizontal to 10° very closely and closely spaced planar rough and planar smooth stained dark reddish brown and black.			
	23C	8.70	10.20	8.70		87 60 12						
	24Cs	9.65	9.85									
	25C	10.20	11.70	10.20		98 95 59						
	26Cs	11.50	11.70									
	27C	11.70	13.20	11.70		97 97 71				12.00	-5.20	
							150 240 350		Very weak to weak reddish brown fine and medium SANDSTONE. Fractures are subhorizontal to 10° medium spaced planar rough.			
	28Cs	12.80	13.05						12.80m: UCS test suggests medium strong.			
							180 150 200		13.05 - 13.10m: Yellowish brown and grey.			
	29C	13.20	14.70	13.20		100 87 82			13.20 - 13.40m: Recovered as brown clayey gravelly fine to coarse sand.			
	30D	13.20	13.40									
	9ES	13.20	13.40		Vo 0.0							
	31Cs	13.40	13.65									
							NI 100 150		14.10 - 14.60m: Fractures are closely spaced.			
									14.40 - 14.50m: Subvertical planar rough fracture.			
							350 350 410					
	32C	14.70	16.20	14.70		100 99 91						
	33Cs	14.70	14.95						14.90m: Yellowish brown and grey band (30mm).			
22/06/17 0930hrs 1.45m										16.20	-9.40	
									Borehole completed at 16.20m.			
										{18.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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STANDARD PENETRATION TEST

CLIENT BUROHAPPOLD

SITE PROJECT BLUE

borehole no.	borehole depth (m)	s.w.p (m)	bottom depth (m)	casing depth (m)	water level (m)	seating drive blows	seating drive pen (mm)	test drive blows	test drive pen (mm)	test type	N	energy ratio (%)
BH01	1.20		1.65	Nil	Dry	1 2	75 75	1 1 1 1	75 75 75 75	C	4	79
BH01	2.20		2.65	Nil	Dry	4 3	75 75	3 2 1 2	75 75 75 75	C	8	79
BH01	3.20		3.65	Nil	Dry	4 3	75 75	3 3 3 3	75 75 75 75	C	12	79
BH01	4.20		4.65	3.20	Dry	3 3	75 75	3 1 2 2	75 75 75 75	C	8	79
BH01	5.20		5.65	3.20	4.90	3 2	75 75	3 3 4 5	75 75 75 75	S	15	79
BH01A	7.00		7.45	7.00	2.96	3 3	75 75	2 2 3 4	75 75 75 75	C	11	79
BH01A	8.50		8.95	8.50	3.14	4 1	75 75	8 4 5 7	75 75 75 75	C	24	79
BH01A	9.80		9.91	9.80	3.36	25	40	50	70	C	214	79
BH01A	11.30		11.40	11.30	Dry	25	70	50	30	C	500	79
BH02	1.20		1.65	Nil	Dry	1 2	75 75	2 2 2 3	75 75 75 75	S	9	69
BH02	2.20		2.65	Nil	Dry	1 2	75 75	2 2 1 2	75 75 75 75	S	7	69
BH02	3.20		3.65	Nil	1.70	2 1	75 75	1 3 2 1	75 75 75 75	S	7	69
BH02	8.20		8.65	6.70	2.15	2 2	75 75	2 3 4 6	75 75 75 75	S	15	69
BH02	9.20		9.63	8.20	1.73	3 4	75 75	4 10 16 20	75 75 75 50	S	55	69
BH04	1.20		1.65	Nil	Dry	1 0	75 75	1 0 1 1	75 75 75 75	C	3	79
BH04	2.00		2.45	Nil	Dry	1 1	75 75	1 1 1 2	75 75 75 75	C	5	79
BH04	6.00		6.45	2.60	2.10	3 3	75 75	3 5 6 7	75 75 75 75	S	21	79
BH04	8.60		9.05	7.10	2.10	6 5	75 75	7 8 11 15	75 75 75 75	S	41	79
BH04	10.10		10.48	7.10	3.14	5 9	75 75	11 17 22	75 75 75	S	67	79
BH04	12.50		12.59	11.60	4.10	25	50	50	40	C	375	79
BH04	14.00		14.06	11.60	2.24	25	40	50	20	C	750	79
BH05	1.20		1.65	Nil	Dry	1 1	75 75	1 1 1 1	75 75 75 75	S	4	69
BH05	2.20		2.65	Nil	Dry	1 1	75 75	1 2 1 2	75 75 75 75	S	6	69
BH05	3.20		3.65	Nil	Dry	1 1	75 75	1 1 2 2	75 75 75 75	S	6	69

notes:
1. Test carried out in general accordance with BS EN ISO 22476-3:2005 + A1:2011
2. s.w.p = self weight penetration.
3. N values have not been subjected to any correction.
4. Test carried out using split spoon S, solid cone C.
5. Where full test drive not completed, linearly extrapolated N value reported.
6. ** Denotes no effective penetration.

CONTRACT	CHECKED
33138	JH

Geotechnical Engineering Limited

STANDARD PENETRATION TEST

CLIENT BUROHAPPOLD

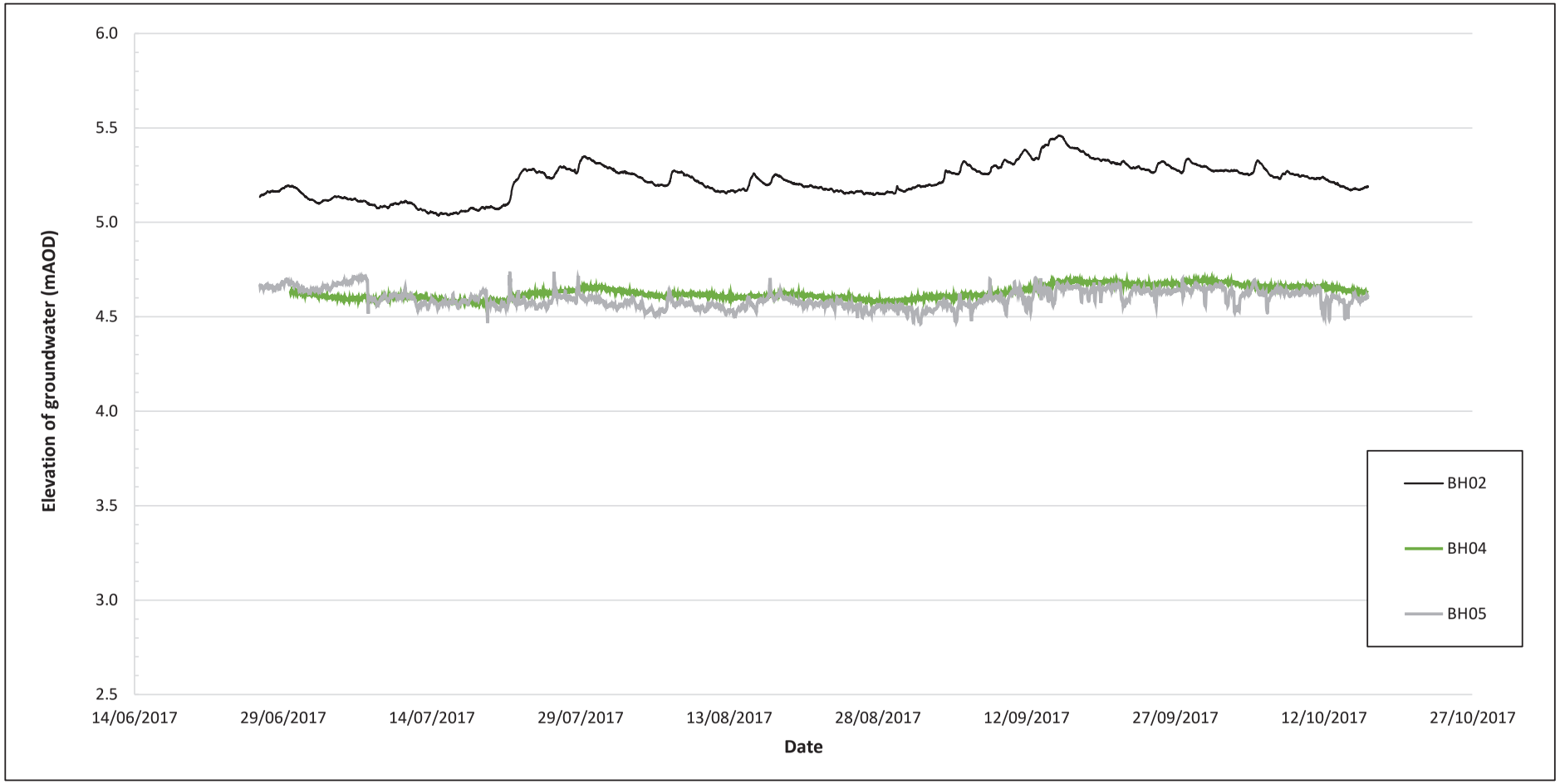
SITE PROJECT BLUE

borehole no.	borehole depth (m)	s.w.p (m)	bottom depth (m)	casing depth (m)	water level (m)	seating drive blows	seating drive pen (mm)	test drive blows	test drive pen (mm)	test type	N	energy ratio (%)
BH05	4.20		4.65	4.20	Dry	1 1	75 75	1 1 2 1	75 75 75 75	S	5	69
BH05	7.20		7.30	7.20	1.75	25	40	50	60	C	250	69

notes:

1. Test carried out in general accordance with BS EN ISO 22476-3:2005 + A1:2011
2. s.w.p = self weight penetration.
3. N values have not been subjected to any correction.
4. Test carried out using split spoon S, solid cone C.
5. Where full test drive not completed, linearly extrapolated N value reported.
6. ** Denotes no effective penetration.

CONTRACT	CHECKED
33138	**JH**


6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
Elevation of groundwater (mAOD)
14/06/2017
29/06/2017
14/07/2017
29/07/2017
13/08/2017
28/08/2017
12/09/2017
27/09/2017
12/10/2017
27/10/2017
Date
BH02
BH04
BH05

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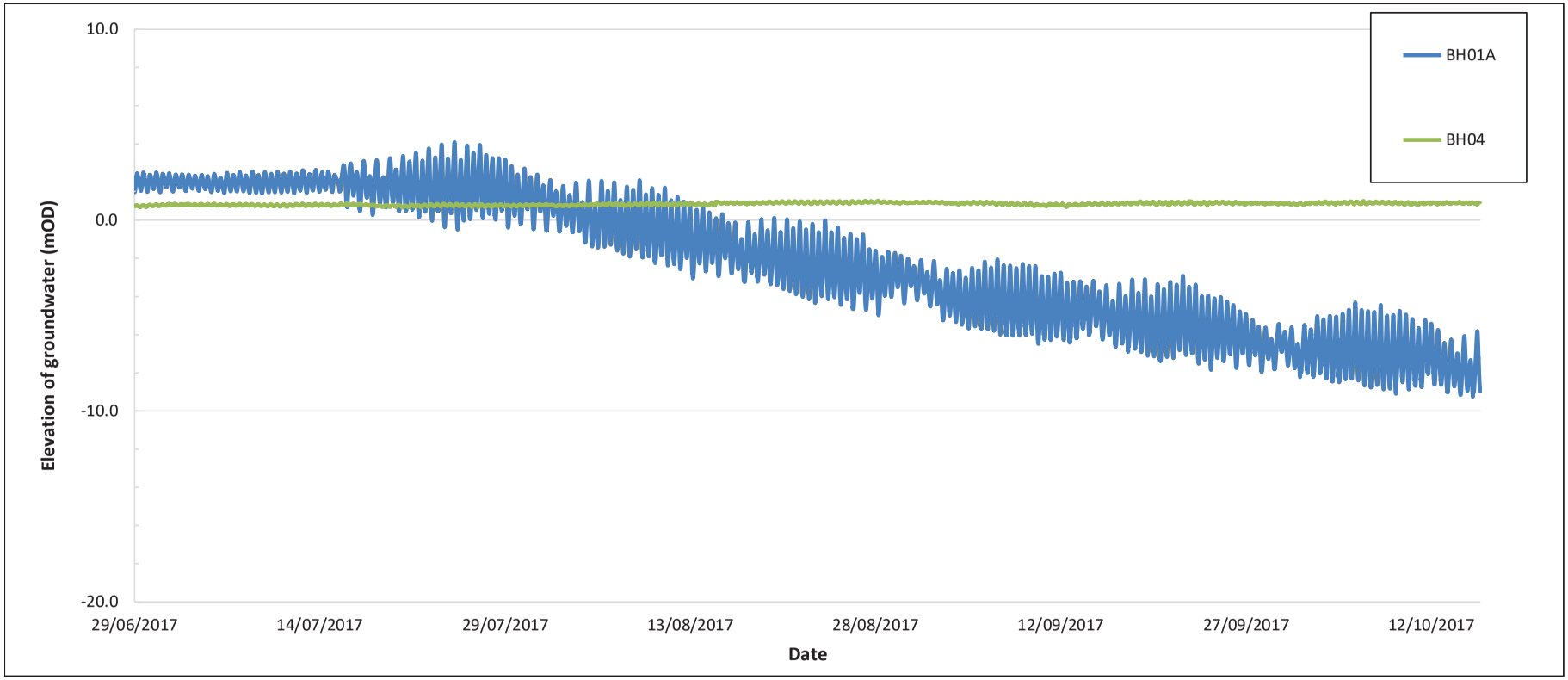
VWP DATA - COMBINED

CLIENT BURO HAPPOLD
SITE PROJECT BLUE



REMARKS

CONTRACT	CHECKED
33138	JH

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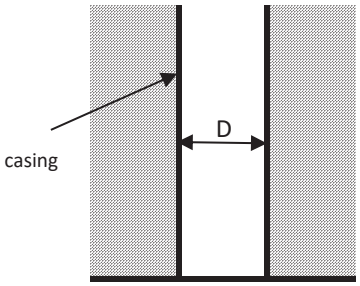
PERMEABILITY TEST - INTAKE FACTORS

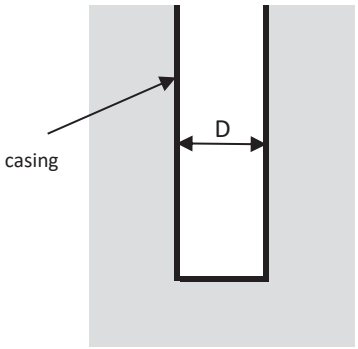
A



$$F=2D$$

Soil flush with bottom at impervious boundary

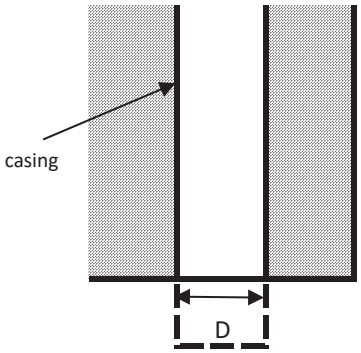
B



$$F=2.75D$$

Soil flush with bottom in uniform soil

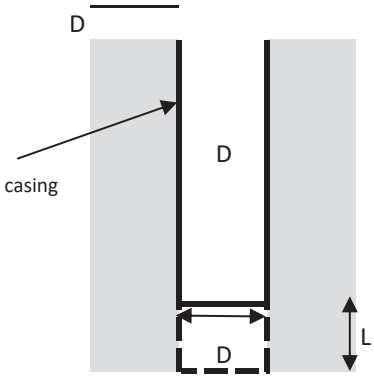
C



$$F=\frac{2\pi L}{\ln\left[\frac{2L}{D}+\sqrt{1+\left(\frac{(2L)^2}{D}\right)}\right]}$$

Well point or hole extended at impervious boundary

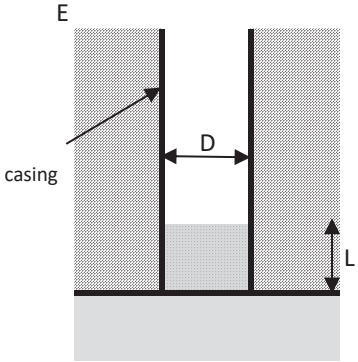
D



$$F=\frac{2\pi L}{\ln\left[\frac{L}{D}+\sqrt{\left(1+(L/D)^2\right)}\right]}$$

Well point or hole extended in uniform soil

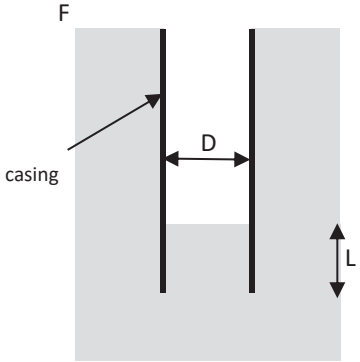
E



$$F=\frac{2D}{1+\left(\left(\frac{8}{\pi}\right)\left(\frac{L}{D}\right)\right)}$$

Soil in casing with bottom at impervious boundary

F



$$F=\frac{2.75D}{1+\left(\left(\frac{11}{\pi}\right)\left(\frac{L}{D}\right)\right)}$$

Soil in casing with bottom in uniform soil

REMARKS

Expressions come from Hvorlsev.
BS EN ISO 22282-2:2012 recommends the use of intake factors given above for the Hvorlsev method variable head test.
BS EN ISO 22282-2:2012 reports equation D as suitable for the Velocity method variable head test where $1.2 < L/D < 10$.
BS EN ISO 22282-2:2012 refers to a simpler version of Equation D for $L/D > 10$, however Equation D will still apply for $L/D > 10$.
Equation D may be used for tests using piezometer tips.
Cases A and B tend to measure the mean permeability of the soil; C and D the horizontal permeability; E and F the vertical permeability.
Where the horizontal permeability is much greater than the vertical, all tests tend to measure the former.

Geotechnical Engineering Limited

PERMEABILITY TEST - VARIABLE HEAD

BS EN ISO 22282-2:2012

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

BOREHOLE **BH01**

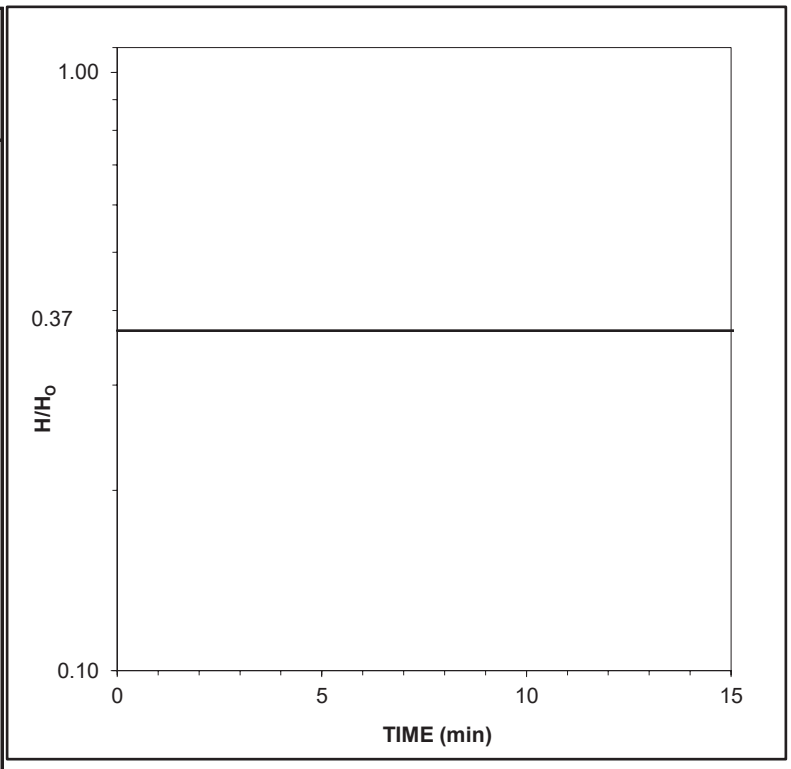
TEST 1

DEPTH RECORD

DEPTH OF BOREHOLE	5.50 m	BOREHOLE DIAMETER IN TEST SECTION	0.17 m
DEPTH TO BASE OF CASING	5.00 m	INTERNAL DIAMETER OF CASING	0.15 m
TEST INTERVAL	0.50 m		
HEIGHT OF DATUM ABOVE GROUND LEVEL	0.60 m	TYPE OF TEST	FALLING
DEPTH TO STANDING WATER BELOW DATUM	5.10 m	DATE	20/06/2017

TEST RECORD

ELAPSED TIME (min)	DEPTH TO WATER BELOW DATUM (m)	HEAD (m) H	$\frac{H}{H_O}$



Hvorslev method $$k = \frac{A}{FT}$$

Velocity graph method $$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

Intake factor based on case* **B**

RESULTS

Hvorslev method		**Velocity graph method**		
Cross sectional area of casing, A	**0.0177** m^2	Cross sectional area of casing, A		**0.0177** m^2
Intake factor*, F	**0.413** m	Intake factor*, F		**0.413** m
Time lag, T	**0** s	Variable head, H_1	**0.00** m at time, t_1	**0** s
		Variable head, H_2	**0.00** m at time, t_2	**0** s
Permeability, k	**-- ms^{-1}**	**Permeability, k**		**-- ms^{-1}**

REMARKS

Test Operator: PR

Unable to raise water head level in borehole. Test abandoned.
Casing lowered and test re-attempted as Test 2.

CONTRACT	CHECKED
33138	**JH**

PR PR

* See intake factors key sheet

rev08 23/06/16 JH

Geotechnical Engineering Limited

PERMEABILITY TEST - VARIABLE HEAD

BS EN ISO 22282-2:2012

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

BOREHOLE **BH01**

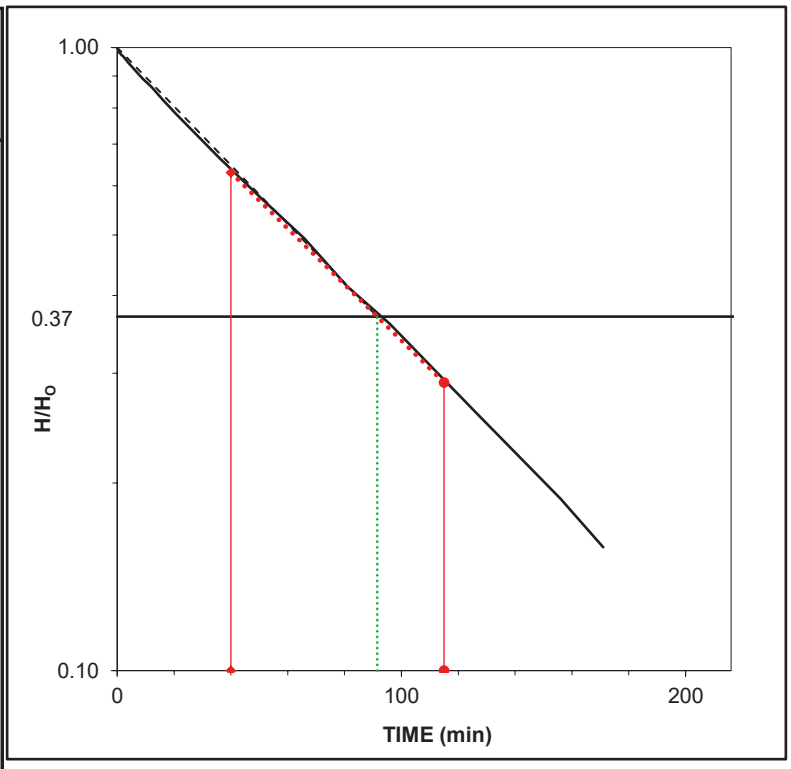
TEST 2

DEPTH RECORD

DEPTH OF BOREHOLE	5.30 m	BOREHOLE DIAMETER IN TEST SECTION	0.17 m
DEPTH TO BASE OF CASING	5.30 m	INTERNAL DIAMETER OF CASING	0.15 m
TEST INTERVAL	0.00 m		
HEIGHT OF DATUM ABOVE GROUND LEVEL	0.30 m	TYPE OF TEST	FALLING
DEPTH TO STANDING WATER BELOW DATUM	4.50 m	DATE	20/06/2017

TEST RECORD

ELAPSED TIME (min)	DEPTH TO WATER BELOW DATUM (m)	HEAD (m) H	$\frac{H}{H_O}$
0.00	0.00	4.50	1.00
0.16	0.01	4.49	1.00
0.33	0.04	4.47	0.99
0.50	0.07	4.43	0.98
1.00	0.10	4.40	0.98
1.50	0.12	4.38	0.97
2.00	0.14	4.36	0.97
3.00	0.20	4.31	0.96
4.00	0.25	4.26	0.95
6.00	0.35	4.16	0.92
9.00	0.49	4.01	0.89
12.00	0.61	3.89	0.86
16.00	0.79	3.71	0.82
21.00	0.99	3.51	0.78
36.00	1.51	2.99	0.66
51.00	1.93	2.57	0.57
66.00	2.28	2.22	0.49
81.00	2.64	1.86	0.41
96.00	2.88	1.62	0.36
126.00	3.33	1.17	0.26
156.00	3.65	0.85	0.19
171.00	3.79	0.71	0.16



Hvorslev method $$k = \frac{A}{FT}$$

Velocity graph method $$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

Intake factor based on case* **B**

RESULTS

Hvorslev method		**Velocity graph method**		
Cross sectional area of casing, A	**0.018** m^2	Cross sectional area of casing, A		**0.018** m^2
Intake factor*, F	**0.413** m	Intake factor*, F		**0.413** m
Time lag, T	**5490** s	Variable head, H_1	**2.84** m at time, t_1	**2400** s
		Variable head, H_2	**1.31** m at time, t_2	**6900** s
Permeability, k	**7.8E-06** ms^{-1}	**Permeability, k**		**7.4E-06** ms^{-1}

REMARKS

Test Operator: PR

CONTRACT	CHECKED
33138	**JH**

PR PR

* See intake factors key sheet

rev08 23/06/16 JH

Geotechnical Engineering Limited

PERMEABILITY TEST - VARIABLE HEAD

BS EN ISO 22282-2:2012

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

BOREHOLE **BH01A**

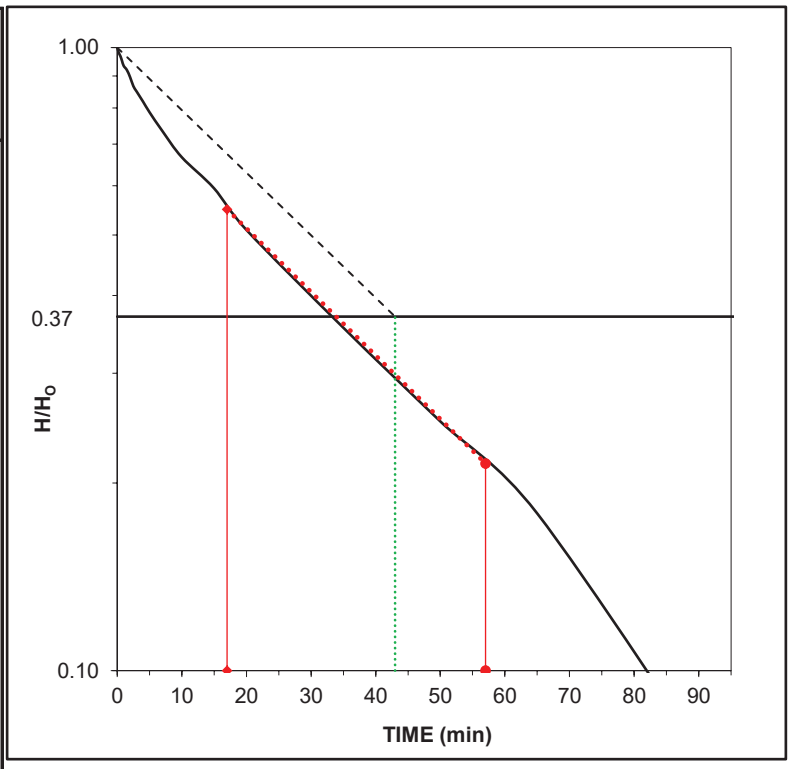
TEST 1

DEPTH RECORD

DEPTH OF BOREHOLE	15.40 m	BOREHOLE DIAMETER IN TEST SECTION	0.17 m
DEPTH TO BASE OF CASING	11.30 m	INTERNAL DIAMETER OF CASING	0.15 m
TEST INTERVAL	4.10 m		
HEIGHT OF DATUM ABOVE GROUND LEVEL	0.25 m	TYPE OF TEST	FALLING
DEPTH TO STANDING WATER BELOW DATUM	4.14 m	DATE	22/06/2017

TEST RECORD

ELAPSED TIME (min)	DEPTH TO WATER BELOW DATUM (m)	HEAD (m) H	$\frac{H}{H_O}$
0.00	0.00	4.14	1.00
0.25	0.08	4.06	0.98
0.50	0.13	4.01	0.97
0.75	0.20	3.94	0.95
1.00	0.27	3.87	0.93
1.50	0.33	3.81	0.92
2.00	0.43	3.71	0.90
2.50	0.55	3.59	0.87
3.00	0.62	3.52	0.85
4.00	0.75	3.39	0.82
5.00	0.88	3.26	0.79
7.00	1.10	3.04	0.73
10.00	1.38	2.76	0.67
15.00	1.68	2.46	0.59
20.00	2.03	2.11	0.51
35.00	2.67	1.47	0.36
50.00	3.10	1.04	0.25
65.00	3.40	0.74	0.18
95.00	3.88	0.26	0.06



Hvorslev method $$k = \frac{A}{FT}$$

Velocity graph method $$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

Intake factor based on case* **D**

RESULTS

Hvorslev method		**Velocity graph method**		
Cross sectional area of casing, A	**0.018** m^2	Cross sectional area of casing, A		**0.018** m^2
Intake factor*, F	**6.645** m	Intake factor*, F		**6.645** m
Time lag, T	**2580** s	Variable head, H_1	**2.28** m at time, t_1	**1020** s
		Variable head, H_2	**0.89** m at time, t_2	**3420** s
Permeability, k	**1.0E-06** ms^{-1}	**Permeability, k**		**1.0E-06** ms^{-1}

REMARKS

Test Operator: PS

CONTRACT	CHECKED
33138	**JH**

* See intake factors key sheet

PS PS

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Geotechnical Engineering Limited

PERMEABILITY TEST - VARIABLE HEAD

BS EN ISO 22282-2:2012

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

BOREHOLE **BH01A**

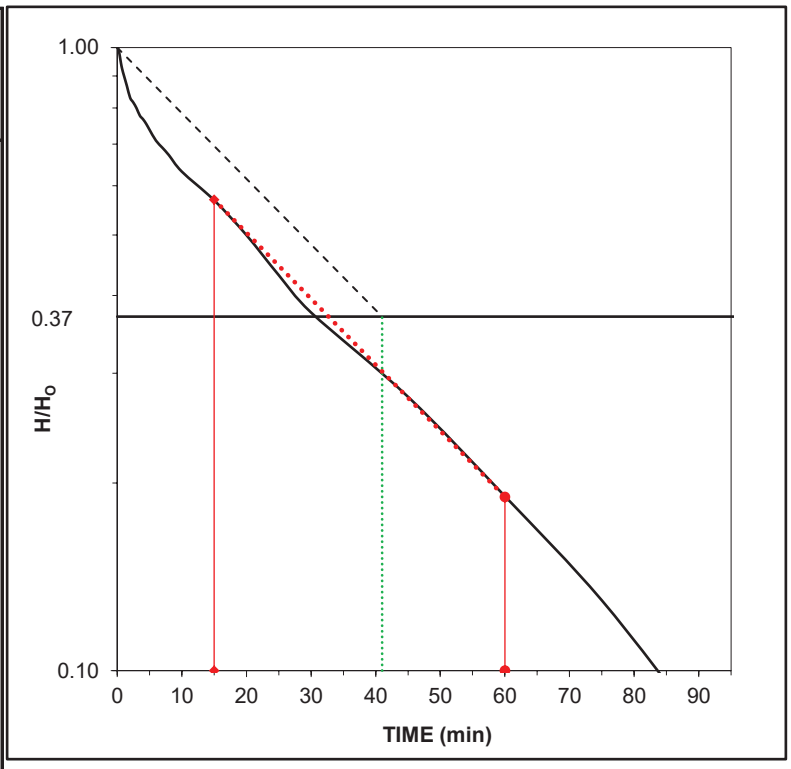
TEST 2

DEPTH RECORD

DEPTH OF BOREHOLE	21.20 m	BOREHOLE DIAMETER IN TEST SECTION	0.17 m
DEPTH TO BASE OF CASING	11.30 m	INTERNAL DIAMETER OF CASING	0.15 m
TEST INTERVAL	9.90 m		
HEIGHT OF DATUM ABOVE GROUND LEVEL	0.24 m	TYPE OF TEST	FALLING
DEPTH TO STANDING WATER BELOW DATUM	3.85 m	DATE	22/06/2017

TEST RECORD

ELAPSED TIME (min)	DEPTH TO WATER BELOW DATUM (m)	HEAD (m) H	$\frac{H}{H_O}$
0.00	0.07	3.78	1.00
0.17	0.09	3.76	0.99
0.33	0.15	3.70	0.98
0.50	0.24	3.61	0.96
0.67	0.32	3.53	0.93
0.83	0.38	3.47	0.92
1.00	0.43	3.42	0.90
1.50	0.57	3.28	0.87
2.00	0.71	3.14	0.83
2.50	0.77	3.09	0.82
3.00	0.83	3.02	0.80
3.50	0.91	2.94	0.78
4.00	0.95	2.90	0.77
4.50	1.00	2.85	0.75
5.00	1.06	2.79	0.74
6.00	1.17	2.68	0.71
7.00	1.24	2.61	0.69
8.00	1.31	2.54	0.67
10.00	1.46	2.39	0.63
15.00	1.70	2.15	0.57
20.00	1.96	1.89	0.50
25.00	2.22	1.63	0.43
30.00	2.43	1.42	0.38
45.00	2.81	1.04	0.28
60.00	3.13	0.72	0.19
75.00	3.36	0.49	0.13
90.00	3.54	0.31	0.08
120.00			



Hvorslev method $$k = \frac{A}{FT}$$

Velocity graph method $$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

Intake factor based on case* **D**

RESULTS

Hvorslev method		**Velocity graph method**		
Cross sectional area of casing, A	**0.018** m^2	Cross sectional area of casing, A		**0.018** m^2
Intake factor*, F	**13.074** m	Intake factor*, F		**13.074** m
Time lag, T	**2460** s	Variable head, H_1	**2.15** m at time, t_1	**900** s
		Variable head, H_2	**0.72** m at time, t_2	**3600** s
Permeability, k	**5.5E-07** ms^{-1}	**Permeability, k**		**5.5E-07** ms^{-1}

REMARKS

Test Operator: PS

CONTRACT	CHECKED
33138	**JH**

PS PS

* See intake factors key sheet

rev08 23/06/16 JH

Geotechnical Engineering Limited

PERMEABILITY TEST - VARIABLE HEAD

BS EN ISO 22282-2:2012

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

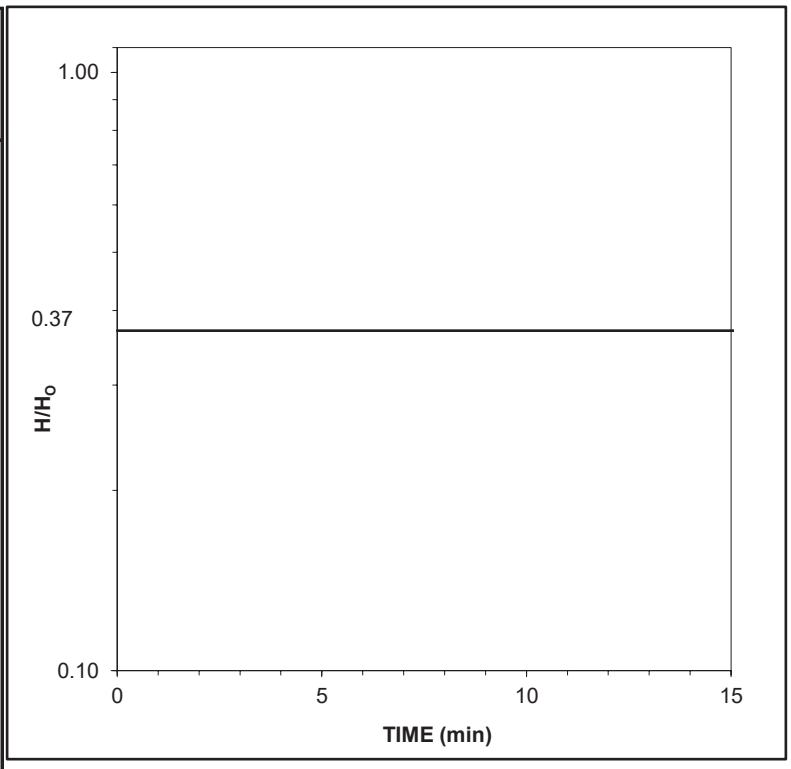
BOREHOLE **BH02**

DEPTH RECORD

DEPTH OF BOREHOLE	4.20 m	BOREHOLE DIAMETER IN TEST SECTION	0.17 m
DEPTH TO BASE OF CASING	3.70 m	INTERNAL DIAMETER OF CASING	0.15 m
TEST INTERVAL	0.50 m		
HEIGHT OF DATUM ABOVE GROUND LEVEL	0.48 m	TYPE OF TEST	FALLING
DEPTH TO STANDING WATER BELOW DATUM	1.80 m	DATE	14/06/2017

TEST RECORD

ELAPSED TIME (min)	DEPTH TO WATER BELOW DATUM (m)	HEAD (m) H	$\frac{H}{H_O}$



Hvorslev method $$k = \frac{A}{FT}$$

Velocity graph method $$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

Intake factor based on case* **B**

RESULTS

Hvorslev method		**Velocity graph method**		
Cross sectional area of casing, A	**0.0177** m^2	Cross sectional area of casing, A		**0.0177** m^2
Intake factor*, F	**0.413** m	Intake factor*, F		**0.413** m
Time lag, T	**0** s	Variable head, H_1	**0.00** m at time, t_1	**0** s
		Variable head, H_2	**0.00** m at time, t_2	**0** s
Permeability, k	**-- ms^{-1}**	**Permeability, k**		**-- ms^{-1}**

REMARKS

Test Operator: PS

Unable to raise water head level in borehole. Test abandoned.

Engineer estimates approximately 400 litres of water used in test.

CONTRACT	CHECKED
33138	**JH**

PS PS

* See intake factors key sheet

rev08 23/06/16 JH

Geotechnical Engineering Limited

PERMEABILITY TEST - VARIABLE HEAD

BS EN ISO 22282-2:2012

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

BOREHOLE **BH04**

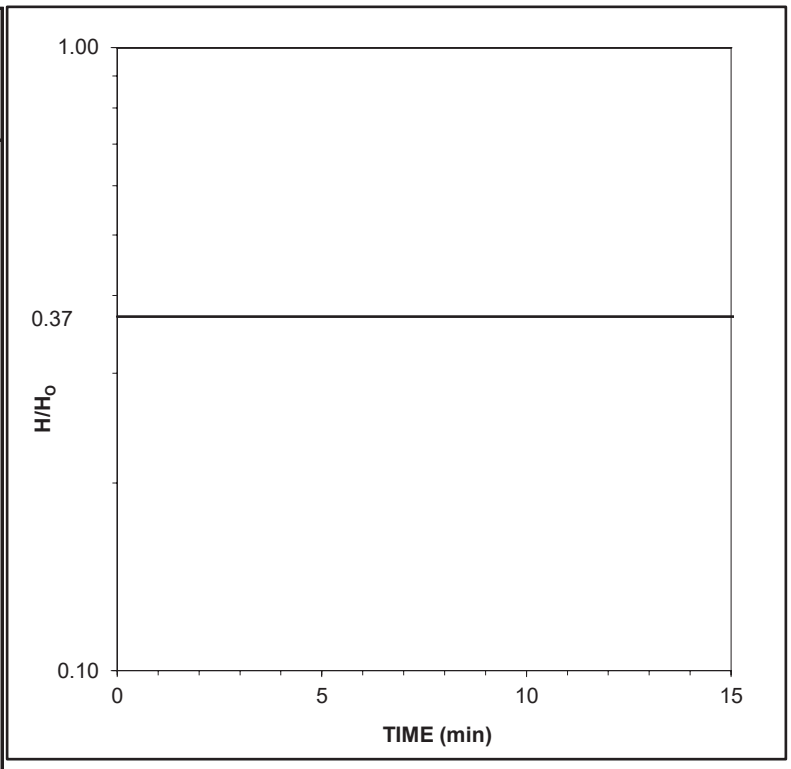
TEST 1

DEPTH RECORD

DEPTH OF BOREHOLE	2.60 m	BOREHOLE DIAMETER IN TEST SECTION	0.17 m
DEPTH TO BASE OF CASING	2.60 m	INTERNAL DIAMETER OF CASING	0.15 m
TEST INTERVAL	0.00 m		
HEIGHT OF DATUM ABOVE GROUND LEVEL	0.40 m	TYPE OF TEST	FALLING
DEPTH TO STANDING WATER BELOW DATUM	2.50 m	DATE	12/06/2017

TEST RECORD

ELAPSED TIME (min)	DEPTH TO WATER BELOW DATUM (m)	HEAD (m) H	$\frac{H}{H_O}$
0.00	0.07	2.43	1.00
0.50	0.07	2.43	1.00
1.00	0.07	2.43	1.00
1.50	0.07	2.43	1.00
2.00	0.07	2.43	1.00
3.00	0.07	2.43	1.00
4.00	0.07	2.43	1.00
5.00	0.07	2.43	1.00
10.00	0.07	2.43	1.00
15.00	0.07	2.43	1.00



Hvorslev method $$k = \frac{A}{FT}$$

Velocity graph method $$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

Intake factor based on case* **B**

RESULTS

Hvorslev method		**Velocity graph method**		
Cross sectional area of casing, A	**0.0177** m^2	Cross sectional area of casing, A		**0.0177** m^2
Intake factor*, F	**0.413** m	Intake factor*, F		**0.413** m
Time lag, T	**0** s	Variable head, H_1	**0.00** m at time, t_1	**0** s
		Variable head, H_2	**0.00** m at time, t_2	**0** s
Permeability, k	**-- ms^{-1}**	**Permeability, k**		**-- ms^{-1}**

REMARKS

Test Operator: PS

Insufficient take to calculate permeability

Casing raised and test re-attempted as Test 2 & Test 3.

CONTRACT	CHECKED
33138	**CT**

PS PS

* See intake factors key sheet

rev08 23/06/16 JH

Geotechnical Engineering Limited

PERMEABILITY TEST - VARIABLE HEAD

BS EN ISO 22282-2:2012

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

BOREHOLE **BH04**

TEST 2

DEPTH RECORD

DEPTH OF BOREHOLE	2.60 m	BOREHOLE DIAMETER IN TEST SECTION	0.17 m
DEPTH TO BASE OF CASING	2.10 m	INTERNAL DIAMETER OF CASING	0.15 m
TEST INTERVAL	0.50 m		
HEIGHT OF DATUM ABOVE GROUND LEVEL	0.90 m	TYPE OF TEST	FALLING
DEPTH TO STANDING WATER BELOW DATUM	3.00 m	DATE	12/06/2017

TEST RECORD

ELAPSED TIME (min)	DEPTH TO WATER BELOW DATUM (m)	HEAD (m) H	$\frac{H}{H_O}$
0.00	2.45	0.55	1.00
0.50	2.64	0.36	0.65
1.00	2.72	0.28	0.51
1.50	2.77	0.23	0.42
2.00	2.80	0.20	0.36
2.50	2.82	0.18	0.33
3.50	2.83	0.17	0.31
4.50	2.84	0.16	0.29
5.00	2.85	0.15	0.27
8.00	2.88	0.12	0.22
10.00	2.90	0.10	0.18
13.00	2.92	0.08	0.15
		3.00	5.45
		3.00	5.45
		3.00	5.45
		3.00	5.45
		3.00	5.45
		3.00	5.45
		3.00	5.45
		3.00	5.45
		3.00	5.45
		3.00	5.45
		3.00	5.45
		3.00	5.45
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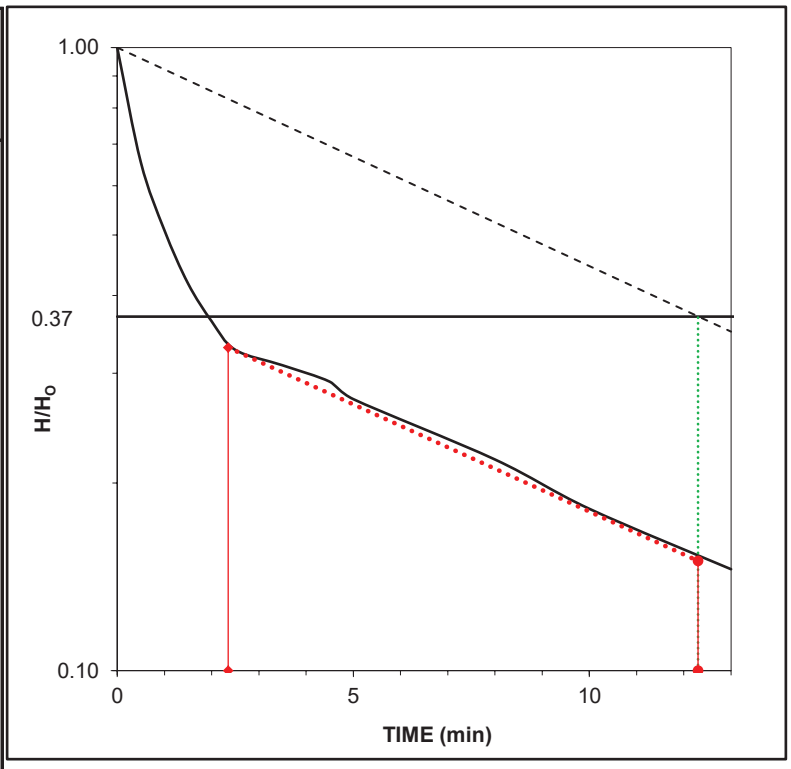
		3.00	5.45
		3.00	5.45



Hvorslev method $$k = \frac{A}{FT}$$

Velocity graph method $$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

Intake factor based on case* **D**

RESULTS

Hvorslev method		**Velocity graph method**		
Cross sectional area of casing, A	**0.018** m^2	Cross sectional area of casing, A		**0.018** m^2
Intake factor*, F	**1.746** m	Intake factor*, F		**1.746** m
Time lag, T	**738** s	Variable head, H_1	**0.18** m at time, t_1	**141** s
		Variable head, H_2	**0.08** m at time, t_2	**738** s
Permeability, k	**1.4E-05** ms^{-1}	**Permeability, k**		**1.3E-05** ms^{-1}

REMARKS

Test Operator: PS

CONTRACT	CHECKED
33138	**CT**

PS PS

* See intake factors key sheet

rev08 23/06/16 JH

Geotechnical Engineering Limited

PERMEABILITY TEST - VARIABLE HEAD

BS EN ISO 22282-2:2012

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

BOREHOLE **BH04**

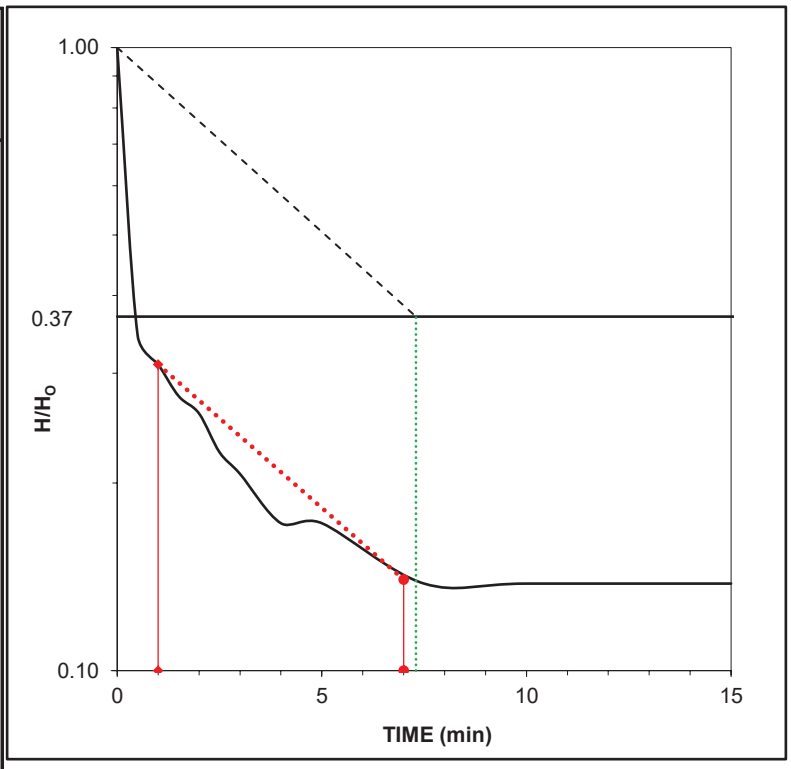
TEST 3

DEPTH RECORD

DEPTH OF BOREHOLE	2.60 m	BOREHOLE DIAMETER IN TEST SECTION	0.17 m
DEPTH TO BASE OF CASING	2.10 m	INTERNAL DIAMETER OF CASING	0.15 m
TEST INTERVAL	0.50 m		
HEIGHT OF DATUM ABOVE GROUND LEVEL	0.90 m	TYPE OF TEST	FALLING
DEPTH TO STANDING WATER BELOW DATUM	3.00 m	DATE	12/06/2017

TEST RECORD

ELAPSED TIME (min)	DEPTH TO WATER BELOW DATUM (m)	HEAD (m) H	$\frac{H}{H_O}$
0.00	2.42	0.58	1.00
0.50	2.80	0.20	0.34
1.00	2.82	0.18	0.31
1.50	2.84	0.16	0.28
2.00	2.85	0.15	0.26
2.50	2.87	0.13	0.22
3.00	2.88	0.12	0.21
4.00	2.90	0.10	0.17
5.00	2.90	0.10	0.17
7.50	2.92	0.08	0.14
10.00	2.92	0.08	0.14
15.00	2.92	0.08	0.14



Hvorslev method $$k = \frac{A}{FT}$$

Velocity graph method $$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

Intake factor based on case* **D**

RESULTS

Hvorslev method		**Velocity graph method**		
Cross sectional area of casing, A	**0.0177** m^2	Cross sectional area of casing, A		**0.0177** m^2
Intake factor*, F	**1.746** m	Intake factor*, F		**1.746** m
Time lag, T	**438** s	Variable head, H_1	**0.18** m at time, t_1	**60** s
		Variable head, H_2	**0.08** m at time, t_2	**420** s
Permeability, k	**2.3E-05 ms^{-1}**	**Permeability, k**		**2.2E-05 ms^{-1}**

REMARKS

Test Operator: PS

Water level at 08:21 13/06/2017 3.02m below datum.

CONTRACT	CHECKED
33138	**CT**

PS PS

* See intake factors key sheet

rev08 23/06/16 JH

Geotechnical Engineering Limited

PERMEABILITY TEST - VARIABLE HEAD

BS EN ISO 22282-2:2012

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

BOREHOLE **BH05**

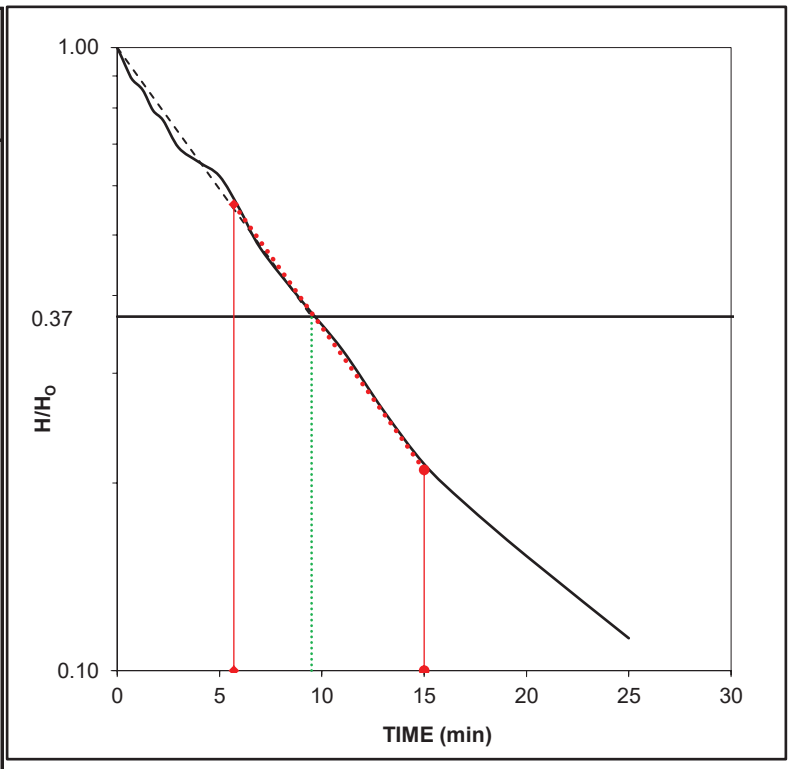
TEST 1 (Borehole)

DEPTH RECORD

DEPTH OF BOREHOLE	13.20 m	BOREHOLE DIAMETER IN TEST SECTION	0.17 m
DEPTH TO BASE OF CASING	5.70 m	INTERNAL DIAMETER OF CASING	0.15 m
TEST INTERVAL	7.50 m		
HEIGHT OF DATUM ABOVE GROUND LEVEL	0.42 m	TYPE OF TEST	FALLING
DEPTH TO STANDING WATER BELOW DATUM	2.82 m	DATE	22/06/2017

TEST RECORD

ELAPSED TIME (min)	DEPTH TO WATER BELOW DATUM (m)	HEAD (m) H	$\frac{H}{H_O}$
0.00	0.07	2.75	1.00
0.25	0.18	2.64	0.96
0.50	0.29	2.53	0.92
0.75	0.38	2.44	0.89
1.25	0.47	2.35	0.85
1.75	0.64	2.18	0.79
2.25	0.72	2.10	0.76
3.00	0.92	1.90	0.69
4.00	1.02	1.80	0.65
5.00	1.11	1.71	0.62
6.00	1.31	1.51	0.55
7.00	1.51	1.31	0.48
9.00	1.74	1.08	0.39
11.00	1.92	0.90	0.33
13.00	2.10	0.72	0.26
15.00	2.23	0.59	0.21
17.00	2.31	0.51	0.19
20.00	2.40	0.42	0.15
25.00	2.51	0.31	0.11



Hvorslev method $$k = \frac{A}{FT}$$

Velocity graph method $$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

Intake factor based on case* **D**

RESULTS

Hvorslev method		**Velocity graph method**		
Cross sectional area of casing, A	**0.0177** m^2	Cross sectional area of casing, A		**0.0177** m^2
Intake factor*, F	**10.518** m	Intake factor*, F		**10.518** m
Time lag, T	**570** s	Variable head, H_1	**1.54** m at time, t_1	**342** s
		Variable head, H_2	**0.58** m at time, t_2	**900** s
Permeability, k	**2.9E-06** ms^{-1}	**Permeability, k**		**3.0E-06** ms^{-1}

REMARKS

Test Operator: TH

CONTRACT	CHECKED
33138	**JH**

* See intake factors key sheet

TH PS

rev08 23/06/16 JH

Geotechnical Engineering Limited

PERMEABILITY TEST - VARIABLE HEAD

BS EN ISO 22282-2:2012

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

BOREHOLE **BH05**

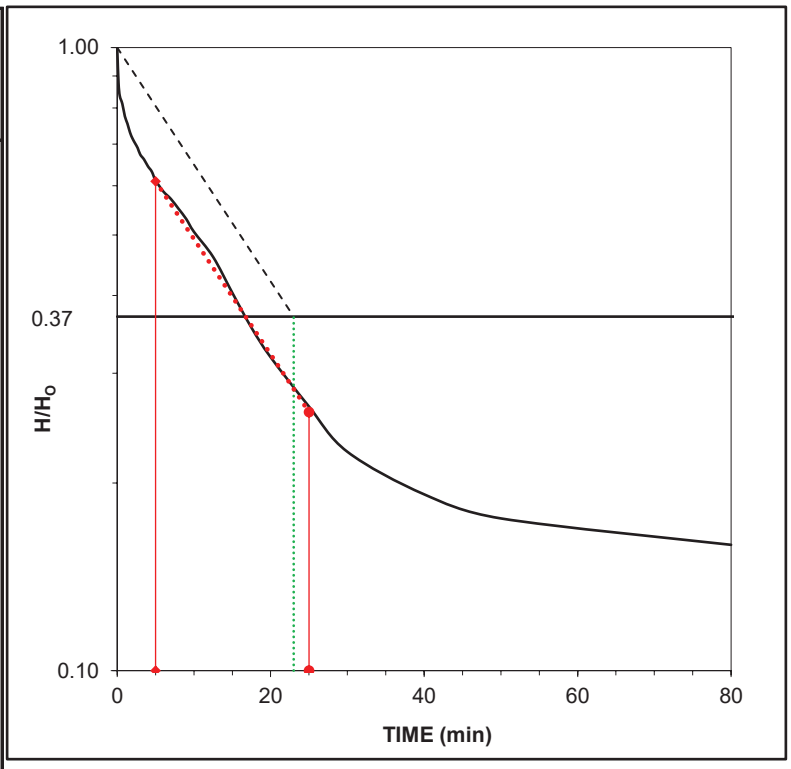
TEST 1 (Borehole)

DEPTH RECORD

BASE OF FILTER	16.20 m	BOREHOLE DIAMETER IN TEST SECTION	0.15 m
TOP OF FILTER	4.60 m	DIAMETER OF ACCESS TUBE	0.02 m
TEST INTERVAL	11.60 m	FILTER MEDIUM	Gravel
HEIGHT OF DATUM ABOVE GROUND LEVEL	0.00 m	TYPE OF TEST	FALLING
DEPTH TO STANDING WATER BELOW DATUM	2.45 m	DATE	26/06/2017

TEST RECORD

ELAPSED TIME (min)	DEPTH TO WATER BELOW DATUM (m)	HEAD (m) H	$\frac{H}{H_O}$
0.00	0.00	2.45	1.00
0.17	0.30	2.15	0.88
0.33	0.40	2.05	0.84
0.67	0.46	1.99	0.81
1.00	0.55	1.90	0.78
1.33	0.60	1.85	0.76
1.67	0.66	1.79	0.73
2.00	0.70	1.75	0.71
2.33	0.73	1.72	0.70
2.67	0.76	1.69	0.69
3.00	0.80	1.65	0.67
3.50	0.83	1.62	0.66
4.00	0.87	1.58	0.64
4.50	0.90	1.55	0.63
5.00	0.95	1.50	0.61
6.00	1.01	1.44	0.59
7.00	1.05	1.40	0.57
8.00	1.10	1.35	0.55
9.00	1.15	1.30	0.53
10.00	1.21	1.24	0.51
12.50	1.32	1.13	0.46
15.00	1.46	0.99	0.40
17.50	1.58	0.87	0.36
20.00	1.67	0.78	0.32
25.00	1.80	0.65	0.27
30.00	1.90	0.55	0.22
40.00	1.98	0.47	0.19
50.00	2.02	0.43	0.18
80.00	2.06	0.39	0.16



Hvorslev method $$k = \frac{A}{FT}$$

Velocity graph method $$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2}$$

Intake factor based on case* **D**

RESULTS

Hvorslev method		**Velocity graph method**		
Cross sectional area of access tube, A	**0.0003** m^2	Cross sectional area of access tube, A		**0.0003** m^2
Intake factor*, F	**14.458** m	Intake factor*, F		**14.458** m
Time lag, T	**1380** s	Variable head, H_1	**1.49** m at time, t_1	**300** s
		Variable head, H_2	**0.64** m at time, t_2	**1500** s
Permeability, k	**1.4E-08** ms^{-1}	**Permeability, k**		**1.4E-08** ms^{-1}

REMARKS

Test Operator: PS

CONTRACT	CHECKED
33138	**JH**

PS PS

* See intake factors key sheet

rev08 23/06/16 JH

Geotechnical Engineering Limited

PACKER TEST - PERMEABILITY

BS EN ISO 22282-3

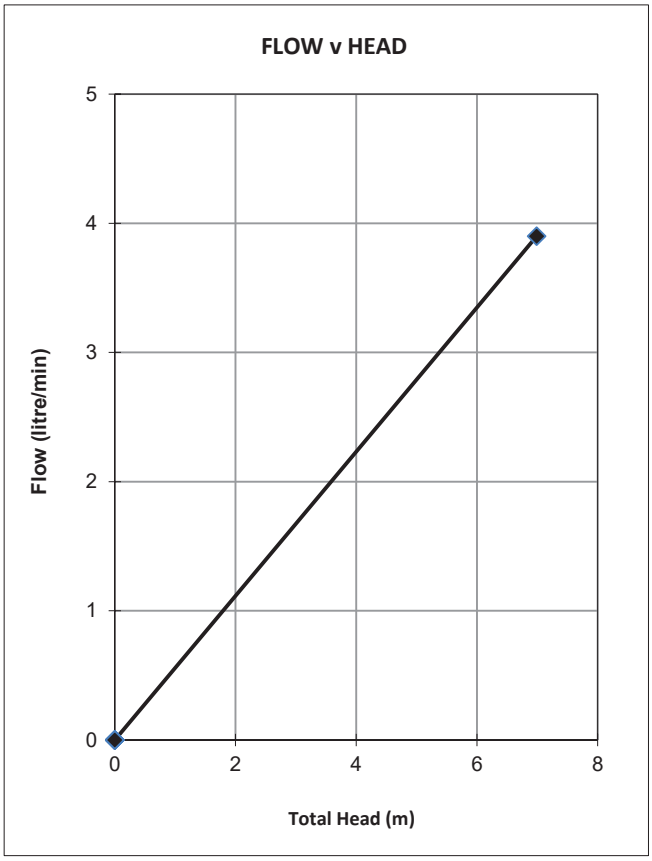
CLIENT	BURO HAPPOLD	BOREHOLE	**BH01A**
SITE	PROJECT BLUE	TEST No.	**1**

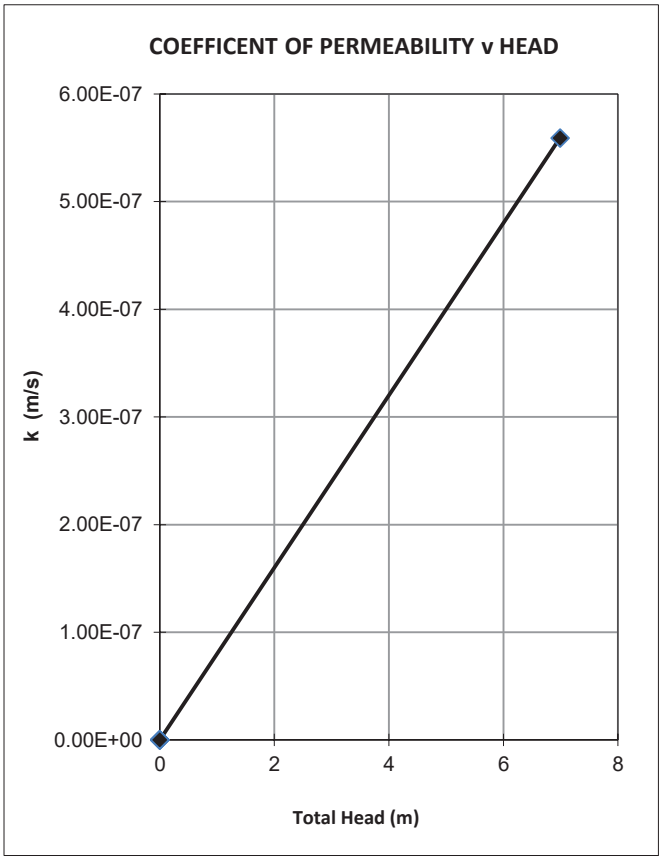
DEPTH RECORD

DEPTH OF BOREHOLE (m bgl)	21.20	PACKER TYPE	DOUBLE/PNEUMATIC
BASE OF TEST ZONE (m bgl)	15.80	INFLATION PRESSURE (bar)	4
TOP OF TEST ZONE (m bgl)	13.90	DIAMETER OF HOLE, d (m)	0.146
TEST INTERVAL, L (m)	1.90	DATE OF TEST	23/06/2017
HEIGHT OF GAUGE (m agl), h_3	0.50	WEATHER	Fine
DEPTH OF CASING (m bgl)	11.30	STRATA DESCRIPTION	Sandstone
DEPTH TO WATER (m bgl)*, h_1	3.85		

TEST RECORD

TEST PERIOD	MEASURED PRESSURE (kPa)	APPLIED HEAD, h_1 (m)	FRICTION HEAD LOSS, h_4 (m)	TOTAL HEAD $H=h_1+h_2+h_3-h_4$ (m)	DEPTH TO WATER ABOVE PACKER (m)	STAGE DURATION (mins)	AVERAGE FLOW, q (litres/min)	PERMEABILITY (m/s)**
A	20	2.04	0.80	6.99	3.85	10	3.90	5.6E-07
B	80	8.16	*		*	*	*	
C	*		*		*	*	*	
D	*		*		*	*	*	
E	*		*		*	*	*	
F	*		*		*	*	*	





REMARKS: *Where test carried out above water table, "depth to water" taken as depth to centre of test section for use in calculations.

Water level rose in borehole during pressure increase to Stage B (70kPa). Test abandoned.

**Coefficent of permeability = $(q/2\pi HL) \times \log_e(L/0.5d)$

CONTRACT	CHECKED
33138	**JH**

PR/PS

Geotechnical Engineering Limited

PACKER TEST - PERMEABILITY

BS EN ISO 22282-3

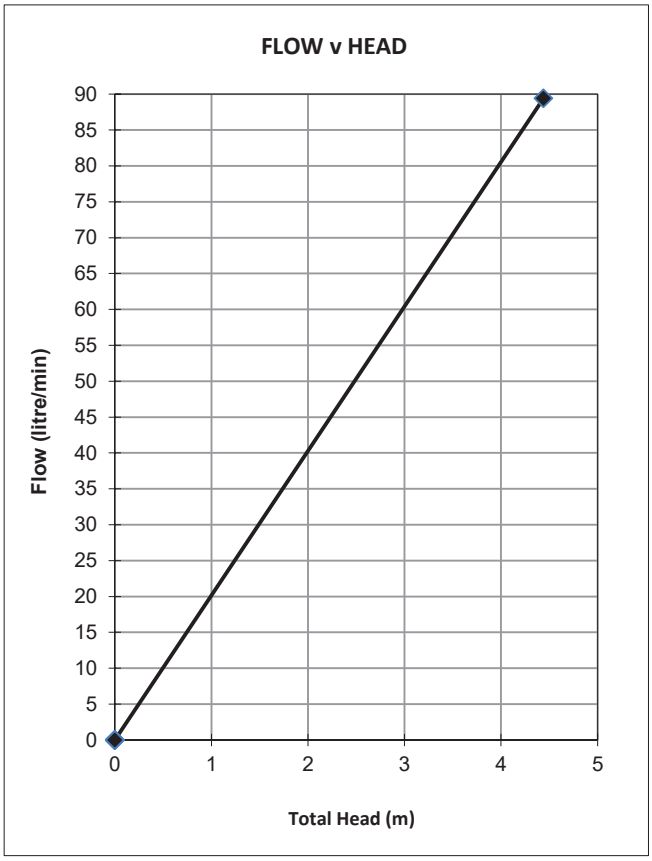
CLIENT	BURO HAPPOLD	BOREHOLE	**BH01A**
SITE	PROJECT BLUE	TEST No.	**2**

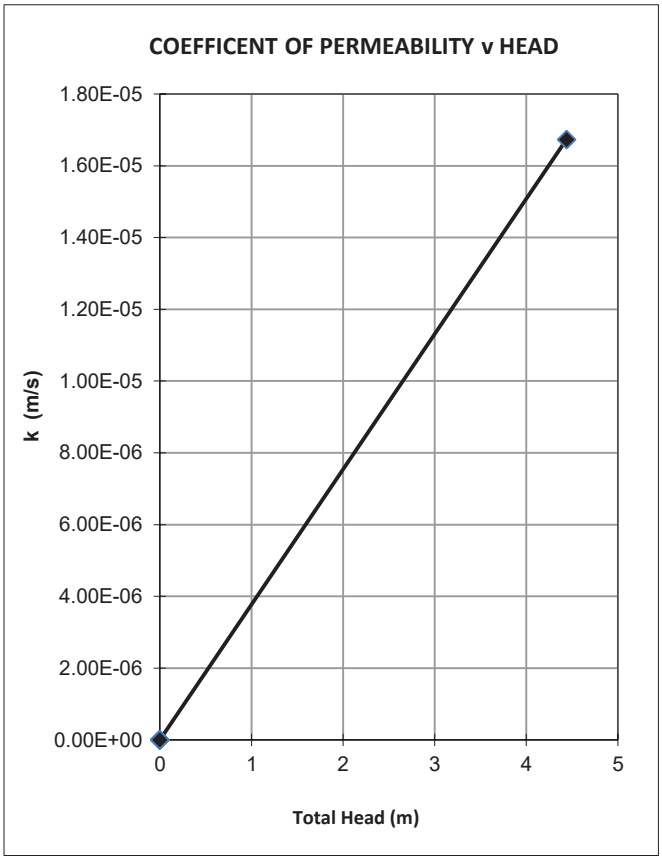
DEPTH RECORD

DEPTH OF BOREHOLE (m bgl)	21.20	PACKER TYPE	DOUBLE/PNEUMATIC
BASE OF TEST ZONE (m bgl)	19.40	INFLATION PRESSURE (bar)	4.5
TOP OF TEST ZONE (m bgl)	17.50	DIAMETER OF HOLE, d (m)	0.146
TEST INTERVAL, L (m)	1.90	DATE OF TEST	23/06/2017
HEIGHT OF GAUGE (m agl), h_3	0.50	WEATHER	Fine
DEPTH OF CASING (m bgl)	11.30	STRATA DESCRIPTION	Sandstone
DEPTH TO WATER (m bgl)*, h_1	3.85		

TEST RECORD

TEST PERIOD	MEASURED PRESSURE (kPa)	APPLIED HEAD, h_1 (m)	FRICTION HEAD LOSS, h_4 (m)	TOTAL HEAD $H=h_1+h_2+h_3-h_4$ (m)	DEPTH TO WATER ABOVE PACKER (m)	STAGE DURATION (mins)	AVERAGE FLOW, q (litres/min)	PERMEABILITY (m/s)**
A	30	3.06	4.37	4.44	3.85	10	89.40	1.7E-05
B	110	11.22	*		*	*	*	
C	*		*		*	*	*	
D	*		*		*	*	*	
E	*		*		*	*	*	
F	*		*		*	*	*	





REMARKS: *Where test carried out above water table, "depth to water" taken as depth to centre of test section for use in calculations.

Water level rose in borehole during pressure increase to Stage B (50kPa). Test abandoned.

**Coefficent of permeability = $(q/2\pi HL) \times \log_e(L/0.5d)$

CONTRACT	CHECKED
33138	**JH**

PR/PS

rev06 05/08/16 JH

Geotechnical Engineering Limited

PACKER TEST - PERMEABILITY

BS EN ISO 22282-3

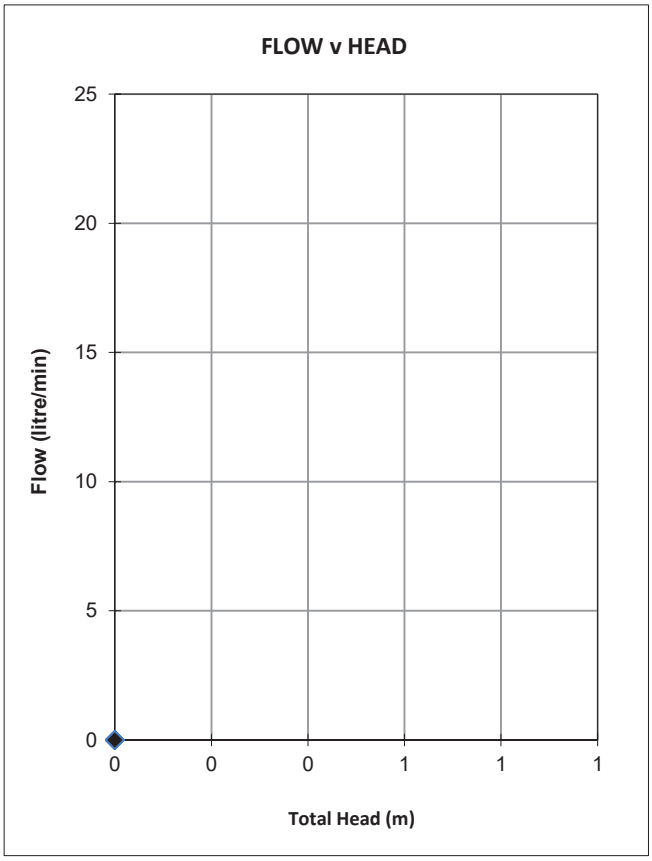
CLIENT	BURO HAPPOLD	BOREHOLE	**BH04**
SITE	PROJECT BLUE	TEST No.	**1**

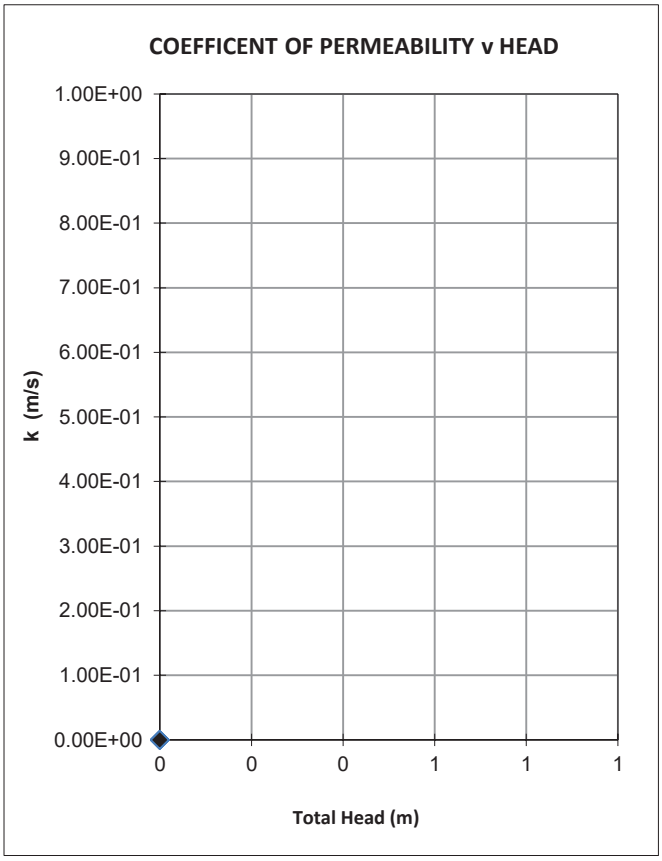
DEPTH RECORD

DEPTH OF BOREHOLE (m bgl)	24.50	PACKER TYPE	DOUBLE/PNEUMATIC
BASE OF TEST ZONE (m bgl)	16.00	INFLATION PRESSURE (bar)	4
TOP OF TEST ZONE (m bgl)	14.10	DIAMETER OF HOLE, d (m)	0.146
TEST INTERVAL, L (m)	1.90	DATE OF TEST	15/06/2017
HEIGHT OF GAUGE (m agl), h_3	0.50	WEATHER	Fine
DEPTH OF CASING (m bgl)	11.60	STRATA DESCRIPTION	Sandstone
DEPTH TO WATER (m bgl)*, h_1	4.70		

TEST RECORD

TEST PERIOD	MEASURED PRESSURE (kPa)	APPLIED HEAD, h_1 (m)	FRICTION HEAD LOSS, h_4 (m)	TOTAL HEAD $H=h_1+h_2+h_3-h_4$ (m)	DEPTH TO WATER ABOVE PACKER (m)	STAGE DURATION (mins)	AVERAGE FLOW, q (litres/min)	PERMEABILITY (m/s)**
A	31	3.16	*		*	*	*	
B	88	8.97	*		*	*	*	
C	146	14.84	*		*	*	*	
D	88	8.97	*		*	*	*	
E	31	3.16	*		*	*	*	
F	*		*		*	*	*	





REMARKS: *Where test carried out above water table, "depth to water" taken as depth to centre of test section for use in calculations.
Unable to hold Stage A pressure - test abandoned.

**Coefficent of permeability = $(q/2\pi HL) \times \log_e(L/0.5d)$

CONTRACT	CHECKED
33138	**CT**

/

rev06 05/08/16 JH

Geotechnical Engineering Limited

PACKER TEST - PERMEABILITY

BS EN ISO 22282-3

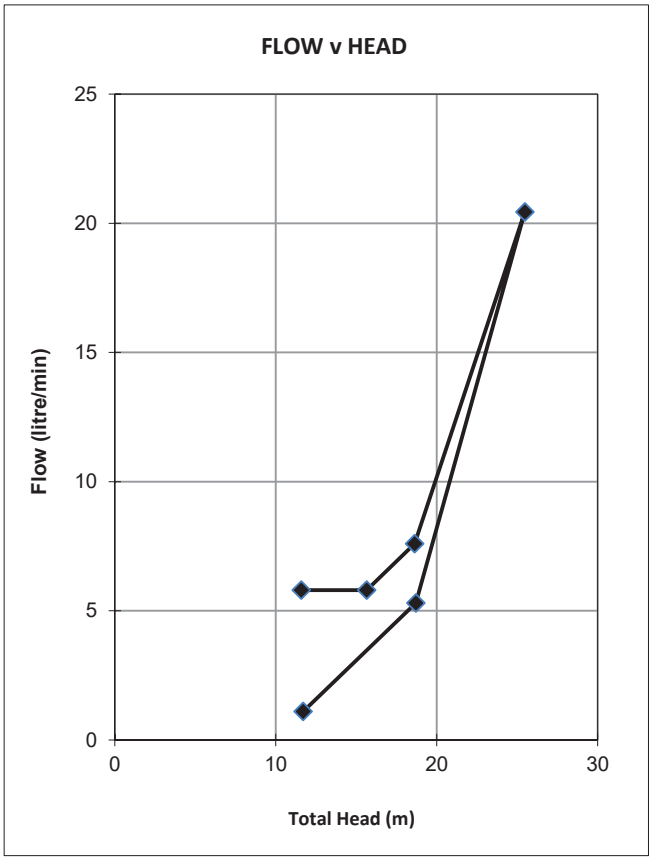
CLIENT	BURO HAPPOLD	BOREHOLE	**BH04**
SITE	PROJECT BLUE	TEST No.	**2**

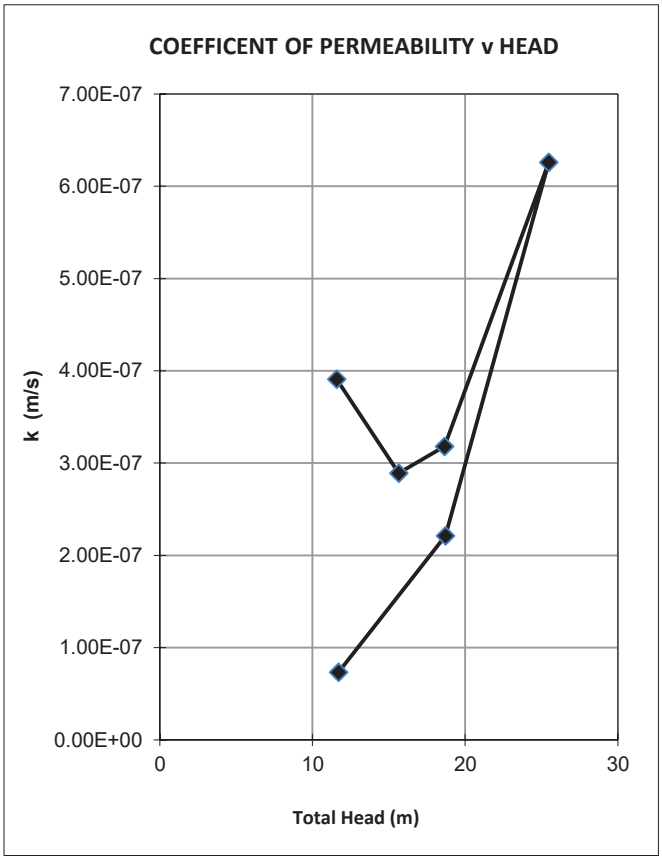
DEPTH RECORD

DEPTH OF BOREHOLE (m bgl)	24.50	PACKER TYPE	DOUBLE/PNEUMATIC
BASE OF TEST ZONE (m bgl)	20.80	INFLATION PRESSURE (bar)	4
TOP OF TEST ZONE (m bgl)	18.90	DIAMETER OF HOLE, d (m)	0.146
TEST INTERVAL, L (m)	1.90	DATE OF TEST	15/06/2017
HEIGHT OF GAUGE (m agl), h_3	0.50	WEATHER	Fine
DEPTH OF CASING (m bgl)	11.60	STRATA DESCRIPTION	Sandstone
DEPTH TO WATER (m bgl)*, h_1	4.70		

TEST RECORD

TEST PERIOD	MEASURED PRESSURE (kPa)	APPLIED HEAD, h_1 (m)	FRICTION HEAD LOSS, h_4 (m)	TOTAL HEAD $H=h_1+h_2+h_3-h_4$ (m)	DEPTH TO WATER ABOVE PACKER (m)	STAGE DURATION (mins)	AVERAGE FLOW, q (litres/min)	PERMEABILITY (m/s)**
A	50	5.10	0.13	11.57	4.70	10	5.80	3.9E-07
B	90	9.18	0.13	15.65	4.70	10	5.80	2.9E-07
C	120	12.24	0.20	18.64	4.70	10	7.60	3.2E-07
D	190	19.37	0.50	25.47	4.65	10	20.44	6.3E-07
E	120	12.24	0.13	18.71	4.65	10	5.30	2.2E-07
F	50	5.10	0.00	11.70	4.65	10	1.1	7.3E-08





REMARKS: *Where test carried out above water table, "depth to water" taken as depth to centre of test section for use in calculations.
Stage D average flow taken from minutes 2 to 10 (reading at minute 1 not representative).

**Coefficent of permeability = $(q/2\pi HL) \times \log_e(L/0.5d)$

CONTRACT	CHECKED
33138	**CT**

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PACKER TEST - LUGEON

BS EN ISO 22282-3

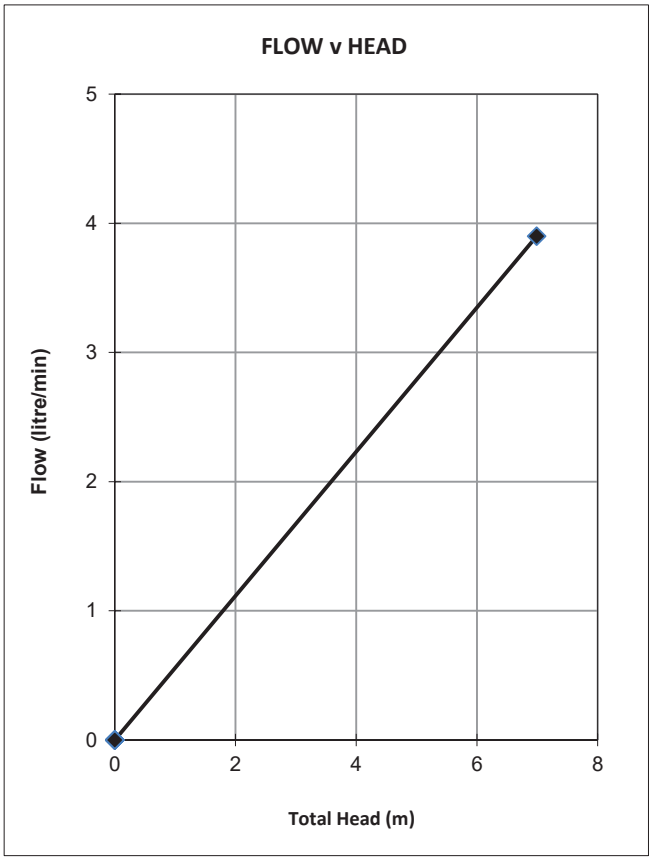
CLIENT	BURO HAPPOLD	BOREHOLE	**BH01A**
SITE	PROJECT BLUE	TEST No.	**1**

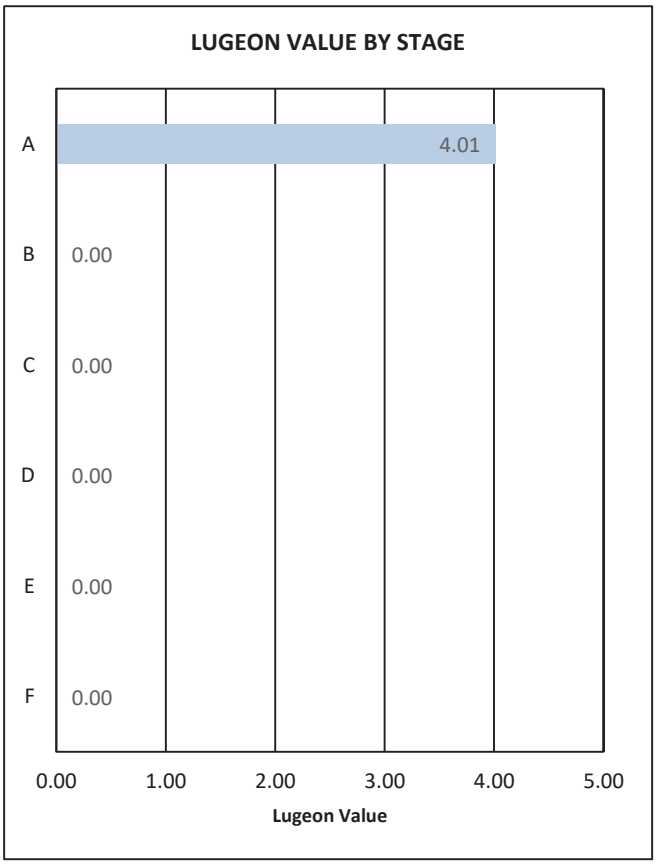
DEPTH RECORD

DEPTH OF BOREHOLE (m bgl)	21.20	PACKER TYPE	DOUBLE/PNEUMATIC
BASE OF TEST ZONE (m bgl)	15.80	INFLATION PRESSURE (bar)	4.5
TOP OF TEST ZONE (m bgl)	13.90	DIAMETER OF HOLE (m)	0.146
TEST INTERVAL, L (m)	1.90	DATE OF TEST	23/06/2017
HEIGHT OF GAUGE (m agl), h_3	0.50	WEATHER	Fine
DEPTH OF CASING (m bgl)	11.30	STRATA DESCRIPTION	Sandstone
DEPTH TO WATER (m bgl)*, h_1	3.85		

TEST RECORD

TEST PERIOD	MEASURED PRESSURE (kPa)	APPLIED HEAD, h_1 (m)	FRICTION HEAD LOSS, h_4 (m)	TOTAL HEAD $H=h_1+h_2+h_3-h_4$ (m)	DEPTH TO WATER ABOVE PACKER (m)	STAGE DURATION (mins)	AVERAGE FLOW, q (litres/min)	LUGEON VALUE **
A	20	2.04	0.80	6.99	3.85	10	3.90	4.01
B	80	8.16	*		*	*	*	
C	*		*		*	*	*	
D	*		*		*	*	*	
E	*		*		*	*	*	
F	*		*		*	*	*	





REMARKS: *Where test carried out above water table, "depth to water" taken as depth to centre of test section for use in calculations.

Water level rose in borehole during pressure increase to Stage B (70kPa). Test abandoned.

** Lugeon Value = (q/H)x(100/L) based on laminar flow conditions

CONTRACT	CHECKED
33138	**JH**

PR/PS

Geotechnical Engineering Limited

PACKER TEST - LUGEON

BS EN ISO 22282-3

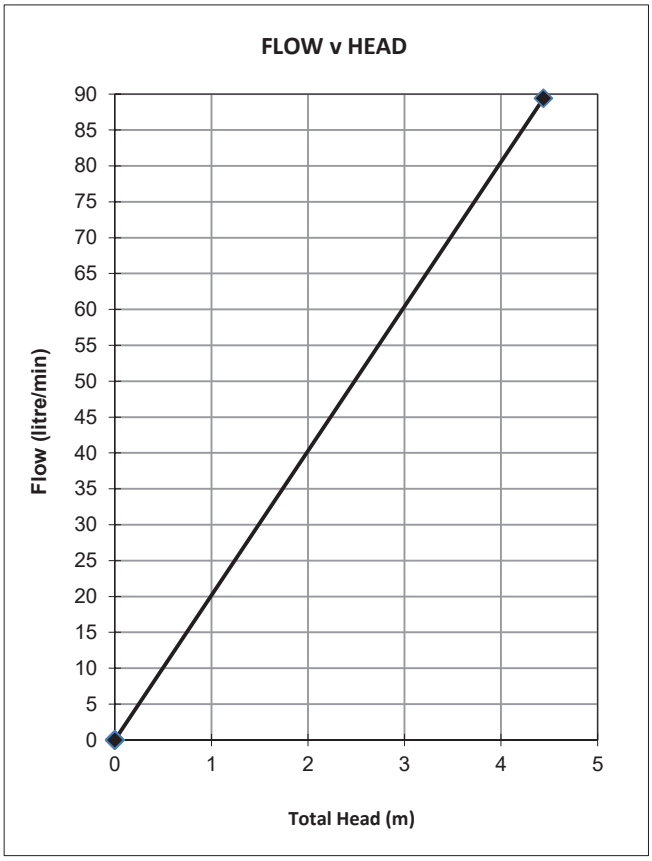
CLIENT	BURO HAPPOLD	BOREHOLE	**BH01A**
SITE	PROJECT BLUE	TEST No.	**2**

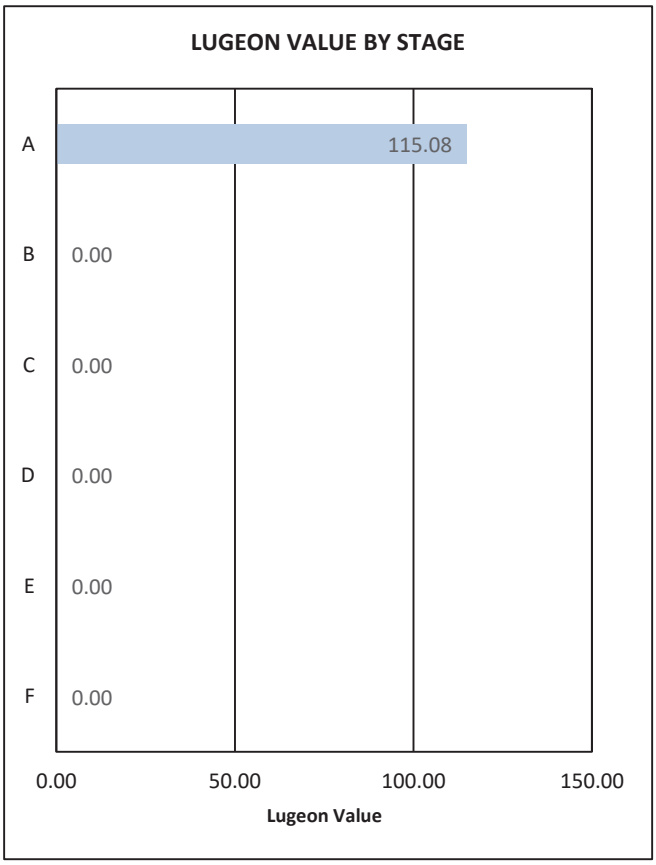
DEPTH RECORD

DEPTH OF BOREHOLE (m bgl)	21.20	PACKER TYPE	DOUBLE/PNEUMATIC
BASE OF TEST ZONE (m bgl)	19.40	INFLATION PRESSURE (bar)	4.5
TOP OF TEST ZONE (m bgl)	17.50	DIAMETER OF HOLE (m)	0.146
TEST INTERVAL, L (m)	1.90	DATE OF TEST	23/06/2017
HEIGHT OF GAUGE (m agl), h_3	0.50	WEATHER	Fine
DEPTH OF CASING (m bgl)	11.30	STRATA DESCRIPTION	Sandstone
DEPTH TO WATER (m bgl)*, h_1	3.85		

TEST RECORD

TEST PERIOD	MEASURED PRESSURE (kPa)	APPLIED HEAD, h_1 (m)	FRICTION HEAD LOSS, h_4 (m)	TOTAL HEAD $H=h_1+h_2+h_3-h_4$ (m)	DEPTH TO WATER ABOVE PACKER (m)	STAGE DURATION (mins)	AVERAGE FLOW, q (litres/min)	LUGEON VALUE **
A	30	3.06	4.37	4.44	3.85	10	89.40	115.08
B	110	11.22	*		*	*	*	
C	*		*		*	*	*	
D	*		*		*	*	*	
E	*		*		*	*	*	
F	*		*		*	*	*	





REMARKS: *Where test carried out above water table, "depth to water" taken as depth to centre of test section for use in calculations.

Water level rose in borehole during pressure increase to Stage B (50kPa). Test abandoned.

** Lugeon Value = (q/H)x(100/L) based on laminar flow conditions

CONTRACT	CHECKED
33138	**JH**

PR/PS

rev06 05/08/16 JH

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PACKER TEST - LUGEON

BS EN ISO 22282-3

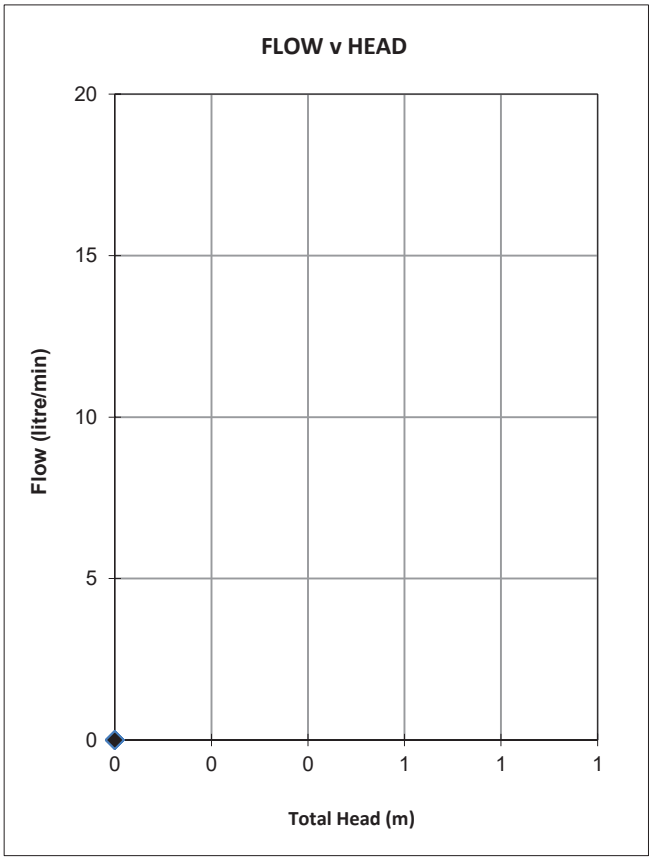
CLIENT	BURO HAPPOLD	BOREHOLE	**BH04**
SITE	PROJECT BLUE	TEST No.	**1**

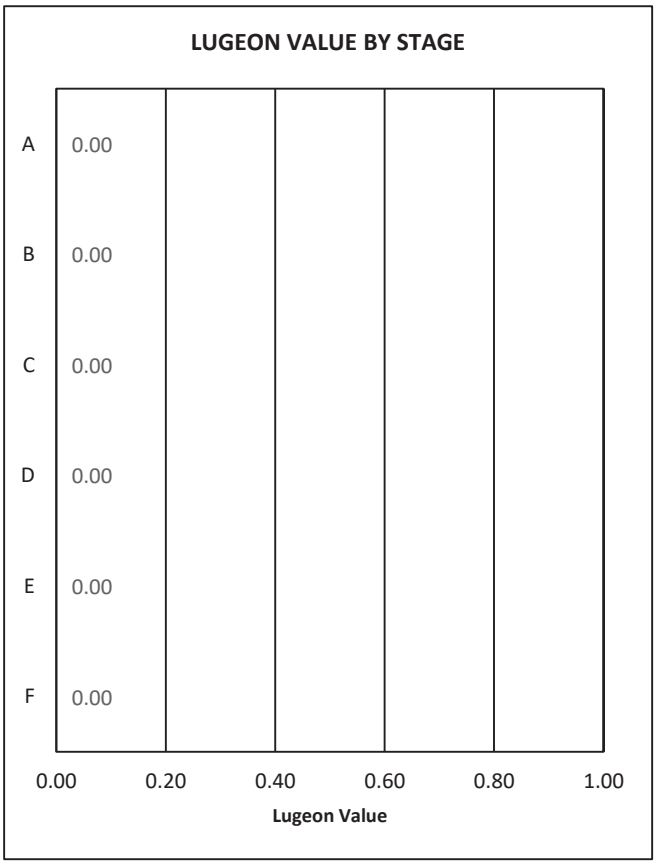
DEPTH RECORD

DEPTH OF BOREHOLE (m bgl)	24.50	PACKER TYPE	DOUBLE/PNEUMATIC
BASE OF TEST ZONE (m bgl)	16.00	INFLATION PRESSURE (bar)	4
TOP OF TEST ZONE (m bgl)	14.10	DIAMETER OF HOLE (m)	0.146
TEST INTERVAL, L (m)	1.90	DATE OF TEST	15/06/2017
HEIGHT OF GAUGE (m agl), h_3	0.50	WEATHER	Fine
DEPTH OF CASING (m bgl)	11.60	STRATA DESCRIPTION	Sandstone
DEPTH TO WATER (m bgl)*, h_1	4.70		

TEST RECORD

TEST PERIOD	MEASURED PRESSURE (kPa)	APPLIED HEAD, h_1 (m)	FRICTION HEAD LOSS, h_4 (m)	TOTAL HEAD $H=h_1+h_2+h_3-h_4$ (m)	DEPTH TO WATER ABOVE PACKER (m)	STAGE DURATION (mins)	AVERAGE FLOW, q (litres/min)	LUGEON VALUE **
A	31	3.16	*		*	*	*	
B	88	8.97	*		*	*	*	
C	146	14.84	*		*	*	*	
D	88	8.97	*		*	*	*	
E	31	3.16	*		*	*	*	
F	*		*		*	*	*	





REMARKS: *Where test carried out above water table, "depth to water" taken as depth to centre of test section for use in calculations.

Unable to hold Stage A pressure - test abandoned.

** Lugeon Value = (q/H)x(100/L) based on laminar flow conditions

CONTRACT	CHECKED
33138	**CT**

xy/xz

rev06 05/08/16 JH

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PACKER TEST - LUGEON

BS EN ISO 22282-3

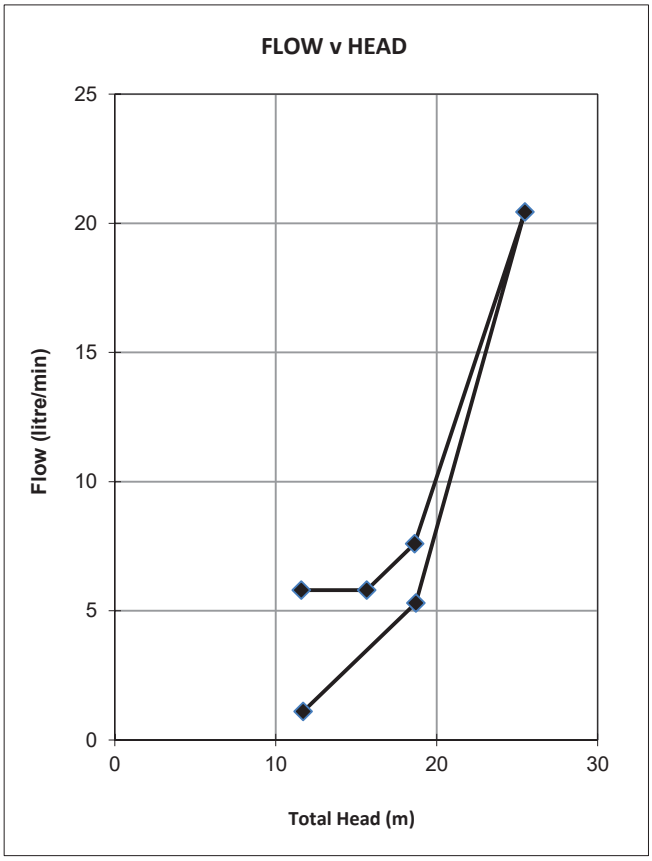
CLIENT	BURO HAPPOLD	BOREHOLE	**BH04**
SITE	PROJECT BLUE	TEST No.	**2**

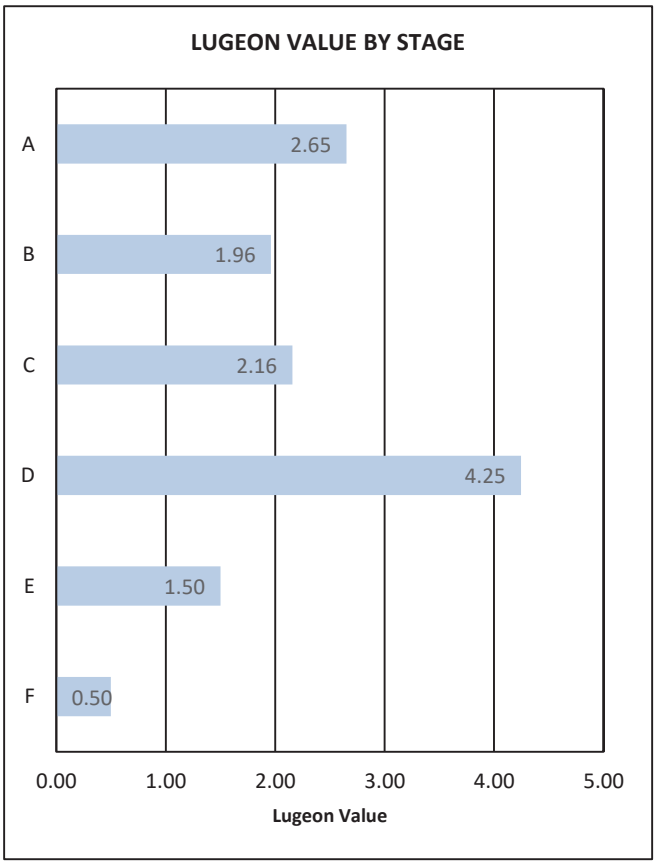
DEPTH RECORD

DEPTH OF BOREHOLE (m bgl)	24.50	PACKER TYPE	DOUBLE/PNEUMATIC
BASE OF TEST ZONE (m bgl)	20.80	INFLATION PRESSURE (bar)	3
TOP OF TEST ZONE (m bgl)	18.90	DIAMETER OF HOLE (m)	0.146
TEST INTERVAL, L (m)	1.90	DATE OF TEST	15/06/2017
HEIGHT OF GAUGE (m agl), h_3	0.50	WEATHER	Fine
DEPTH OF CASING (m bgl)	11.60	STRATA DESCRIPTION	Sandstone
DEPTH TO WATER (m bgl)*, h_1	4.70		

TEST RECORD

TEST PERIOD	MEASURED PRESSURE (kPa)	APPLIED HEAD, h_1 (m)	FRICTION HEAD LOSS, h_4 (m)	TOTAL HEAD $H=h_1+h_2+h_3-h_4$ (m)	DEPTH TO WATER ABOVE PACKER (m)	STAGE DURATION (mins)	AVERAGE FLOW, q (litres/min)	LUGEON VALUE **
A	50	5.10	0.13	11.57	4.70	10	5.80	2.65
B	90	9.18	0.13	15.65	4.70	10	5.80	1.96
C	120	12.24	0.20	18.64	4.70	10	7.60	2.16
D	190	19.37	0.50	25.47	4.65	10	20.44	4.25
E	120	12.24	0.13	18.71	4.65	10	5.30	1.50
F	50	5.10	0.00	11.70	4.65	10	1.1	0.50





REMARKS: *Where test carried out above water table, "depth to water" taken as depth to centre of test section for use in calculations.

Stage D average flow taken from minutes 2 to 10 (reading at minute 1 not representative).

** Lugeon Value = (q/H)x(100/L) based on laminar flow conditions

CONTRACT	CHECKED
33138	**CT**

PR/PS

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BOREHOLE LOG

P01

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 2
Start Date	27 June 2017	Easting	333289.0			Scale	1 : 50
End Date	27 June 2017	Northing	392443.0	Ground level	6.70mOD	Depth	10.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
27/06/17 1240hrs	C	0.00 - 0.50	Nil		100			MADE GROUND comprising CONCRETE (Driller's description).	0.50	6.20	
	C	0.70 - 1.30	Nil		100			MADE GROUND (Driller's description). 0.70 - 2.30m: Possible wall (Driller's description).			
	C	1.30 - 1.50	Nil		100						
	C	1.50 - 2.30	Nil		100						
	CASE	2.30 - 10.00									
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Waterflush rotary cored (300mm) 0.00-0.50m. Hand dug inspection pit 0.50-0.70m. Waterflush rotary cored (146mm) 0.70-2.30m (through hard strata). Borehole advanced by flushing casing (168mm) 2.30-10.00m.

CASING: 168mm diam to 10.00m.

BACKFILL: On completion, hole backfilled with bentonite pellets 10.00-0.30m and concrete 0.30-0.00m.

REMARKS: No samples retained on Client's instruction. Borehole undertaken 5.50m from western dock wall. Borehole terminated at 10.00m on Client's instruction without encountering structure / foundation. Driller notes 90% grey flush returns 0.00-2.30m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

CLIENT	BUROHAPPOLD						**P01**
SITE	PROJECT BLUE					Sheet	2 of 2
Start Date	27 June 2017	Easting	333289.0			Scale	1 : 50
End Date	27 June 2017	Northing	392443.0	Ground level	6.70mOD	Depth	10.00 m

progress date/time water depth	sample no & type	depth (m) from	to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
27/06/17 1530hrs 0.70m										10.00	-3.30	
		10.00		10.00					Borehole completed at 10.00m.			
										{18.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

P01A

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 2
Start Date	27 June 2017	Easting	333290.0			Scale	1 : 50
End Date	27 June 2017	Northing	392443.0	Ground level	6.75mOD	Depth	8.30 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
27/06/17 1040hrs	C	0.00 - 0.50	Nil		100			MADE GROUND comprising CONCRETE (Driller's description).	0.50	6.25	
								MADE GROUND (Driller's description).			
	CASE	1.20 - 7.80									
27/06/17 1230hrs 0.00m	C	7.80 - 8.30	7.80		100				7.80	-1.05	
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Waterflush rotary cored (300mm) 0.00-0.50m. Hand dug inspection pit 0.50-1.20m. Borehole advanced by flushing casing (168mm) 1.20-7.80m. Waterflush rotary cored (146mm) 7.80-8.30m.

CASING: 168mm diam to 7.80m.

BACKFILL: On completion, hole backfilled with bentonite pellets 8.30-0.30m and concrete 0.30-0.00m.

REMARKS: No samples retained on Client's instruction. Borehole undertaken 4.20m from western dock wall. Borehole terminated at 8.30m on Client's instruction after encountering structure / foundation. Driller notes 70% grey flush returns 7.80-8.30m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

P01A

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	2 of 2
Start Date	27 June 2017	Easting	333290.0			Scale	1 : 50
End Date	27 June 2017	Northing	392443.0	Ground level	6.75mOD	Depth	8.30 m

progress date/time water depth	sample no & type	depth (m) from	to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
									MADE GROUND comprising reddish brown fine sandstone MASONRY.	8.10	-1.35	
									MADE GROUND comprising light grey crystalline MASONRY.	8.30	-1.55	
									Borehole completed at 8.30m.			
										{18.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

P01B

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 2
Start Date	27 June 2017	Easting	333291.0			Scale	1 : 50
End Date	27 June 2017	Northing	392443.0	Ground level	6.70mOD	Depth	8.80 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
27/06/17 0730hrs	C	0.00 - 0.50	Nil		100			MADE GROUND comprising CONCRETE (Driller's description).	0.50	6.20	
								MADE GROUND (Driller's description).			
	CASE	1.20 - 8.00									
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Waterflush rotary cored (300mm) 0.00-0.50m. Hand dug inspection pit 0.50-1.20m. Borehole advanced by flushing casing (168mm) 1.20-8.00m. Waterflush rotary cored (146mm) 8.00-8.80m.

CASING: 168mm diam to 8.00m.

BACKFILL: On completion, hole backfilled with bentonite pellets 8.80-0.50m and concrete 0.50-0.00m.

REMARKS: No samples retained on Client's instruction. Borehole undertaken 3.50m from western dock wall. Borehole terminated at 8.80m on Client's instruction upon encountering structure / foundation. Driller notes 90% red flush returns 8.00-8.80m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

P01B

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	2 of 2
Start Date	27 June 2017	Easting	333291.0			Scale	1 : 50
End Date	27 June 2017	Northing	392443.0	Ground level	6.70mOD	Depth	8.80 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
	C	8.00 - 8.80	8.00		100				8.10	-1.40	
27/06/17 1030hrs 0.00m								MADE GROUND comprising reddish brown fine sandstone MASONRY.	8.40	-1.70	
								MADE GROUND comprising reddish brown sandstone blocks with up to 50% well bonded light grey mortar.	8.80	-2.10	
								Borehole completed at 8.80m.	{18.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks
				Groundwater not encountered prior to use of water flush.

AGS

CONTRACT	CHECKED
33138	JH

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BOREHOLE LOG

P01C

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 1
Start Date	27 June 2017	Easting	333292.0			Scale	1 : 50
End Date	28 June 2017	Northing	392443.0	Ground level	6.65mOD	Depth	2.80 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
27/06/17 1545hrs	C	0.00 - 1.30	Nil		100			MADE GROUND comprising strongly cemented light and dark grey CONCRETE composed of 70% subangular to rounded fine to coarse aggregate of sandstone, mudstone and brick.			
27/06/17 1645hrs Dry									1.00	5.65	
28/06/17 0700hrs Dry	C	1.30 - 2.80	Nil		86			MADE GROUND comprising strongly cemented light grey CONCRETE composed of 20% subangular fine aggregate of sandstone.			
28/06/17 1300hrs Dry									2.80	3.85	
								Borehole completed at 2.80m.			
									{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.
METHOD: Waterflush rotary cored (146mm) 0.00-2.80m.
CASING: None used.
BACKFILL: On completion, hole backfilled with bentonite pellets 2.80-0.30m and concrete 0.30-0.00m.
REMARKS: No samples retained on Client's instruction. Borehole undertaken 2.50m from western dock wall. Borehole terminated at 2.80m on Client's instruction due to encountering a buried structure from ground level. Driller notes loss of flush returns 0.00-2.80m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

P02

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 2
Start Date	27 June 2017	Easting	333603.0			Scale	1 : 50
End Date	27 June 2017	Northing	392464.0	Ground level	6.65mOD	Depth	11.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
27/06/17 1330hrs	C	0.00 - 0.40	Nil		100			MADE GROUND comprising CONCRETE (Driller's description).	0.40	6.25	
								Sandy CLAY (Driller's description). (MADE GROUND)	1.20	5.45	
	CASE	1.20 - 10.00						Sandy CLAY and gravel (Driller's Description). (MADE GROUND)			
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Waterflush rotary cored (300mm) 0.00-0.40m. Hand dug inspection pit 0.40-1.20m. Borehole advanced by flushing casing (168mm) 1.20-10.00m. Waterflush rotary cored (116mm) 10.00-11.00m.

CASING: 168mm diam to 10.00m.

BACKFILL: On completion, hole backfilled with bentonite pellets 11.00-0.40m and concrete 0.40-0.00m.

REMARKS: No samples retained on Client's instruction. Borehole undertaken 3.50m from eastern dock wall. Borehole terminated at 11.00m on Client's instruction after encountering natural strata. Driller notes 70% grey flush returns 10.00-11.00m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

P02

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	2 of 2
Start Date	27 June 2017	Easting	333603.0			Scale	1 : 50
End Date	27 June 2017	Northing	392464.0	Ground level	6.65mOD	Depth	11.00 m

progress date/time water depth	sample no & type	depth (m) from	to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
	C	10.00	11.00	10.00		70			10.00 - 10.30m: Assessed zone of core loss.	10.30	-3.65	
									Reddish brown subrounded medium and coarse sandstone GRAVEL (drilling disturbed).	10.60	-3.95	
27/06/17 1430hrs 0.00m									Dark grey fine SANDSTONE.	10.85	-4.20	
									Light grey fine SANDSTONE.	11.00	-4.35	
									Borehole completed at 11.00m.			
										{18.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

P02A

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 1
Start Date	28 June 2017	Easting	333602.0			Scale	1 : 50
End Date	28 June 2017	Northing	392465.0	Ground level	6.65mOD	Depth	0.50 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
28/06/17 0800hrs	C	0.00 - 0.40	Nil		100			MADE GROUND comprising grey CONCRETE.	0.40	6.25	
28/06/17 0945hrs Dry								MADE GROUND comprising reddish brown brick MASONRY.	0.50	6.15	
								Borehole completed at 0.50m.	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.
METHOD: Waterflush rotary cored (300mm) 0.00-0.40m. Hand dug inspection pit 0.40-0.50m.
CASING: None used.
BACKFILL: On completion, borehole backfilled with arisings 0.50-0.30m and concrete 0.30-0.00m.
REMARKS: No samples retained on Client's instruction. Borehole undertaken 2.50m from eastern dock wall. Borehole terminated at 0.50m on Client's instruction after encountering buried structure.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

P03

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 2
Start Date	26 June 2017	Easting	333351.0			Scale	1 : 50
End Date	26 June 2017	Northing	392420.0	Ground level	6.70mOD	Depth	11.50 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
26/06/17 1030hrs	C	0.00 - 0.30	Nil		100			MADE GROUND comprising CONCRETE (Driller's description).	0.30	6.40	
								Sandy CLAY and gravels (Driller's description). (MADE GROUND)			
	CASE	1.20 - 10.00									
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Waterflush rotary cored (300mm) 0.00-0.30m. Hand dug inspection pit 0.30-1.20m. Borehole advanced by flushing casing (168mm) 1.20-10.00m. Waterflush rotary cored (116mm) 10.00-11.50m.

CASING: 168mm diam to 10.00m.

BACKFILL: On completion, hole backfilled with bentonite pellets 11.50-0.30m and concrete 0.30-0.00m.

REMARKS: No samples retained on Client's instruction. Borehole undertaken 3.50m from southern dock wall. Borehole terminated at 11.50m on Client's instruction after encountering natural strata. Driller notes 80% red flush returns 10.00-11.50m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

P03

CLIENT	BUROHAPPOLD					Sheet	2 of 2
SITE	PROJECT BLUE					Scale	1 : 50
Start Date	26 June 2017	Easting	333351.0				
End Date	26 June 2017	Northing	392420.0	Ground level	6.70mOD	Depth	11.50 m

progress date/time water depth	sample no & type	depth (m) from	to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
										10.00	-3.30	
	C	10.00	11.50	10.00		100			Light brown SANDSTONE disintegrated to claybound subangular fine to coarse sandstone lithorelicts.	10.40	-3.70	
									Light brown and cream fine SANDSTONE.	10.75	-4.05	
26/06/17 1600hrs 0.00m									Reddish brown fine SANDSTONE.	11.50	-4.80	
									Borehole completed at 11.50m.	{18.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

P03A

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 2
Start Date	27 June 2017	Easting	333351.0			Scale	1 : 50
End Date	27 June 2017	Northing	392421.0	Ground level	6.65mOD	Depth	11.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
27/06/17 1030hrs	C	0.00 - 0.30	Nil		100			MADE GROUND comprising CONCRETE (Driller's description).	0.30	6.35	
								Sandy CLAY and gravels (Driller's description). (MADE GROUND)			
	CASE	1.20 - 10.00									
								Continued Next Page	{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.

METHOD: Waterflush rotary cored (300mm) 0.00-0.30m. Hand dug inspection pit 0.30-1.20m. Borehole advanced by flushing casing (168mm) 1.20-10.00m. Waterflush rotary cored (116mm) 10.00-11.00m.

CASING: 168mm diam to 10.00m.

BACKFILL: On completion, hole backfilled with bentonite pellets 11.00-0.30m and concrete 0.30-0.00m.

REMARKS: No samples retained on Client's instruction. Borehole undertaken 2.50m from southern dock wall. Borehole terminated at 11.00m on Client's instruction after encountering natural strata. Driller notes 80% red flush returns 10.00-11.00m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

P03A

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	2 of 2
Start Date	27 June 2017	Easting	333351.0			Scale	1 : 50
End Date	27 June 2017	Northing	392421.0	Ground level	6.65mOD	Depth	11.00 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
	C	10.00 - 11.00	10.00		95				10.20	-3.55	
								Light brownish grey fine SANDSTONE.	10.50	-3.85	
27/06/17 1100hrs 0.00m								Reddish brown fine SANDSTONE.	11.00	-4.35	
								Borehole completed at 11.00m.	{18.00}		

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks	CONTRACT	CHECKED
				Groundwater not encountered prior to use of water flush.	33138	JH

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BOREHOLE LOG

P04

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 1
Start Date	28 June 2017	Easting	333626.0			Scale	1 : 50
End Date	28 June 2017	Northing	392559.0	Ground level	6.70mOD	Depth	0.50 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
28/06/17 1030hrs	C	0.00 - 0.20	Nil		100			MADE GROUND comprising light grey CONCRETE.	0.20	6.50	
								MADE GROUND (Driller's description).	0.50	6.20	
28/06/17 1100hrs								0.50m: Driller notes concrete at base. Borehole completed at 0.50m.			
									{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.
METHOD: Waterflush rotary cored (300mm) 0.00-0.20m. Hand dug inspection pit 0.20-0.50m.
CASING: None used.
BACKFILL: On completion, borehole backfilled with arisings 0.50-0.20m and concrete 0.20-0.00m.
REMARKS: No samples retained on Client's instruction. Inspection pit undertaken 3.50m from dock wall (north eastern corner). Inspection pit terminated upon discovery of concrete structure / foundation across base of pit at 0.50m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks
				Groundwater not encountered.

AGS

CONTRACT	CHECKED
33138	JH

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BOREHOLE LOG

P04A

CLIENT	BUROHAPPOLD						
SITE	PROJECT BLUE					Sheet	1 of 1
Start Date	28 June 2017	Easting	333626.0			Scale	1 : 50
End Date	28 June 2017	Northing	392558.0	Ground level	6.70mOD	Depth	0.50 m

progress date/time water depth	sample no & type	depth (m) from to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
28/06/17 1100hrs	C	0.00 - 0.20	Nil		100			MADE GROUND comprising light grey CONCRETE.	0.20	6.50	
								MADE GROUND (Driller's description).	0.50	6.20	
28/06/17 1200hrs								0.50m: Pipe and power cable. Borehole completed at 0.50m.			
									{8.00}		

EQUIPMENT: Geotechnical Pioneer rig.
METHOD: Waterflush rotary cored (300mm) 0.00-0.20m. Hand dug inspection pit 0.20-0.50m.
CASING: None used.
BACKFILL: On completion, borehole backfilled with arisings 0.50-0.20m and concrete 0.20-0.00m.
REMARKS: No samples retained on Client's instruction. Inspection pit undertaken 2.50m from dock wall (north eastern corner). Inspection pit terminated upon discovery of pipe and power cable at 0.50m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (m)	remarks
				Groundwater not encountered.

AGS

CONTRACT	CHECKED
33138	JH

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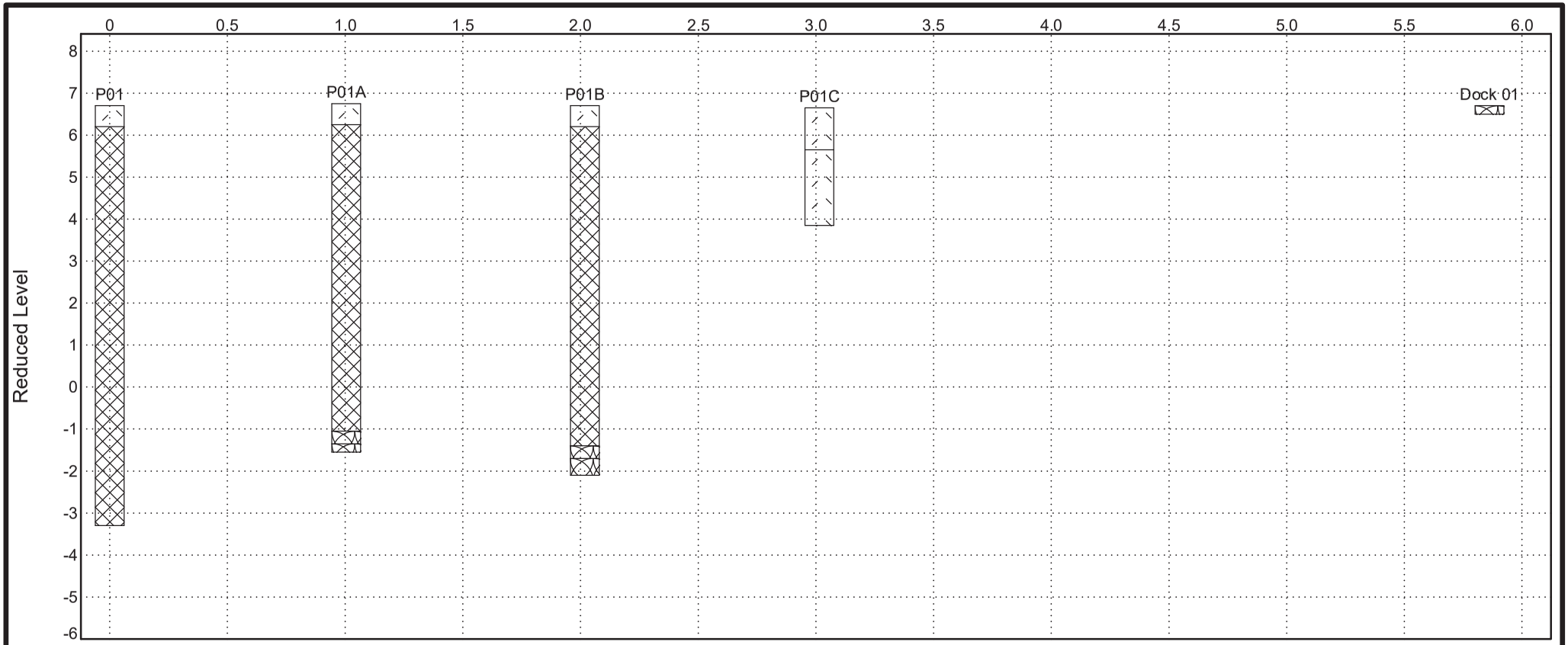

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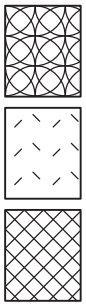

Masonry

Concrete

Made ground

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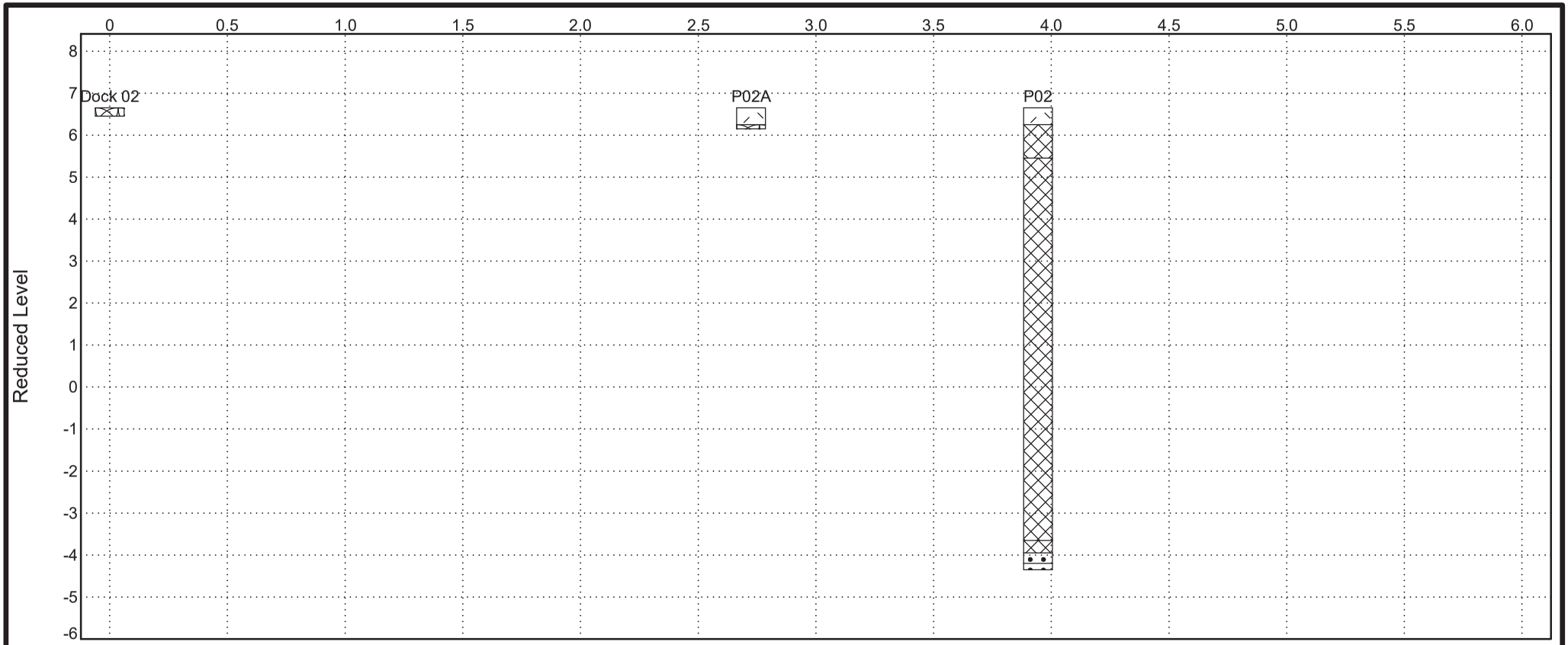
CLIENT: BUROHAPPOLD

SITE: PROJECT BLUE

CONTRACT	CHECKED
33138	

CROSS SECTION



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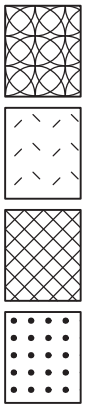


Masonry

Concrete

Made ground

Sandstone

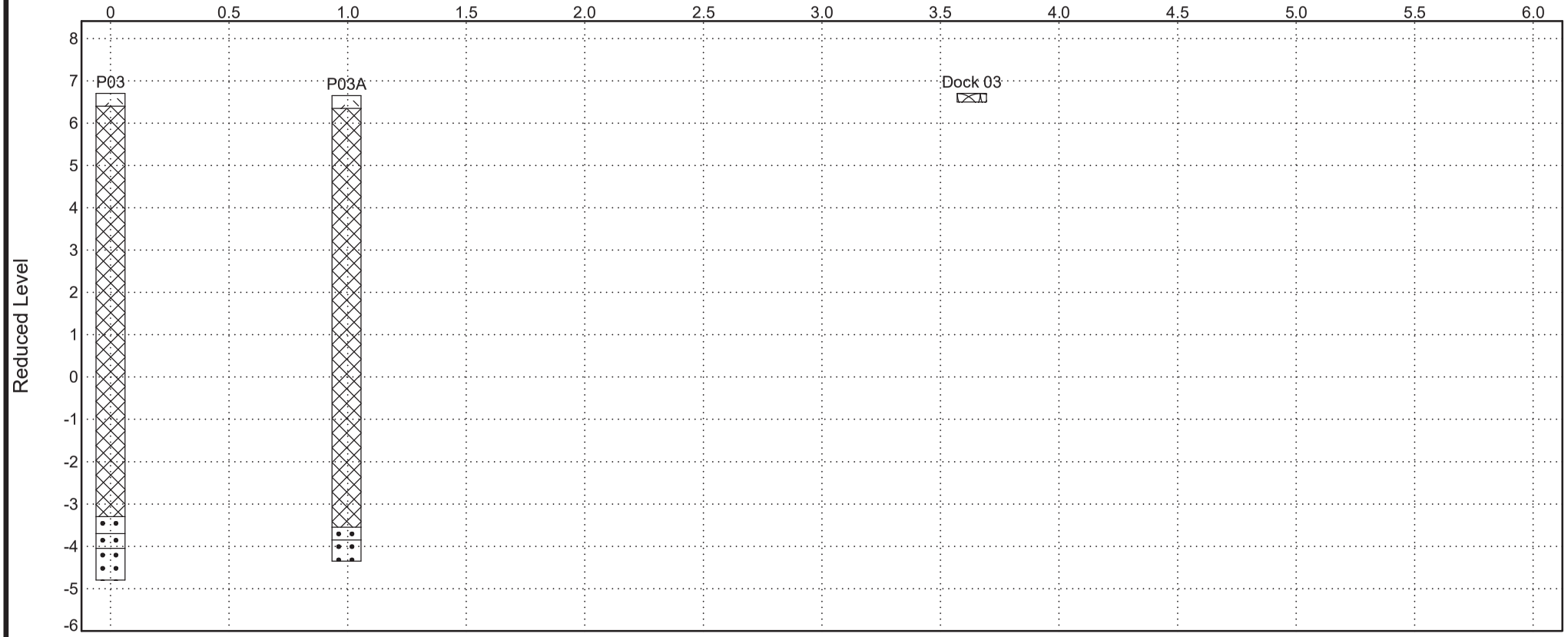
Geotechnical Engineering Limited

CLIENT: BUROHAPPOLD

SITE: PROJECT BLUE

CONTRACT	CHECKED
33138	

CROSS SECTION



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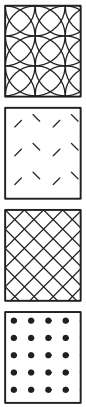


Masonry

Concrete

Made ground

Sandstone

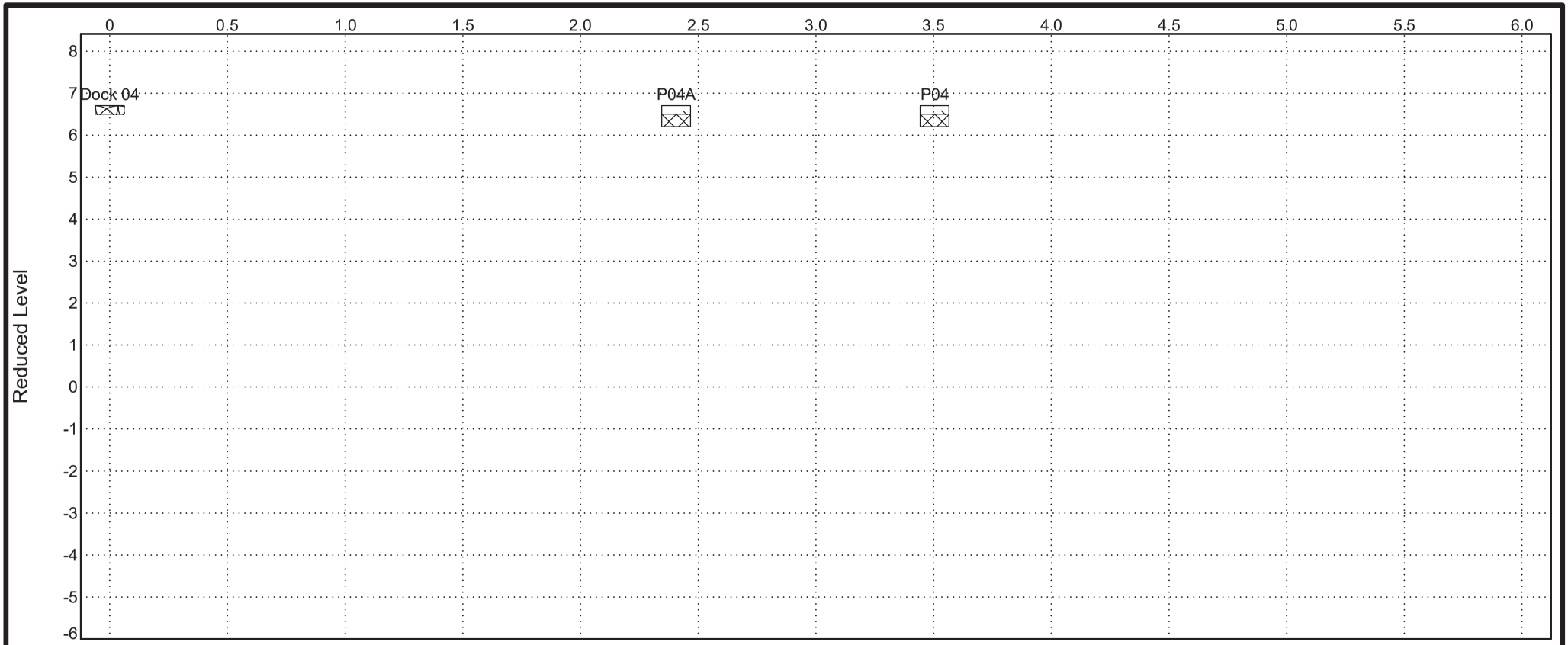
Geotechnical Engineering Limited

CLIENT: BUROHAPPOLD

SITE: PROJECT BLUE

CONTRACT	CHECKED
33138	

CROSS SECTION



KEY

Masonry

Concrete

Made ground

N

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CLIENT: BUROHAPPOLD

SITE: PROJECT BLUE

CONTRACT	CHECKED
33138	

APPENDIX B

LABORATORY TESTING

2718

GEOTECHNICAL ENGINEERING LIMITED

		Version No.	1
For the attention of	Pete Woolley/Perran Spear	Page No.	1 of 6
		Date of Issue	08/08/2017

TEST REPORT

PROJECT/SITE	Project Blue	Samples received	11/07/2017
GEL REPORT NUMBER	33138/A	Schedule received	11/07/2017
Your ref/PO:	0	Testing commenced	11/07/2017
Test report refers to	Schedule A	Status	Final

SUMMARY OF RESULTS ATTACHED

TEST METHOD & DESCRIPTION	QUANTITY	ACCREDITED TEST
BS EN ISO 17892-1: 2014:5. Water Content	4	YES
BS1377: Part 2: 1990:4.2-4.4&5.2-5.4, Liquid & Plastic Limits	4	YES
BS EN ISO 17892-4: 2016: 5.2, Particle Size Distribution - Wet Sieve	3	YES
BS EN ISO 17892-4: 2016: 5.4, Particle Size Distribution - Pipette	3	YES

Remarks

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Approved Signatories:

S Robinson (Client Manager) **C Andrew (Laboratory Consultant)**

W Jones (Technical Support) J Hanson (Director) N Parry (Director)

CAndrew

Doc TR01 Rev No. 19 Revision date 10/03/17 DC:JH

Geotechnical Engineering Ltd
Centurion House
Olympus Park, Quedgeley
Gloucester GL2 4NF

Registered number: 00700739
VAT Number: 682 5857 89

www.geoeng.co.uk
geotech@geoeng.co.uk
TEL: 01452 527743
Fax: 01452 729314

Payments: Geotechnical Engineering Limited
Sort code: 30-15-99 **Bank account**: 00072116

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LIQUID AND PLASTIC LIMITS

BS.1377 : PART 2 : 1990 : 4 and 5

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

borehole /trial pit no.	sample no./type	sample depth (m)	specimen depth (m)	natural water content (%)	specimen preparation and test method	fraction >0.425 mm (%)	liquid limit (%)	plastic limit (%)	plasticity index (%)	description and remarks
2	1D	0.00	0.00	113	BXE	9	63	29	34	Greyish brown slightly sandy slightly gravelly silty CLAY
4	1D	0.00	0.00	161	BXE	7	73	NP		Greyish brown slightly sandy slightly gravelly silty CLAY
5	1D	0.00	0.00	161	BXE	6	72	32	40	Greyish brown slightly sandy slightly gravelly silty CLAY
7	1D	0.00	0.00	81.6	BXE	17	51	25	26	Greyish brown slightly sandy slightly gravelly silty CLAY

general remarks
natural water content determined in accordance with BS EN ISO 17892 - 1 : 2014 (unless specified)
NP denotes non plastic
# denotes sample tested is smaller than that which is recommended in accordance with BS1377 or BS EN ISO 17892

specimen preparation		test method	CONTRACT	CHECKED
A - as received	D - oven dried (60oC)	X - cone penetrometer (test 4.3)	33138	CA
B - washed on 0.425mm sieve	E - oven dried (105oC)	Y - cone penetrometer (test 4.4)		
C - air dried	F - not known	Z - casagrande apparatus (test 4.5)		

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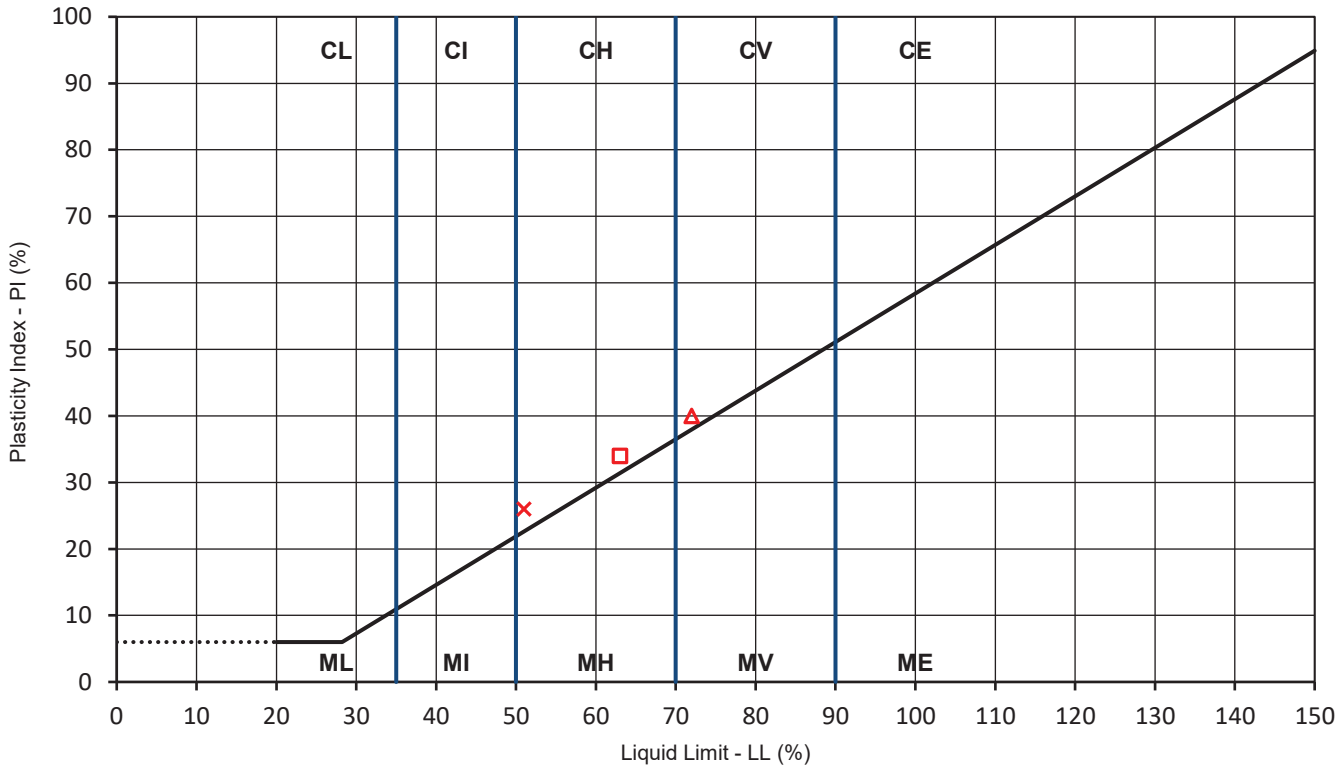
ATTERBERG LINE PLOT

CLIENT BURO HAPPOLD

SITE PROJECT BLUE



	BH/TP No.	depth (m)	LL	PL	PI	remarks
□	2	0.00	63	29	34	
◇	4	0.00	73	NP		
△	5	0.00	72	32	40	
×	7	0.00	51	25	26	

CONTRACT	CHECKED
33138	CA

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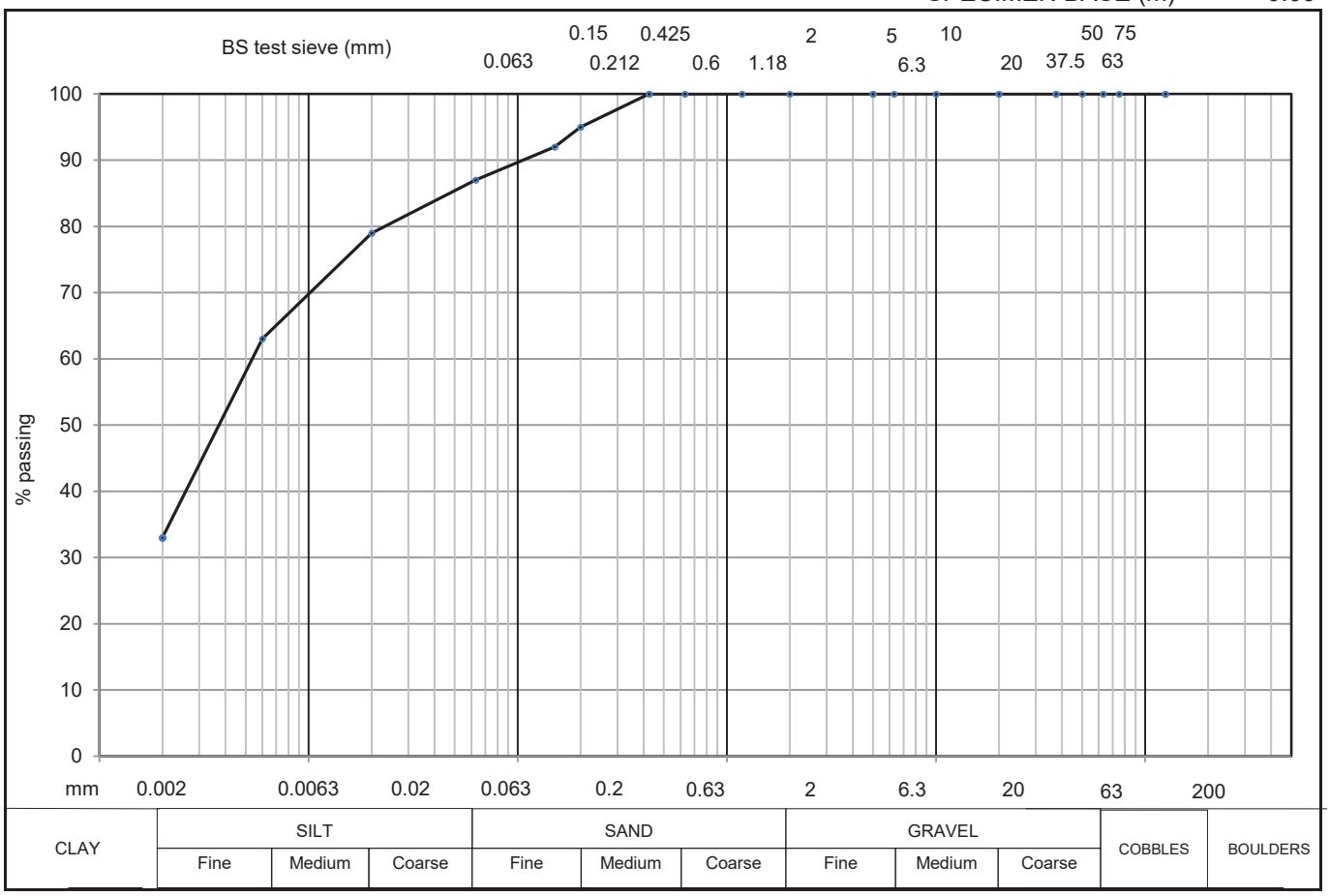
PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	1
SITE	PROJECT BLUE	SAMPLE No./TYPE	1B
		SAMPLE DEPTH (m)	0.00
DESCRIPTION	Greyish brown slightly sandy silty CLAY	SPECIMEN TOP (m)	0.00
		SPECIMEN BASE (m)	0.00



soil type	% fraction
CLAY	33
SILT	54
SILT & CLAY	87
SAND	13
GRAVEL	0
COBBLE & BOULDER	0
test method(s)	5.2 & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5		20	79
75		2		6	63
63		1.18		2	33
50		0.63			
37.5		0.425	100		
20		0.2	95		
10		0.15	92		
6.3		0.063	87		

remarks

# denotes sample tested is smaller than that which is recommended in accordance with BS EN 17892

CONTRACT	CHECKED
33138	**CA**

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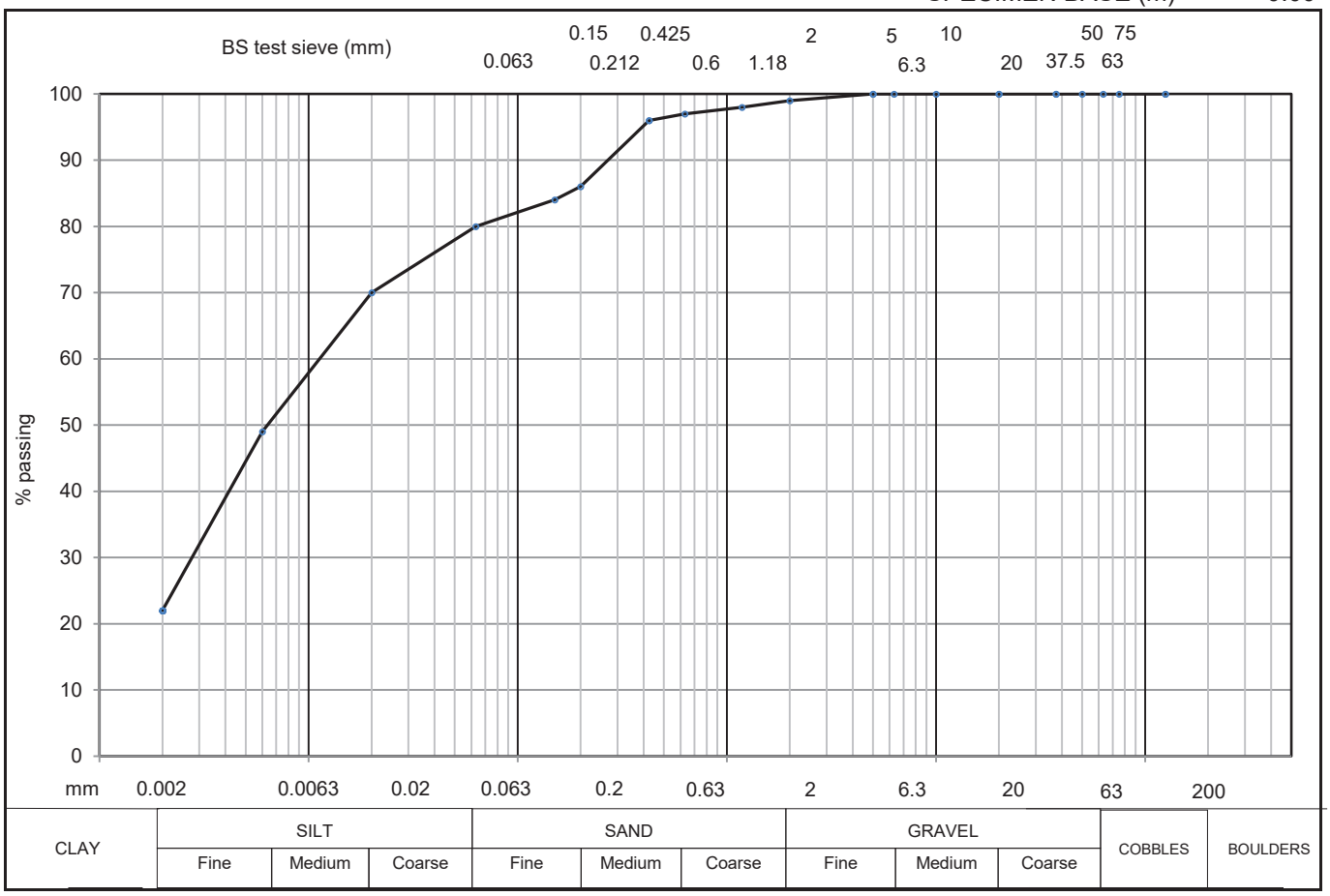
PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	4
SITE	PROJECT BLUE	SAMPLE No./TYPE	2B
		SAMPLE DEPTH (m)	0.00
DESCRIPTION	Greyish brown slightly sandy slightly gravelly silty CLAY	SPECIMEN TOP (m)	0.00
		SPECIMEN BASE (m)	0.00



soil type	% fraction
CLAY	22
SILT	58
SILT & CLAY	80
SAND	19
GRAVEL	1
COBBLE & BOULDER	0
test method(s)	5.2 & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5	100	20	70
75		2	99	6	49
63		1.18	98	2	22
50		0.63	97		
37.5		0.425	96		
20		0.2	86		
10		0.15	84		
6.3		0.063	80		

remarks

# denotes sample tested is smaller than that which is recommended in accordance with BS EN 17892

CONTRACT	CHECKED
33138	**CA**

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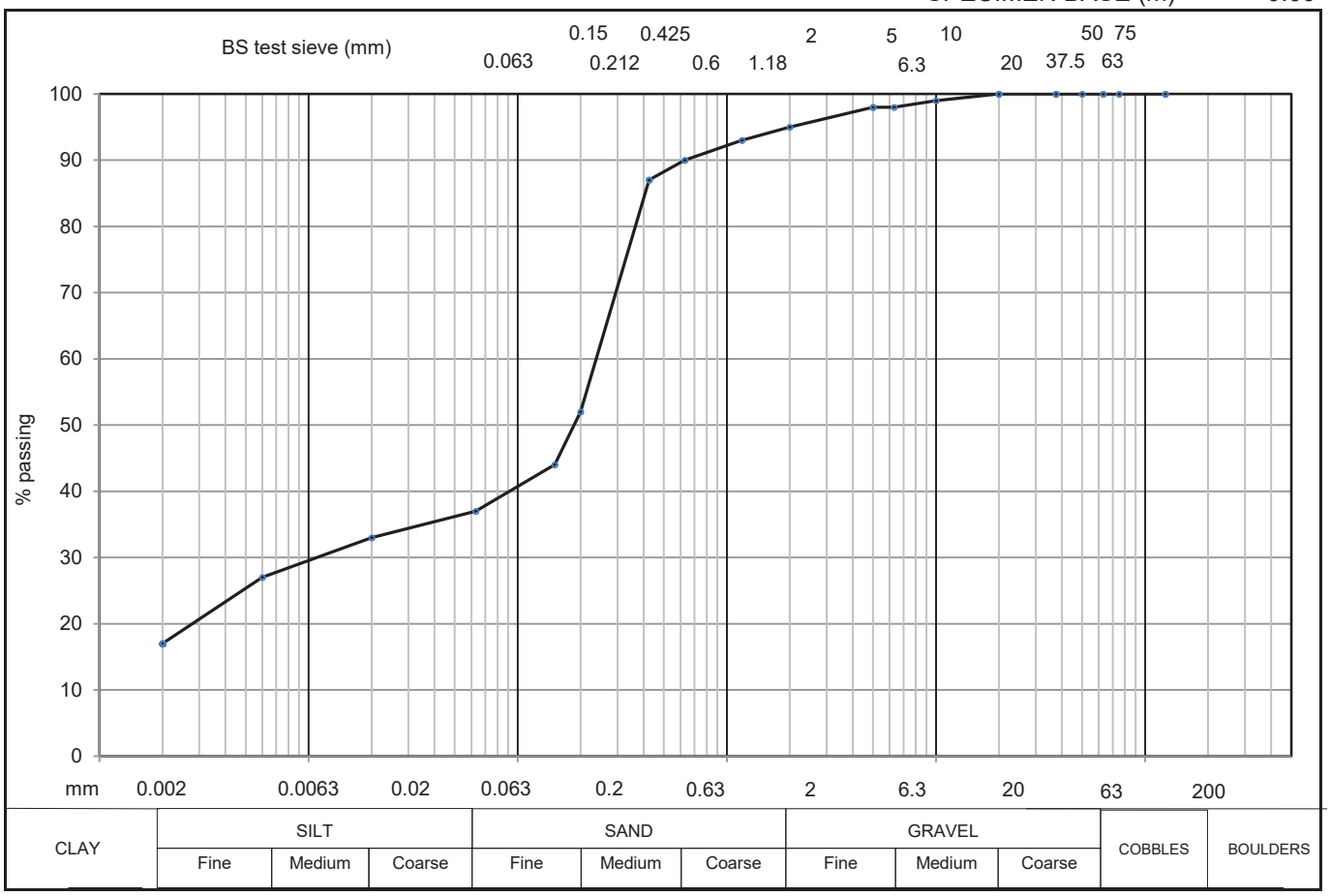
PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	7
SITE	PROJECT BLUE	SAMPLE No./TYPE	1B
		SAMPLE DEPTH (m)	0.00
DESCRIPTION	Greyish brown slightly gravelly very sandy silty CLAY	SPECIMEN TOP (m)	0.00
		SPECIMEN BASE (m)	0.00



soil type	% fraction
CLAY	17
SILT	20
SILT & CLAY	37
SAND	58
GRAVEL	5
COBBLE & BOULDER	0
test method(s)	5.2 & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5	98	20	33
75		2	95	6	27
63		1.18	93	2	17
50		0.63	90		
37.5		0.425	87		
20	100	0.2	52		
10	99	0.15	44		
6.3	98	0.063	37		

remarks

# denotes sample tested is smaller than that which is recommended in accordance with BS EN 17892

CONTRACT	CHECKED
33138	**CA**

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		Version No.	2
For the attention of	Perran Spear / Peter Woolley	Page No.	1 of 32
		Date of Issue	02/10/2017

TEST REPORT

PROJECT/SITE	Project Blue	Samples received	31/07/2017
GEL REPORT NUMBER	33138 B	Schedule received	31/07/2017
Your ref/PO:	0	Testing commenced	31/07/2017
Test report refers to	Schedule B	Status	Final

SUMMARY OF RESULTS ATTACHED

TEST METHOD & DESCRIPTION	QUANTITY	ACCREDITED TEST
BS EN ISO 17892-1: 2014:5. Water Content	22	YES
BS1377: Part 2: 1990:4.2-4.4&5.2-5.4, Liquid & Plastic Limits	11	YES
BS EN ISO 17892-4: 2016: 5.2, Particle Size Distribution - Wet Sieve	10	YES
BS EN ISO 17892-4: 2016: 5.4, Particle Size Distribution - Pipette	10	YES
BS1377: Part 4: 1990:3, Dry Density/Moisture Content Relationship	1	YES
BS1377: Part 5: 1990:3, Consolidation	2	YES
BS1377: Part 7: 1990:8&9, Undrained Triaxial Compression	2	YES
ISRM Suggested Methods: Part 2: 2007 Unconfined Compressive Strength with Young's Modulus & Poisson's Ratio (subcontracted)	4	NO
ISRM: 2007: Point Load Strength Test	11	NO
BRE SD1 Suite (Subcontracted)	6	YES/NO

Remarks

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Approved Signatories:

S Robinson (Client Manager) **C Andrew (Laboratory Consultant)**

W Jones (Technical Support) J Hanson (Director) N Parry (Director)

CAndrew

Doc TR01 Rev No. 19 Revision date 10/03/17 DC:JH

Geotechnical Engineering Ltd
Centurion House
Olympus Park, Quedgeley
Gloucester GL2 4NF

Registered number: 00700739
VAT Number: 682 5857 89

www.geoeng.co.uk
geotech@geoeng.co.uk
TEL: 01452 527743
Fax: 01452 729314

Payments: Geotechnical Engineering Limited
Sort code: 30-15-99 **Bank account**: 00072116

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WATER CONTENT

BS EN ISO 17892 - 1 : 2014 : 5

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

borehole /trial pit no.	sample no./type	sample depth (m)	specimen depth (m)	specimen preparation	natural water content (%)	description and remarks
BH01	4D	2.00	2.00	E#	13.6	Reddish brown slightly clayey gravelly SAND
BH01	10D	5.00	5.00	E#	11.7	Reddish brown slightly clayey sandy GRAVEL
BH01A	5D	7.50	7.50	E	16.6	Reddish brown clayey very gravelly SAND
BH01A	9D	10.50	10.50	E	17.3	Reddish brown slightly clayey gravelly SAND
BH02	10D	2.20	2.20	E	16.5	Reddish brown slightly gravelly slightly clayey SAND
BH02	12D	3.20	3.65	E	18.2	Reddish brown slightly clayey gravelly SAND
BH02	17D	4.65	4.65	E	17.6	Reddish brown slightly clayey gravelly SAND
BH02	21D	6.50	6.50	E	20.2	Reddish brown slightly gravelly clayey SAND
BH02	29D	9.50	9.50	E	19.1	Reddish brown slightly clayey slightly gravelly SAND
BH04	16D	10.10	10.10	E	15.1	Reddish brown slightly gravelly clayey SAND
BH05	7L	1.20	1.20	E	18.9	Yellowish brown slightly clayey slightly gravelly SAND

general remarks

# denotes sample tested is smaller than that which is recommended in accordance with BS EN ISO 17892 - 1 : 2014 Table 1

test method

D - oven drying method at 60°C
E - oven drying method at 105°C

CONTRACT	CHECKED
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LIQUID AND PLASTIC LIMITS

BS.1377 : PART 2 : 1990 : 4 and 5

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

borehole /trial pit no.	sample no./type	sample depth (m)	specimen depth (m)	natural water content (%)	specimen preparation and test method	fraction >0.425 mm (%)	liquid limit (%)	plastic limit (%)	plasticity index (%)	description and remarks
BH01A	7D	9.00	9.00	12.3	BXE	12	25	14	11	Brown slightly sandy slightly gravelly CLAY
BH02	24D	8.00	8.00	20	BXE	5	36	18	18	Brown mottled orange slightly sandy slightly gravelly CLAY
BH04	8D	6.00	6.00	20.6	BXE	4	35	18	17	Brown slightly sandy slightly gravelly CLAY
BH04	12D	7.40	7.40	18.5	BXE	8	33	18	15	Brown slightly sandy slightly gravelly CLAY
BH04	14D	8.60	8.60	18.8	BXE	5	34	16	18	Brown slightly sandy slightly gravelly CLAY
BH05	5D	1.00	1.00	34.2	BXE	14	43	22	21	Brown slighty sandy slightly gravelly CLAY
BH05	8D	1.50	1.50	22.4	BXE	16	26	21	5	Light brown slightly gravelly slightly clayey silty SAND
BH05	11L	2.20	2.30	21.8	BYE	9	28	NP		Brown slightly gravelly slightly clayey silty SAND
BH05	14D	3.50	3.50	22.5	BXE	22	25	19	6	Dark grey slightly gravelly sandy clayey SILT
BH05	15D	4.20	4.20	37.3	BXE	10	37	21	16	Dark greyish brown slightly sandy slightly gravelly silty CLAY
BH05	17D	5.00	5.00	42.6	BXE	0	43	25	18	Dark greyish brown slightly sandy slightly gravelly silty CLAY

general remarks

natural water content determined in accordance with BS EN ISO 17892 - 1 : 2014 (unless specified)

NP denotes non plastic

# denotes sample tested is smaller than that which is recommended in accordance with BS1377 or BS EN ISO 17892

specimen preparation		test method	CONTRACT	CHECKED
A - as received	D - oven dried (60oC)	X - cone penetrometer (test 4.3)	33138	CA
B - washed on 0.425mm sieve	E - oven dried (105oC)	Y - cone penetrometer (test 4.4)		
C - air dried	F - not known	Z - casagrande apparatus (test 4.5)		

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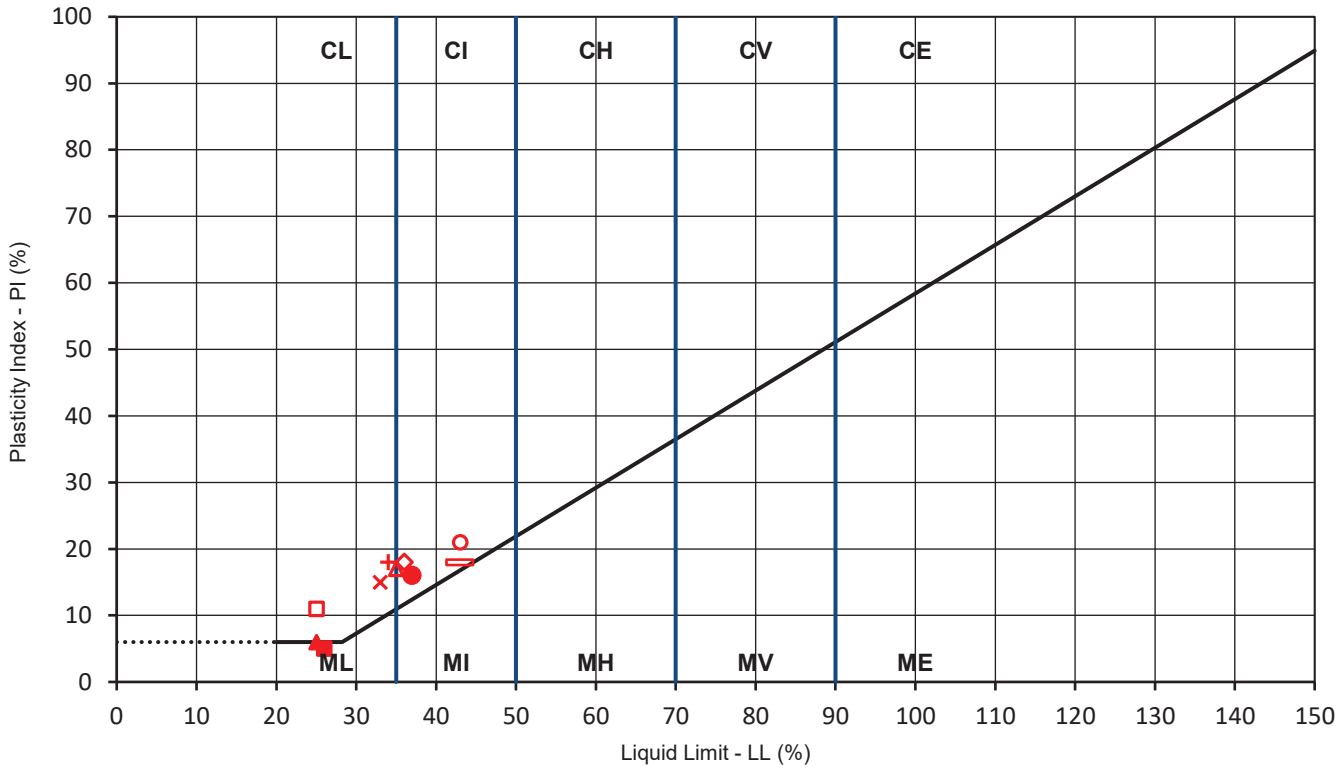
ATTERBERG LINE PLOT

CLIENT BURO HAPPOLD

SITE PROJECT BLUE



	BH/TP No.	depth (m)	LL	PL	PI	remarks
□	BH01A	9.00	25	14	11	
◇	BH02	8.00	36	18	18	
△	BH04	6.00	35	18	17	
×	BH04	7.40	33	18	15	
+	BH04	8.60	34	16	18	
○	BH05	1.00	43	22	21	
■	BH05	1.50	26	21	5	
◆	BH05	2.30	28	NP		
▲	BH05	3.50	25	19	6	
●	BH05	4.20	37	21	16	
▭	BH05	5.00	43	25	18	

CONTRACT	CHECKED
33138 B	CA

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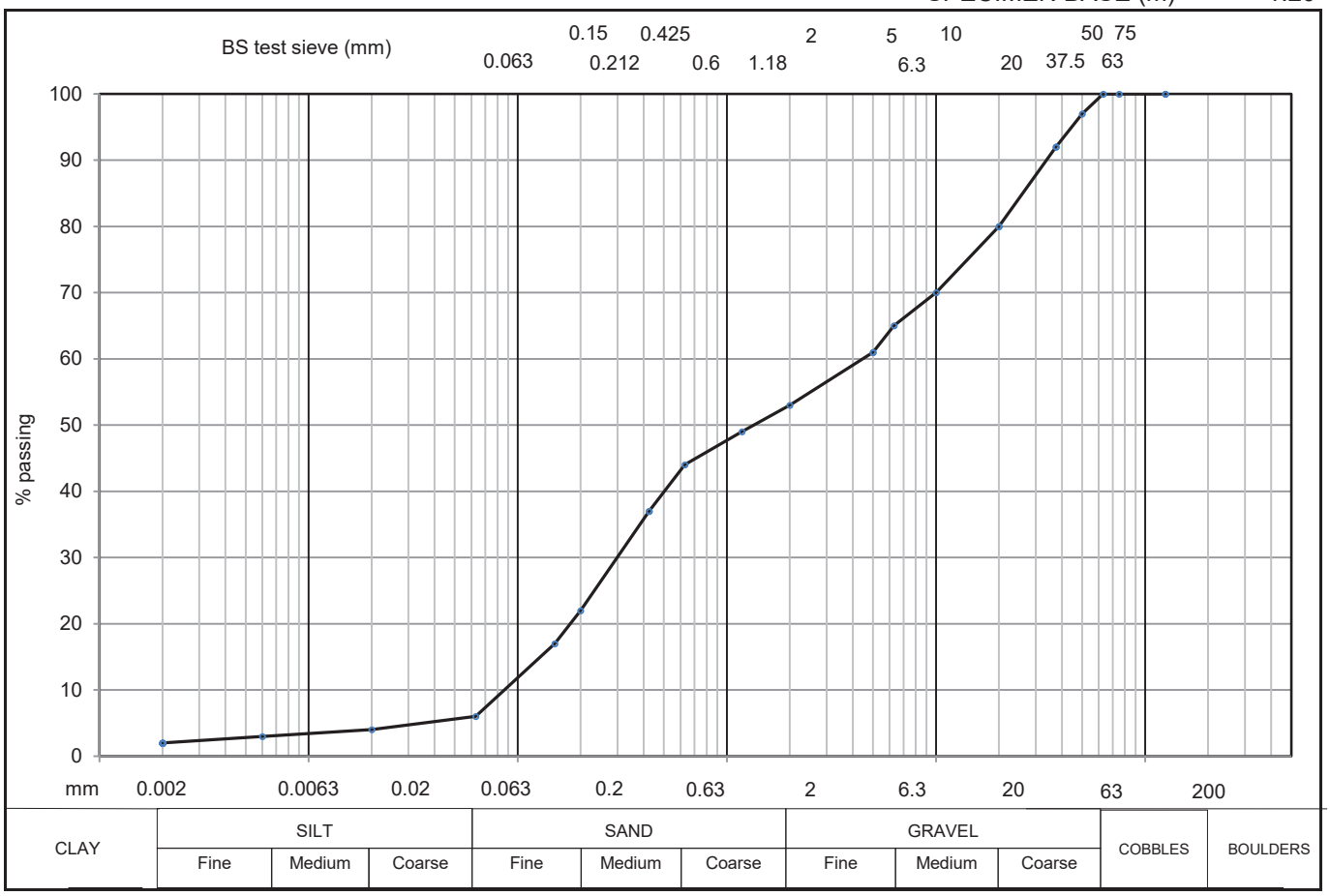
PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	BH01
SITE	PROJECT BLUE	SAMPLE No./TYPE	2B
		SAMPLE DEPTH (m)	1.00
DESCRIPTION	Brown slightly silty very gravelly SAND	SPECIMEN TOP (m)	1.00
		SPECIMEN BASE (m)	1.20



soil type	% fraction
CLAY	2
SILT	4
SILT & CLAY	6
SAND	47
GRAVEL	47
COBBLE & BOULDER	0
test method(s)	5.2 & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5	61	20	4
75		2	53	6	3
63	100	1.18	49	2	2
50	97	0.63	44		
37.5	92	0.425	37		
20	80	0.2	22		
10	70	0.15	17		
6.3	65	0.063	6		

remarks

# denotes sample tested is smaller than that which is recommended in accordance with BS EN 17892

CONTRACT	CHECKED
33138 B	**CA**

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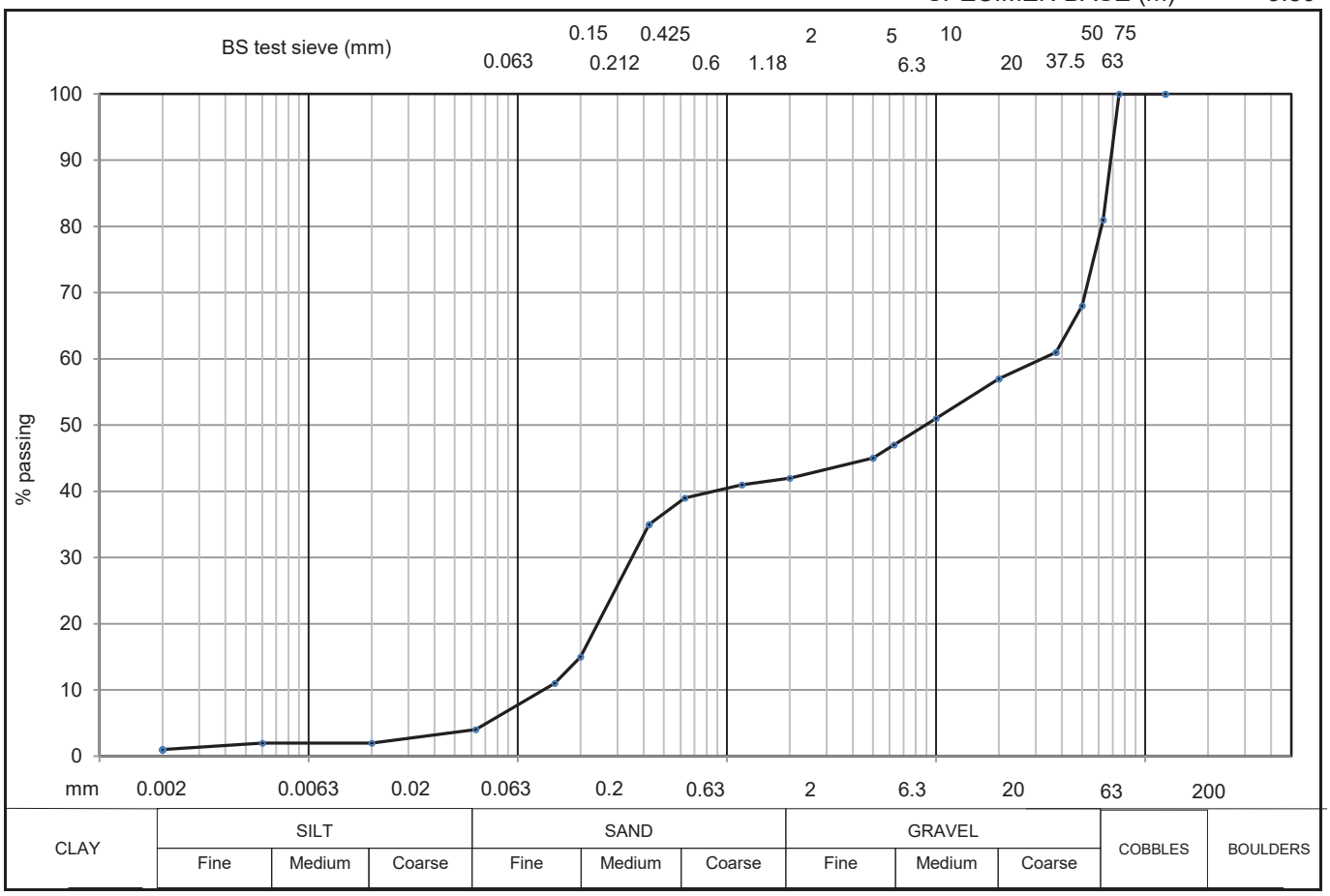
PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	BH01
SITE	PROJECT BLUE	SAMPLE No./TYPE	7L
		SAMPLE DEPTH (m)	3.20
DESCRIPTION	Reddish brown slightly silty very sandy GRAVEL with medium cobbles	SPECIMEN TOP (m)	3.60
		SPECIMEN BASE (m)	3.80



soil type	% fraction
CLAY	1
SILT	3
SILT & CLAY	4
SAND	38
GRAVEL	39
COBBLE & BOULDER	19
test method(s)	5.2# & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5	45	20	2
75	100	2	42	6	2
63	81	1.18	41	2	1
50	68	0.63	39		
37.5	61	0.425	35		
20	57	0.2	15		
10	51	0.15	11		
6.3	47	0.063	4		

remarks

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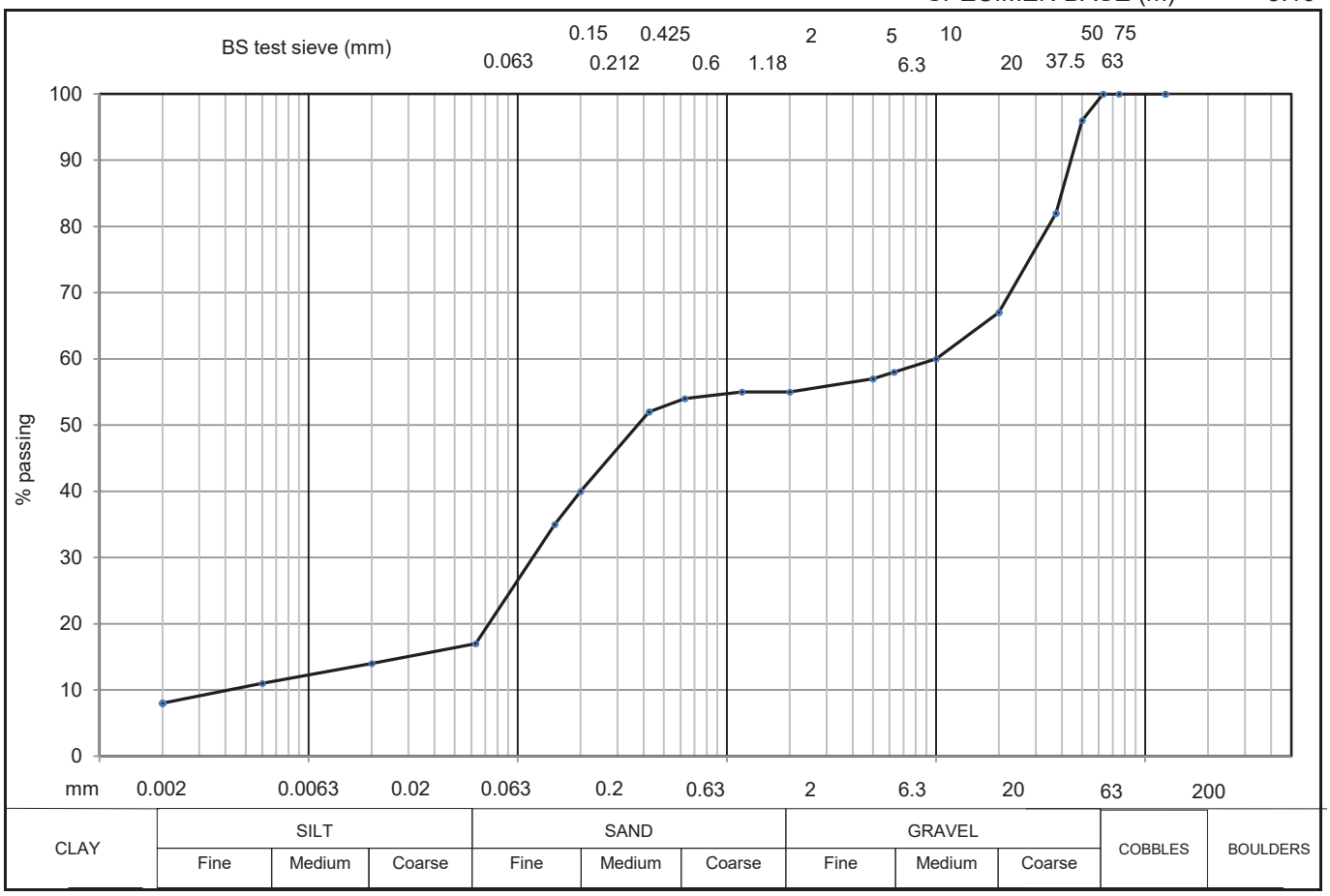
PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	BH01A
SITE	PROJECT BLUE	SAMPLE No./TYPE	4L
		SAMPLE DEPTH (m)	7.00
DESCRIPTION	Reddish brown clayey silty very sandy GRAVEL	SPECIMEN TOP (m)	7.80
		SPECIMEN BASE (m)	8.10



soil type	% fraction
CLAY	8
SILT	9
SILT & CLAY	17
SAND	39
GRAVEL	45
COBBLE & BOULDER	0
test method(s)	5.2# & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5	57	20	14
75		2	55	6	11
63	100	1.18	55	2	8
50	96	0.63	54		
37.5	82	0.425	52		
20	67	0.2	40		
10	60	0.15	35		
6.3	58	0.063	17		

remarks

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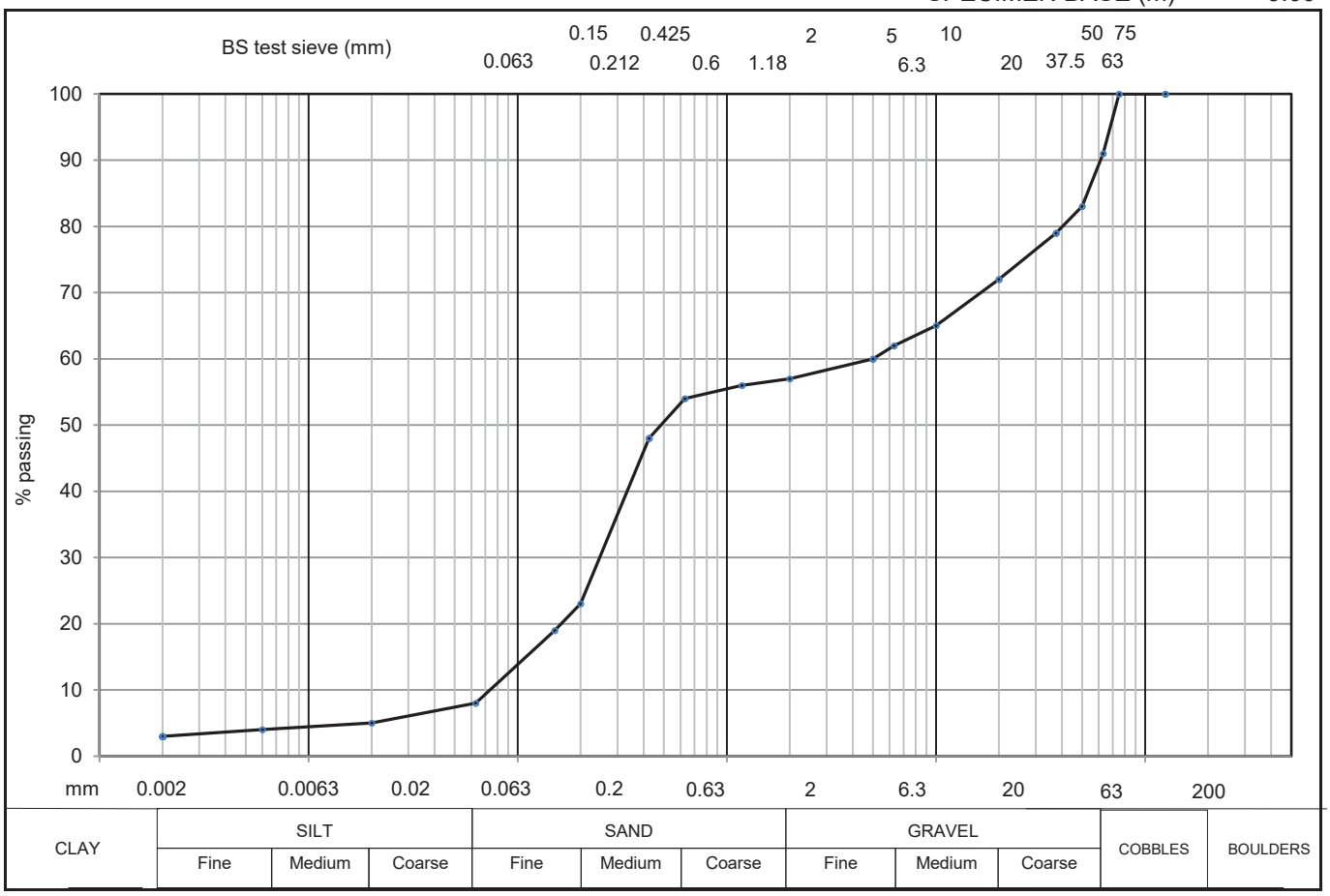
PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	BH02
SITE	PROJECT BLUE	SAMPLE No./TYPE	11L
		SAMPLE DEPTH (m)	2.20
DESCRIPTION	Reddish brown clayey silty very gravelly SAND	SPECIMEN TOP (m)	2.80
		SPECIMEN BASE (m)	3.00



soil type	% fraction
CLAY	3
SILT	5
SILT & CLAY	8
SAND	49
GRAVEL	34
COBBLE & BOULDER	9
test method(s)	5.2# & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5	60	20	5
75	100	2	57	6	4
63	91	1.18	56	2	3
50	83	0.63	54		
37.5	79	0.425	48		
20	72	0.2	23		
10	65	0.15	19		
6.3	62	0.063	8		

remarks

# denotes sample tested is smaller than that which is recommended in accordance with BS EN 17892

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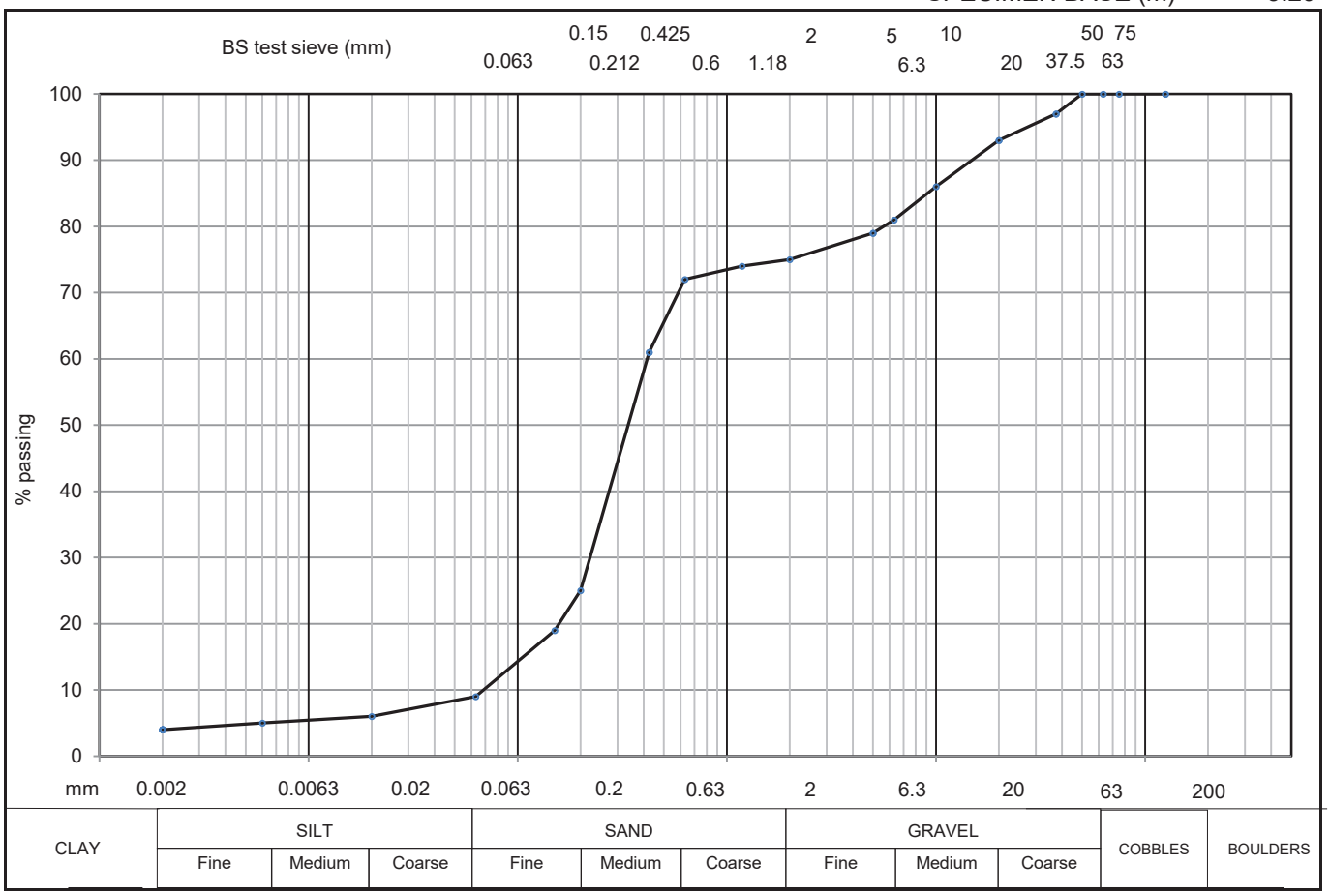
PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	BH02
SITE	PROJECT BLUE	SAMPLE No./TYPE	16L
		SAMPLE DEPTH (m)	4.20
DESCRIPTION	Reddish brown silty clayey very gravelly SAND	SPECIMEN TOP (m)	4.80
		SPECIMEN BASE (m)	5.20



soil type	% fraction
CLAY	4
SILT	5
SILT & CLAY	9
SAND	66
GRAVEL	25
COBBLE & BOULDER	0
test method(s)	5.2 & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5	79	20	6
75		2	75	6	5
63		1.18	74	2	4
50	100	0.63	72		
37.5	97	0.425	61		
20	93	0.2	25		
10	86	0.15	19		
6.3	81	0.063	9		

remarks

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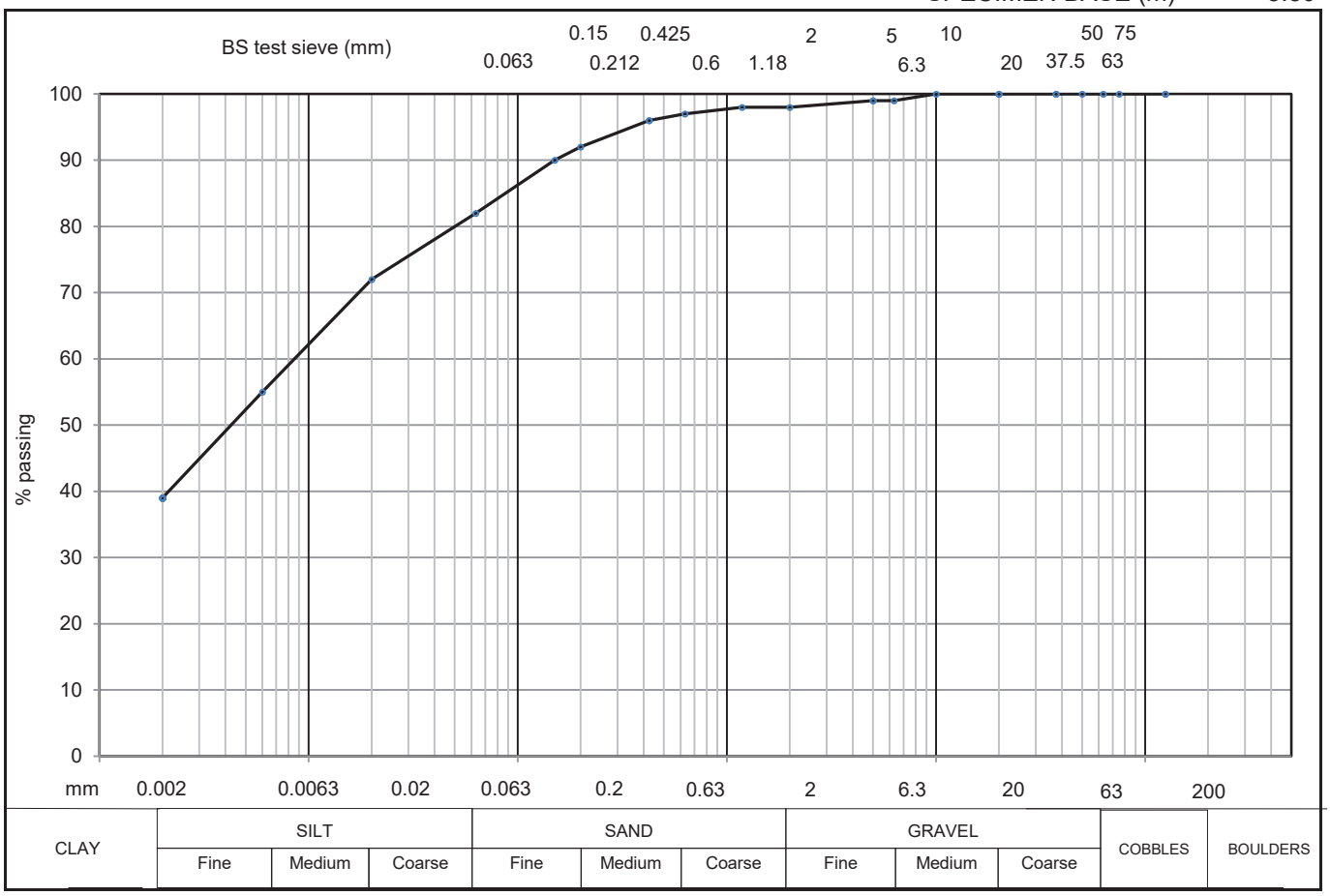
PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	BH02
SITE	PROJECT BLUE	SAMPLE No./TYPE	25L
		SAMPLE DEPTH (m)	8.20
DESCRIPTION	Brown slightly sandy slightly gravelly silty CLAY	SPECIMEN TOP (m)	8.70
		SPECIMEN BASE (m)	8.80



soil type	% fraction
CLAY	39
SILT	43
SILT & CLAY	82
SAND	16
GRAVEL	2
COBBLE & BOULDER	0
test method(s)	5.2 & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5	99	20	72
75		2	98	6	55
63		1.18	98	2	39
50		0.63	97		
37.5		0.425	96		
20		0.2	92		
10	100	0.15	90		
6.3	99	0.063	82		

remarks

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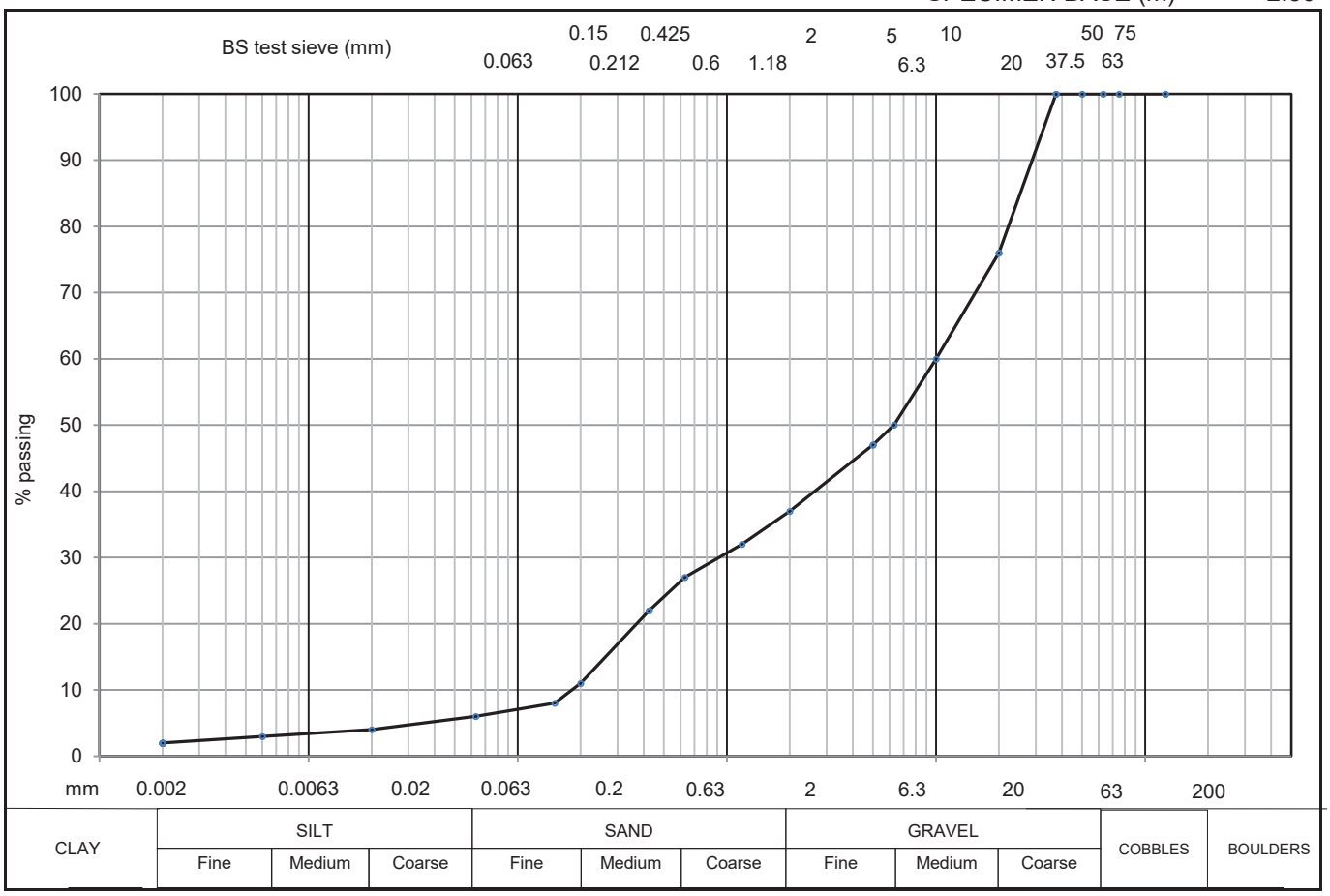
PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	BH04
SITE	PROJECT BLUE	SAMPLE No./TYPE	5L
		SAMPLE DEPTH (m)	2.00
DESCRIPTION	Dark brown silty very sandy GRAVEL	SPECIMEN TOP (m)	2.00
		SPECIMEN BASE (m)	2.50



soil type	% fraction
CLAY	2
SILT	5
SILT & CLAY	6
SAND	32
GRAVEL	63
COBBLE & BOULDER	0
test method(s)	5.2 & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5	47	20	4
75		2	37	6	3
63		1.18	32	2	2
50		0.63	27		
37.5	100	0.425	22		
20	76	0.2	11		
10	60	0.15	8		
6.3	50	0.063	6		

remarks

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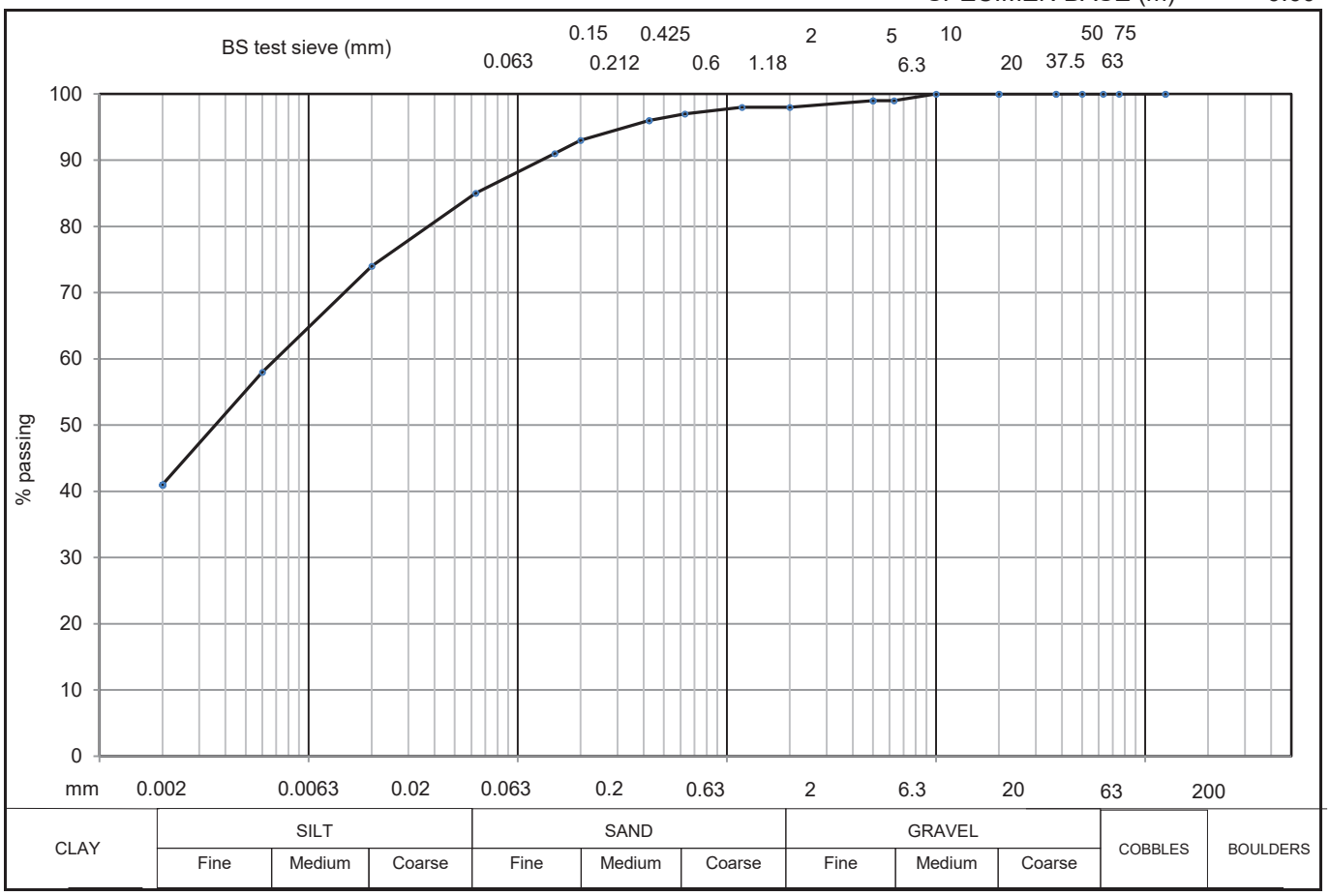
PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	BH04
SITE	PROJECT BLUE	SAMPLE No./TYPE	9L
		SAMPLE DEPTH (m)	6.00
DESCRIPTION	Brown slightly sandy slightly gravelly silty CLAY	SPECIMEN TOP (m)	6.50
		SPECIMEN BASE (m)	6.60



soil type	% fraction
CLAY	41
SILT	44
SILT & CLAY	85
SAND	14
GRAVEL	2
COBBLE & BOULDER	0
test method(s)	5.2 & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5	99	20	74
75		2	98	6	58
63		1.18	98	2	41
50		0.63	97		
37.5		0.425	96		
20		0.2	93		
10	100	0.15	91		
6.3	99	0.063	85		

remarks

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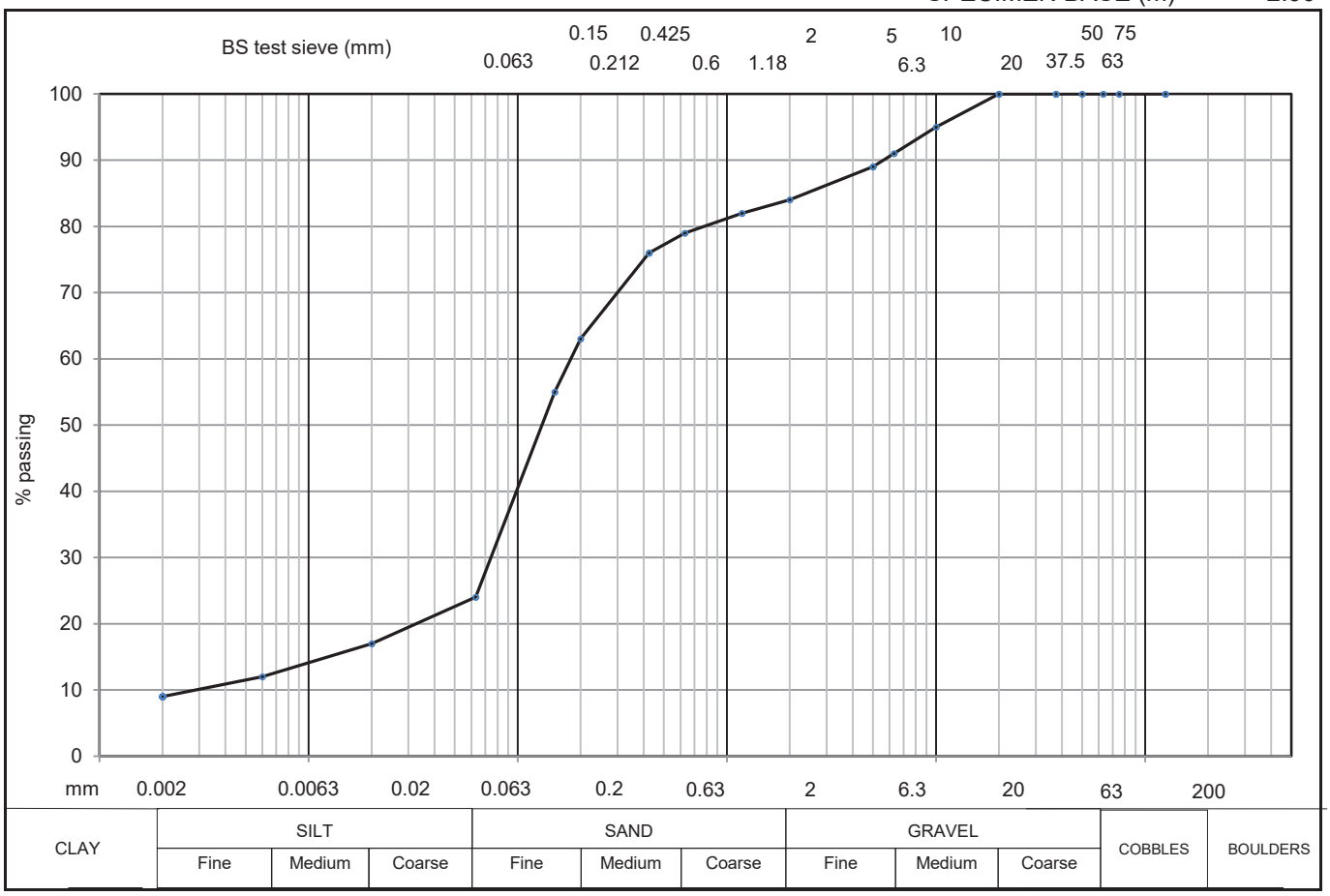
BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	BH05
SITE	PROJECT BLUE	SAMPLE No./TYPE	11L
		SAMPLE DEPTH (m)	2.20
DESCRIPTION	Brown gravelly clayey silty SAND	SPECIMEN TOP (m)	2.70
		SPECIMEN BASE (m)	2.90



soil type	% fraction
CLAY	9
SILT	15
SILT & CLAY	24
SAND	60
GRAVEL	16
COBBLE & BOULDER	0
test method(s)	5.2 & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5	89	20	17
75		2	84	6	12
63		1.18	82	2	9
50		0.63	79		
37.5		0.425	76		
20	100	0.2	63		
10	95	0.15	55		
6.3	91	0.063	24		

remarks

# denotes sample tested is smaller than that which is recommended in accordance with BS EN 17892

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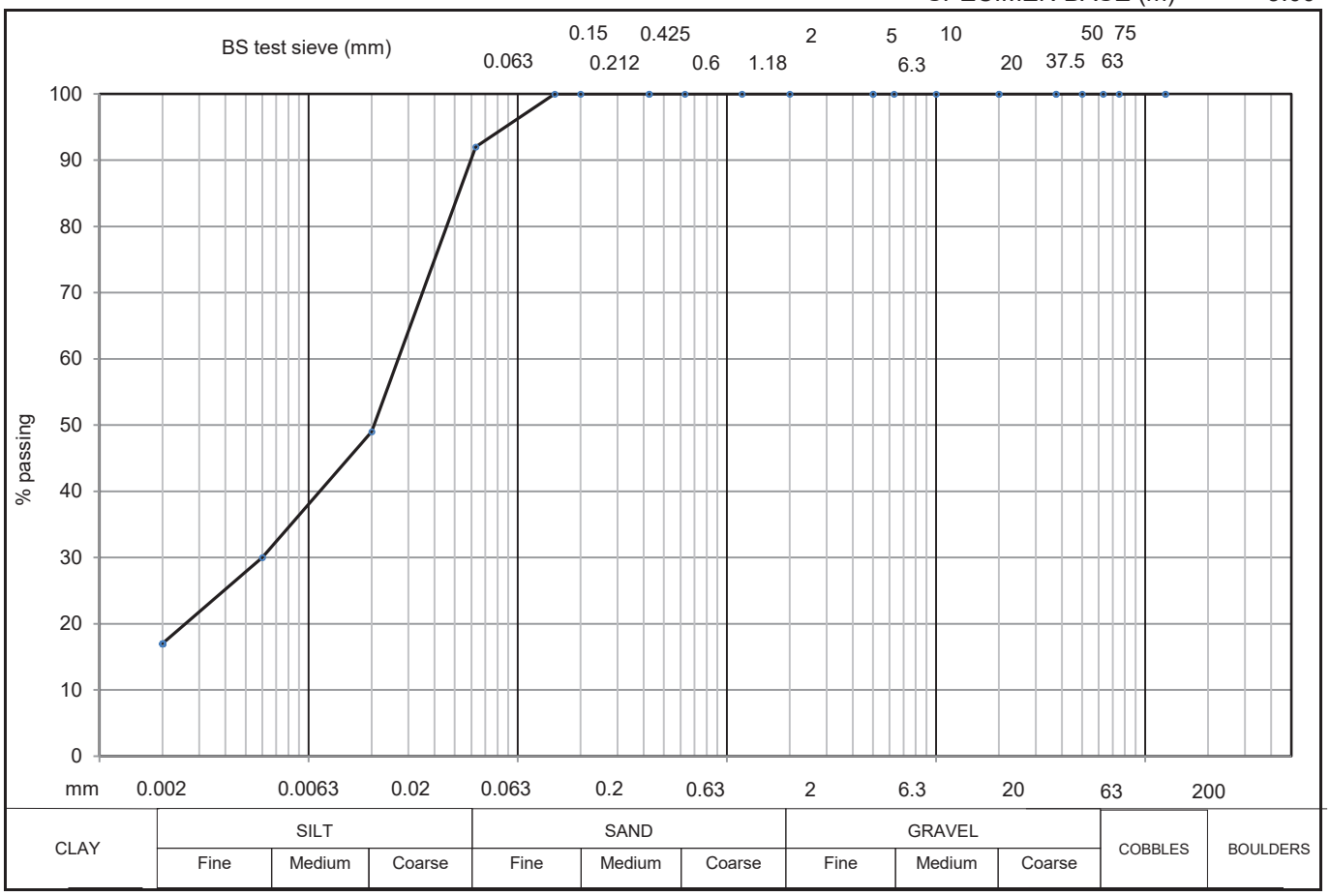
BS EN ISO 17892 - 4 : 2016 : 5

CLIENT	BURO HAPPOLD	BH/TP No.	BH05
SITE	PROJECT BLUE	SAMPLE No./TYPE	16L
		SAMPLE DEPTH (m)	4.20
DESCRIPTION	Dark greyish brown slightly sandy clayey SILT	SPECIMEN TOP (m)	4.60
		SPECIMEN BASE (m)	5.00



soil type	% fraction
CLAY	17
SILT	75
SILT & CLAY	92
SAND	8
GRAVEL	0
COBBLE & BOULDER	0
test method(s)	5.2 & 5.4

test method

5.2 - sieving

5.3 - sedimentation by hydrometer

5.4 - sedimentation by pipette

BS test sieve (mm)	% passing	BS test sieve (mm)	% passing	BS test sieve (µm)	% finer
150		5		20	49
75		2		6	30
63		1.18		2	17
50		0.63			
37.5		0.425			
20		0.2			
10		0.15	100		
6.3		0.063	92		

remarks

# denotes sample tested is smaller than that which is recommended in accordance with BS EN 17892

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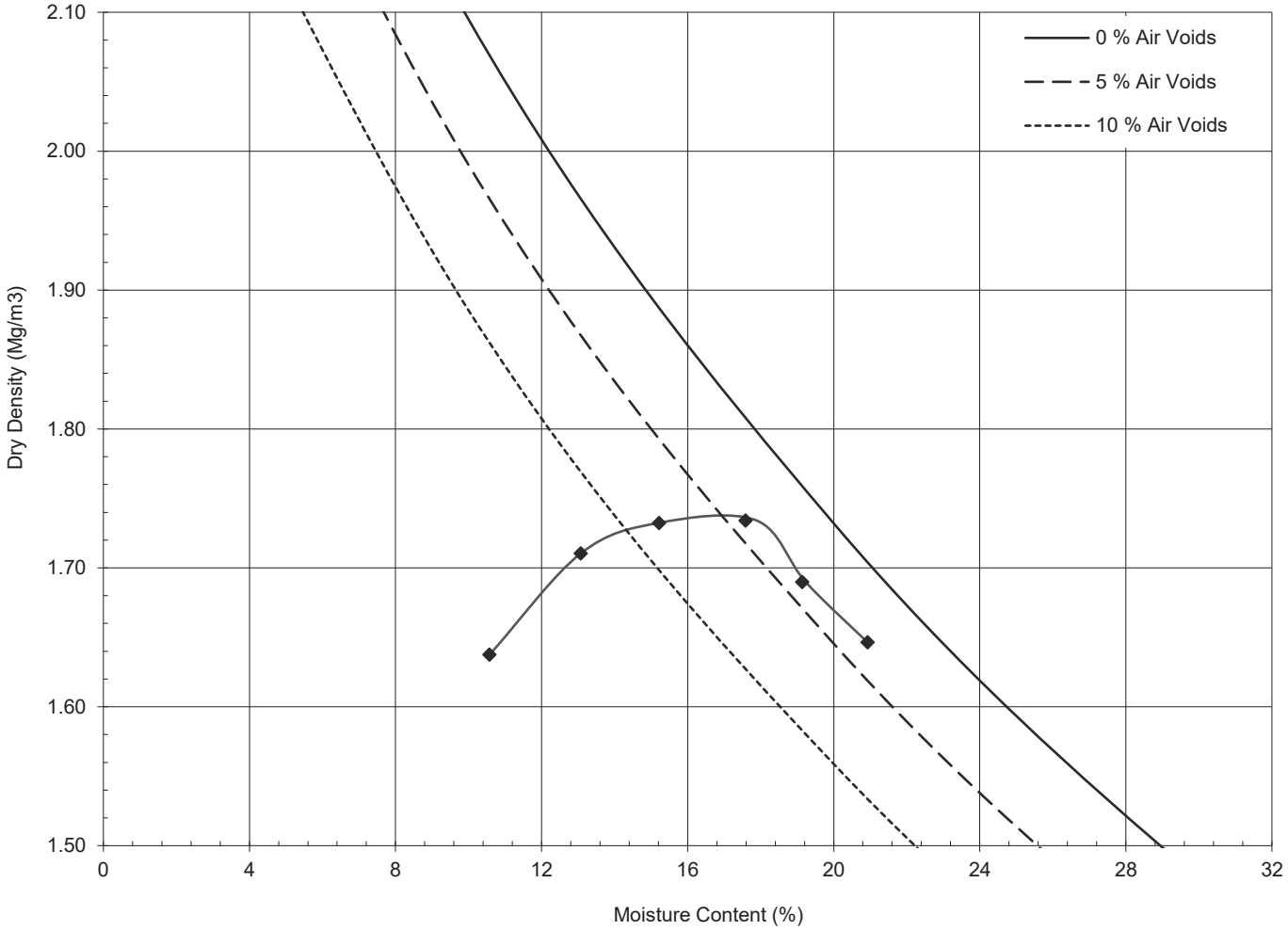
DRY DENSITY/MOISTURE CONTENT RELATIONSHIP

BS. 1377 : Part 4 : 1990 : 3

CLIENT	BURO HAPPOLD	BH/TP No.	BH04
SITE	PROJECT BLUE	SAMPLE No./TYPE	3B
DESCRIPTION	Brown slightly sandy slightly gravelly CLAY	SAMPLE DEPTH (m)	1.00
		SPECIMEN DEPTH (m)	1.00



test method		3.3.4.1 2.5kg dynamic compaction - 1L mould			
preparation procedure		3.2.4.2 (grading zone 2)			
sample preparation		C R			
proportion retained on 37.5mm sieve	%	0	initial moisture content	%	25
proportion retained on 20mm sieve	%	4	maximum dry density	(Mg/m3)	1.74
particle density	(Mg/m3)	#2.65	optimum moisture content	%	17

remarks

# denotes particle density has been assigned an assumed value

C denotes sample has been chopped to pass 20mm sieve

S denotes sample has been shredded to pass 20mm sieve

R denotes sample material has been recycled between/for points

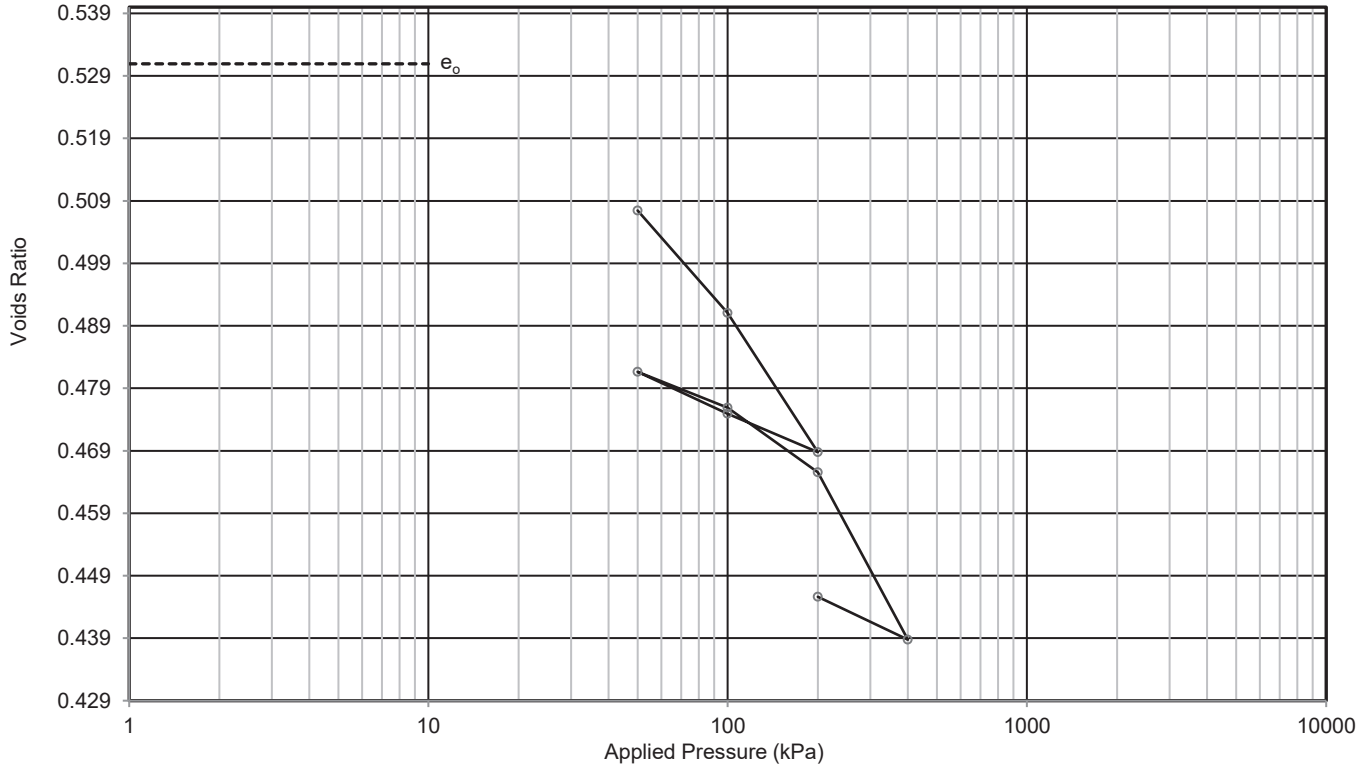
CONTRACT	CHECKED
33138 B	**CA**

Geotechnical Engineering Limited

DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

BS.1377 : Part 5 : 1990 : 3

CLIENT	BURO HAPPOLD	BH/TP No.	BH04
SITE	PROJECT BLUE	SAMPLE No./TYPE	10UT
DESCRIPTION	Brown slightly sandy slightly gravelly CLAY	SAMPLE DEPTH (m)	7.10
		SPECIMEN DEPTH (m)	7.30



test and sample details		
specimen diameter	mm	63.06
specimen height	mm	18.97
initial moisture content	%	20.4
final moisture content	%	19.1
initial bulk density	Mg/m3	2.12
initial dry density	Mg/m3	1.76
initial voids ratio		0.531
initial degree of saturation	%	104
particle density	Mg/m3	#2.70
swelling pressure	kPa	N/A
P'o to P'o +100 kPa		-
laboratory temperature	oC	20 ± 2
method of time fitting		root time

test results

pressure stage (kPa)	voids ratio	laboratory coefficients of compressibility mv (m2/MN)	laboratory coefficients of consolidation Cv (m2/yr)
50	0.507	0.31	1.5
100	0.491	0.22	1.2
200	0.469	0.15	1.9
100	0.475	0.042	
50	0.482	0.091	
100	0.476	0.077	2
200	0.466	0.07	3.5
400	0.439	0.091	1.8
200	0.446	0.024	

remarks # denotes particle density has been assigned an assumed value

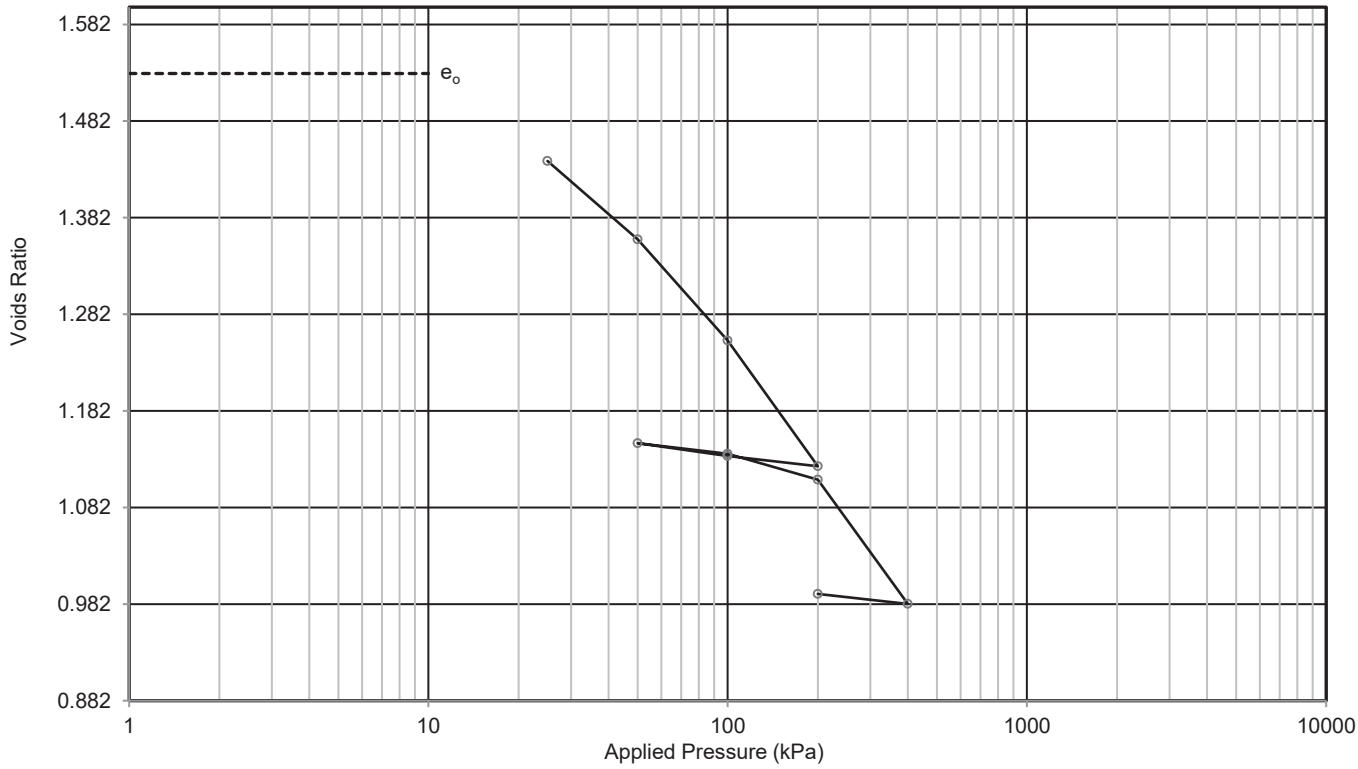
CONTRACT	CHECKED
33138	**CA**

Geotechnical Engineering Limited

DETERMINATION OF ONE-DIMENSIONAL CONSOLIDATION PROPERTIES

BS.1377 : Part 5 : 1990 : 3

CLIENT	BURO HAPPOLD	BH/TP No.	BH05
SITE	PROJECT BLUE	SAMPLE No./TYPE	18UT
DESCRIPTION	Black mottled dark grey slightly sandy clayey SILT	SAMPLE DEPTH (m)	5.20
		SPECIMEN DEPTH (m)	5.60



test and sample details		
specimen diameter	mm	49.90
specimen height	mm	20.00
initial moisture content	%	55.3
final moisture content	%	37.8
initial bulk density	Mg/m3	1.66
initial dry density	Mg/m3	1.07
initial voids ratio		1.531
initial degree of saturation	%	98
particle density	Mg/m3	#2.70
swelling pressure	kPa	N/A
P'o to P'o +100 kPa		-
laboratory temperature	oC	20 ± 2
method of time fitting		root time

test results

pressure stage (kPa)	voids ratio	laboratory coefficients of compressibility mv (m2/MN)	laboratory coefficients of consolidation Cv (m2/yr)
25	1.441	1.4	2.4
50	1.359	1.3	1.5
100	1.255	0.89	2.5
200	1.125	0.58	1.6
100	1.135	0.051	
50	1.149	0.12	
100	1.138	0.1	1.3
200	1.111	0.13	4.7
400	0.982	0.3	1.2
200	0.992	0.026	

remarks # denotes particle density has been assigned an assumed value

CONTRACT	CHECKED
33138	**CA**

Geotechnical Engineering Limited

UNDRAINED TRIAXIAL COMPRESSION

BS.1377 : PART 7 : 1990 : 8

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

borehole /trial pit no.	sample no./type	sample depth (m)	specimen depth (m)	code	moisture content initial (%)	moisture content final (%)	dimensions length (mm)	dimensions diameter (mm)	density bulk (Mg/m3)	density dry (Mg/m3)	cell pressure (kPa)	rate of strain (%/min)	deviator stress (kPa)	failure strain (%)	failure mode	shear strength* (kPa)	description and remarks
BH04	10UT	7.10	7.10	UU100	18.5	18.4	179	105	2.15	1.81	150	2.0	145	19.6	B	73	Brown slightly sandy slightly gravelly CLAY
BH05	18UT	5.20	5.31	UU100	27.3	30.1	201	103	1.90	1.49	130	2.0	25	19.9	B	12	Orangish brown slightly sandy slightly gravelly CLAY (5.3-5.4) Black and dark grey slightly sandy silty CLAY (5.4-5.5)

general remarks:

* shear strength taken as half deviator stress at failure for each stage
membrane correction applied
sample taken vertically (unless otherwise specified)
strain rate 2%/min (unless otherwise specified)

code:

UU - unconsolidated undrained
M - multi stage
S - set of three
R - remoulded

failure mode:

B - barrel (plastic failure)
S - shear (brittle failure)
I - intermediate
O - other (see remarks)

membrane type/thickness:

latex membrane used (unless otherwise specified)
38 - 0.2mm
70 - 0.4mm
100 - 0.4mm

CONTRACT **33138**

CHECKED **CA**

ISRM - Suggested Methods : Part 2 : 2007

Unconfined Compressive Strength with Young's Modulus and Poisson's Ratio

Borehole Ref.:	BH01A
Sample Ref.:	13
Depth (m):	13.95

Description:
Medium strong to weak, thinly laminated, orangish brown and yellowish grey SANDSTONE. Slightly weathered

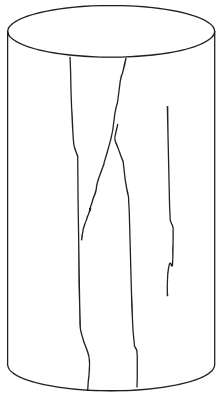
2000 kN capacity compression frame used

Diameter	116.90 mm
Height	189.50 mm
Bulk Density	2.33 Mg/m³
Dry Density	2.11 Mg/m³
Water Content	10 %

Degree of Saturation: 98.3 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Failure Sketch

Mode of failure: Axial splitting



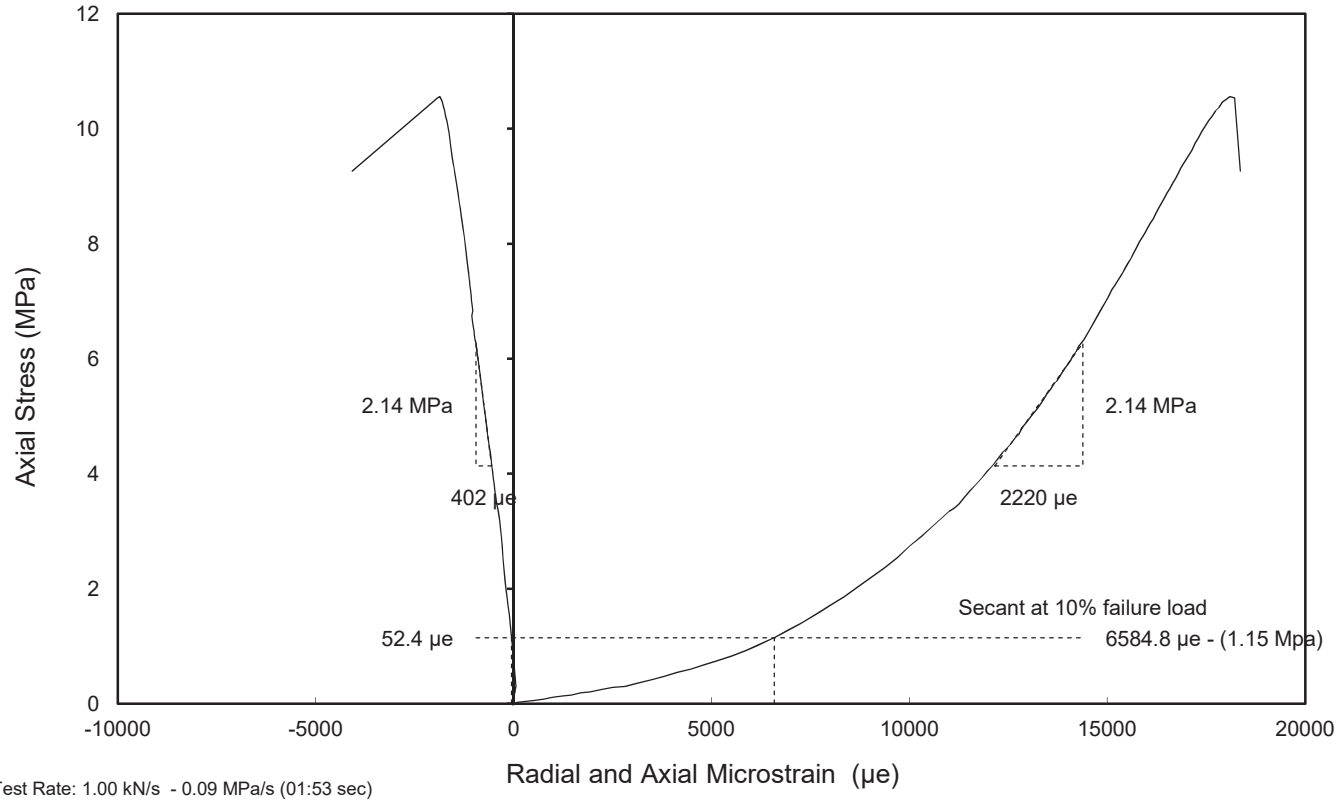
Solid lines for material failures.
Dashed lines for apparent weakness failure.

Date tested: 09/08/2017

Test results

Unconfined Compressive Strength	10.6 MPa
Young's Modulus (tangential at 50% failure load)	0.964 GPa
Poisson's Ratio (tangential at 50% failure load)	0.18
Young's Modulus (secant at 10% failure load)	0.174 GPa
Poisson's Ratio (secant at 10% failure load)	0.01

Sample type	**CS**



Test Rate: 1.00 kN/s - 0.09 MPa/s (01:53 sec)

Remarks: Height/diameter ratio according to client's request

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are all met.

Checked and Approved by CC C Clergeaud (Snr. Geol.) Date: 23/08/2017	Project Number: **GEO / 26269** Project Name: **PROJECT BLUE** **33138/PW**	GEOLABS®

ISRM - Suggested Methods : Part 2 : 2007

Unconfined Compressive Strength with Young's Modulus and Poisson's Ratio

Borehole Ref.:	BH02
Sample Ref.:	37
Depth (m):	13.75

Description:
Weak, thinly laminated, orangish brown SANDSTONE with organic matter throughout the sample. Moderately weathered

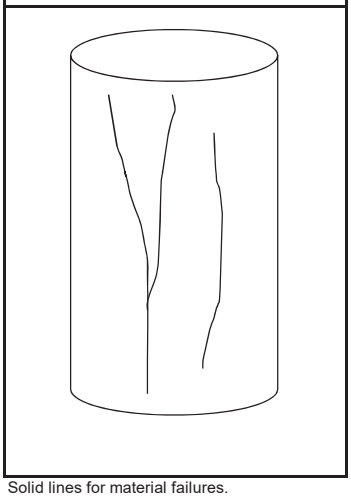
2000 kN capacity compression frame used

Diameter	97.70 mm
Height	162.50 mm
Bulk Density	2.17 Mg/m³
Dry Density	1.88 Mg/m³
Water Content	15 %

Degree of Saturation: 94.1 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Failure Sketch

Mode of failure: Axial splitting



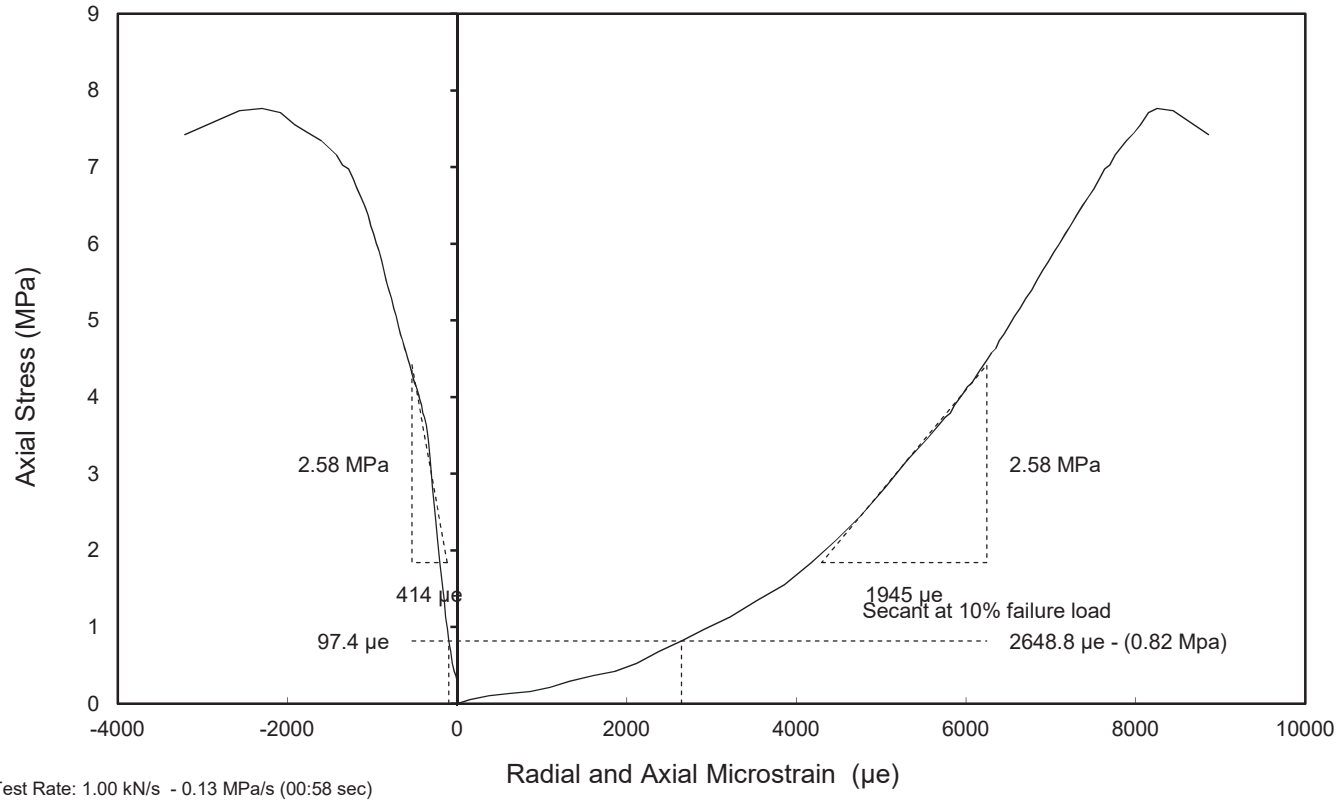
Solid lines for material failures.
Dashed lines for apparent weakness failure.

Date tested: 09/08/2017

Test results

Unconfined Compressive Strength	7.76 MPa
Young's Modulus (tangential at 50% failure load)	1.33 GPa
Poisson's Ratio (tangential at 50% failure load)	0.21
Young's Modulus (secant at 10% failure load)	0.308 GPa
Poisson's Ratio (secant at 10% failure load)	0.04

Sample type	**CS**



Test Rate: 1.00 kN/s - 0.13 MPa/s (00:58 sec)

Remarks: Height/diameter ratio according to client's request

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are all met.

Checked and Approved by CC C Clergeaud (Snr. Geol.) Date: 23/08/2017	Project Number: **GEO / 26269** Project Name: **PROJECT BLUE** **33138/PW**	GEOLABS®

ISRM - Suggested Methods : Part 2 : 2007

Unconfined Compressive Strength with Young's Modulus and Poisson's Ratio

Borehole Ref.:	BH02
Sample Ref.:	41
Depth (m):	16.55

Description:
Medium strong to weak, thinly laminated, yellowish grey and orangish brown SANDSTONE. Slightly weathered

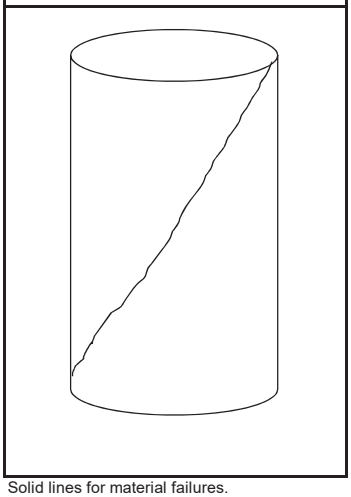
2000 kN capacity compression frame used

Diameter	98.70 mm
Height	254.30 mm
Bulk Density	2.30 Mg/m³
Dry Density	2.11 Mg/m³
Water Content	9.0 %

Degree of Saturation: 84.2 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Failure Sketch

Mode of failure: Diagonal shearing



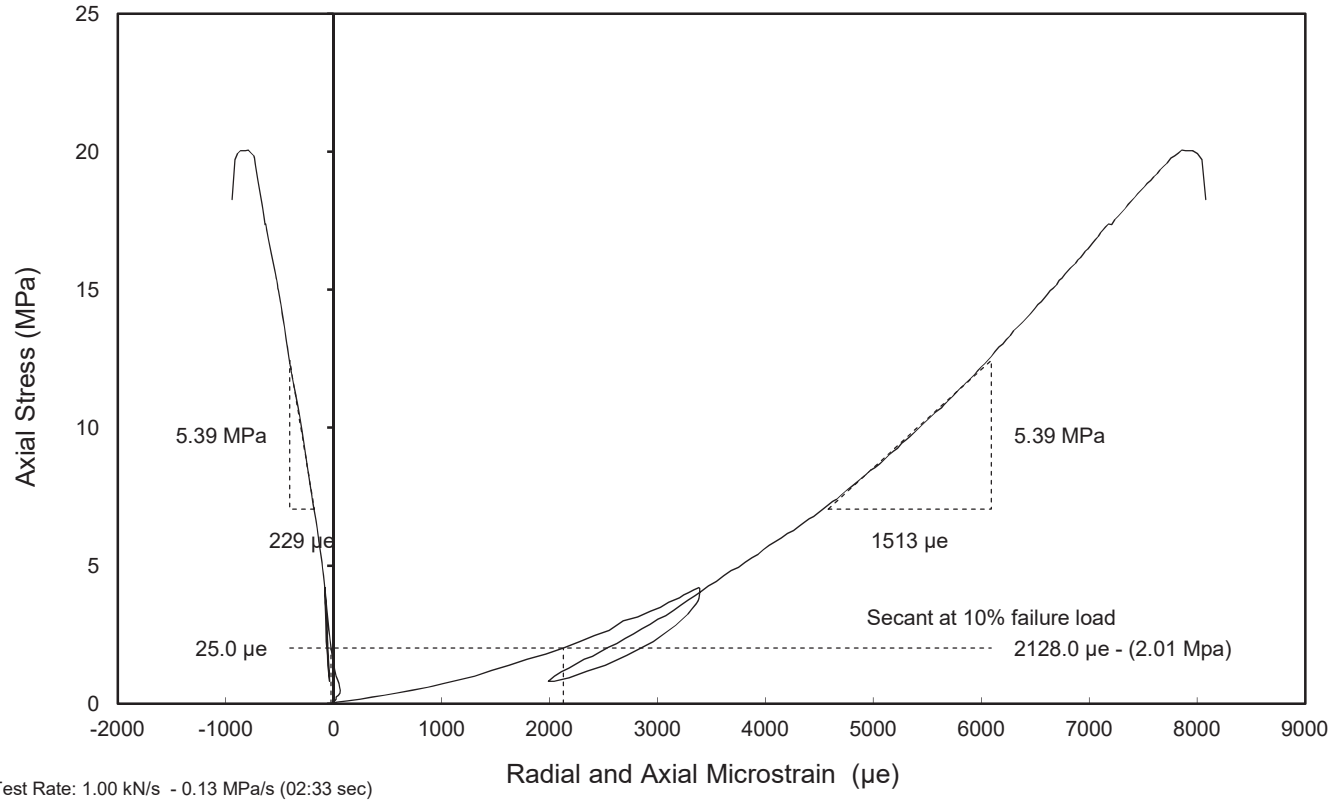
Solid lines for material failures.
Dashed lines for apparent weakness failure.

Date tested: 08/08/2017

Sample type	CS

Test results

Unconfined Compressive Strength	20.1 MPa
Young's Modulus (tangential at 50% failure load)	3.56 GPa
Poisson's Ratio (tangential at 50% failure load)	0.15
Young's Modulus (secant at 10% failure load)	0.945 GPa
Poisson's Ratio (secant at 10% failure load)	0.01



Test Rate: 1.00 kN/s - 0.13 MPa/s (02:33 sec)

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are all met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 23/08/2017

Project Number:

GEO / 26269

Project Name:

PROJECT BLUE
33138/PW

GEOLABS®

ISRM - Suggested Methods : Part 2 : 2007

Unconfined Compressive Strength with Young's Modulus and Poisson's Ratio

Borehole Ref.:	BH05
Sample Ref.:	24
Depth (m):	9.65

Description:
Weak, thinly laminated, orangish brown SANDSTONE. Moderately weathered

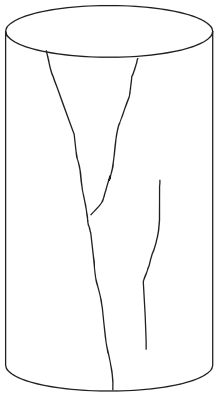
2000 kN capacity compression frame used

Diameter	91.50 mm
Height	153.30 mm
Bulk Density	2.22 Mg/m³
Dry Density	1.96 Mg/m³
Water Content	13 %

Degree of Saturation: 92.1 %. Specific Gravity: 2.72 Mg/m³ (Assumed)

Failure Sketch

Mode of failure: Axial splitting



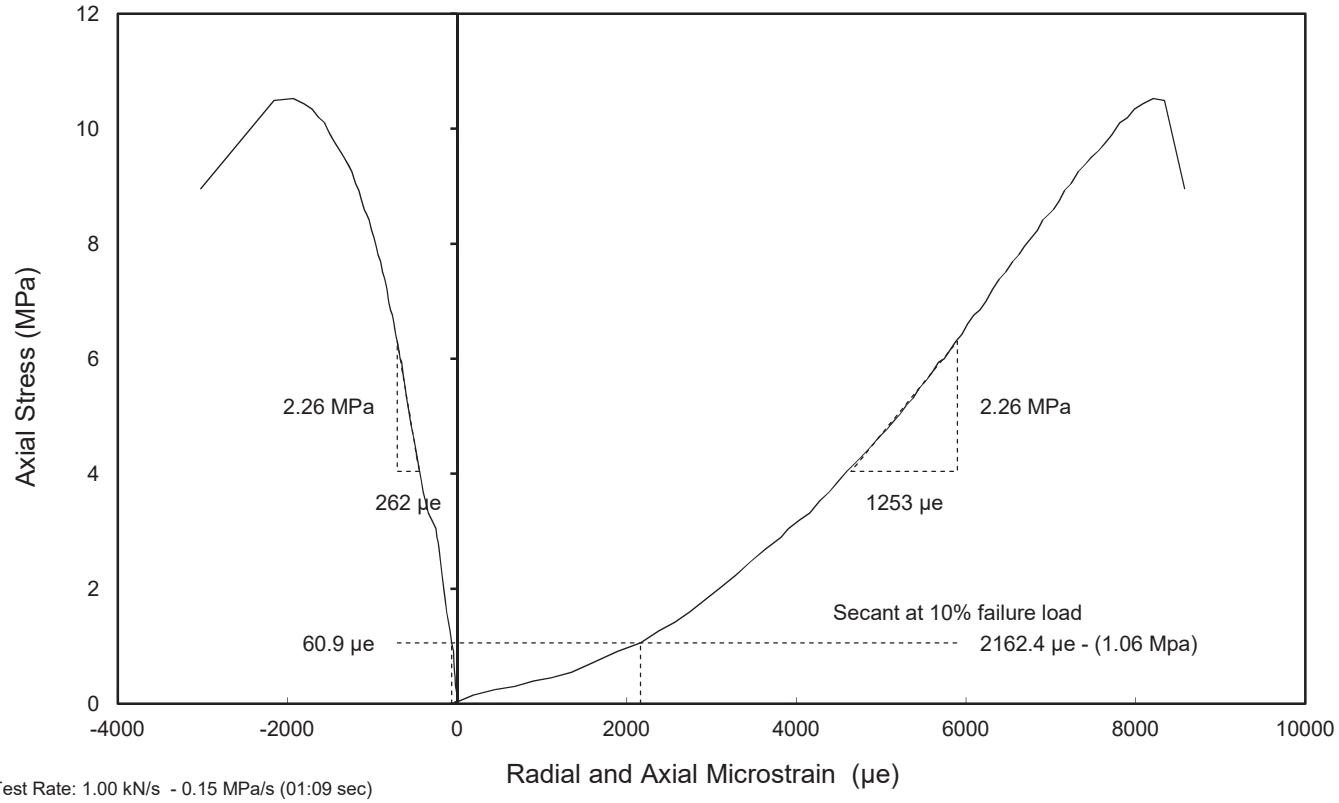
Solid lines for material failures.
Dashed lines for apparent weakness failure.

Date tested: 09/08/2017

Sample type	CS

Test results

Unconfined Compressive Strength	10.5 MPa
Young's Modulus (tangential at 50% failure load)	1.81 GPa
Poisson's Ratio (tangential at 50% failure load)	0.21
Young's Modulus (secant at 10% failure load)	0.488 GPa
Poisson's Ratio (secant at 10% failure load)	0.03



Test Rate: 1.00 kN/s - 0.15 MPa/s (01:09 sec)

Remarks: Height/diameter ratio according to client's request

Note: The dimensional requirements of Flatness (<0.02 mm), Perpendicularity (<0.05 / 50 mm) and Straightness (0.3 mm deviation) are all met.

Checked and Approved by

CC

C Clergeaud (Snr. Geol.)

Date: 23/08/2017

Project Number:

GEO / 26269

Project Name:

PROJECT BLUE
33138/PW

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Geotechnical Engineering Limited

POINT LOAD STRENGTH TEST

I.S.R.M. Suggested Methods : 2007 Edition

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

borehole /trial pit no.	sample depth (m)	test type	test orien-tation	moisture condi-tion	width W (mm)	length L (mm)	platen sep. D (mm)	failure load P (kN)	equiv. diam. De (mm)	Is (MPa)	size factor	Is(50) (MPa)	description and remarks
BH01A	11.90	D	Y	P		35	120	1.80	120.00	0.12	1.48	0.18	Red SANDSTONE
BH01A	11.90	A	X	P	120		40	2.61	78.18	0.43	1.22	0.52	Red SANDSTONE
BH01A	13.70	D	Y	P		45	120	0.28	120.00	0.02	1.48	0.03	Red SANDSTONE
BH01A	13.70	A	X	P	120		55	2.33	91.67	0.28	1.31	0.36	Red SANDSTONE
BH01A	14.70	D	Y	C		30	120	0.85	120.00	0.06	1.48	0.09	Red SANDSTONE
BH01A	14.70	A	X	C	120		70	1.19	103.42	0.11	1.39	0.15	Red SANDSTONE
BH01A	16.00	D	Y	C		100	120	0.90	120.00	0.06	1.48	0.09	Red SANDSTONE
BH01A	16.00	A	X	C	120		70	1.19	103.42	0.11	1.39	0.15	Red SANDSTONE
BH01A	21.10	D	Y	C		110	120	2.92	120.00	0.20	1.48	0.30	Red SANDSTONE
BH01A	21.10	A	X	C	120		70	3.71	103.42	0.35	1.39	0.48	Red SANDSTONE
BH02	13.10	D	Y	C		80	100	1.13	100.00	0.11	1.37	0.15	Red SANDSTONE
BH02	13.10	A	X	C	100		55	1.68	83.68	0.24	1.26	0.30	Red SANDSTONE
BH02	19.86	D	Y	P		40	90	1.41	90.00	0.17	1.30	0.23	Red SANDSTONE
BH02	19.86	A	X	P	90		60	4.26	82.92	0.62	1.26	0.78	Red SANDSTONE
BH04	13.25	D	Y	P		40	120	0.65	120.00	0.04	1.48	0.07	Grey SANDSTONE
BH04	13.25	A	X	P	120		60	1.48	95.75	0.16	1.34	0.22	Grey SANDSTONE
BH04	19.10	D	Y	C		70	120	0.38	120.00	0.03	1.48	0.04	Red SANDSTONE
BH04	19.10	A	X	C	120		60	0.83	95.75	0.09	1.34	0.12	Red SANDSTONE
BH05	8.20	D	Y	P		60	100	2.22	100.00	0.22	1.37	0.30	Red and yellow SANDSTONE

general remarks

tests carried out in accordance with I.S.R.M.(2007): Suggested Methods for Determining Point Load Strength.

test type	test orientation relative to discontinuities		moisture condition	CONTRACT	CHECKED
A - axial	X - perpendicular	U - unknown	N - natural moisture content	33138	CA
D - diametral	Y - parallel		P - partially air dried		
I - irregular lump	Z - oblique		S - soaked		

Geotechnical Engineering Limited

POINT LOAD STRENGTH TEST

I.S.R.M. Suggested Methods : 2007 Edition

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

borehole /trial pit no.	sample depth (m)	test type	test orien-tation	moisture condi-tion	width W (mm)	length L (mm)	platen sep. D (mm)	failure load P (kN)	equiv. diam. De (mm)	Is (MPa)	size factor	Is(50) (MPa)	description and remarks
BH05	8.20	A	X	P	100		55	3.42	83.68	0.49	1.26	0.61	Red and yellow SANDSTONE
BH05	9.35	I	X	P	90	80	50	3.32	75.69	0.58	1.21	0.70	Yellow SANDSTONE

general remarks

tests carried out in accordance with I.S.R.M.(2007): Suggested Methods for Determining Point Load Strength.

test type	test orientation relative to discontinuities		moisture condition	CONTRACT	CHECKED
A - axial	X - perpendicular	U - unknown	N - natural moisture content	33138	CA
D - diametral	Y - parallel		P - partially air dried		
I - irregular lump	Z - oblique		S - soaked		

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING
2183

Final Report

Report No.:	17-20040-1		
Initial Date of Issue:	07-Aug-2017		
Client	Geotechnical Engineering Ltd		
Client Address:	Centurion House Olympus Park Quedgeley Gloucester Gloucestershire GL2 4NF		
Contact(s):	Claire Andrew Mark Panther		
Project	33138 B Project Blue		
Quotation No.:		**Date Received:**	01-Aug-2017
Order No.:	33138 B	**Date Instructed:**	01-Aug-2017
No. of Samples:	4		
Turnaround (Wkdays):	5	**Results Due:**	07-Aug-2017
Date Approved:	07-Aug-2017		
Approved By:			
Details:	Keith Jones, Technical Manager		

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 33138 B Project Blue

Client: Geotechnical Engineering Ltd			**Chemtest Job No.:**		17-20040	17-20040	17-20040	17-20040
Quotation No.:			**Chemtest Sample ID.:**		491247	491248	491249	491250
Order No.: 33138 B			Client Sample Ref.:		BH01A	BH02	BH02	BH05
			Client Sample ID.:		9D	6D	24D	12D
			Sample Type:		SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		10.50	1.20	8.00	3.20
			Date Sampled:		31-Jul-2017	31-Jul-2017	31-Jul-2017	31-Jul-2017
			Asbestos Lab:		COVENTRY	COVENTRY	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
Moisture	N	2030	%	0.020	14	14	16	18
pH	U	2010		N/A	9.1	9.0	8.7	8.0
Magnesium (Water Soluble)	N	2120	g/l	0.010	0.038	0.011	0.012	0.018
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.11	0.040	0.082	0.32
Total Sulphur	U	2175	%	0.010	0.021	0.018	0.053	0.11
Chloride (Water Soluble)	U	2220	g/l	0.010	1.3	0.44	0.80	0.037
Nitrate (Water Soluble)	N	2220	g/l	0.010	< 0.010	< 0.010	< 0.010	< 0.010
Sulphate (Acid Soluble)	U	2430	%	0.010	0.045	0.022	0.056	0.10

Chemtest
The right chemistry to deliver results

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.
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2175	Total Sulphur in Soils	Total Sulphur	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2220	Water soluble Chloride in Soils	Chloride	Aqueous extraction and measuremernt by 'Aquakem 600' Discrete Analyser using ferric nitrate / mercuric thiocyanate.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.

Chemtest
The right chemistry to deliver results

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"

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

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.co.uk

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING
2183

Amended Report

Report No.:	17-21792-2		
Initial Date of Issue:	22-Aug-2017	**Date of Re-Issue:**	27-Sep-2017
Client	Geotechnical Engineering Ltd		
Client Address:	Centurion House Olympus Park Quedgeley Gloucester Gloucestershire GL2 4NF		
Contact(s):	Claire Andrew		
Project	33138 B Project Blue		
Quotation No.:		**Date Received:**	18-Aug-2017
Order No.:	33138 B	**Date Instructed:**	18-Aug-2017
No. of Samples:	2		
Turnaround (Wkdays):	3	**Results Due:**	22-Aug-2017
Date Approved:	22-Aug-2017		
Approved By:			
Details:	Keith Jones, Technical Manager		

Chemtest
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Results - Soil

Project: 33138 B Project Blue

Client: Geotechnical Engineering Ltd				**Chemtest Job No.:**	17-21792	17-21792
Quotation No.:				**Chemtest Sample ID.:**	499542	499543
Order No.: 33138 B				Client Sample Ref.:	BH04	BH02
				Client Sample ID.:	10UT	35CS
				Sample Type:	SOIL	SOIL
				Top Depth (m):	7.10	13.05
				Bottom Depth (m):	7.3	
				Date Sampled:	17-Aug-2017	17-Aug-2017
Determinand	**Accred.**	**SOP**	**Units**	**LOD**		
Moisture	N	2030	%	0.020	15	9.3
pH	U	2010		N/A	8.7	9.1
Magnesium (Water Soluble)	N	2120	g/l	0.010	< 0.010	0.012
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.039	0.17
Total Sulphur	U	2175	%	0.010	0.12	0.032
Chloride (Water Soluble)	U	2220	g/l	0.010	0.20	0.52
Nitrate (Water Soluble)	N	2220	g/l	0.010	< 0.010	< 0.010
Sulphate (Acid Soluble)	U	2430	%	0.010	0.037	0.034

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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.
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2175	Total Sulphur in Soils	Total Sulphur	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2220	Water soluble Chloride in Soils	Chloride	Aqueous extraction and measuremernt by 'Aquakem 600' Discrete Analyser using ferric nitrate / mercuric thiocyanate.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.

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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"

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.co.uk

2718

GEOTECHNICAL ENGINEERING LIMITED

		Version No.	2
For the attention of	Pete Woolley/Perran Spear	Page No.	1 of 3
		Date of Issue	01/11/2017

TEST REPORT

PROJECT/SITE	Project Blue	Samples received	28/07/2017
GEL REPORT NUMBER	33138/C	Schedule received	28/07/2017
Your ref/PO:	33138/PW	Testing commenced	28/07/2017
Test report refers to	Schedule C	Status	Final

SUMMARY OF RESULTS ATTACHED

TEST METHOD & DESCRIPTION	QUANTITY	ACCREDITED TEST
ISRM: Suggested Methods: 1981: Uniaxial Compressive Strength of Rock	11	YES
ISRM: 2007: Point Load Strength Test	4	NO

Remarks

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Approved Signatories:

S Robinson (Client Manager) **C Andrew (Laboratory Consultant)**

W Jones (Technical Support) J Hanson (Director) N Parry (Director)

CAndrew

Doc TR01 Rev No. 19 Revision date 10/03/17 DC:JH

Geotechnical Engineering Ltd
Centurion House
Olympus Park, Quedgeley
Gloucester GL2 4NF

Registered number: 00700739
VAT Number: 682 5857 89

www.geoeng.co.uk
geotech@geoeng.co.uk
TEL: 01452 527743
Fax: 01452 729314

Payments: Geotechnical Engineering Limited
Sort code: 30-15-99 **Bank account**: 00072116

Geotechnical Engineering Limited

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK

I.S.R.M. Suggested Methods : 2007 Edition

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

borehole /trial pit no.	sample no./type	sample depth (m)	specimen depth (m)	diameter D (mm)	height H (mm)	H/D	moisture content (%)	bulk density (Mg/m3)	loading rate (kN/min)	time to failure (min:sec)	UCS (MPa)	description, codes and remarks
BH01A	11Cs	12.00	12.00	117.4	155.9	1.33	11.2	2.28	10	09:21	8.63	Reddish brown SANDSTONE, N, Ax
BH01A	20Cs	18.50	18.50	116.9	303.7	2.60	10.4	2.26	20	04:34	8.53	Reddish brown SANDSTONE, N, Ax
BH02	39Cs	15.15	15.15	96.7	234.7	2.43	11.8	2.34	20	07:48	18.82	Reddish brown SANDSTONE, N, Ax
BH02	43Cs	18.70	18.70	97.9	218.9	2.24	10.9	2.20	20	07:04	18.83	Reddish brown SANDSTONE, N, AxCa
BH02	45Cs	20.20	20.20	95.6	234.4	2.45	7.3	2.32	20	10:04	28.15	Reddish brown and orangish brown SANDSTONE, N, AxCa
BH02	48Cs	22.65	26.70	99.8	267.4	2.68	8.4	2.29	20	07:16	19.13	Red SANDSTONE, N, Sh
BH05	22Cs	8.40	8.40	94.3	162.9	1.73	10	2.24	20	04:09	12.07	Reddish brown SANDSTONE, N, AxCa
BH05	26Cs	11.50	11.50	95.2	164.2	1.72	7.2	2.25	20	04:38	12.76	Reddish brown SANDSTONE, N, AxCa
BH05	28Cs	12.80	12.80	100.0	202.9	2.03	8.1	2.34	20	11:19	28.76	Reddish brown SANDSTONE, N, AxCa
BH05	31Cs	13.40	13.45	99.8	214.5	2.15	12.5	2.20	20	05:16	13.94	Red SANDSTONE, N, ShOt
BH05	33Cs	14.70	14.70	99.5	233.3	2.35	10	2.29	20	05:23	14.92	Reddish brown SANDSTONE, N, AxCa

general remarks

sample obtained from vertically drilled core (unless specified), test machine - VJT6000

coding:

moisture condition	sample storage	failure mode
N - natural moisture content	U - not wrapped	Ax - axial cleavage
F - fully saturated	F - wrapped in cling film/foil	Ca - cataclasis
S - soaked	W - waxed	Sh - shear
P - air/partially dried	G - contained in sealed Geoline	Ex - explosive
		Ot - other

CONTRACT	CHECKED
33138 C	**CA**

Geotechnical Engineering Limited

POINT LOAD STRENGTH TEST

I.S.R.M. Suggested Methods : 2007 Edition

CLIENT BURO HAPPOLD

SITE PROJECT BLUE

borehole /trial pit no.	sample depth (m)	test type	test orien-tation	moisture condition	width W (mm)	length L (mm)	platen sep. D (mm)	failure load P (kN)	equiv. diam. De (mm)	Is (MPa)	size factor	Is(50) (MPa)	description and remarks
BH04	13.70	D	Y	P		60	60	0.09	60.00	0.02	1.09	0.03	Reddish brown SANDSTONE
BH04	13.70	A	X	P	60		70	0.79	73.13	0.15	1.19	0.18	Reddish brown SANDSTONE
BH04	15.15	D	Y	P		60	105	0.09	105.00	0.01	1.40	0.01	Reddish brown SANDSTONE
BH04	15.15	A	X	P	105		45	1.16	77.56	0.19	1.22	0.23	Reddish brown SANDSTONE
BH04	16.60	D	Y	P		50	120	0.47	120.00	0.03	1.48	0.05	Reddish brown SANDSTONE
BH04	16.60	A	X	P	120		50	1.20	87.40	0.16	1.29	0.20	Reddish brown SANDSTONE
BH04	23.00	D	Y	P		60	120	0.12	120.00	0.01	1.48	0.01	Reddish brown SANDSTONE
BH04	23.00	A	X	P	120		60	1.89	95.75	0.21	1.34	0.28	Reddish brown SANDSTONE

general remarks

tests carried out in accordance with I.S.R.M.(2007): Suggested Methods for Determining Point Load Strength.

test type	test orientation relative to discontinuities		moisture condition	CONTRACT	CHECKED
A - axial	X - perpendicular	U - unknown	N - natural moisture content	33138	CA
D - diametral	Y - parallel		P - partially air dried		
I - irregular lump	Z - oblique		S - soaked		

APPENDIX C

CHEMICAL ANALYSES

Perran Spear
Geotechnical Engineering Ltd
Centurion House
Olympus Park
Quedgeley
Gloucester
GL2 4NF

t: 01452 527 743
f: 01452 729 314
e: perran.spear@geoeng.co.uk

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 17-54068

Project / Site name:	Project Blue	**Samples received on:**	22/06/2017
Your job number:	33138	**Samples instructed on:**	11/07/2017
Your order number:		**Analysis completed by:**	17/07/2017
Report Issue Number:	1	**Report issued on:**	17/07/2017
Samples Analysed:	20 soil samples		

Signed:

Dr Irma Doyle
Senior Account Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780762	780763	780764	780765	780766
Sample Reference				BH01	BH01	BH01	BH01A	BH01A
Sample Number				1	2	4	1	4
Depth (m)				0.20-0.50	1.00-1.20	3.10	6.10	10.60
Date Sampled				19/06/2017	19/06/2017	20/06/2017	21/06/2017	21/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	6.6	12	11	13	13
Total mass of sample received	kg	0.001	NONE	2.0	2.0	2.0	2.0	2.0
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	Chrysotile- Loose Fibres, Loose Fibrous Debris	-	-	-
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Detected	Not-detected	Not-detected	-
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	10.2	9.6	9.4	8.9	8.8
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	-
Organic Matter	%	0.1	MCERTS	3.4	0.8	0.2	0.3	-
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	8.9	8.5	2.4	7.7	2.1
Boron (water soluble)	mg/kg	0.2	MCERTS	3.1	2.5	0.4	1.2	1.3
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	24	17	8.4	17	9.7
Copper (aqua regia extractable)	mg/kg	1	MCERTS	33	30	8.1	12	6.0
Lead (aqua regia extractable)	mg/kg	1	MCERTS	350	55	13	12	4.2
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	21	13	7.5	15	6.9
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	29	19	9.2	18	9.6
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	97	74	24	24	10

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780762	780763	780764	780765	780766
Sample Reference				BH01	BH01	BH01	BH01A	BH01A
Sample Number				1	2	4	1	4
Depth (m)				0.20-0.50	1.00-1.20	3.10	6.10	10.60
Date Sampled				19/06/2017	19/06/2017	20/06/2017	21/06/2017	21/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	4.7	< 2.0	< 2.0	< 2.0	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	15	< 8.0	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	70	< 8.0	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	90	< 10	< 10	< 10	< 10
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	2.9	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	15	2.8	< 2.0	< 2.0	< 2.0
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	65	19	< 10	< 10	< 10
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	220	59	< 10	< 10	< 10
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	300	81	< 10	< 10	< 10

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780762	780763	780764	780765	780766
Sample Reference				BH01	BH01	BH01	BH01A	BH01A
Sample Number				1	2	4	1	4
Depth (m)				0.20-0.50	1.00-1.20	3.10	6.10	10.60
Date Sampled				19/06/2017	19/06/2017	20/06/2017	21/06/2017	21/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloroethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vinyl Chloride	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichlorofluoromethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloropropene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,2-dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromomethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromodichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromochloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromoethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Styrene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tribromomethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Isopropylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
n-Propylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
4-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
tert-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
sec-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p-Isopropyltoluene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,4-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Hexachlorobutadiene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780762	780763	780764	780765	780766
Sample Reference				BH01	BH01	BH01	BH01A	BH01A
Sample Number				1	2	4	1	4
Depth (m)				0.20-0.50	1.00-1.20	3.10	6.10	10.60
Date Sampled				19/06/2017	19/06/2017	20/06/2017	21/06/2017	21/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenol	mg/kg	0.2	ISO 17025	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
2-Chlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2-Methylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Hexachloroethane	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nitrobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
4-Methylphenol	mg/kg	0.2	NONE	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Isophorone	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
2-Nitrophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Naphthalene	mg/kg	0.05	MCERTS	1.5	0.78	< 0.05	< 0.05	< 0.05
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
4-Chloroaniline	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Hexachlorobutadiene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
2-Methylnaphthalene	mg/kg	0.1	NONE	0.9	< 0.1	< 0.1	< 0.1	< 0.1
2-Chloronaphthalene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dimethylphthalate	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	0.69	< 0.05	< 0.05	< 0.05	< 0.05
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Dibenzofuran	mg/kg	0.2	MCERTS	0.4	< 0.2	< 0.2	< 0.2	< 0.2
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Diethyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
4-Nitroaniline	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Fluorene	mg/kg	0.05	MCERTS	0.55	< 0.05	< 0.05	< 0.05	< 0.05
Azobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hexachlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Phenanthrene	mg/kg	0.05	MCERTS	4.5	1.8	0.12	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	1.0	0.17	< 0.05	< 0.05	< 0.05
Carbazole	mg/kg	0.3	MCERTS	0.3	< 0.3	< 0.3	< 0.3	< 0.3
Dibutyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Anthraquinone	mg/kg	0.3	MCERTS	0.5	< 0.3	< 0.3	< 0.3	< 0.3
Fluoranthene	mg/kg	0.05	MCERTS	4.2	2.5	0.15	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	4.5	2.6	0.16	< 0.05	< 0.05
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Benzo(a)anthracene	mg/kg	0.05	MCERTS	2.1	1.1	< 0.05	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	2.1	1.6	< 0.05	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	2.2	1.3	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	1.2	0.77	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	2.3	1.3	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	1.2	0.61	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.32	0.18	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	1.3	0.73	< 0.05	< 0.05	< 0.05

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780762	780763	780764	780765	780766
Sample Reference				BH01	BH01	BH01	BH01A	BH01A
Sample Number				1	2	4	1	4
Depth (m)				0.20-0.50	1.00-1.20	3.10	6.10	10.60
Date Sampled				19/06/2017	19/06/2017	20/06/2017	21/06/2017	21/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
PCBs by GC-MS								
PCB Congener 28	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 52	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 101	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 118	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 138	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 153	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 180	mg/kg	0.001	MCERTS	-	-	-	-	-
Total PCBs by GC-MS								
Total PCBs	mg/kg	0.007	MCERTS	-	-	-	-	-
Organotins								
Tributyl Tin	µg/kg	10	NONE	< 10	< 10	-	-	-
Environmental Forensics								
Glycols								
Ethylene Glycol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
Triethylene Glycol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
1,2-Propanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
1,3-Propanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
1,2-Butanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
1,3-Butanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
1,4-Butanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
1,5-Pentanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780767	780768	780769	780770	780771
Sample Reference				BH02	BH02	BH02	BH02	BH02
Sample Number				2	4	6	9	11
Depth (m)				1.00	2.00	4.00	7.00	9.00
Date Sampled				14/06/2017	14/06/2017	15/06/2017	15/06/2017	15/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	9.5	20	15	18	10
Total mass of sample received	kg	0.001	NONE	2.0	2.0	2.0	2.0	2.0
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	-	-	-
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	-
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.8	9.4	8.9	8.6	9.1
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	-
Organic Matter	%	0.1	MCERTS	0.3	0.3	0.3	0.2	-
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	5.5	3.5	7.8	5.2	7.9
Boron (water soluble)	mg/kg	0.2	MCERTS	2.2	1.8	2.2	1.4	2.1
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	0.3	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	14	14	20	9.5	25
Copper (aqua regia extractable)	mg/kg	1	MCERTS	14	17	14	18	18
Lead (aqua regia extractable)	mg/kg	1	MCERTS	23	28	8.1	64	24
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	12	9.6	20	9.3	24
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	14	14	20	11	25
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	20	28	31	95	41

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780767	780768	780769	780770	780771
Sample Reference				BH02	BH02	BH02	BH02	BH02
Sample Number				2	4	6	9	11
Depth (m)				1.00	2.00	4.00	7.00	9.00
Date Sampled				14/06/2017	14/06/2017	15/06/2017	15/06/2017	15/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	4.9	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	60	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	< 10	71	< 10

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0	4.0	4.7
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10	< 10	< 10	12	18
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	< 10	< 10	< 10	91	45
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	10	< 10	110	68

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780767	780768	780769	780770	780771
Sample Reference				BH02	BH02	BH02	BH02	BH02
Sample Number				2	4	6	9	11
Depth (m)				1.00	2.00	4.00	7.00	9.00
Date Sampled				14/06/2017	14/06/2017	15/06/2017	15/06/2017	15/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloroethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vinyl Chloride	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichlorofluoromethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloropropene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,2-dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromomethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromodichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromochloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromoethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Styrene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tribromomethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Isopropylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
n-Propylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
4-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
tert-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
sec-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p-Isopropyltoluene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,4-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Hexachlorobutadiene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780767	780768	780769	780770	780771
Sample Reference				BH02	BH02	BH02	BH02	BH02
Sample Number				2	4	6	9	11
Depth (m)				1.00	2.00	4.00	7.00	9.00
Date Sampled				14/06/2017	14/06/2017	15/06/2017	15/06/2017	15/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenol	mg/kg	0.2	ISO 17025	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
2-Chlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2-Methylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Hexachloroethane	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nitrobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
4-Methylphenol	mg/kg	0.2	NONE	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Isophorone	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
2-Nitrophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Naphthalene	mg/kg	0.05	MCERTS	0.27	0.40	< 0.05	0.15	0.36
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
4-Chloroaniline	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Hexachlorobutadiene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
2-Methylnaphthalene	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	0.2
2-Chloronaphthalene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dimethylphthalate	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.25
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Dibenzofuran	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Diethyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
4-Nitroaniline	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.18
Azobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hexachlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Phenanthrene	mg/kg	0.05	MCERTS	0.30	0.27	< 0.05	0.26	1.4
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.36
Carbazole	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Dibutyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Anthraquinone	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Fluoranthene	mg/kg	0.05	MCERTS	0.23	0.23	< 0.05	0.30	1.5
Pyrene	mg/kg	0.05	MCERTS	0.24	0.25	< 0.05	0.31	1.5
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.12	0.13	< 0.05	0.17	0.71
Chrysene	mg/kg	0.05	MCERTS	0.18	0.17	< 0.05	0.19	0.83
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.13	< 0.05	0.17	0.74
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.10	< 0.05	0.10	0.37
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	0.12	< 0.05	0.17	0.66
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.34
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.39

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780767	780768	780769	780770	780771
Sample Reference				BH02	BH02	BH02	BH02	BH02
Sample Number				2	4	6	9	11
Depth (m)				1.00	2.00	4.00	7.00	9.00
Date Sampled				14/06/2017	14/06/2017	15/06/2017	15/06/2017	15/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
PCBs by GC-MS								
PCB Congener 28	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 52	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 101	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 118	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 138	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 153	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 180	mg/kg	0.001	MCERTS	-	-	-	-	-
Total PCBs by GC-MS								
Total PCBs	mg/kg	0.007	MCERTS	-	-	-	-	-
Organotins								
Tributyl Tin	µg/kg	10	NONE	< 10	-	-	-	-
Environmental Forensics								
Glycols								
Ethylene Glycol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
Triethylene Glycol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
1,2-Propanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
1,3-Propanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
1,2-Butanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
1,3-Butanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
1,4-Butanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-
1,5-Pentanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	-

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780772	780773	780774	780775	780776
Sample Reference				BH03	BH03A	BH04	BH04	BH04
Sample Number				1	1	2	3	4
Depth (m)				0.10	0.50	1.00-1.20	2.00	5.00
Date Sampled				15/06/2017	15/06/2017	13/06/2017	13/06/2017	13/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	12	1.3	9.4	7.1	16
Total mass of sample received	kg	0.001	NONE	2.0	0.28	1.2	2.0	2.0
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	-	-	-
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	9.0	12.1	9.8	8.6	12.4
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	2	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Organic Matter	%	0.1	MCERTS	7.4	0.7	5.7	4.9	0.9
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	32	11	24	9.9	8.2
Boron (water soluble)	mg/kg	0.2	MCERTS	14	2.1	2.7	1.9	3.3
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.6	< 0.2	< 0.2	0.2	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	39	26	21	24	18
Copper (aqua regia extractable)	mg/kg	1	MCERTS	180	23	230	74	230
Lead (aqua regia extractable)	mg/kg	1	MCERTS	1700	28	950	340	150
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	0.4	< 0.3	1.0	1.7	0.7
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	39	20	21	15	28
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	39	29	29	43	25
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	320	59	350	180	45

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780772	780773	780774	780775	780776
Sample Reference				BH03	BH03A	BH04	BH04	BH04
Sample Number				1	1	2	3	4
Depth (m)				0.10	0.50	1.00-1.20	2.00	5.00
Date Sampled				15/06/2017	15/06/2017	13/06/2017	13/06/2017	13/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	32	< 1.0	12	14	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	96	< 2.0	57	38	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	170	< 8.0	78	35	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	490	< 8.0	320	110	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	790	< 10	470	200	< 10

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	150	< 1.0	590	540	2.5
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	600	2.3	1900	1700	7.6
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	2400	< 10	4700	4000	22
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	4500	< 10	6400	4600	48
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	7600	11	14000	11000	80

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780772	780773	780774	780775	780776
Sample Reference				BH03	BH03A	BH04	BH04	BH04
Sample Number				1	1	2	3	4
Depth (m)				0.10	0.50	1.00-1.20	2.00	5.00
Date Sampled				15/06/2017	15/06/2017	13/06/2017	13/06/2017	13/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloroethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vinyl Chloride	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichlorofluoromethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloropropene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,2-dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromomethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromodichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromochloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromoethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Styrene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tribromomethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Isopropylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
n-Propylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
4-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
tert-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
sec-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p-Isopropyltoluene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,4-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Hexachlorobutadiene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780772	780773	780774	780775	780776
Sample Reference				BH03	BH03A	BH04	BH04	BH04
Sample Number				1	1	2	3	4
Depth (m)				0.10	0.50	1.00-1.20	2.00	5.00
Date Sampled				15/06/2017	15/06/2017	13/06/2017	13/06/2017	13/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenol	mg/kg	0.2	ISO 17025	6.2	< 0.2	4.5	6.9	< 0.2
2-Chlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2-Methylphenol	mg/kg	0.3	MCERTS	3.9	< 0.3	15	13	< 0.3
Hexachloroethane	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nitrobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
4-Methylphenol	mg/kg	0.2	NONE	8.5	< 0.2	40	34	< 0.2
Isophorone	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
2-Nitrophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	25	22	< 0.3
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Naphthalene	mg/kg	0.05	MCERTS	130	< 0.05	380	250	0.82
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
4-Chloroaniline	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Hexachlorobutadiene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
2-Methylnaphthalene	mg/kg	0.1	NONE	190	< 0.1	240	180	0.4
2-Chloronaphthalene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dimethylphthalate	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	0.05	MCERTS	3.4	< 0.05	11	3.6	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	84	< 0.05	180	160	0.62
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Dibenzofuran	mg/kg	0.2	MCERTS	46	< 0.2	92	80	0.3
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Diethyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
4-Nitroaniline	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Fluorene	mg/kg	0.05	MCERTS	73	< 0.05	160	150	0.52
Azobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hexachlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Phenanthrene	mg/kg	0.05	MCERTS	390	0.65	1000	820	3.9
Anthracene	mg/kg	0.05	MCERTS	100	0.23	250	210	0.75
Carbazole	mg/kg	0.3	MCERTS	38	< 0.3	100	79	< 0.3
Dibutyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Anthraquinone	mg/kg	0.3	MCERTS	21	< 0.3	72	51	< 0.3
Fluoranthene	mg/kg	0.05	MCERTS	380	1.1	760	540	2.9
Pyrene	mg/kg	0.05	MCERTS	360	1.0	810	570	3.1
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Benzo(a)anthracene	mg/kg	0.05	MCERTS	190	0.64	390	270	1.1
Chrysene	mg/kg	0.05	MCERTS	150	0.62	420	230	1.3
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	170	0.66	410	250	0.89
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	76	0.46	200	110	0.66
Benzo(a)pyrene	mg/kg	0.05	MCERTS	170	0.67	410	240	0.99
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	73	0.32	190	100	0.52
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	20	< 0.05	56	30	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	86	0.34	210	120	0.53

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780772	780773	780774	780775	780776
Sample Reference				BH03	BH03A	BH04	BH04	BH04
Sample Number				1	1	2	3	4
Depth (m)				0.10	0.50	1.00-1.20	2.00	5.00
Date Sampled				15/06/2017	15/06/2017	13/06/2017	13/06/2017	13/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
PCBs by GC-MS								
PCB Congener 28	mg/kg	0.001	MCERTS	-	-	-	< 0.001	-
PCB Congener 52	mg/kg	0.001	MCERTS	-	-	-	< 0.001	-
PCB Congener 101	mg/kg	0.001	MCERTS	-	-	-	< 0.001	-
PCB Congener 118	mg/kg	0.001	MCERTS	-	-	-	< 0.001	-
PCB Congener 138	mg/kg	0.001	MCERTS	-	-	-	< 0.001	-
PCB Congener 153	mg/kg	0.001	MCERTS	-	-	-	< 0.001	-
PCB Congener 180	mg/kg	0.001	MCERTS	-	-	-	< 0.001	-
Total PCBs by GC-MS								
Total PCBs	mg/kg	0.007	MCERTS	-	-	-	< 0.007	-
Organotins								
Tributyl Tin	µg/kg	10	NONE	-	-	< 10	-	-
Environmental Forensics								
Glycols								
Ethylene Glycol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	< 10
Triethylene Glycol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	< 10
1,2-Propanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	< 10
1,3-Propanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	< 10
1,2-Butanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	< 10
1,3-Butanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	< 10
1,4-Butanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	< 10
1,5-Pentanediol	mg/kg	10	NONE	< 10	< 10	< 10	< 10	< 10

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780777	780778	780779	780780	780781
Sample Reference				BH04	BH05	BH05	BH05	BH05
Sample Number				5	1	3	5	7
Depth (m)				5.60	0.50	1.50	3.00	5.00
Date Sampled				13/06/2017	13/06/2017	13/06/2017	13/06/2017	13/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	14	17	18	18	22
Total mass of sample received	kg	0.001	NONE	2.0	2.0	2.0	2.0	2.0
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	-	-	-
Asbestos in Soil	Type	N/A	ISO 17025	-	Not-detected	Not-detected	Not-detected	-
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	9.0	8.3	8.7	8.1	8.0
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	-	< 1	< 1	< 1	-
Organic Matter	%	0.1	MCERTS	-	0.9	1.2	1.6	-
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	7.4	10	6.8	6.2	9.0
Boron (water soluble)	mg/kg	0.2	MCERTS	1.8	0.5	1.0	2.8	3.9
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	31	18	16	13	24
Copper (aqua regia extractable)	mg/kg	1	MCERTS	26	34	28	69	29
Lead (aqua regia extractable)	mg/kg	1	MCERTS	20	50	50	110	53
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	32	17	13	11	19
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	29	23	18	15	26
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	46	42	35	32	52

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780777	780778	780779	780780	780781
Sample Reference				BH04	BH05	BH05	BH05	BH05
Sample Number				5	1	3	5	7
Depth (m)				5.60	0.50	1.50	3.00	5.00
Date Sampled				13/06/2017	13/06/2017	13/06/2017	13/06/2017	13/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	6.2	< 2.0	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	8.1	< 8.0	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	< 8.0	86	< 8.0	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	< 10	100	< 10	< 10

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	7.8	3.8	< 1.0	5.1
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	10	8.2	4.4	18
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10	15	17	45	52
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	< 10	26	120	96	86
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	59	150	150	160

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780777	780778	780779	780780	780781
Sample Reference				BH04	BH05	BH05	BH05	BH05
Sample Number				5	1	3	5	7
Depth (m)				5.60	0.50	1.50	3.00	5.00
Date Sampled				13/06/2017	13/06/2017	13/06/2017	13/06/2017	13/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloroethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vinyl Chloride	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichlorofluoromethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloropropene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,2-dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromomethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromodichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibromochloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethene	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromoethane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Styrene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tribromomethane	µg/kg	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Isopropylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
n-Propylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
4-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
tert-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
sec-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p-Isopropyltoluene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,4-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Hexachlorobutadiene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780777	780778	780779	780780	780781
Sample Reference				BH04	BH05	BH05	BH05	BH05
Sample Number				5	1	3	5	7
Depth (m)				5.60	0.50	1.50	3.00	5.00
Date Sampled				13/06/2017	13/06/2017	13/06/2017	13/06/2017	13/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenol	mg/kg	0.2	ISO 17025	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
2-Chlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2-Methylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Hexachloroethane	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nitrobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
4-Methylphenol	mg/kg	0.2	NONE	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Isophorone	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
2-Nitrophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	0.70	< 0.05	0.13	0.95
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
4-Chloroaniline	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Hexachlorobutadiene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
2-Methylnaphthalene	mg/kg	0.1	NONE	< 0.1	1.0	< 0.1	< 0.1	0.6
2-Chloronaphthalene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dimethylphthalate	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.71
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Dibenzofuran	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	0.4
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Diethyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
4-Nitroaniline	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.57
Azobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Hexachlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	0.36	0.19	0.45	4.2
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.97
Carbazole	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	0.3
Dibutyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Anthraquinone	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	0.3
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.28	0.22	0.52	3.2
Pyrene	mg/kg	0.05	MCERTS	< 0.05	0.27	0.22	0.58	3.5
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.15	0.16	0.29	1.5
Chrysene	mg/kg	0.05	MCERTS	< 0.05	0.14	0.20	0.30	1.6
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.18	0.15	0.21	1.3
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.08	0.10	0.20	0.68
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	0.16	0.13	0.27	1.4
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.65
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.17
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	0.68

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Analytical Report Number: 17-54068

Project / Site name: Project Blue

Lab Sample Number				780777	780778	780779	780780	780781
Sample Reference				BH04	BH05	BH05	BH05	BH05
Sample Number				5	1	3	5	7
Depth (m)				5.60	0.50	1.50	3.00	5.00
Date Sampled				13/06/2017	13/06/2017	13/06/2017	13/06/2017	13/06/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
PCBs by GC-MS								
PCB Congener 28	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 52	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 101	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 118	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 138	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 153	mg/kg	0.001	MCERTS	-	-	-	-	-
PCB Congener 180	mg/kg	0.001	MCERTS	-	-	-	-	-
Total PCBs by GC-MS								
Total PCBs	mg/kg	0.007	MCERTS	-	-	-	-	-
Organotins								
Tributyl Tin	µg/kg	10	NONE	-	< 10	-	-	-
Environmental Forensics								
Glycols								
Ethylene Glycol	mg/kg	10	NONE	-	< 10	< 10	< 10	-
Triethylene Glycol	mg/kg	10	NONE	-	< 10	< 10	< 10	-
1,2-Propanediol	mg/kg	10	NONE	-	< 10	< 10	< 10	-
1,3-Propanediol	mg/kg	10	NONE	-	< 10	< 10	< 10	-
1,2-Butanediol	mg/kg	10	NONE	-	< 10	< 10	< 10	-
1,3-Butanediol	mg/kg	10	NONE	-	< 10	< 10	< 10	-
1,4-Butanediol	mg/kg	10	NONE	-	< 10	< 10	< 10	-
1,5-Pentanediol	mg/kg	10	NONE	-	< 10	< 10	< 10	-

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Analytical Report Number : 17-54068

Project / Site name: Project Blue

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
780762	BH01	1	0.20-0.50	Brown sand with gravel.
780763	BH01	2	1.00-1.20	Brown clay and sand with gravel and brick.
780764	BH01	4	3.10	Brown clay and sand.
780765	BH01A	1	6.10	Brown sandy clay with gravel.
780766	BH01A	4	10.60	Red sand with gravel.
780767	BH02	2	1.00	Red sand with gravel.
780768	BH02	4	2.00	Brown clay with gravel.
780769	BH02	6	4.00	Brown clay and sand.
780770	BH02	9	7.00	Brown sand.
780771	BH02	11	9.00	Brown clay and sand with gravel.
780772	BH03	1	0.10	Brown clay and sand with gravel.
780773	BH03A	1	0.50	Light brown rubble.
780774	BH04	2	1.00-1.20	Brown clay and sand with gravel.
780775	BH04	3	2.00	Brown sand with brick.
780776	BH04	4	5.00	Brown clay and sand with gravel.
780777	BH04	5	5.60	Brown clay.
780778	BH05	1	0.50	Brown sandy clay with gravel.
780779	BH05	3	1.50	Brown sandy clay with gravel.
780780	BH05	5	3.00	Brown sandy clay.
780781	BH05	7	5.00	Brown clay.

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Analytical Report Number : 17-54068

Project / Site name: Project Blue

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
EF - Organotins by GC-MS/MS in soil	Organotins by GC-MS/MS	In-house method	UK	W	NONE
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
PCB's By GC-MS in soil	Determination of PCB by extraction with acetone and hexane followed by GC-MS.	In-house method based on USEPA 8082	L027-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds in soil by extraction in dichloromethane and hexane followed by GC-MS.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
TO - Glycols in Soil	Determination of glycols by GC-MS.	In-house method		W	NONE
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method	L088/76-PL	W	MCERTS
Volatile organic compounds in soil	Determination of volatile organic compounds in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS

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Analytical Report Number : 17-54068

Project / Site name: Project Blue

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
BH01	1	S	17-54068	780762	c	Free cyanide in soil	L080-PL	c
BH01	1	S	17-54068	780762	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH01	1	S	17-54068	780762	c	EF - Organotins by GC-MS/MS in soil	UK	c
BH01	1	S	17-54068	780762	c	Monohydric phenols in soil	L080-PL	c
BH01	1	S	17-54068	780762	c	Organic matter (Automated) in soil	L009-PL	c
BH01	1	S	17-54068	780762	c	Semi-volatile organic compounds in soil	L064-PL	c
BH01	1	S	17-54068	780762	c	TPHCWG (Soil)	L088/76-PL	c
BH01	1	S	17-54068	780762	c	Total cyanide in soil	L080-PL	c
BH01	1	S	17-54068	780762	c	Volatile organic compounds in soil	L073B-PL	c
BH01	2	S	17-54068	780763	c	Free cyanide in soil	L080-PL	c
BH01	2	S	17-54068	780763	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH01	2	S	17-54068	780763	c	EF - Organotins by GC-MS/MS in soil	UK	c
BH01	2	S	17-54068	780763	c	Monohydric phenols in soil	L080-PL	c
BH01	2	S	17-54068	780763	c	Organic matter (Automated) in soil	L009-PL	c
BH01	2	S	17-54068	780763	c	Semi-volatile organic compounds in soil	L064-PL	c
BH01	2	S	17-54068	780763	c	TPHCWG (Soil)	L088/76-PL	c
BH01	2	S	17-54068	780763	c	Total cyanide in soil	L080-PL	c
BH01	2	S	17-54068	780763	c	Volatile organic compounds in soil	L073B-PL	c
BH01	4	S	17-54068	780764	c	Free cyanide in soil	L080-PL	c
BH01	4	S	17-54068	780764	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH01	4	S	17-54068	780764	c	Organic matter (Automated) in soil	L009-PL	c
BH01	4	S	17-54068	780764	c	Total cyanide in soil	L080-PL	c
BH01	4	S	17-54068	780764	c	Volatile organic compounds in soil	L073B-PL	c
BH01A	1	S	17-54068	780765	c	Free cyanide in soil	L080-PL	c
BH01A	1	S	17-54068	780765	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH01A	1	S	17-54068	780765	c	Organic matter (Automated) in soil	L009-PL	c
BH01A	1	S	17-54068	780765	c	Total cyanide in soil	L080-PL	c
BH01A	1	S	17-54068	780765	c	Volatile organic compounds in soil	L073B-PL	c
BH01A	4	S	17-54068	780766	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH01A	4	S	17-54068	780766	c	Total cyanide in soil	L080-PL	c
BH01A	4	S	17-54068	780766	c	Volatile organic compounds in soil	L073B-PL	c
BH02	11	S	17-54068	780771	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH02	11	S	17-54068	780771	c	Monohydric phenols in soil	L080-PL	c
BH02	11	S	17-54068	780771	c	Semi-volatile organic compounds in soil	L064-PL	c
BH02	11	S	17-54068	780771	c	TPHCWG (Soil)	L088/76-PL	c
BH02	11	S	17-54068	780771	c	Total cyanide in soil	L080-PL	c
BH02	11	S	17-54068	780771	c	Volatile organic compounds in soil	L073B-PL	c
BH02	2	S	17-54068	780767	c	Free cyanide in soil	L080-PL	c
BH02	2	S	17-54068	780767	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH02	2	S	17-54068	780767	c	EF - Organotins by GC-MS/MS in soil	UK	c
BH02	2	S	17-54068	780767	c	Monohydric phenols in soil	L080-PL	c
BH02	2	S	17-54068	780767	c	Organic matter (Automated) in soil	L009-PL	c
BH02	2	S	17-54068	780767	c	Semi-volatile organic compounds in soil	L064-PL	c
BH02	2	S	17-54068	780767	c	TPHCWG (Soil)	L088/76-PL	c
BH02	2	S	17-54068	780767	c	Total cyanide in soil	L080-PL	c
BH02	2	S	17-54068	780767	c	Volatile organic compounds in soil	L073B-PL	c
BH02	4	S	17-54068	780768	c	Free cyanide in soil	L080-PL	c
BH02	4	S	17-54068	780768	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH02	4	S	17-54068	780768	c	Monohydric phenols in soil	L080-PL	c
BH02	4	S	17-54068	780768	c	Organic matter (Automated) in soil	L009-PL	c
BH02	4	S	17-54068	780768	c	Semi-volatile organic compounds in soil	L064-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

BH02	4	S	17-54068	780768	c	TPHCWG (Soil)	L088/76-PL	c
BH02	4	S	17-54068	780768	c	Total cyanide in soil	L080-PL	c
BH02	4	S	17-54068	780768	c	Volatile organic compounds in soil	L073B-PL	c
BH02	6	S	17-54068	780769	c	Free cyanide in soil	L080-PL	c
BH02	6	S	17-54068	780769	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH02	6	S	17-54068	780769	c	Monohydric phenols in soil	L080-PL	c
BH02	6	S	17-54068	780769	c	Organic matter (Automated) in soil	L009-PL	c
BH02	6	S	17-54068	780769	c	Semi-volatile organic compounds in soil	L064-PL	c
BH02	6	S	17-54068	780769	c	TPHCWG (Soil)	L088/76-PL	c
BH02	6	S	17-54068	780769	c	Total cyanide in soil	L080-PL	c
BH02	6	S	17-54068	780769	c	Volatile organic compounds in soil	L073B-PL	c
BH02	9	S	17-54068	780770	c	Free cyanide in soil	L080-PL	c
BH02	9	S	17-54068	780770	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH02	9	S	17-54068	780770	c	Monohydric phenols in soil	L080-PL	c
BH02	9	S	17-54068	780770	c	Organic matter (Automated) in soil	L009-PL	c
BH02	9	S	17-54068	780770	c	Semi-volatile organic compounds in soil	L064-PL	c
BH02	9	S	17-54068	780770	c	TPHCWG (Soil)	L088/76-PL	c
BH02	9	S	17-54068	780770	c	Total cyanide in soil	L080-PL	c
BH02	9	S	17-54068	780770	c	Volatile organic compounds in soil	L073B-PL	c
BH03	1	S	17-54068	780772	c	Free cyanide in soil	L080-PL	c
BH03	1	S	17-54068	780772	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH03	1	S	17-54068	780772	c	Monohydric phenols in soil	L080-PL	c
BH03	1	S	17-54068	780772	c	Organic matter (Automated) in soil	L009-PL	c
BH03	1	S	17-54068	780772	c	Semi-volatile organic compounds in soil	L064-PL	c
BH03	1	S	17-54068	780772	c	TPHCWG (Soil)	L088/76-PL	c
BH03	1	S	17-54068	780772	c	Total cyanide in soil	L080-PL	c
BH03	1	S	17-54068	780772	c	Volatile organic compounds in soil	L073B-PL	c
BH03A	1	S	17-54068	780773	c	Free cyanide in soil	L080-PL	c
BH03A	1	S	17-54068	780773	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH03A	1	S	17-54068	780773	c	Monohydric phenols in soil	L080-PL	c
BH03A	1	S	17-54068	780773	c	Organic matter (Automated) in soil	L009-PL	c
BH03A	1	S	17-54068	780773	c	Semi-volatile organic compounds in soil	L064-PL	c
BH03A	1	S	17-54068	780773	c	TPHCWG (Soil)	L088/76-PL	c
BH03A	1	S	17-54068	780773	c	Total cyanide in soil	L080-PL	c
BH03A	1	S	17-54068	780773	c	Volatile organic compounds in soil	L073B-PL	c
BH04	2	S	17-54068	780774	c	Free cyanide in soil	L080-PL	c
BH04	2	S	17-54068	780774	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH04	2	S	17-54068	780774	c	EF - Organotins by GC-MS/MS in soil	UK	c
BH04	2	S	17-54068	780774	c	Monohydric phenols in soil	L080-PL	c
BH04	2	S	17-54068	780774	c	Organic matter (Automated) in soil	L009-PL	c
BH04	2	S	17-54068	780774	c	Semi-volatile organic compounds in soil	L064-PL	c
BH04	2	S	17-54068	780774	c	TPHCWG (Soil)	L088/76-PL	c
BH04	2	S	17-54068	780774	c	Total cyanide in soil	L080-PL	c
BH04	2	S	17-54068	780774	c	Volatile organic compounds in soil	L073B-PL	c
BH04	3	S	17-54068	780775	c	Free cyanide in soil	L080-PL	c
BH04	3	S	17-54068	780775	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH04	3	S	17-54068	780775	c	Monohydric phenols in soil	L080-PL	c
BH04	3	S	17-54068	780775	c	Organic matter (Automated) in soil	L009-PL	c
BH04	3	S	17-54068	780775	c	PCB's By GC-MS in soil	L027-PL	c
BH04	3	S	17-54068	780775	c	Semi-volatile organic compounds in soil	L064-PL	c
BH04	3	S	17-54068	780775	c	TPHCWG (Soil)	L088/76-PL	c
BH04	3	S	17-54068	780775	c	Total cyanide in soil	L080-PL	c
BH04	3	S	17-54068	780775	c	Volatile organic compounds in soil	L073B-PL	c
BH04	4	S	17-54068	780776	c	Free cyanide in soil	L080-PL	c

BH04	4	S	17-54068	780776	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH04	4	S	17-54068	780776	c	Monohydric phenols in soil	L080-PL	c
BH04	4	S	17-54068	780776	c	Organic matter (Automated) in soil	L009-PL	c
BH04	4	S	17-54068	780776	c	Semi-volatile organic compounds in soil	L064-PL	c
BH04	4	S	17-54068	780776	c	TPHCWG (Soil)	L088/76-PL	c
BH04	4	S	17-54068	780776	c	Total cyanide in soil	L080-PL	c
BH04	4	S	17-54068	780776	c	Volatile organic compounds in soil	L073B-PL	c
BH04	5	S	17-54068	780777	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH04	5	S	17-54068	780777	c	Monohydric phenols in soil	L080-PL	c
BH04	5	S	17-54068	780777	c	Semi-volatile organic compounds in soil	L064-PL	c
BH04	5	S	17-54068	780777	c	TPHCWG (Soil)	L088/76-PL	c
BH04	5	S	17-54068	780777	c	Total cyanide in soil	L080-PL	c
BH04	5	S	17-54068	780777	c	Volatile organic compounds in soil	L073B-PL	c
BH05	1	S	17-54068	780778	c	Free cyanide in soil	L080-PL	c
BH05	1	S	17-54068	780778	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH05	1	S	17-54068	780778	c	EF - Organotins by GC-MS/MS in soil	UK	c
BH05	1	S	17-54068	780778	c	Monohydric phenols in soil	L080-PL	c
BH05	1	S	17-54068	780778	c	Organic matter (Automated) in soil	L009-PL	c
BH05	1	S	17-54068	780778	c	Semi-volatile organic compounds in soil	L064-PL	c
BH05	1	S	17-54068	780778	c	TPHCWG (Soil)	L088/76-PL	c
BH05	1	S	17-54068	780778	c	Total cyanide in soil	L080-PL	c
BH05	1	S	17-54068	780778	c	Volatile organic compounds in soil	L073B-PL	c
BH05	3	S	17-54068	780779	c	Free cyanide in soil	L080-PL	c
BH05	3	S	17-54068	780779	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH05	3	S	17-54068	780779	c	Monohydric phenols in soil	L080-PL	c
BH05	3	S	17-54068	780779	c	Organic matter (Automated) in soil	L009-PL	c
BH05	3	S	17-54068	780779	c	Semi-volatile organic compounds in soil	L064-PL	c
BH05	3	S	17-54068	780779	c	TPHCWG (Soil)	L088/76-PL	c
BH05	3	S	17-54068	780779	c	Total cyanide in soil	L080-PL	c
BH05	3	S	17-54068	780779	c	Volatile organic compounds in soil	L073B-PL	c
BH05	5	S	17-54068	780780	c	Free cyanide in soil	L080-PL	c
BH05	5	S	17-54068	780780	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH05	5	S	17-54068	780780	c	Monohydric phenols in soil	L080-PL	c
BH05	5	S	17-54068	780780	c	Organic matter (Automated) in soil	L009-PL	c
BH05	5	S	17-54068	780780	c	Semi-volatile organic compounds in soil	L064-PL	c
BH05	5	S	17-54068	780780	c	TPHCWG (Soil)	L088/76-PL	c
BH05	5	S	17-54068	780780	c	Total cyanide in soil	L080-PL	c
BH05	5	S	17-54068	780780	c	Volatile organic compounds in soil	L073B-PL	c
BH05	7	S	17-54068	780781	c	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	c
BH05	7	S	17-54068	780781	c	Monohydric phenols in soil	L080-PL	c
BH05	7	S	17-54068	780781	c	Semi-volatile organic compounds in soil	L064-PL	c
BH05	7	S	17-54068	780781	c	TPHCWG (Soil)	L088/76-PL	c
BH05	7	S	17-54068	780781	c	Total cyanide in soil	L080-PL	c
BH05	7	S	17-54068	780781	c	Volatile organic compounds in soil	L073B-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

Peter Woolley
Geotechnical Engineering Ltd
Centurion House
Olympus Park
Quedgeley
Gloucester
GL2 4NF

t: 01452 527 743
f: 01452 729 314
e: peter.woolley@geoeng.co.uk

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 17-53915

Replaces Analytical Report Number : 17-53915, issue no. 1

Project / Site name:	Project Blue	**Samples received on:**	07/07/2017
Your job number:	33138	**Samples instructed on:**	10/07/2017
Your order number:	33138-PW	**Analysis completed by:**	22/09/2017
Report Issue Number:	2	**Report issued on:**	22/09/2017
Samples Analysed:	3 water samples		

Signed: _____

Emma Winter
Assistant Reporting Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 17-53915

Project / Site name: Project Blue

Your Order No: 33138-PW

Lab Sample Number				779720	779721	779722		
Sample Reference				BH04	BH02	BH05		
Sample Number				7	10	10		
Depth (m)				2.22-5.84	1.65-6.17	2.09-4.85		
Date Sampled				07/07/2017	07/07/2017	07/07/2017		
Time Taken				1110	1205	1250		
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
General Inorganics								
pH	pH Units	N/A	ISO 17025	7.9	7.4	7.3		
Sulphate as SO_4	µg/l	45	ISO 17025	454000	723000	93400		
Total Sulphur	µg/l	15	NONE	150000	240000	31000		
Chloride	mg/l	0.15	ISO 17025	3300	4500	650		
Ammonium as NH_4	µg/l	15	ISO 17025	2300	2200	20000		
Nitrate as N	mg/l	0.01	ISO 17025	0.24	0.16	0.14		
Nitrate as NO_3	mg/l	0.05	ISO 17025	1.06	0.69	0.64		
Heavy Metals / Metalloids								
Magnesium (dissolved)	mg/l	0.005	ISO 17025	160	290	71		

U/S = Unsuitable Sample I/S = Insufficient Sample

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Analytical Report Number : 17-53915

Project / Site name: Project Blue

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Ammonium as NH4 in water	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method. Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	ISO 17025
Chloride in water	Determination of Chloride colorimetrically by discrete analyser.	In house based on MEWAM Method ISBN 0117516260. Accredited matrices: SW, PW, GW.	L082-PL	W	ISO 17025
Metals in water by ICP-OES (dissolved)	Determination of metals in water by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW, PrW.(Al, Cu,Fe,Zn).	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Nitrate as N in water	Determination of nitrate by reaction with sodium salicylate and colorimetry. Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08,	L078-PL	W	ISO 17025
Nitrate in water	Determination of nitrate by reaction with sodium salicylate and colorimetry. Accredited matrices SW, GW, PW	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08,	L078-PL	W	ISO 17025
pH at 20oC in water (automated)	Determination of pH in water followed by electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	W	ISO 17025
Sulphate in water	Determination of sulphate in water by acidification followed by ICP-OES. Accredited matrices: SW PW GW, PrW.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Total Sulphur in water	Determination of total sulphur in water by acidification followed by ICP-OES.	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L039-PL	W	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
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Perran Spear
Geotechnical Engineering Ltd
Centurion House
Olympus Park
Quedgeley
Gloucester
GL2 4NF

t: 01452 527 743
f: 01452 729 314
e: perran.spear@geoeng.co.uk

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 17-55162

Project / Site name:	Project Blue	**Samples received on:**	21/07/2017
Your job number:	33138	**Samples instructed on:**	24/07/2017
Your order number:	33138-PW	**Analysis completed by:**	27/07/2017
Report Issue Number:	1	**Report issued on:**	27/07/2017
Samples Analysed:	3 water samples		

Signed:

Rexona Rahman
Reporting Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Analytical Report Number: 17-55162

Project / Site name: Project Blue

Your Order No: 33138-PW

Lab Sample Number				787188	787189	787190		
Sample Reference				BH02	BH04	BH05		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				1.72	2.25	2.13		
Date Sampled				19/07/2017	19/07/2017	19/07/2017		
Time Taken				0930	1145	1320		
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
General Inorganics								
pH	pH Units	N/A	ISO 17025	7.3	7.6	7.3		
Sulphate as SO_4	µg/l	45	ISO 17025	594000	620000	60600		
Total Sulphur	µg/l	15	NONE	200000	210000	20000		
Chloride	mg/l	0.15	ISO 17025	190	200	470		
Ammonium as NH_4	µg/l	15	ISO 17025	1100	1100	23000		
Nitrate as N	mg/l	0.01	ISO 17025	0.26	0.32	0.29		
Nitrate as NO_3	mg/l	0.05	ISO 17025	1.17	1.43	1.27		
Heavy Metals / Metalloids								
Magnesium (dissolved)	mg/l	0.005	ISO 17025	250	220	62		

U/S = Unsuitable Sample I/S = Insufficient Sample

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 17-55162

Project / Site name: Project Blue

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Ammonium as NH4 in water	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method. Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	ISO 17025
Chloride in water	Determination of Chloride colorimetrically by discrete analyser.	In house based on MEWAM Method ISBN 0117516260. Accredited matrices: SW, PW, GW.	L082-PL	W	ISO 17025
Metals in water by ICP-OES (dissolved)	Determination of metals in water by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW, PrW.(Al, Cu,Fe,Zn).	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Nitrate as N in water	Determination of nitrate by reaction with sodium salicylate and colorimetry. Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08,	L078-PL	W	ISO 17025
Nitrate in water	Determination of nitrate by reaction with sodium salicylate and colorimetry. Accredited matrices SW, GW, PW	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08,	L078-PL	W	ISO 17025
pH at 20oC in water (automated)	Determination of pH in water followed by electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	W	ISO 17025
Sulphate in water	Determination of sulphate in water by acidification followed by ICP-OES. Accredited matrices: SW PW GW, PrW.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Total Sulphur in water	Determination of total sulphur in water by acidification followed by ICP-OES.	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L039-PL	W	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
BH02		W	17-55162	787188	c	Ammoniacal Nitrogen as N in water	L082-PL	c
BH02		W	17-55162	787188	c	Ammonium as NH4 in water	L082-PL	c
BH02		W	17-55162	787188	c	pH at 20oC in water (automated)	L099-PL	c
BH04		W	17-55162	787189	c	Ammoniacal Nitrogen as N in water	L082-PL	c
BH04		W	17-55162	787189	c	Ammonium as NH4 in water	L082-PL	c
BH04		W	17-55162	787189	c	pH at 20oC in water (automated)	L099-PL	c
BH05		W	17-55162	787190	c	Ammoniacal Nitrogen as N in water	L082-PL	c
BH05		W	17-55162	787190	c	Ammonium as NH4 in water	L082-PL	c
BH05		W	17-55162	787190	c	pH at 20oC in water (automated)	L099-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

Peter Woolley
Geotechnical Engineering Ltd
Centurion House
Olympus Park
Quedgeley
Gloucester
GL2 4NF

t: 01452 527 743
f: 01452 729 314
e: peter.woolley@geoeng.co.uk

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 17-54291

Project / Site name:	Project Blue	**Samples received on:**	13/07/2017
Your job number:	33138	**Samples instructed on:**	13/07/2017
Your order number:	33138-PW	**Analysis completed by:**	20/07/2017
Report Issue Number:	1	**Report issued on:**	20/07/2017
Samples Analysed:	1 soil sample		

Signed:

Dr Irma Doyle
Senior Account Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 17-54291

Project / Site name: Project Blue
Your Order No: 33138-PW

Lab Sample Number				782023				
Sample Reference				6				
Sample Number				1				
Depth (m)				None Supplied				
Date Sampled				Deviating				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1				
Moisture Content	%	N/A	NONE	44				
Total mass of sample received	kg	0.001	NONE	0.47				
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected				
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.2				
Total Cyanide	mg/kg	1	MCERTS	< 1				
Free Cyanide	mg/kg	1	MCERTS	< 1				
Total Sulphate as SO_4	mg/kg	50	MCERTS	5500				
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	5000				
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	2480				
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	13000				
Total Sulphur	mg/kg	50	MCERTS	7200				
Ammonium as NH_4	mg/kg	0.5	MCERTS	3.8				
Ammonium as NH_4 (leachate equivalent)	mg/l	0.05	MCERTS	0.4				
Organic Matter	%	0.1	MCERTS	4.2				
Water Soluble Nitrate (2:1) as NO_3	mg/kg	2	NONE	< 2.0				
Water Soluble Nitrate (2:1) as NO_3 (leachate equivalent)	mg/l	5	NONE	< 5.0				
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0				
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	31				
Boron (water soluble)	mg/kg	0.2	MCERTS	17				
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	1.1				
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	82				
Copper (aqua regia extractable)	mg/kg	1	MCERTS	140				
Lead (aqua regia extractable)	mg/kg	1	MCERTS	150				
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	2.1				
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	36				
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0				
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	440				
Magnesium (water soluble)	mg/kg	5	NONE	1100				
Magnesium (leachate equivalent)	mg/l	2.5	NONE	570				

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Analytical Report Number: 17-54291

Project / Site name: Project Blue
Your Order No: 33138-PW

Lab Sample Number				782023				
Sample Reference				6				
Sample Number				1				
Depth (m)				None Supplied				
Date Sampled				Deviating				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0				
Toluene	µg/kg	1	MCERTS	< 1.0				
Ethylbenzene	µg/kg	1	MCERTS	< 1.0				
p & m-xylene	µg/kg	1	MCERTS	< 1.0				
o-xylene	µg/kg	1	MCERTS	< 1.0				
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0				
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0				
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	24				
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	86				
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	270				
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	380				
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0				
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	22				
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	140				
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	540				
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	710				

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Analytical Report Number: 17-54291

Project / Site name: Project Blue
Your Order No: 33138-PW

Lab Sample Number				782023				
Sample Reference				6				
Sample Number				1				
Depth (m)				None Supplied				
Date Sampled				Deviating				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	< 1.0				
Chloroethane	µg/kg	1	NONE	< 1.0				
Bromomethane	µg/kg	1	ISO 17025	< 1.0				
Vinyl Chloride	µg/kg	1	NONE	< 1.0				
Trichlorofluoromethane	µg/kg	1	NONE	< 1.0				
1,1-Dichloroethene	µg/kg	1	NONE	< 1.0				
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	< 1.0				
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	< 1.0				
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0				
1,1-Dichloroethane	µg/kg	1	MCERTS	< 1.0				
2,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0				
Trichloromethane	µg/kg	1	MCERTS	< 1.0				
1,1,1-Trichloroethane	µg/kg	1	MCERTS	< 1.0				
1,2-Dichloroethane	µg/kg	1	MCERTS	< 1.0				
1,1-Dichloropropene	µg/kg	1	MCERTS	< 1.0				
Trans-1,2-dichloroethene	µg/kg	1	NONE	< 1.0				
Benzene	µg/kg	1	MCERTS	< 1.0				
Tetrachloromethane	µg/kg	1	MCERTS	< 1.0				
1,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0				
Trichloroethene	µg/kg	1	MCERTS	< 1.0				
Dibromomethane	µg/kg	1	MCERTS	< 1.0				
Bromodichloromethane	µg/kg	1	MCERTS	< 1.0				
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0				
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0				
Toluene	µg/kg	1	MCERTS	< 1.0				
1,1,2-Trichloroethane	µg/kg	1	MCERTS	< 1.0				
1,3-Dichloropropane	µg/kg	1	ISO 17025	< 1.0				
Dibromochloromethane	µg/kg	1	ISO 17025	< 1.0				
Tetrachloroethene	µg/kg	1	NONE	< 1.0				
1,2-Dibromoethane	µg/kg	1	ISO 17025	< 1.0				
Chlorobenzene	µg/kg	1	MCERTS	< 1.0				
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0				
Ethylbenzene	µg/kg	1	MCERTS	< 1.0				
p & m-Xylene	µg/kg	1	MCERTS	< 1.0				
Styrene	µg/kg	1	MCERTS	< 1.0				
Tribromomethane	µg/kg	1	NONE	< 1.0				
o-Xylene	µg/kg	1	MCERTS	< 1.0				
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0				
Isopropylbenzene	µg/kg	1	MCERTS	< 1.0				
Bromobenzene	µg/kg	1	MCERTS	< 1.0				
n-Propylbenzene	µg/kg	1	ISO 17025	< 1.0				
2-Chlorotoluene	µg/kg	1	MCERTS	< 1.0				
4-Chlorotoluene	µg/kg	1	MCERTS	< 1.0				
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0				
tert-Butylbenzene	µg/kg	1	MCERTS	< 1.0				
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0				
sec-Butylbenzene	µg/kg	1	MCERTS	< 1.0				
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	< 1.0				
p-Isopropyltoluene	µg/kg	1	ISO 17025	< 1.0				
1,2-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0				
1,4-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0				
Butylbenzene	µg/kg	1	MCERTS	< 1.0				
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	< 1.0				
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	< 1.0				
Hexachlorobutadiene	µg/kg	1	MCERTS	< 1.0				
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	< 1.0				

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Analytical Report Number: 17-54291

Project / Site name: Project Blue
Your Order No: 33138-PW

Lab Sample Number				782023				
Sample Reference				6				
Sample Number				1				
Depth (m)				None Supplied				
Date Sampled				Deviating				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	< 0.1				
Phenol	mg/kg	0.2	ISO 17025	< 0.2				
2-Chlorophenol	mg/kg	0.1	MCERTS	< 0.1				
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	< 0.2				
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2				
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	< 0.1				
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2				
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	< 0.1				
2-Methylphenol	mg/kg	0.3	MCERTS	< 0.3				
Hexachloroethane	mg/kg	0.05	MCERTS	< 0.05				
Nitrobenzene	mg/kg	0.3	MCERTS	< 0.3				
4-Methylphenol	mg/kg	0.2	NONE	< 0.2				
Isophorone	mg/kg	0.2	MCERTS	< 0.2				
2-Nitrophenol	mg/kg	0.3	MCERTS	< 0.3				
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	< 0.3				
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	< 0.3				
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	< 0.3				
Naphthalene	mg/kg	0.05	MCERTS	0.17				
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	< 0.3				
4-Chloroaniline	mg/kg	0.1	NONE	< 0.1				
Hexachlorobutadiene	mg/kg	0.1	MCERTS	< 0.1				
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	< 0.1				
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	< 0.1				
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	< 0.2				
2-Methylnaphthalene	mg/kg	0.1	NONE	< 0.1				
2-Chloronaphthalene	mg/kg	0.1	MCERTS	< 0.1				
Dimethylphthalate	mg/kg	0.1	MCERTS	< 0.1				
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	< 0.1				
Acenaphthylene	mg/kg	0.05	MCERTS	0.24				
Acenaphthene	mg/kg	0.05	MCERTS	0.14				
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	< 0.2				
Dibenzofuran	mg/kg	0.2	MCERTS	< 0.2				
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	< 0.3				
Diethyl phthalate	mg/kg	0.2	MCERTS	< 0.2				
4-Nitroaniline	mg/kg	0.2	MCERTS	< 0.2				
Fluorene	mg/kg	0.05	MCERTS	0.29				
Azobenzene	mg/kg	0.3	MCERTS	< 0.3				
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	< 0.2				
Hexachlorobenzene	mg/kg	0.3	MCERTS	< 0.3				
Phenanthrene	mg/kg	0.05	MCERTS	0.62				
Anthracene	mg/kg	0.05	MCERTS	0.33				
Carbazole	mg/kg	0.3	MCERTS	< 0.3				
Dibutyl phthalate	mg/kg	0.2	MCERTS	< 0.2				
Anthraquinone	mg/kg	0.3	MCERTS	< 0.3				
Fluoranthene	mg/kg	0.05	MCERTS	1.2				
Pyrene	mg/kg	0.05	MCERTS	1.6				
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	< 0.3				
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.85				
Chrysene	mg/kg	0.05	MCERTS	0.81				
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	1.6				
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.62				
Benzo(a)pyrene	mg/kg	0.05	MCERTS	1.4				
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.77				
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.84				

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Analytical Report Number: 17-54291

Project / Site name: Project Blue
Your Order No: 33138-PW

Lab Sample Number				782023				
Sample Reference				6				
Sample Number				1				
Depth (m)				None Supplied				
Date Sampled				Deviating				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Organotins								
Tributyl Tin	µg/kg	10	NONE	< 10				
Dibutyl Tin	µg/kg	10	NONE	U/S**				
Tetrabutyl Tin	µg/kg	10	NONE	U/S**				
Triphenyl Tin	µg/kg	10	NONE	< 10				
Environmental Forensics								
Glycols								
Ethylene Glycol	mg/kg	10	NONE	< 10				
Triethylene Glycol	mg/kg	10	NONE	U/S				
1,2-Propanediol	mg/kg	10	NONE	< 10				
1,3-Propanediol	mg/kg	10	NONE	< 10				
1,2-Butanediol	mg/kg	10	NONE	< 10				
1,3-Butanediol	mg/kg	10	NONE	< 10				
1,4-Butanediol	mg/kg	10	NONE	< 10				
1,5-Pentanediol	mg/kg	10	NONE	< 10				

**Unsuitable due to matrix interferance.

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Analytical Report Number : 17-54291

Project / Site name: Project Blue

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
782023	6	1	None Supplied	Brown clay.

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Analytical Report Number : 17-54291

Project / Site name: Project Blue

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Ammonium as NH4 in soil	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method, 10:1 water extraction.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	MCERTS
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests. 2:1 extraction.	L082-PL	D	MCERTS
EF - Organotins by GC-MS/MS in soil	Organotins by GC-MS/MS	In-house method	UK	W	NONE
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Magnesium, water soluble, in soil	Determination of water soluble magnesium by extraction with water followed by ICP-OES.	In-house method based on TRL 447	L038-PL	D	NONE
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Nitrate, water soluble, in soil	Determination of nitrate by reaction with sodium salicylate and colorimetry.	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08, 2:1 extraction.	L078-PL	D	NONE
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds in soil by extraction in dichloromethane and hexane followed by GC-MS.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil by Gallery 16hr	Determination of water soluble Sulphate by discrete analyser (precipitation method).	In house method based on BS1377-3: 1990.	L082B-PL	D	MCERTS

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Analytical Report Number : 17-54291

Project / Site name: Project Blue

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
TO - Glycols in Soil	Determination of glycols by GC-MS.	In-house method		W	NONE
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, and MEWAM 2006 Methods for the Determination of Metals in Soil	L038-PL	D	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method	L088/76-PL	W	MCERTS
Volatile organic compounds in soil	Determination of volatile organic compounds in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
6	1	S	17-54291	782023	a			

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

Peter Woolley
Geotechnical Engineering Ltd
Centurion House
Olympus Park
Quedgeley
Gloucester
GL2 4NF

t: 01452 527 743
f: 01452 729 314
e: peter.woolley@geoeng.co.uk

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 17-54285

Project / Site name:	Project Blue	**Samples received on:**	12/07/2017
Your job number:	33138	**Samples instructed on:**	12/07/2017
Your order number:	33138-PW	**Analysis completed by:**	19/07/2017
Report Issue Number:	1	**Report issued on:**	19/07/2017
Samples Analysed:	2 soil samples		

Signed:

Dr Irma Doyle
Senior Account Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 17-54285

Project / Site name: Project Blue
Your Order No: 33138-PW

Lab Sample Number				781972	781973			
Sample Reference				1	3			
Sample Number				1	1			
Depth (m)				None Supplied	None Supplied			
Date Sampled				Deviating	Deviating			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1			
Moisture Content	%	N/A	NONE	57	50			
Total mass of sample received	kg	0.001	NONE	0.48	0.50			
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected			
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.9	8.2			
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1			
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1			
Total Sulphate as SO_4	mg/kg	50	MCERTS	3900	3700			
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	3300	3400			
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	1630	1680			
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	11000	5700			
Total Sulphur	mg/kg	50	MCERTS	3600	3000			
Ammonium as NH_4	mg/kg	0.5	MCERTS	35	19			
Ammonium as NH_4 (leachate equivalent)	mg/l	0.05	MCERTS	3.5	1.9			
Organic Matter	%	0.1	MCERTS	3.6	3.3			
Water Soluble Nitrate (2:1) as NO_3	mg/kg	2	NONE	4.9	5.7			
Water Soluble Nitrate (2:1) as NO_3 (leachate equivalent)	mg/l	5	NONE	< 5.0	< 5.0			
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0			
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	19	15			
Boron (water soluble)	mg/kg	0.2	MCERTS	17	18			
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	55	44			
Copper (aqua regia extractable)	mg/kg	1	MCERTS	100	99			
Lead (aqua regia extractable)	mg/kg	1	MCERTS	87	100			
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	1.0	0.9			
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	26	25			
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0			
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	250	220			
Magnesium (water soluble)	mg/kg	5	NONE	1300	1100			
Magnesium (leachate equivalent)	mg/l	2.5	NONE	650	570			

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Project / Site name: Project Blue
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Lab Sample Number				781972	781973			
Sample Reference				1	3			
Sample Number				1	1			
Depth (m)				None Supplied	None Supplied			
Date Sampled				Deviating	Deviating			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0	< 1.0			
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0			
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0			
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0			
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0			

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001			
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001			
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001			
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0			
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	2.9	7.1			
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	27	34			
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	130	160			
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	160	200			

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001			
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001			
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001			
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0			
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0			
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	16	11			
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	86	74			
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	100	85			

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Project / Site name: Project Blue
Your Order No: 33138-PW

Lab Sample Number				781972	781973			
Sample Reference				1	3			
Sample Number				1	1			
Depth (m)				None Supplied	None Supplied			
Date Sampled				Deviating	Deviating			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
VOCs								
Chloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0			
Chloroethane	µg/kg	1	NONE	< 1.0	< 1.0			
Bromomethane	µg/kg	1	ISO 17025	< 1.0	< 1.0			
Vinyl Chloride	µg/kg	1	NONE	< 1.0	< 1.0			
Trichlorofluoromethane	µg/kg	1	NONE	< 1.0	< 1.0			
1,1-Dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0			
1,1,2-Trichloro 1,2,2-Trifluoroethane	µg/kg	1	ISO 17025	< 1.0	< 1.0			
Cis-1,2-dichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0			
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,1-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0			
2,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0			
Trichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,1,1-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,2-Dichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,1-Dichloropropene	µg/kg	1	MCERTS	< 1.0	< 1.0			
Trans-1,2-dichloroethene	µg/kg	1	NONE	< 1.0	< 1.0			
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
Tetrachloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,2-Dichloropropane	µg/kg	1	MCERTS	< 1.0	< 1.0			
Trichloroethene	µg/kg	1	MCERTS	< 1.0	< 1.0			
Dibromomethane	µg/kg	1	MCERTS	< 1.0	< 1.0			
Bromodichloromethane	µg/kg	1	MCERTS	< 1.0	< 1.0			
Cis-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0			
Trans-1,3-dichloropropene	µg/kg	1	ISO 17025	< 1.0	< 1.0			
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,1,2-Trichloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,3-Dichloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0			
Dibromochloromethane	µg/kg	1	ISO 17025	< 1.0	< 1.0			
Tetrachloroethene	µg/kg	1	NONE	< 1.0	< 1.0			
1,2-Dibromoethane	µg/kg	1	ISO 17025	< 1.0	< 1.0			
Chlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,1,1,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0			
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
p & m-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0			
Styrene	µg/kg	1	MCERTS	< 1.0	< 1.0			
Tribromomethane	µg/kg	1	NONE	< 1.0	< 1.0			
o-Xylene	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,1,2,2-Tetrachloroethane	µg/kg	1	MCERTS	< 1.0	< 1.0			
Isopropylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
Bromobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
n-Propylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0			
2-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0			
4-Chlorotoluene	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,3,5-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0			
tert-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,2,4-Trimethylbenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0			
sec-Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,3-Dichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0			
p-Isopropyltoluene	µg/kg	1	ISO 17025	< 1.0	< 1.0			
1,2-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,4-Dichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
Butylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,2-Dibromo-3-chloropropane	µg/kg	1	ISO 17025	< 1.0	< 1.0			
1,2,4-Trichlorobenzene	µg/kg	1	MCERTS	< 1.0	< 1.0			
Hexachlorobutadiene	µg/kg	1	MCERTS	< 1.0	< 1.0			
1,2,3-Trichlorobenzene	µg/kg	1	ISO 17025	< 1.0	< 1.0			

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Analytical Report Number: 17-54285

Project / Site name: Project Blue
Your Order No: 33138-PW

Lab Sample Number				781972	781973			
Sample Reference				1	3			
Sample Number				1	1			
Depth (m)				None Supplied	None Supplied			
Date Sampled				Deviating	Deviating			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
SVOCs								
Aniline	mg/kg	0.1	NONE	< 0.1	< 0.1			
Phenol	mg/kg	0.2	ISO 17025	< 0.2	< 0.2			
2-Chlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1			
Bis(2-chloroethyl)ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
1,3-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
1,2-Dichlorobenzene	mg/kg	0.1	MCERTS	< 0.1	< 0.1			
1,4-Dichlorobenzene	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
Bis(2-chloroisopropyl)ether	mg/kg	0.1	MCERTS	< 0.1	< 0.1			
2-Methylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3			
Hexachloroethane	mg/kg	0.05	MCERTS	< 0.05	< 0.05			
Nitrobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3			
4-Methylphenol	mg/kg	0.2	NONE	< 0.2	< 0.2			
Isophorone	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
2-Nitrophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3			
2,4-Dimethylphenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3			
Bis(2-chloroethoxy)methane	mg/kg	0.3	MCERTS	< 0.3	< 0.3			
1,2,4-Trichlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3			
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05			
2,4-Dichlorophenol	mg/kg	0.3	MCERTS	< 0.3	< 0.3			
4-Chloroaniline	mg/kg	0.1	NONE	< 0.1	< 0.1			
Hexachlorobutadiene	mg/kg	0.1	MCERTS	< 0.1	< 0.1			
4-Chloro-3-methylphenol	mg/kg	0.1	NONE	< 0.1	< 0.1			
2,4,6-Trichlorophenol	mg/kg	0.1	MCERTS	< 0.1	< 0.1			
2,4,5-Trichlorophenol	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
2-Methylnaphthalene	mg/kg	0.1	NONE	< 0.1	< 0.1			
2-Chloronaphthalene	mg/kg	0.1	MCERTS	< 0.1	< 0.1			
Dimethylphthalate	mg/kg	0.1	MCERTS	< 0.1	< 0.1			
2,6-Dinitrotoluene	mg/kg	0.1	MCERTS	< 0.1	< 0.1			
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05			
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05			
2,4-Dinitrotoluene	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
Dibenzofuran	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
4-Chlorophenyl phenyl ether	mg/kg	0.3	ISO 17025	< 0.3	< 0.3			
Diethyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
4-Nitroaniline	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05			
Azobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3			
Bromophenyl phenyl ether	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
Hexachlorobenzene	mg/kg	0.3	MCERTS	< 0.3	< 0.3			
Phenanthrene	mg/kg	0.05	MCERTS	0.19	0.23			
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05			
Carbazole	mg/kg	0.3	MCERTS	< 0.3	< 0.3			
Dibutyl phthalate	mg/kg	0.2	MCERTS	< 0.2	< 0.2			
Anthraquinone	mg/kg	0.3	MCERTS	< 0.3	< 0.3			
Fluoranthene	mg/kg	0.05	MCERTS	0.39	0.48			
Pyrene	mg/kg	0.05	MCERTS	0.46	0.54			
Butyl benzyl phthalate	mg/kg	0.3	ISO 17025	< 0.3	< 0.3			
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.23	0.32			
Chrysene	mg/kg	0.05	MCERTS	0.28	0.30			
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	0.52	0.64			
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.29	0.30			
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.41	0.48			
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.28	0.29			
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05			
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.33	0.33			

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Analytical Report Number: 17-54285

Project / Site name: Project Blue
Your Order No: 33138-PW

Lab Sample Number				781972	781973			
Sample Reference				1	3			
Sample Number				1	1			
Depth (m)				None Supplied	None Supplied			
Date Sampled				Deviating	Deviating			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Organotins								
Tributyl Tin	µg/kg	10	NONE	< 10	16			
Dibutyl Tin	µg/kg	10	NONE	U/S**	U/S**			
Triphenyl Tin	µg/kg	10	NONE	< 10	< 10			
Environmental Forensics								
Glycols								
Ethylene Glycol	mg/kg	10	NONE	< 10	< 10			
Triethylene Glycol	mg/kg	10	NONE	< 10	< 10			
1,2-Propanediol	mg/kg	10	NONE	< 10	< 10			
1,3-Propanediol	mg/kg	10	NONE	< 10	< 10			
1,2-Butanediol	mg/kg	10	NONE	< 10	< 10			
1,3-Butanediol	mg/kg	10	NONE	< 10	< 10			
1,4-Butanediol	mg/kg	10	NONE	< 10	< 10			
1,5-Pentanediol	mg/kg	10	NONE	< 10	< 10			

**Unsuitable due to matrix interferance.

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Analytical Report Number : 17-54285

Project / Site name: Project Blue

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
781972	1	1	None Supplied	Brown clay.
781973	3	1	None Supplied	Brown clay.

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Analytical Report Number : 17-54285

Project / Site name: Project Blue

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Ammonium as NH4 in soil	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method, 10:1 water extraction.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	MCERTS
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests. 2:1 extraction.	L082-PL	D	MCERTS
EF - Organotins by GC-MS/MS in soil	Organotins by GC-MS/MS	In-house method	UK	W	NONE
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Magnesium, water soluble, in soil	Determination of water soluble magnesium by extraction with water followed by ICP-OES.	In-house method based on TRL 447	L038-PL	D	NONE
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Nitrate, water soluble, in soil	Determination of nitrate by reaction with sodium salicylate and colorimetry.	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08, 2:1 extraction.	L078-PL	D	NONE
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds in soil by extraction in dichloromethane and hexane followed by GC-MS.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil by Gallery 16hr	Determination of water soluble Sulphate by discrete analyser (precipitation method).	In house method based on BS1377-3: 1990.	L082B-PL	D	MCERTS

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Analytical Report Number : 17-54285

Project / Site name: Project Blue

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
TO - Glycols in Soil	Determination of glycols by GC-MS.	In-house method		W	NONE
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Total sulphate (as SO4 in soil)	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L038-PL	D	MCERTS
Total Sulphur in soil	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, and MEWAM 2006 Methods for the Determination of Metals in Soil	L038-PL	D	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method	L088/76-PL	W	MCERTS
Volatile organic compounds in soil	Determination of volatile organic compounds in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
1	1	S	17-54285	781972	a			
3	1	S	17-54285	781973	a			

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

Perran Spear
Geotechnical Engineering Ltd
Centurion House
Olympus Park
Quedgeley
Gloucester
GL2 4NF

t: 01452 527 743
f: 01452 729 314
e: perran.spear@geoeng.co.uk

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 17-54069

Project / Site name:	Project Blue	**Samples received on:**	22/06/2017
Your job number:	33138	**Samples instructed on:**	11/07/2017
Your order number:		**Analysis completed by:**	17/07/2017
Report Issue Number:	1	**Report issued on:**	17/07/2017
Samples Analysed:	4 wac multi samples		

Signed:

Rexona Rahman
Reporting Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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i2 Analytical
7 Woodshots Meadow
Croxley Green Business Park
Watford, WD18 8YS

Telephone: 01923 225404
Fax: 01923 237404
email:reception@i2analytical.com

Waste Acceptance Criteria Analytical Results

Report No:	**17-54069**						
					Client: GEOENG		
Location	**Project Blue**						
Lab Reference (Sample Number)	780782				**Landfill Waste Acceptance Criteria Limits**		
Sampling Date	19/06/2017				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID	BH01 1						
Depth (m)	0.20-0.50						
Solid Waste Analysis							
TOC (%)**	0.9				3%	5%	6%
Loss on Ignition (%) **	5.8				--	--	10%
BTEX (µg/kg) **	< 10				6000	--	--
Sum of PCBs (mg/kg) **	< 0.30				1	--	--
Mineral Oil (mg/kg) #	110				500	--	--
Total PAH (WAC-17) (mg/kg)	30				100	--	--
pH (units)**	9.0				--	>6	--
Acid Neutralisation Capacity (mol / kg)	6.4				--	To be evaluated	To be evaluated
Eluate Analysis (BS EN 12457 - 3 preparation utilising end over end leaching procedure)	2:1	8:1		Cumulative 10:1	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)		
	mg/l	mg/l		mg/kg			
Arsenic *	0.018	< 0.010		0.090	0.5	2	25
Barium *	0.031	0.0089		0.12	20	100	300
Cadmium *	< 0.0005	< 0.0005		< 0.0020	0.04	1	5
Chromium *	0.011	0.0057		0.062	0.5	10	70
Copper *	0.040	0.019		0.21	2	50	100
Mercury *	< 0.0015	< 0.0015		< 0.010	0.01	0.2	2
Molybdenum *	< 0.0030	< 0.0030		< 0.020	0.5	10	30
Nickel *	0.0040	0.0019		0.022	0.4	10	40
Lead *	0.18	0.049		0.64	0.5	10	50
Antimony *	0.016	0.0053		0.066	0.06	0.7	5
Selenium *	< 0.010	< 0.010		0.045	0.1	0.5	7
Zinc *	0.035	0.0104		0.13	4	50	200
Chloride *	100	11		220	800	4000	25000
Fluoride	0.61	0.26		3.0	10	150	500
Sulphate *	46	7.8		120	1000	20000	50000
TDS	410	100		1400	4000	60000	100000
Phenol Index (Monhydric Phenols) *	< 0.13	< 0.13		< 0.50	1	-	-
DOC	15	5.9		70	500	800	1000
Leach Test Information							
Stone Content (%)	< 0.1						
Sample Mass (kg)	2.0						
Dry Matter (%)	93						
Moisture (%)	6.6						
Stage 1							
Volume Eluate L2 (litres)	0.33						
Filtered Eluate VE1 (litres)	0.21						

Results are expressed on a dry weight basis, after correction for moisture content where applicable.

*= UKAS accredited (liquid eluate analysis only)

Stated limits are for guidance only and i2 cannot be held responsible for any discrepencies with current legislation

** = MCERTS accrediited

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes as defined by the Waste (England and Wales) Regulations 2011 (as amended) and EA Guidance WM3.
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i2 Analytical
7 Woodshots Meadow
Croxley Green Business Park
Watford, WD18 8YS

Telephone: 01923 225404
Fax: 01923 237404
email:reception@i2analytical.com

Waste Acceptance Criteria Analytical Results

Report No:	**17-54069**						
					Client: GEOENG		
Location	**Project Blue**						
Lab Reference (Sample Number)	780783				**Landfill Waste Acceptance Criteria Limits**		
Sampling Date	14/06/2017				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID	BH02 4						
Depth (m)	2.00						
Solid Waste Analysis							
TOC (%)**	< 0.1				3%	5%	6%
Loss on Ignition (%) **	1.5				--	--	10%
BTEX (µg/kg) **	< 10				6000	--	--
Sum of PCBs (mg/kg) **	< 0.30				1	--	--
Mineral Oil (mg/kg) #	< 10				500	--	--
Total PAH (WAC-17) (mg/kg)	1.8				100	--	--
pH (units)**	8.8				--	>6	--
Acid Neutralisation Capacity (mol / kg)	7.2				--	To be evaluated	To be evaluated
Eluate Analysis	2:1	8:1		Cumulative 10:1	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)		
(BS EN 12457 - 3 preparation utilising end over end leaching procedure)	mg/l	mg/l		mg/kg			
Arsenic *	0.018	0.018		0.18	0.5	2	25
Barium *	0.040	0.0067		0.099	20	100	300
Cadmium *	< 0.0005	< 0.0005		< 0.0020	0.04	1	5
Chromium *	< 0.0010	< 0.0010		< 0.0050	0.5	10	70
Copper *	0.023	0.014		0.15	2	50	100
Mercury *	< 0.0015	< 0.0015		< 0.010	0.01	0.2	2
Molybdenum *	< 0.0030	< 0.0030		< 0.020	0.5	10	30
Nickel *	0.0018	0.0013		0.014	0.4	10	40
Lead *	< 0.0050	< 0.0050		< 0.020	0.5	10	50
Antimony *	< 0.0050	< 0.0050		0.021	0.06	0.7	5
Selenium *	< 0.010	< 0.010		< 0.040	0.1	0.5	7
Zinc *	0.0032	0.0013		< 0.020	4	50	200
Chloride *	250	28		490	800	4000	25000
Fluoride	0.61	0.13		1.8	10	150	500
Sulphate *	33	4.7		75	1000	20000	50000
TDS	600	110		1600	4000	60000	100000
Phenol Index (Monhydric Phenols) *	< 0.13	< 0.13		< 0.50	1	-	-
DOC	9.8	4.7		52	500	800	1000
Leach Test Information							
Stone Content (%)	< 0.1						
Sample Mass (kg)	2.0						
Dry Matter (%)	80						
Moisture (%)	20						
Stage 1							
Volume Eluate L2 (litres)	0.30						
Filtered Eluate VE1 (litres)	0.17						

Results are expressed on a dry weight basis, after correction for moisture content where applicable. *= UKAS accredited (liquid eluate analysis only)

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i2 Analytical
7 Woodshots Meadow
Croxley Green Business Park
Watford, WD18 8YS

Telephone: 01923 225404
Fax: 01923 237404
email:reception@i2analytical.com

Waste Acceptance Criteria Analytical Results

Report No:	**17-54069**						
					Client:	**GEOENG**	
Location	**Project Blue**						
Lab Reference (Sample Number)	780784				**Landfill Waste Acceptance Criteria Limits**		
Sampling Date	13/06/2017				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID	BH04 3						
Depth (m)	2.00						
Solid Waste Analysis							
TOC (%)**	2.6				3%	5%	6%
Loss on Ignition (%) **	7.9				--	--	10%
BTEX (µg/kg) **	< 10				6000	--	--
Sum of PCBs (mg/kg) **	< 0.30				1	--	--
Mineral Oil (mg/kg) #	200				500	--	--
Total PAH (WAC-17) (mg/kg)	4100				100	--	--
pH (units)**	8.1				--	>6	--
Acid Neutralisation Capacity (mol / kg)	6.4				--	To be evaluated	To be evaluated
Eluate Analysis	2:1	8:1		Cumulative 10:1	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)		
(BS EN 12457 - 3 preparation utilising end over end leaching procedure)	mg/l	mg/l		mg/kg			
Arsenic *	< 0.010	< 0.010		< 0.050	0.5	2	25
Barium *	0.062	0.039		0.42	20	100	300
Cadmium *	< 0.0005	< 0.0005		< 0.0020	0.04	1	5
Chromium *	0.0039	0.0018		0.021	0.5	10	70
Copper *	0.022	0.014		0.15	2	50	100
Mercury *	< 0.0015	< 0.0015		< 0.010	0.01	0.2	2
Molybdenum *	0.012	< 0.0030		0.030	0.5	10	30
Nickel *	0.0021	0.0026		0.025	0.4	10	40
Lead *	0.0086	0.021		0.19	0.5	10	50
Antimony *	< 0.0050	< 0.0050		0.031	0.06	0.7	5
Selenium *	< 0.010	< 0.010		< 0.040	0.1	0.5	7
Zinc *	0.015	0.0171		0.17	4	50	200
Chloride *	150	9.4		290	800	4000	25000
Fluoride	0.85	0.30		3.8	10	150	500
Sulphate *	46	7.1		130	1000	20000	50000
TDS	410	75		1200	4000	60000	100000
Phenol Index (Monhydric Phenols) *	< 0.13	< 0.13		< 0.50	1	-	-
DOC	13	7.2		80	500	800	1000
Leach Test Information							
Stone Content (%)	< 0.1						
Sample Mass (kg)	1.8						
Dry Matter (%)	93						
Moisture (%)	7.1						
Stage 1							
Volume Eluate L2 (litres)	0.29						
Filtered Eluate VE1 (litres)	0.25						

Results are expressed on a dry weight basis, after correction for moisture content where applicable.

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i2 Analytical
7 Woodshots Meadow
Croxley Green Business Park
Watford, WD18 8YS

Telephone: 01923 225404
Fax: 01923 237404
email:reception@i2analytical.com

Waste Acceptance Criteria Analytical Results

Report No:	**17-54069**						
					Client:	**GEOENG**	
Location	**Project Blue**						
Lab Reference (Sample Number)	780785				**Landfill Waste Acceptance Criteria Limits**		
Sampling Date	21/06/2017				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID	BH05 1						
Depth (m)	0.50						
Solid Waste Analysis							
TOC (%)**	0.4				3%	5%	6%
Loss on Ignition (%) **	3.8				--	--	10%
BTEX (µg/kg) **	< 10				6000	--	--
Sum of PCBs (mg/kg) **	< 0.30				1	--	--
Mineral Oil (mg/kg) #	< 10				500	--	--
Total PAH (WAC-17) (mg/kg)	2.7				100	--	--
pH (units)**	8.0				--	>6	--
Acid Neutralisation Capacity (mol / kg)	14				--	To be evaluated	To be evaluated
Eluate Analysis (BS EN 12457 - 3 preparation utilising end over end leaching procedure)	2:1	8:1		Cumulative 10:1	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)		
	mg/l	mg/l		mg/kg			
Arsenic *	< 0.010	< 0.010		0.079	0.5	2	25
Barium *	0.088	0.016		0.26	20	100	300
Cadmium *	< 0.0005	< 0.0005		< 0.0020	0.04	1	5
Chromium *	< 0.0010	< 0.0010		0.0058	0.5	10	70
Copper *	0.015	0.0084		0.094	2	50	100
Mercury *	< 0.0015	< 0.0015		< 0.010	0.01	0.2	2
Molybdenum *	0.013	< 0.0030		0.041	0.5	10	30
Nickel *	< 0.0010	0.0013		0.012	0.4	10	40
Lead *	< 0.0050	< 0.0050		< 0.020	0.5	10	50
Antimony *	< 0.0050	< 0.0050		< 0.020	0.06	0.7	5
Selenium *	< 0.010	< 0.010		< 0.040	0.1	0.5	7
Zinc *	0.011	0.0022		0.035	4	50	200
Chloride *	690	50		1400	800	4000	25000
Fluoride	0.87	0.27		3.5	10	150	500
Sulphate *	110	9.8		240	1000	20000	50000
TDS	1500	150		3400	4000	60000	100000
Phenol Index (Monhydric Phenols) *	< 0.13	< 0.13		< 0.50	1	-	-
DOC	6.1	5.5		56	500	800	1000
Leach Test Information							
Stone Content (%)	< 0.1						
Sample Mass (kg)	2.0						
Dry Matter (%)	83						
Moisture (%)	17						
Stage 1							
Volume Eluate L2 (litres)	0.30						
Filtered Eluate VE1 (litres)	0.25						

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Analytical Report Number : 17-54069

Project / Site name: Project Blue

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
780782	BH01	1	0.20-0.50	Brown sand with gravel.
780783	BH02	4	2.00	Brown clay with gravel.
780784	BH04	3	2.00	Brown sand with brick.
780785	BH05	1	0.50	Brown sandy clay with gravel.

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Analytical Report Number : 17-54069

Project / Site name: Project Blue

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Acid neutralisation capacity of soil	Determination of acid neutralisation capacity by addition of acid or alkali followed by electronic probe.	In-house method based on Guidance an Sampling and Testing of Wastes to Meet Landfill Waste Acceptance	L046-PL	W	NONE
BTEX (Sum of BTEX compounds) in soil	Determination of BTEX in soil by headspace GC-MS. Individual components MCERTS accredited	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Chloride in WAC leachate (BS EN 12457-3 Prep)	Determination of Chloride colorimetrically by discrete analyser.	In house based on MEWAM Method ISBN 0117516260.	L082-PL	W	ISO 17025
DOC in WAC leachate (BS EN 12457-3 Prep)	Determination of dissolved organic carbon in leachate by TOC/DOC NDIR analyser.	In-house method based on Standard Methods for the Examination of Water and Waste Water, 21st Ed.	L037-PL	W	NONE
Fluoride in WAC leachate (BS EN 12457-3 Prep)	Determination of fluoride in leachate by 1:1ratio with a buffer solution followed by Ion Selective Electrode.	In-house method based on Standard Methods for the Examination of Water and Waste Water, 21st Ed.	L033-PL	W	NONE
Loss on ignition of soil @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L047-PL	D	MCERTS
Metals in WAC leachate (BS EN 12457-3 Prep)	Determination of metals in leachate by acidification followed by ICP-OES.	In-house method based on Standard Methods for the Examination of Water and Waste Water, 21st Ed.	L039-PL	W	ISO 17025
Mineral Oil in Soil C10 - C40	Determination of dichloromethane/hexane extractable hydrocarbons in soil by GC-MS.	In-house method based on USEPA 8270	L076-PL	D	NONE
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE

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Analytical Report Number : 17-54069

Project / Site name: Project Blue

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
PCB's by GC-MS in soil	Determination of PCB by extraction with acetone and hexane followed by GC-MS.	In-house method based on USEPA 8082	L027-PL	D	MCERTS
pH in soil	Determination of pH in soil by addition of water followed by electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L005-PL	W	MCERTS
Phenol Index in WAC leachate (BS EN 12457-3 Prep)	Determination of monohydric phenols in leachate by continuous flow analyser.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	ISO 17025
Speciated WAC-17 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate in WAC leachate (BS EN 12457-3 Prep)	Determination of sulphate in leachate by acidification followed by ICP-OES.	In-house method based on Standard Methods for the Examination of Water and Waste Water, 21st Ed.	L039-PL	W	ISO 17025
TDS in WAC leachate (BS EN 12457-3 Prep)	Determination of total dissolved solids in leachate by electrometric measurement.	In-house method based on Standard Methods for the Examination of Water and Waste Water, 21st Ed.	L031-PL	W	NONE
Total organic carbon in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L023-PL	D	MCERTS

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For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
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Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
BH01	1	M	17-54069	780782	c	BTEX (Sum of BTEX compounds) in soil	L073B-PL	c
BH01	1	M	17-54069	780782	c	BTEX in soil (Monoaromatics)	L073B-PL	c
BH01	1	M	17-54069	780782	c	Mineral Oil in Soil C10 - C40	L076-PL	c
BH01	1	M	17-54069	780782	c	Organic Matter (Raw data) in soil	L023-PL	c
BH01	1	M	17-54069	780782	c	PCB's by GC-MS in soil	L027-PL	c
BH01	1	M	17-54069	780782	c	Speciated WAC-17 PAHs in soil	L064-PL	c
BH02	4	M	17-54069	780783	c	BTEX (Sum of BTEX compounds) in soil	L073B-PL	c
BH02	4	M	17-54069	780783	c	BTEX in soil (Monoaromatics)	L073B-PL	c
BH02	4	M	17-54069	780783	c	Mineral Oil in Soil C10 - C40	L076-PL	c
BH02	4	M	17-54069	780783	c	Organic Matter (Raw data) in soil	L023-PL	c
BH02	4	M	17-54069	780783	c	PCB's by GC-MS in soil	L027-PL	c
BH02	4	M	17-54069	780783	c	Speciated WAC-17 PAHs in soil	L064-PL	c
BH04	3	M	17-54069	780784	c	BTEX (Sum of BTEX compounds) in soil	L073B-PL	c
BH04	3	M	17-54069	780784	c	BTEX in soil (Monoaromatics)	L073B-PL	c
BH04	3	M	17-54069	780784	c	Mineral Oil in Soil C10 - C40	L076-PL	c
BH04	3	M	17-54069	780784	c	Organic Matter (Raw data) in soil	L023-PL	c
BH04	3	M	17-54069	780784	c	PCB's by GC-MS in soil	L027-PL	c
BH04	3	M	17-54069	780784	c	Speciated WAC-17 PAHs in soil	L064-PL	c
BH05	1	M	17-54069	780785	c	BTEX (Sum of BTEX compounds) in soil	L073B-PL	c
BH05	1	M	17-54069	780785	c	BTEX in soil (Monoaromatics)	L073B-PL	c
BH05	1	M	17-54069	780785	c	Mineral Oil in Soil C10 - C40	L076-PL	c
BH05	1	M	17-54069	780785	c	Organic Matter (Raw data) in soil	L023-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

Project Blue: Phase 2 Ground Investigation

Factual Report on Ground Investigation

Project No: 764393

Client: Buro Happold Ltd

JUNE 2018

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Project No.:	764393
Report No.:	764393-1 (01)
Project Name:	Project Blue
Document Title	Factual Report on Ground Investigation
Client:	Buro Happold Ltd
Engineer:	Buro Happold Ltd
Status:	Final

Author		Alex Jones, BA (Hons), FGS
Technical Reviewer		Philip Rowlay, BSc (Hons), FGS
Approved by		John McCarthy, BSc (Hons)
Report Issue Date		04 June 2018

DOCUMENT ISSUE RECORD

REVISION RECORD

Revision	Date	Description of revisions	Prepared by
00	13/04/2018	Draft Factual Report	A Jones
01	04/06/2018	Final Factual Report	A Jones

STRUCTURAL SOILS LIMITED
The Potteries
Pottery Street
CASTLEFORD
West Yorkshire
WF10 1NJ

Tel: 01977 552255
Email: ask@soils.co.uk
www.soils.co.uk

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1 INTRODUCTION

This investigation was carried out by Structural Soils Ltd (SSL) on the instructions of Buro Happold Ltd (the Client and the Engineer) at Bramley-Moore Dock, Liverpool.

The purpose of the work was to obtain detailed geotechnical, geo-environmental and groundwater information in order to inform the design of a proposed new football stadium and associated infrastructure and also to resolve the geotechnical risks identified by a previous phase of ground investigation at the site.

The works included an intrusive investigation, laboratory testing and the preparation of this report, which contains a description of the site and the works carried out, the exploratory hole logs, in-situ and laboratory testing results.

The ground investigation has been carried out in accordance with the contract specification, and the general requirements of BS 5930:2015, BS 10175:2011+A1: 2013, BS EN 1997-2 (2007), BS EN ISO 22475-1 (2006) and their related standards.

Whilst every attempt is made to record full details of the strata encountered in the exploratory holes, techniques of hole formation and sampling will inevitably lead to disturbance, mixing or loss of material in some soils and rocks. All information given in this report is based on the ground conditions encountered during the site work, and on the results of laboratory and field tests performed during the investigation. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata, contaminant concentrations, and water conditions between or below exploratory holes.

This report was prepared by SSL for the sole and exclusive use of Buro Happold in response to particular instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded. No liability will be accepted after a period of 6 years from the date of the report.

2 SITE DESCRIPTION

2.1 Location and Topography

The proposed development site is within Bramley-Moore Dock, Liverpool, located adjacent to the River Mersey and forms part of the Port of Liverpool. The dock is centred on approximate Ordnance Survey National Grid Reference SJ 334 924 approximately 2.40 km north-west of Liverpool city centre. Bramley-Moore Dock forms a small part of a larger dock and canal network along the 7.8 km river frontage of Liverpool, from Albert Dock to the south of the Site to the Royal Seaforth Dock to the north.

The site measures approximately 300 m by 185 m with the long axis aligned east-west. The site is bound to the east by Regent Road (A5038) and to the west by the River Mersey. Adjacent to the south is Nelson dock and to the north is Sandon Half-tide Dock and Wellington Dock, which at the time of the investigation was occupied by a waste water treatment facility.

The site is currently a working dock used mainly for the import of aggregates and the mooring of tug boats. The open water within the dock occupies an area of 4 hectares. The northern and eastern dock walls are currently utilised by a sand supplier to stockpile sand and gravels dredged from the River Mersey. A workshop and warehouse is located at the western end of the northern wharf, and towards the eastern end is located a Grade II listed disused hydraulic engine house.

The southern wharf of the dock is occupied by a large warehouse structure, divided into three sections. The western section is unoccupied, the eastern section used as offices by a marine services company and the section in-between used as storage. Access to the dock is maintained by a path running east-west along the northern edge of the warehouse.

The western wharf of the dock is unoccupied except for two historical outhouse structures which are located on the wharf. Access to this wharf comprises a bridge from the western end of the southern wharf.

2.2 Geology

Information on the geology of the site was obtained from the following sources published by the British Geological Survey (BGS):

- BGS map (Sheet 96, Liverpool, 1:50,000 scale, Bedrock and Superficial edition, published 2006).
- The BGS digital geology map, which utilises the most up to date names for geological units (www.bgs.ac.uk/data).
- The BGS Lexicon of Named Rock Units, which provides typical descriptions for most geological units (www.bgs.ac.uk/lexicon).

The site is shown to be underlain by the following strata:

TABLE 1: SUMMARY OF EXPECTED SITE GEOLOGY	
Geological Unit Name	**Description**
DRIFT DEPOSITS	
Made Ground	Deposits associated with major industrial complexes and dockland areas.
Tidal Flat Deposits	Clay, Silt and Sand. Superficial deposits formed up to 2 million years ago in the Quaternary Period. Local environment previously dominated by shorelines.
Till Devensian	Clay, Sandy, Gravelly Cobbly. Superficial Deposits formed up to 2 million years ago in the Quaternary Period. Local environment previously dominated by ice age conditions.
SOLID GEOLOGY	
Chester Formation – Sandstone (Sherwood Sandstone Group)	Pebbly (gravelly). Sedimentary Bedrock, formed approximately 247 to 250 million years ago in the Triassic Period. Local environment previously dominated by rivers
OTHER FEATURES	
A named fault, the Castle Street Fault, is noted approximately 150m to the east of the site. The fault generally trends north-south with downthrow to the east.	

Note: Information obtained from BGS digital records © NERC.

3 FIELDWORK

3.1 General

The ground investigation was carried out by SSL between 11 December 2017 and 25 January 2018. The investigation was supervised by an engineer from SSL. The scope of works and positions of exploratory holes were determined by Buro Happold and were set out and surveyed by SSL.

Positions were adjusted where necessary to take account of buried or overhead services, or other restrictions on site.

The exploratory hole locations are shown on the Exploratory Hole Location Plan presented in Appendix A.

3.2 Exploratory Holes

The exploratory holes are summarised in the following table.

TABLE 2: SCOPE OF INTRUSIVE WORKS

Quantity	Exploratory Hole Type	Maximum depth (m)	Hole / Test Numbers
6	Dynamic Sampling Boreholes with Rotary Core follow-on (on-shore)	40.20 m	BH101, BH102, BH108, BH109, BH111, BH114
9	Rotary Cored Boreholes (off- shore)	32.70 m	BH103, BH104, BH105, BH106, BH107, BH110, BH112, BH113, BH113A
5	Rotary Open Hole Boreholes (for installation purposes)	15.00 m	BH102A, BH108A, OH101, OH102, OH103
15	Rotary Probe Boreholes	11.50 m	P101A, P101B, P101C, P102A, P103A, P103B, P104A, P104B, P105A, P105B, P105C, P106A, P106B, P106C, P106D
5	Machine Dug Trial Pits	3.10 m	P101, P102, P102.1, P105, P106
10	Site Strip (Machine Dug Trial Trenches)	2.30 m	SS1.1, SS1.2, SS1.3, SS1.4, SS1.5, SS2.1, SS2.2, SS2.3, SS2.4, SS2.5
16	Grab Samples (Dock Silt)	Dock Bed Level	PAC01A, PAC01B, PAC02A, PAC02B, PAC03A, PAC03B, PAC04A, PAC04B, PAC05A, PAC05B, PAC06A, PAC06B, PAC07A, PAC07B, PAC08A, PAC08B

The exploratory hole logs are presented in Appendix B. These provide information including the equipment and methods used, samples taken, tests carried out, water observations and descriptions of the strata encountered. Explanation of the terms and abbreviations used on the logs is given in the Key to Exploratory Hole Records in Appendix B, together with other explanatory information.

The holes were logged by an Engineering Geologist in general accordance with the recommendations of BS 5930:2015 (which incorporates the requirements of BS EN ISO 14688-1, 14688-2 and 14689-1). Detailed descriptions, together with relevant comments, are given on the logs.

On completion of the works, a survey of the exploratory hole locations was undertaken using specialist Differential Global Positioning System (DGPS) equipment. The coordinates of each exploratory hole were measured relative to British National Grid, and the level relative to Ordnance Datum. These are shown on the exploratory hole logs which have been printed with a reduced level column.

3.3 Buried Service Avoidance

In order to reduce the risk of damaging buried services, prior to the commencement of any exploratory hole or intrusive test a scan was carried out at surface using a cable avoidance tool (CAT) and signal generator ('genny'). In addition all mechanically excavated trial pits and site strip trial trenches were scanned using ground penetrating radar (GPR) equipment in line with SSL procedures.

Inspection pits were hand dug at exploratory locations where noted on the relevant exploratory hole logs or in-situ test results. In areas of hard standing, large diameter concrete coring was undertaken from ground level to allow hand excavation of the underlying material.

3.4 Dynamic Sampling

A total of six on-shore boreholes were formed to depths up to 12.20 m by using either tracked or lorry mounted rotary drilling rigs together with 150 mm diameter temporary steel casings. Dynamic sampling was carried out using a hydraulic hammer (integrated into the drilling rig) to drive hollow steel sample tubes containing a plastic liner into the ground. The diameter of sample tubes was varied as necessary in order to maximise recovery of material with minimal disturbance. Where a loss of sample recovery has been recorded on the logs, unless noted otherwise, this is deemed as a result of variances in the strata encountered (such as changes in consistency or particle sizes).

Boreholes were advanced into competent sandstone using these methods before being extended by conventional rotary coring techniques.

The liners were transported to the on-site logging facility and disturbed representative samples of the strata being penetrated were recovered for geotechnical description and laboratory testing. The depths of the samples recovered are shown on the relevant exploratory hole logs presented in Appendix B.

100 mm diameter undisturbed samples were recovered where required from natural cohesive strata in accordance with BS EN ISO 22475-1 using a thin walled UT100

sampler. Standard Penetration Tests (SPT) were carried out at regular intervals as detailed in Section 3.12.1.

Soil samples for contamination testing were taken from the exploratory holes as detailed in Section 3.11.

3.5 Rotary Drilling

3.5.1 Conventional Coring

Fourteen boreholes, (both on-shore and over-water [off-shore]) were extended to a maximum depth of 40.20 m by conventional rotary coring techniques using either tracked or lorry mounted rotary drilling rigs.

Off-shore boreholes were drilled utilising a tracked rotary drilling rig on a floating pontoon barge held in position using a spud-leg system. These boreholes were initially advanced through the dock silt into competent rock using either a thin walled UT100 or hydraulic piston sampler to obtain 100 mm diameter undisturbed samples.

Rotary coring was carried out using conventional equipment comprising a double walled SWF core barrel to produce a hole of 146 mm nominal diameter. A semi-rigid liner was incorporated within the inner barrel to maximise the quality of core recovery to produce cores of 106 mm nominal diameter.

Due to excessive water swell within the dock which caused malfunction of the piston sampler, borehole BH113 was terminated at shallow depth without coring being undertaken. The borehole was relocated and designated BH113A which was subsequently cored to the scheduled depth.

Air-mist was used as a flush medium for on-shore boreholes and water was used as a flush medium for all off-shore boreholes.

The cores recovered were transported to the on-site logging facility they were photographed, sub-sampled and described and by an Engineering Geologist. Sub-samples were preserved in accordance with the project specification.

Details of the strata encountered are given on the borehole logs along with the Engineering Geologist's assessment of Total Core Recovery (TCR), Solid Core Recovery (SCR), and Rock Quality Designation (RQD) each expressed as a percentage of the individual core runs. Where applicable a fracture spacing (I_f) has also been determined and this information is given on the logs.

Unless otherwise noted on the logs, where core loss has been reported, this is deemed as a result of natural variances in the condition of the rock encountered (such as weathered or weakened zones). In such circumstances it is usual for drilling parameters (such as barrel rotation speed and flush injection) to be varied as necessary in order to maximise recovery.

Photographs of the rotary drilled core are presented in Appendix B alongside the borehole hole logs.

3.5.2 Dock Wall Rotary Probes

A total of fifteen rotary probes were drilled to depths of up to 11.50 m at six general locations adjacent to the existing dock walls (two locations each on the northern, southern and western wharves). The boreholes were drilled using both tracked and lorry mounted rotary drilling rigs with the purpose of determining the extents and buried profile of the dock walls.

Rotary open hole drilling was undertaken using a tri-cone rock bit to produce holes of nominal 100 mm diameter. Air-mist was used as a flush medium. Boreholes were advanced until a reduction in penetration rate became apparent due to either the presence of sandstone or possible back of the dock wall.

Once the top of either the dock wall or the sandstone was achieved an approximately 0.50 m long core run was undertaken at each location in order to positively identify the material.

Cross section diagrams showing the findings of the rotary probed boreholes are presented in Appendix B of this report.

3.5.3 Boreholes for Installation of Gas and Groundwater Monitoring Wells

Five boreholes designated OH101, OH102, OH103, BH102A and BH108A were formed to depths between 3.50 m and 15.00 m using rotary open hole techniques for the purpose of installing long term gas and groundwater monitoring wells. Boreholes BH102A and BH108A were drilled adjacent to boreholes BH102 and BH108 respectively and specifically formed for installation of automatic data logging equipment as detailed in Section 3.10 below.

Open hole drilling was undertaken using a tri-cone rock roller to produce holes of nominally 100 mm in diameter. Air mist was used as a flush medium.

A summary of instrumentation installed in each borehole is provided in Section 3.10 below.

3.6 Trial Pits

A total of five trial pits were excavated up to a maximum depth of 3.10 m using a tracked mechanical excavator with the aim of determining the buried extents of the dock walls. A hydraulic breaker attachment was utilised on the excavator where necessary in order to break through areas of hardstanding.

The trial pits were logged by an Engineering Geologist who provided a detailed description of the ground conditions encountered in each pit and also obtained disturbed soil samples at regular intervals for geotechnical and chemical analysis. Water samples were taken when required.

The strata encountered in the trial pits are described on the trial pit logs presented in Section B of this report together with detailed sketches of the trial pit faces and photographs.

On completion the trial pits were backfilled using arisings and reinstated with concrete where necessary.

3.7 Site Strip

A total of ten trial trenches were excavated on the northern wharf, and within the warehouse on the southern wharf, to a maximum depth of 4.00 m using a tracked mechanical excavator. A hydraulic breaker attachment was utilised on the excavator where necessary in order to break through areas of hardstanding. Trenches on the northern wharf were designated SS1.1 to SS1.5 and those excavated on the southern wharf designated SS2.1 to SS2.5.

The trenches formed the 'site strip' and were excavated to establish the locations of specific buried features, including steel girders, obstructions, chambers and tanks on the northern wharf, and the suspected locations of piles and pile caps on the southern wharf.

In order to assist in targeting the excavations a Ground Penetrating Radar (GPR) survey was undertaken at surface across the designated site strip areas. The GPR logging unit used low power shielded ground-coupled antennae, operating at 400 MHz and 1.5 GHz. The unit was attached to a trolley and 'walked over' the ground at a constant pace in a grid pattern across the site strip area. Readings were taken at regular intervals in order to build a sub-surface ground profile.

Due to nature of the Made Ground, standing water and the substantial thickness of concrete on the southern wharf which attenuated the GPR radar signals, specific features were not able to be firmly identified from the results of the survey, though where features were suspected, the ground surface was marked in order to target the excavations.

The trenches were logged by an Engineering Geologist who provided a detailed description of the ground conditions encountered in each pit and also obtained soil and water samples where required for chemical analysis.

The strata encountered in the trial trenches are described on the trial trench logs presented in Section B of this report together with detailed sketches and photographs.

On completion the excavations were backfilled using arisings, and on the southern dock warehouse the surface was reinstated with concrete.

3.8 Grab Samples

Sixteen grab samples were obtained of the silt material within the dock at locations selected by Buro Happold. The grab samples were obtained for the purpose of chemical analysis using a Van Veen Grab which was lowered from the side of a boat.

The locations of the sampling points are shown on the Exploratory Hole Location Plan presented in Appendix A.

3.9 Sonar and Laser Survey

In order to determine the extent and location of a possible network of underground tunnels and chambers on the northern wharf, a laser and sonar void survey was undertaken by specialist subcontractor Geoterra Limited. The survey was undertaken on 10 January 2018.

A laser scan survey was undertaken underneath an existing workshop structure to the western end of the wharf using a specialised Cavity Auto-scanning Laser System (C-ALS). Access to the chamber was via a manhole located on the dock side.

A sonar scan survey was used to determine the extents of a void adjacent to the historical water tower located to the eastern end of the wharf and which was identified during a previous phase of the Ground Investigation. A borehole was drilled through the material above the known location of the chamber and lined with plastic casing. Due to the likelihood of the chamber being completely filled with water, the survey was undertaken utilising a multi beam sonar scanner, capable of underwater measurements, which was lowered into the water down the cased borehole. On completion of the scan, the borehole was plugged using a sacrificial inflatable bladder and backfilled with concrete.

Both void surveys were supplemented by manual measurements of co-ordinates and levels obtained using DGPS.

Using void survey measurements, Geoterra determined the volume of the chamber underlying the workshop to be 23.5 m³ and the volume of the void adjacent to the water tower to be 31.5 m³. Drawings and further details of the surveys can be found within the information supplied by Geoterra which is presented in Appendix H.

3.10 Backfill and Instrumentation

On completion either 19 mm ceramic tipped casagrande type piezometers or 50 mm diameter gas and groundwater monitoring wells were installed in exploratory holes BH101, BH114, OH101, OH102 and OH103, the design of each determined by Buro Happold. In addition, 35 mm diameter standpipes were installed in boreholes BH102A and BH108A to facilitate installation of long term data logging equipment.

A plastic cap with a gas valve was placed onto selected installations to facilitate long term gas monitoring.

A summary of the instrumentation installed in each exploratory hole is presented in Table 3 below and a schematic of each installation is shown on the relevant borehole logs presented in Appendix B.

TABLE 3: BOREHOLE INSTRUMENTATION / BACKFILLING

Hole ID	Installation Diameter / Type	Tip/pipe depth (mbgl)	Filter Pack	Gas Tap	Notes
BH101	50 mm standpipe	3.50	0.50 - 3.50	Y	
BH102	19 mm piezometer	4.50	0.50 - 5.50	N	
BH102A	35 mm standpipe	5.00	1.00 - 5.50	N	Datalogger
BH103	N/A				Grouted
BH104	N/A				Grouted
BH105	N/A				Grouted

TABLE 3: BOREHOLE INSTRUMENTATION / BACKFILLING					
BH106	N/A				Grouted
BH107	N/A				Grouted
BH108	19 mm piezometer	14.00	12.00 - 15.00	N	
BH108A	35 mm standpipe	14.50	12.00 - 15.00	N	Datalogger
BH109	N/A				Grouted
BH110	N/A				Grouted
BH111	N/A				Grouted
BH112	N/A				Grouted
BH113	N/A				Grouted
BH113A	N/A				Grouted
BH114	50 mm standpipe	5.00	0.50 – 5.00	Y	
OH101	50 mm standpipe	3.00	0.50 – 3.00	Y	
OH102	50 mm standpipe	4.00	0.50 - 4.50	Y	
OH103	50 mm standpipe	5.50	0.50-5.50	Y	

3.11 Chemical Contamination Sampling

Samples for contamination testing were taken from the exploratory holes where indicated on the exploratory hole logs, recorded as sample types ES for soil or EW for water.

Water samples were also taken from the monitoring wells as described in Monitoring and Post Fieldwork Environmental Sampling, below.

All samples were placed in appropriate contamination sample containers that were supplied by the laboratory. Containers for volatiles testing of soil samples were filled to capacity. Any water sample containers (with preservatives where required) were filled to capacity to minimise volatilisation. All samples were then kept in cool boxes with ice packs and were transported to the laboratories under Chain of Custody documentation, as promptly as possible to maintain sample integrity.

3.12 In-Situ Testing

The in-situ tests are listed in the following table. The test methods used are detailed on the test result sheets included in Appendix C, unless otherwise noted.

TABLE 4: SCOPE OF IN-SITU TESTING		
Quantity	**In-situ Test**	**Remarks**

TABLE 4: SCOPE OF IN-SITU TESTING		
58	Standard Penetration Tests (SPT).	Carried out in boreholes; test results included on exploratory hole logs presented in Appendix B.
1	Double Packer Test	BH114 (test zone 12.00m to 13.50m)
3	Variable Head Permeability Tests.	BH101, BH102, BH111

3.12.1 Standard Penetration Tests

Standard Penetration Tests (SPT) were carried out in boreholes, where required in accordance with BS EN ISO 22476-3 using either a split spoon sampler or a solid 60° cone and hammers which had been calibrated for efficiency.

Seating drives have been recorded in increments of 75 mm in accordance with recommended UK practice. The SPT N-values are reported on the borehole logs, on which the calibration number of the hammers used is recorded.

The full results are presented in tabular format on the Summary of Standard Penetration Tests in Appendix C and the calibration certificates of the hammers used in Appendix G.

3.12.2 Variable Head Permeability Tests

Three Variable Head Permeability tests were undertaken, one each in boreholes BH101, BH102 and BH111 in general accordance with BS5930:1999 (including Amendment A2, 2010). The test results are presented in tabular and graphical format in Appendix C. The test locations and depths were determined by Buro Happold.

3.12.3 Packer Tests

One double packer test was completed in BH114 in accordance with BS EN ISO 22282-3:2012 with the test section between 12.00 m and 13.50 m as instructed by Buro Happold. The packers were inflated to a pressure of 7 bar. Results of the test are presented in Appendix C.

3.13 Monitoring and Post Fieldwork Environmental Sampling

In general accordance with the specification, a programme of gas and groundwater monitoring was undertaken at regular intervals during the post site works period.

Ground gas and water monitoring was carried out over eight generally weekly monitoring rounds between 7 February and 27 March 2018. Subsequent, water monitoring visits were requested at monthly intervals for a period of 6 months following completion of field works. The scheduled completion of water monitoring programme is in July 2018, with the results to be included as an addendum to this report.

A calibrated infrared gas meter was used to measure concentrations of carbon dioxide (CO2), methane (CH4) and oxygen (O2) in percentage by volume, whilst hydrogen sulphide (H2S) and carbon monoxide (CO) were recorded in parts per million. Initial and steady state concentrations were recorded. An integral flow meter was used to measure

borehole flow rates (initial and steady state) in litres per hour (l/hr). In addition the atmospheric pressure before and during monitoring was recorded.

It should be noted that groundwater levels, gas concentrations and gas flows usually vary due to seasonal, atmospheric and/or other effects and may at times differ to those measured during the investigation.

Groundwater samples were retrieved using a low-flow purging and sampling methodology as approved by the United States Environment Protection Agency (USEPA). Samples were taken during the visits carried out on 15 February and 1 March 2018.

The low-flow purging and sampling method relies on moving groundwater through the well screen at approximately the same rate as it flows through the geological formation. This results in a significant reduction in the volume of water extracted before sampling and significantly reduces the amount of disturbance of the water in the monitoring well during purging and sampling.

Groundwater levels in the monitoring well and water quality indicator parameters (pH, temperature, electrical conductivity, redox potential and dissolved oxygen) are monitored during low-flow purging, with parameter stabilisation indicating that purging is complete and sampling can begin. As the flow rate used for purging is (in most cases) the same as or only slightly higher than the flow rate used for sampling, purging and sampling are conducted as one continuous operation in the field.

In situ water quality measurements (pH, temperature, electrical conductivity, redox potential and dissolved oxygen) undertaken during the purging or sampling process and are provided in Appendix F together with gas and groundwater monitoring results to date.

On completion of the monitoring programme, a full set of results is to be included as an addendum to this report.

4 LABORATORY TESTING

Samples for potential geotechnical testing were returned to one of the Company's UKAS accredited laboratories, and those for potential geoenvironmental testing were sent to a sister company Envirolab Limited, a MCERTS and UKAS accredited testing laboratory. Additional geotechnical testing was carried out by an external laboratory; Soil Engineering, a UKAS accredited testing laboratory No 1265.

Laboratory tests were scheduled by Buro Happold. Tests carried out in accordance with MCERTS/UKAS standards where noted on the results sheets.

4.1 Geotechnical Laboratory Testing

Geotechnical laboratory testing was generally carried out in accordance with the relevant part of BS1377: 1990, *Methods of Test for Soils for Civil Engineering Purposes*, or, where superseded, by the relevant part of BS EN ISO 17892:2014+ *Geotechnical investigation and testing – Laboratory Testing of Soil*.

The number of tests completed and the test methods used are summarised below. Where non-standard procedures have been undertaken, this is recorded on the report sheet. The results are reported in tabular and/or graphical form and included as Appendix D of this report.

TABLE 5: SUMMARY OF GEOTECHNICAL TESTING		
No. of tests	**Test**	**Remarks**
Classification Tests		
27	Moisture Content.	
23	Liquid and plastic (Atterberg) limits.	
1	Particle Density	
24	Particle size distribution by sieving.	
16	Particle size distribution by sedimentation.	
Compressibility, Permeability and Durability Tests		
12	One-dimensional consolidation test.	
Shear Strength - Total Stress		
4	Multistage unconsolidated undrained triaxial compression tests without the measurement of pore pressure.	
13	Single stage unconsolidated undrained triaxial compression tests without the measurement of pore pressure.	

TABLE 5: SUMMARY OF GEOTECHNICAL TESTING		
No. of tests	**Test**	**Remarks**
Rock Tests		
67	Uniaxial compressive strength tests.	
10	Uniaxial compressive strength with measurement of deformation (Young's Modulus)	
83	Point Load Index.	The natural ('as received') water content of the samples was determined.
Chemical Tests: Soil*		
6	Sulphate content and pH value.	

Note:*Test(s) carried out to method approved in BRE Special Digest 1.

4.2 Geoenvironmental Laboratory Testing

The geoenvironmental testing carried out is summarised in the following table. The results are included as Appendix E of this report, and include details of the test method. Testing suites were specified by Buro Happold.

TABLE 6: SUMMARY OF GEOENVIRONMENTAL LABORATORY TESTING		
Numbers of tests	**Description**	**Notes**
SOIL		
35	Suite 1 (Made Ground)	pH, asbestos screen, CLEA metals suite, total cyanide, free cyanide, total mercury, phenol, glycols, speciated PAH's, speciated TPH, BTEX, Soil Organic Matter.
1	Suite 1 (Natural Ground)	pH, CLEA metals suite, total cyanide, total mercury, phenol, speciated PAH's, speciated TPH including BTEX.
7	Volatile organic compounds (VOC).	
7	Semi volatile organic compounds (SVOC)	
6	Tributyltin	
6	Dibutyltin	
2	Asbestos presence screen.	Identification was undertaken if/where asbestos fibres were detected.
12	Leachate Analysis	CLEA metals, magnesium, TBT, PAH 16, TPH total,

TABLE 6: SUMMARY OF GEOENVIRONMENTAL LABORATORY TESTING		
WATER		
6	Groundwater Analysis Suite	pH, Hardness, CLEA metals suite, total cyanide, speciated PAH's, VOC's, SVOC's, speciated TPH, including BTEX, Chloride, Sulphide, ammoniacal nitrogen.
8	Groundwater Analysis Suite 2	pH, hardness, CLEA metals suite, total cyanide, speciated PAHs, speciated TPH including BTEX, chloride, sulphide, ammoniacal nitrogen
WASTE ACCEPTANCE CRITERIA (WAC)		
2	WAC-E suite.	Total waste suite. Single batch test (BS EN 12457-2, L/S 10:1).

5 REFERENCES

5.1 BS 5930:2015 *Code of practice for ground investigations*

5.2 BS EN 1997-1:2004 *Eurocode 7 — Geotechnical Design Part 1 - General Rules* incorporating corrigendum Feb 2009 and Amemdment A1 2013

5.3 BS EN 1997-2:2007 Eurocode 7 — *Geotechnical design Part 2: Ground Investigation and testing*

5.4 British Geological Survey sheet 96 Liverpool scale 1:50000, published 2006

5.5 British Geological Survey online digital geological map, www.bgs.ac.uk/data

5.6 British Geological Survey Lexicon of Named Rock Units, www.bgs.ac.uk/lexicon

5.7 BS EN ISO 14688-1:2002 *Geotechnical investigation and testing – Identification and classification of soil: Part 1: Identification and description*, including Amendment A1 2013

5.8 BS EN ISO 14688-2:2004 *Geotechnical investigation and testing – Identification and classification of soil: Part 2: Principles for a classification*, including Amendment A1 2013

5.9 BS EN ISO 22475-1:2006 *Geotechnical Investigation and Testing – Sampling methods and groundwater measurements, Part 1 Technical principals for execution*

5.10 BS EN ISO 22476-3:2005 (updated February 2007) *Geotechnical Investigation and Testing – Field Testing Part 3: Standard Penetration Test*, including Amendment A1 (2011)

5.11 CIRIA Report R143 (1995) *The Standard Penetration Test (SPT) - Methods and Use*

5.12 BS EN ISO 22282-3:2012 *Geotechnical investigation and testing – Geohydraulic testing Part 3 Water pressure tests in rock*

5.13 BS 1377:1990 *Method of Test for Soils for Civil Engineering Purposes*

5.14 BS EN ISO 17892:2014 *Geotechnical investigation and testing – Laboratory Testing of Soil*

APPENDIX A - PLANS AND DRAWINGS

(i) Site Location Plan

(ii) Exploratory Hole Location Plan