



Ground Investigation Report

Vantage Data Centres

March 2025

5222535/Sub/GIR/R001/V1

150 MVA SUBSTATION



Notice

This document and its contents have been prepared and are intended solely as information for Vantage Data Centres and use in relation to summarising the results of the recent intrusive ground investigation, presenting a ground model and recommendations for foundation design, refining the Conceptual Site Model and presenting the findings of a Generic Quantitative Risk Assessment to assess the potential risks to human health and controlled waters at the site.

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1. Introduction

1.1 General

AtkinsRéalis UK Limited (AtkinsRéalis) has been appointed by Vantage Data Centres to undertake a Geo-environmental and Geotechnical site investigation at their site located within Imperial Park in Coedkernew, Newport, Wales. This document presents the factual and interpretative findings of the ground investigation in relation to geotechnical and land contamination aspects and should be read in conjunction with the Geotechnical Engineering Factual Ground Investigation Report [1], presented within Appendix A.

The proposed development comprises a 150 Megavolt Amps (MVA) substation and underground electricity connection cable routes.

The site location and red line boundary for the site are shown on Drawing 5185749-ATK-XX-M2-L-41009, presented in Appendix B. The red line boundary also includes an area of land to the north of Imperial Park which is proposed for ecological compensation and a cable route. Due to the distance between the proposed substation, the cable route area and the ecological compensation area, only the substation is considered in this report. A separate desk study report was produced in August 2024 considering the compensation area alone [2]. Herein, reference to 'the site' refers to the substation.

The site layout for the substation is shown by the red line boundary on Drawing 5185749-ATK-XX-XX-DR-L-41001 presented in Appendix B.

1.2 Proposed Scheme

The proposed scheme comprises the construction of an electricity substation and installation of underground electricity transmission cables within the Imperial Park industrial estate in Newport, South Wales. From the proposed Vantage electricity substation, a below ground electricity transmission cable will connect to the CWL12 Data Centre further to the north at Imperial Park with a southerly spur following South Lake Drive for 180 m.

1.3 Objectives

This report is written to assess the geotechnical characteristics of the soils and rock underlying the site, and the potential risks to human health, controlled waters and property receptors from potential sources of contamination in the context of the proposed Scheme.

1.4 Scope of Works

This report presents a summary of the intrusive ground investigation, completed at the site between October and November 2024.

The report is structured as outlined below:

- Site location and description;
- Environmental desk study and existing ground investigation information;
- Summary of the site-specific ground investigation;



- Interpretation of the findings of the ground investigation;
- Presentation of a geotechnical ground model and preliminary engineering assessment;
- Presentation of a land contamination assessment including development of a conceptual site model (CSM) and the results of generic quantitative risk assessment (GQRA); and
- Conclusions and recommendations.

1.5 Data Sources

The following data sources have been reviewed to provide information for this report:

- Ground Investigation Factual Report, Ref:37989, Jan 2025 [1];
- Groundsure, Enviro&Geo Insight, Newport Site 2, Ref: GSIP-2023-13616-13747, Ref: GSIP-2023-13616-13748, 2023 [3];
- British Geological Survey, Onshore GeoIndex, 2023 [4];
- British Geological Survey, The BGS Lexicon of Named Rock Units, 2023 [5];
- Coal Authority, Coal Authority Interactive Map, 2023 [6];
- Natural Resources Wales, Interactive Map Viewer, 2023 [7]; and
- Zetica, Unexploded Ordnance (UXO) Risk Maps, 2023 [8].

1.6 Limitations

This report was prepared by AtkinsRéalis for Vantage for the specific purpose of presenting the findings of the ground investigation and associated preliminary engineering assessment and geo-environmental risk specific to the development proposals as outlined above.

The findings and opinions conveyed via this report are based on information obtained from a variety of sources as detailed within this report. AtkinsRéalis cannot and does not guarantee the authenticity or reliability of the third-party information.

It should be noted that, as with any physical ground investigation involving discrete sampling, test results will only be representative of the point sampled and further ground investigation and analysis may be required should ground conditions differ from those reported. If, during any excavation/construction works, visibly contaminated material is encountered in excavations, advice should be sought from an Environmental Scientist and the requirement for additional testing and assessment of the risks agreed.



2. Site Description

2.1 Site Location and Description

The site is located to the south east of the Celtic Way and Dyffryn Lane roundabout within Imperial Park, in Coedkernew, Newport, NP10 8BE approximately 20 m south of the A48 and approximately 400 m south east of the M4. The site is located at approximate Ordnance Survey (OS) National Grid Reference 328433E, 184168N. Topographically the site lies at approximately 13 m above ordnance datum (AOD).

2.2 Site Description

A site walkover was undertaken by AtkinsRéalis on 11 July 2023. The following provides a description of key observations.

The site comprises an irregular shaped parcel of vacant undeveloped land. The ground cover at the site comprises a mix of grassland, trees and overgrown shrubs. The site is generally flat with the southern boundary of the site bounded by a small bund.

The site has been previously occupied by travellers. During the site walkover there was a small pile of fly tipped bricks and fine grey gravel recorded within the northern area of the site. There was no visual and / or olfactory evidence of potential contaminative sources recorded during the site walkover in this area.

The surrounding area comprises:

- North: Dyffryn Lane with vacant land and Imperial Park commercial buildings beyond;
- East: South Lake Drive with a pond and undeveloped vegetated land beyond;
- South: Undeveloped vegetated land with a pumping station and National Grid Imperial Park substation beyond; and
- West: Dyffryn Lane with Imperial Park commercial buildings beyond.

2.3 Site History

Historical OS maps and aerial photography obtained from the Groundsure Report [3] were reviewed to determine historically pertinent developments on-site and within the surrounding area (500 m of the site).

The Groundsure Report is included in Appendix C.

A summary of the historical development of the site is provided in Table 2-1.

Table 2-1 – Summary of Historical Land Use

Date and Scale	On-site	Off-site (within 500 m)
1882 1:10,560 1883 1:2,500	The site generally comprises undeveloped land.	The surrounding area generally comprises undeveloped agricultural land with some small pockets of woodland. Middle Pen-carn farm is located approximately 100 m southwest of the site.
1898-1900 1:10,560 1901 1:2,500	No significant changes.	No significant changes.
1916-1920 1:10,560 1920-1021 1:2,500	No significant changes.	No significant changes.
1922 1:10,560	No significant changes.	No significant changes.
1937 1:2,500 1938 1:10,560	No significant changes.	No significant changes.
1948-1950 1:10,560	No significant changes.	No significant changes.
1964 1:10,560	No significant changes.	No significant changes.
1966 1:2,500 1967 1:2,500 1968 1:2,500	No significant changes.	No significant changes.
1970 1:10,000	The access track in the south of the site is labelled as Dyffryn Lane.	No significant changes.
1974 1:2,500 (partial coverage)	No significant changes.	No significant changes.
1978 1:2,500 (partial coverage) 1979 1:2,500 (partial coverage)	No significant changes.	No significant changes.
1987-1990 1:10,000 1987 1:2,500 1989 1:2,500	No significant changes.	No significant changes.
1993 1:2,500 1994 1:2,500 1995 1:10,000	Dyffryn Lane and South Lake Drive have been constructed bordering the site to the north, east and west.	A pond is mapped 40 m east of the site. A network of drains are mapped approximately 500 m south of the site. A pumping station is located approximately 300 m southwest of the site. Celtic Way and North Lake Drive roads have been constructed extending 500 m north of the site.

Date and Scale	On-site	Off-site (within 500 m)
2000 aerial photograph 2001 1:10,000	No significant changes.	Commercial buildings associated with the construction of Imperial Park have been constructed 200 m to 500 m north and west of the site. A residential housing development has been constructed 400 m east of the site.
2009 aerial photograph 2010 1:10,000	No significant changes.	Further expansion of Imperial Park to the north and west.
2014 aerial photograph	No significant changes.	No significant changes.
2017 aerial photograph	No significant changes.	No significant changes.
2020 aerial photograph	No significant changes.	Expansion of several of the building car parking areas within Imperial Park.

3. Environmental Site Setting

3.1 General

This section provides a summary of the environmental site setting based on information obtained from the Groundsure Reports [3] and freely available information as reference in the text.

3.2 Geology

The geology for the site has been obtained from the British Geological Survey (BGS) GeoIndex [4] and the BGS Lexicon of Named Rock Units [5] websites.

3.2.1 Made Ground

Published data does not record Made Ground on-site. However, it is considered that Made Ground is likely to be present associated with the construction of the general urban environment within the Imperial Park estate such as roads and roundabouts (Celtic Way, Dyffryn Lane, South Lake Drive and North Lake Drive).

3.2.2 Superficial Geology

The published geological maps indicate that superficial deposits of River Terrace Deposits are recorded underlying the site, typically comprising sand and gravel.

3.3 Bedrock Geology

The bedrock geology underlying the site comprises mudstone of the Mercia Mudstone Group. The Mercia Mudstone is described by the BGS as “*dominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick halite bearing units in some basinal area. Thin beds of gypsum/anhydrite are widespread; thin sandstones are also present*”.

3.4 Boreholes

The BGS GeoIndex [4] records that there is one BGS borehole located 250 m north of the site. A summary of the BGS borehole located nearest to the site is provided below in Table 3-1. Copies of the BGS records are provided in Appendix E.

Table 3-1 – Summary of Nearest BGS Boreholes

BGS Reference	Location / Distance (m)	Year of Drilling	Depth (m) of Borehole	Strata Description and Depth (metres below ground (m bgl))	Groundwater Strikes
ST28SE133	250 m north	1989	9.00	0.00 – 1.00 m: Firm orange brown silty CLAY with abundant fine and medium gravel (RIVER TERRACE DEPOSITS). 1.00 – 6.50 m: Very dense medium brown coarse SAND/fine GRAVEL with abundant medium and coarse	Not reported.



BGS Reference	Location / Distance (m)	Year of Drilling	Depth (m) of Borehole	Strata Description and Depth (metres below ground (m bgl))	Groundwater Strikes
				gravel and occasional clayey or silty pockets (RIVER TERRACE DEPOSITS).	
				6.50 – 9.00 m: Very stiff red brown with abundant light grey green pockets silty CLAY (KEUPER MARL).	

3.5 Mining

3.5.1 Previous Coal Mining

The Coal Authority online map [6] indicates that the site is not located within an area affected by coal mining.

3.5.2 Mineral Sites

The Groundsure Report [3] records that there is one former sand and gravel quarry located within 500 m of the site. A summary of the recorded mineral site is provided below in Table 3-2.

Table 3-2 – Summary of Mineral Sites

Quarry ID	Approximate Distance from Site (m)	Commodity
Pont-estyll	142 m south	Sand and gravel

The Groundsure Report [3] records that sporadic underground mining of vein minerals of restricted extent may have occurred.

3.6 Hydrogeology

The Natural Resource Wales (NRW) Interactive Map Viewer [7] classifies the superficial River Terrace Deposits and the bedrock St Maughans Formation as secondary A aquifers. Secondary A aquifers are defined as *‘permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers’*, [3].

The bedrock Mercia Mudstone is classified as a secondary B aquifer defined as, *‘predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering’* [3].

The site is not located within a groundwater Source Protection Zone [7].

3.6.1 Groundwater Abstractions

The Groundsure Report [3] records that there are no active licenced groundwater abstractions located within 500 m of the site. It should be noted that there may be other groundwater abstractions present not recorded within the Groundsure dataset, such as those licensed with the local authority to abstract < 20 m³ per day.

3.6.2 Groundwater Quality

The Groundsure Report [3] indicates that there is a Water Framework Directive (WFD) Class 2 groundwater body on-site. The South East Valleys Southern Devonian Old Red Sandstone and Triassic Mercia Mudstone groundwater body (ref: GB40902G201500), was classified in 2017 as possessing a good overall quality rating comprising a good chemical and good quantitative rating. This groundwater body is associated with the Mercia Mudstone bedrock geology.

3.6.3 Groundwater Vulnerability

The Groundsure report [3] indicates that the highest vulnerability rating of groundwater within the superficial and bedrock geology underlying the site is a rating of high; this rating refers to the aquifers ability to potentially transmit pollution, if present, to groundwater.

3.7 Hydrology

The nearest surface water feature is an unnamed pond located approximately 40 m east of the site. Several unnamed ponds and drains are also located within 500 m to the south of the site. The area to the south and south east of the site up to the Bristol Channel (3 km south east) has been extensively drained with a large number of drains, reens and ponds controlling shallow water levels. The nearest Main River is the Ebbw River located approximately 2 km to the north and east.

3.7.1 Surface Water Abstractions

The Groundsure Report [3] records that there are no active licenced surface water abstractions located within 500 m of the site. It should be noted that there may be other surface water abstractions present, not recorded within the Groundsure dataset, such as those licensed with the local authority to abstract <20 m³ per day.

3.7.2 Surface Water Discharge Consents

The Groundsure Report [3] records that there are five active discharge consents to surface water located within 500 m of the site. A summary of the discharge consents is provided in Table 3-3 with distances from each area stated (where the consent is within 500 m).

Table 3-3 – Summary of Active Discharge Consents

Distance and orientation from the site	Location	Discharge type	Details
184 m south:	Celtic Lakes Development	Sewage discharges, sewer storm overflow, not water company into unnamed reen.	Effective Date: 03/10/1991 Status: Effective
206 m south:	Celtic Way Lakes Development	Trade discharges, unspecified into Percoed Reen.	Effective Date: 11/05/1998 Status: Effective
244 m south:	Celtic Way, Celtic Lakes	Trade discharges, unspecified into Percoed Reen.	Effective Date: 11/05/1998 Status: Effective

Distance and orientation from the site	Location	Discharge type	Details
315 m south east	Western Valley Trunk Sewer CSO	Sewage discharges, sewer storm overflow, water company into Severn Estuary	Effective Date: 10/10/2019 Status: Effective
423 m south	Duffryn 33/11kV Substation	Trade discharges, site drainage into Percoed Reen.	Effective Date: 28/01/1998 Status: Effective

3.7.3 Pollution Incidents

The Groundsure Report [3] records that the nearest substantiated pollution incident is located approximately 145 m north west for the release of storm sewage on the 27 May 2002. The impact to water and land was listed as Category 3 (minor). There is one further pollution incident located within 500 m related to the release of contaminated water. The impact to land is listed as Category 3 (minor) and the impact to water as Category 4 (no impact).

3.7.4 Flooding

The Groundsure Report [3] records that the site is not located in area at risk from flooding from rivers and the sea.

3.8 Landfill Sites

3.8.1 Current Licensed Landfill / Waste Disposal Sites

The Groundsure Report [3] records that there are no current licensed landfill sites located within 500 m of the site.

There is one current licensed waste transfer site located within 500 m of the site as summarised in Table 3-4.

Table 3-4 – Summary of Active Waste Disposal Sites

Distance (approximate) and orientation from the site	Location	Type of Site	Details
248 to 263 m north east	Panasonic Communications Ltd, Pencarn Way, Duffryn	Material Recycling Treatment Facility	Operator: Panasonic Size: 25,000 tonnes Issue date: 18/03/2005 Status: Issued

3.8.2 Historical Landfill and Waste Sites

The Groundsure Report [3] records that there are no historical landfills located within 500 m of the site.

3.9 Control of Major Accident Hazard Sites

The Groundsure Report [3] records that there are no Control of Major Accident Hazard (COMAH) sites located on-site.

The IQE Silicon Compounds Limited COMAH site is located within 500 m of the site, located 305 m southeast. The COMAH site is recorded as a COMAH lower tier operator.

3.10 Ecologically Sensitive Areas

The Groundsure Report [3] records that the Gwent Levels St Brides Site of Special Scientific Interest is located approximately 315 m south of the site.

There are no further statutory designated sites located within 500 m of the site.

3.11 Cultural Heritage and Archaeological Sensitive Areas

The Groundsure Report [3] records that there are no cultural heritage or archaeological sensitive areas located within 500 m of the site.

3.12 Radon

The Groundsure Report [3] records that the site is located in an area where less than 1% of properties exceed the radon action level where no radon protection measures are required for development.



3.13 Unexploded Ordnance

Publicly available Zetica [8] bomb risk mapping indicates that the site is located in an area of low risk from Unexploded Ordnance (UXO) which is defined having a bomb density of 15 bombs per 1000 acre or less, based on a high-level review of desk based records. A copy of the Zetica map is provided in Appendix D.

3.14 Fuel Stations

The Groundsure Report [3] records that there are no historical or current fuel stations located within 500 m of the site.



4. Field and Laboratory Studies

4.1 Ground Investigation

The intrusive site investigation was completed by a specialist sub-contractor, Geotechnical Engineering Limited, to a ground investigation specification provided by AtkinsRéalis. The methodology and physical investigation findings are presented in the sections below and a summary of the scope of works and key dates specified below.

The site investigation works were carried out in general accordance with BS5930:2015+A1:2020 during October 2024. AtkinsRéalis provided part time supervision of the works to ensure compliance with the requirements of the scope and specification. The works comprised:

- three boreholes to a maximum depth of 13.34 m bgl;
- five machine-excavated trial pits to a maximum depth of 3.0 m bgl;
- two infiltration (soakaway) tests within trial pits TP03 and TP05;
- six hand-excavated inspection pits;
- two dynamic cone penetrometer (DCP) tests;
- two plate bearing tests; and
- six gas and groundwater monitoring visits between November 2024 and January 2025;
- Follow-on groundwater monitoring and sampling and ground gas monitoring.

Site investigation logs and an exploratory hole location map is presented in the Geotechnical Engineering Factual Report [1], provided in Appendix A.

4.2 Methodology

4.2.1 Service Clearance

Statutory utility service plans were obtained and consulted prior to the works commencing.

Service clearance was undertaken by Geotechnical Engineering on the first day of the intrusive works; a non-intrusive survey was completed using a cable avoidance tool (CAT) and signal generator. All identified live and unknown services were marked on the ground. Intrusive investigation locations were positioned to avoid identified services traces.

4.2.2 Inspection Pits

All proposed exploratory hole locations were initially excavated using hand pitting methods using insulated hand tools to a maximum depth of 1.2 m bgl to check for buried services and obstructions.

4.2.3 Trial Pitting

A total of five mechanically excavated trial pits (TP01 to TP05) were progressed to a maximum depth of 3.0 m bgl using a 14-tonne tracked excavator with a 0.60 m bucket under the direction and supervision of a Geotechnical Engineering engineer. Excavated material was removed using a grading bucket to remove the uppermost soil horizon and a digging bucket to reach the necessary depth. Excavated material was placed onto

plastic sheeting. Topsoil was kept separate from subsoils and placed onto different sections of the plastic sheeting.

Following logging and sampling all trial pit excavations were backfilled with arisings in the order of excavation. Backfilled material was compacted using the excavator bucket in stages during backfilling.

4.2.3.1 Dynamic Cone Penetrometer Testing

Dynamic cone penetrometer (DCP) testing was completed in two locations using a handheld penetrometer. These locations are referenced as TP01-DCP and TP04-DCP. Probe depths were measured with respect to ground level and the number of blows for the penetration of the probe was recorded, and an equivalent CBR value calculated. A summary of the DCP testing is provided in the logs within the factual report in Appendix A [9].

4.2.4 Soil Infiltration Testing

Soakaway Testing was undertaken within TP03 and TP05, at one depth in TP03 and two within TP05, carried out in general accordance with BRE 365 [10]. The soakaway locations and depths were carried out in locations in accordance with the proposed sustainable urban drainage system (SUDS) design for the scheme.

In all three cases, there was too little water take to calculate the infiltration rate, tests were undertaken within the cohesive River Terrace Deposits. This is not likely to be representative of the granular (gravel) River Terrace Deposits.

A summary of the soakaway testing and results are provided within the factual report in Appendix A [1].

4.2.5 Boreholes

Three boreholes, referenced as BH01 to BH03 were advanced using a track mounted Geotechnical Pioneer Rig (Comacchio).

Dynamic sampling techniques were used to produce a continuous disturbed core sample of 112 mm nominal diameter which was recovered in semi-rigid plastic liner. Disturbed samples were taken from the core sample and retained in a combination of plastic tubs, bags and glass jars.

Cores were logged on-site by a Geotechnical Engineering engineer.

Standard penetration tests (SPT) were carried out in general accordance with BS EN ISO 22476 3:2005+A1:2011. 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. A summary of the SPT N value recorded is provided on the borehole logs provided within the factual report in Appendix A [1].

4.2.6 Standpipe Installations

Dual installations, comprising separate groundwater and ground gas monitoring standpipes, were installed in all locations, constructed with two 50 mm diameter HDPE plain and slotted pipe with a bunged gas tap to facilitate access for groundwater dipping/sampling and measurement of ground gas.

The standpipe installations are summarised in Table 4-1.

Each installation was finished with concrete and a flush traffic rated surface cover.

Table 4-1 - Summary of 50 mm Standpipe Installation

Location	Type of Well	Water Strike (m bgl)	Top of Response Zone (m bgl)	Base of Response Zone (m bgl)	Screened Hydrogeological Unit
BH01	Dual Groundwater & Ground Gas	Not encountered	1.00	1.50	River Terrace Deposits
			2.00	8.00	
BH02	Dual Groundwater & Ground Gas	Not encountered	1.00	1.50	
			2.00	6.50	
BH03	Dual Groundwater & Ground Gas	Not encountered	1.00	1.50	
			2.00	6.00	

4.2.7 Geoenvironmental Laboratory Testing

Soil and groundwater samples recovered from a number of exploratory hole locations during the intrusive investigation were selected for laboratory analysis as summarised below.

All analysis was scheduled by AtkinsRéalis and undertaken by i2 Analytical Ltd. A UKAS accredited laboratory.

Analytical data is presented in the Geotechnical Engineering Factual Report provided in Appendix A [1].

4.2.7.1 Soil Analysis

A total of 18 samples were taken from the natural strata on-site. Sampling was informed by visual and olfactory indicators of contamination.

All analysis was scheduled by AtkinsRéalis and undertaken by i2 Analytical, a UKAS Accredited Laboratory. Samples were scheduled for the following analysis cognisant of current and historical land uses identified on-site:

- asbestos screen (with quantification if asbestos identified);
- inorganic parameters: pH, cyanide (total, complex and free), total sulphate, water soluble sulphate, sulphide, chloride, ammoniacal nitrogen as N and NH₃, ammonium, total nitrogen, organic matter and nitrite;
- metals / metalloids: arsenic, boron, cadmium, calcium, chromium, chromium hexavalent, copper, lead, mercury, nickel, selenium and zinc;
- total phenols;
- benzene, toluene, ethylbenzene and xylene (BTEX);
- methyl tertiary butyl ether (MTBE);
- speciated polycyclic aromatic hydrocarbons (PAHs); and
- total petroleum hydrocarbons criteria working group (TPH CWG), C5 – C44

A selected two samples were also analysed for polychlorinated biphenyls (PCBs) 7 congeners.

All analysis was scheduled by AtkinsRéalis and undertaken by i2 (a UKAS and MCERTS accredited laboratory). The original laboratory certificates are presented in the Geotechnical Engineering Factual Report provided in Appendix A [1].



4.2.7.2 Soil Leachate Analysis

A total of 13 samples were taken from the natural strata on site. Sampling was informed by visual and olfactory indicators of contamination.

All analysis was scheduled by AtkinsRéalis and undertaken by i2 Analytical, a UKAS Accredited Laboratory. Samples were scheduled for the following analysis cognisant of current and historical land uses identified on-site:

- inorganic parameters: pH, cyanide (total, complex and free), total sulphate, sulphide, chloride, ammoniacal nitrogen as N and NH₃, ammonium, total nitrogen, nitrate and nitrite;
- metals / metalloids: arsenic, boron, cadmium, calcium, chromium, chromium hexavalent, copper, lead, mercury, nickel, selenium and zinc;
- total phenols;
- BTEX;
- MTBE;
- PAHs; and
- TPH CWG.

All analysis was scheduled by AtkinsRéalis and undertaken by i2 (a UKAS and MCERTS accredited laboratory). The original laboratory certificates are presented in the Geotechnical Engineering Factual Report provided in Appendix A [1].

4.2.7.3 Groundwater Sampling

Geotechnical Engineering purged groundwater monitoring wells of three volumes of water using a well development pump following completion of the intrusive investigation works.

Groundwater sampling was undertaken in accordance with British Standards [11] using a low-flow methodology comprising the use of a peristaltic pump and YSI pro water quality meter with flow cell recording water quality parameters (pH, temperature, dissolved oxygen, redox potential and conductivity). Groundwater samples were collected when the water parameters were considered to be sufficiently stable. The depth to water in each borehole was measured using a dip meter.

Groundwater monitoring data are presented in the Geotechnical Engineering Factual Report provided in Appendix A [1].

A total of six groundwater samples were scheduled over two monitoring visits completed on 14th November 2024 and 7th January 2025 from BH01, BH02, and BH03. The water samples were scheduled for the following analysis cognisant of current and historical land uses identified on-site:

- Total organic carbon (TOC);
- inorganic parameters: pH, cyanide (total and free), water soluble sulphate (as SO₄), sulphide, chloride, ammoniacal nitrogen as N and NH₃, nitrate, nitrite;
- metals / metalloids: arsenic, boron, cadmium, calcium, chromium (total), chromium (hexavalent), copper, lead, mercury, nickel, selenium and zinc;
- total phenols;
- BTEX;
- MTBE;
- speciated PAHs; and
- TPH CWG, C5 – C44.



All analysis was scheduled by AtkinsRéalis and undertaken by i2. The original laboratory certificates are presented in the Geotechnical Engineering Factual Report provided in Appendix A [1].

4.3 Monitoring Data

4.3.1 Groundwater

Groundwater levels within the standpipes were recorded during seven monitoring visits completed by Geotechnical Engineering and are summarised in Table 4-2.

The groundwater flow direction is interpreted to be south towards the Bristol Channel.

Table 4-2 - Summary of Groundwater Monitoring

Location	Stratum	Ground Level (m AOD)	Groundwater Monitoring Round Date	Water Level	
				m bgl	m AOD
BH01	River Terrace Deposits	13.05	11 November 2024	3.68	9.37
			14 November 2024	3.68	9.37
			21 November 2024	3.40	9.65
			6 December 2024	2.95	10.1
			13 December 2024	2.74	10.31
			19 December 2024	2.72	10.33
			7 January 2025	2.70	10.35
BH02	River Terrace Deposits	13.05	11 November 2024	4.76	8.29
			14 November 2024	4.76	8.29
			21 November 2024	4.50	8.55
			6 December 2024	2.95	10.1
			13 December 2024	3.21	9.84
			19 December 2024	3.48	9.57
			7 January 2025	2.72	10.33
BH03	River Terrace Deposits	13.35	11 November 2024	3.60	9.75
			14 November 2024	3.92	9.43
			21 November 2024	3.40	9.95
			6 December 2024	3.10	10.25
			13 December 2024	2.75	10.6
			19 December 2024	2.91	10.44
			7 January 2025	2.92	10.43



4.3.2 Ground Gas

Ground gas monitoring has been undertaken from monitoring standpipes comprising three locations installed within the River Terrace Deposits (BH01, BH02, BH03).

The monitoring wells were installed with dual installs with shallow response zones to record groundwater levels and gas concentrations in the near surface soils and deeper response zones to record groundwater levels. Installations at different depths were used to allow comparison of the results and to identify variances which may be indicative of interaction with dissolved gas release from groundwater and full / partial flooding of the response zone.

A summary of the monitored locations and the installations details is provided in Table 4-3.

The ground gas monitoring was undertaken on seven occasions as presented in the list below. The monitoring was conducted at approximately weekly intervals.

- 11 November 2024
- 14 November 2024
- 21 November 2024
- 6 December 2024
- 13 December 2024
- 19 December 2024
- 7 January 2025

Table 4-3 - Summary of Ground Gas Monitoring Installations

Exploratory ID	Strata Monitored	Standpipe Construction (m bgl)
BH01	River Terrace Deposits	Plain pipe: 0.0 to 1.0 Slotted Pipe: 1.0 to 1.5
BH02	River Terrace Deposits	Plain pipe: 0.0 to 1.0 Slotted Pipe: 1.0 to 1.5
BH03	River Terrace Deposits	Plain pipe: 0.0 to 1.0 Slotted Pipe: 1.0 to 1.5

4.3.3 Ground Gas Monitoring Results

A summary of the ground gas concentrations recorded is presented in Table 4-4.

The monitoring period was undertaken during a steady and falling atmospheric pressures.



Table 4-4 - Summary of Ground Gas Monitoring

Location / Date	Barometric Pressure (mb)	Maximum parameter concentration (% volume)					Maximum Parameter concentration (ppm)		Maximum flow Rate (litres / hour)
		Methane	Carbon Dioxide	Oxygen		Steady	Hydrogen Sulphide	Carbon Monoxide	
Min.	Max.								
BH01 Shallow									
11 November 2024	1030, rising	0.0*	0.7	17.8	20.2	20.2	0.0*	0.0*	0.0*
21 November 2024	997, steady	0.0*	9.5	1.8	4.1	4.1	0.0*	10	0.0*
6 December 2024	1016 to 1017, falling	0.0*	7.3	1.4	19.8	4.9	0.0*	0*	0.0*
13 December 2024	1022 to 1023, steady	0.0*	0.0*	20.3	20.5	20.4	0.0*	0.0*	-0.1
19 December 2024	1009 to 1010, steady	0.0*	8.8	5.1	10.1	6.6	0.0*	0.0*	0.0*
7 January 2025	998, steady	0.0*	7.6	8.5	12.2	8.5	0.0*	0.0*	-0.9
BH02 Shallow									
11 November 2024	1030, rising	0.0*	0.1	20.1	20.4	20.4	0.0*	0.0*	0.0*
21 November 2024	997, steady	0.0*	5.5	8.3	8.8	8.4	0.0*	10	0.0*
6 December 2024	1015, falling	0.0*	4.1	10	11.4	11.4	0.0*	0.0*	0.0*
13 December 2024	1022, steady	0.0*	0.5	19.4	20.4	20.2	0.0*	0.0*	-0.3
19 December 2024	1009, steady	0.0*	0.5	10.9	14.3	10.9	0.0*	0.0*	0.0*
7 January 2025	998, steady	0.0*	5.5	5.6	11.5	5.6	0.0*	0.0*	-0.9
BH03 Shallow									



Location / Date	Barometric Pressure (mb)	Maximum parameter concentration (% volume)					Maximum Parameter concentration (ppm)		Maximum flow Rate (litres / hour)
		Methane	Carbon Dioxide	Oxygen			Hydrogen Sulphide	Carbon Monoxide	
				Min.	Max.	Steady			
11 November 2024	1031, rising	0.0*	1.0	18.6	19.6	19.6	0.0*	0.0*	-0.3
21 November 2024	998, steady	0.0*	9.5	2.3	2.8	2.4	0.0*	0.0*	Not availab le
6 December 2024	1015, falling	0.0*	9.3	4.1	6.7	4.4	0.0*	0.0*	0.0*
13 December 2024	1022, steady	0.0*	1.3	17.0	19.3	19.3	0.0*	0.0*	-0.4
19 December 2024	1009, steady	0.0*	10.9	2.9	7.8	2.9	0.0*	0.0*	0.0*
7 January 2025	997, falling	0.0*	9.1	18.6	5.8	5.8	0.0*	0.0*	-0.9

Note: * denotes concentrations below the limit of detection if the instrument (0.1% / 1ppm / 0.1 l/hr)

4.4 Ground Conditions

4.4.1 Summary

A summary of the ground conditions identified on site during the ground investigation is presented in Table 4-5 and a cross section through the site of the materials presented in Figure 4-1. A description of each stratum is provided below.

Table 4-5 - Summary of Geology Encountered

Stratum	Elevation (m AOD)	Depth (m bgl)	Maximum Thickness (m)
Made Ground / Topsoil	13.4 – 12.6	0 – 0.7	0 – 0.7
River Terrace Deposits (Cohesive)	12.9 – 11.9	0 – 1.8	0.3 – 1.6
River Terrace Deposits (Granular)	12.4 – 6.4	0.5 – 6.5	4.4 – 4.9
Mercia Mudstone	7.8+	5.3 – 13.3+	Unproven, deepest borehole at 13.3 m didn't prove depth.

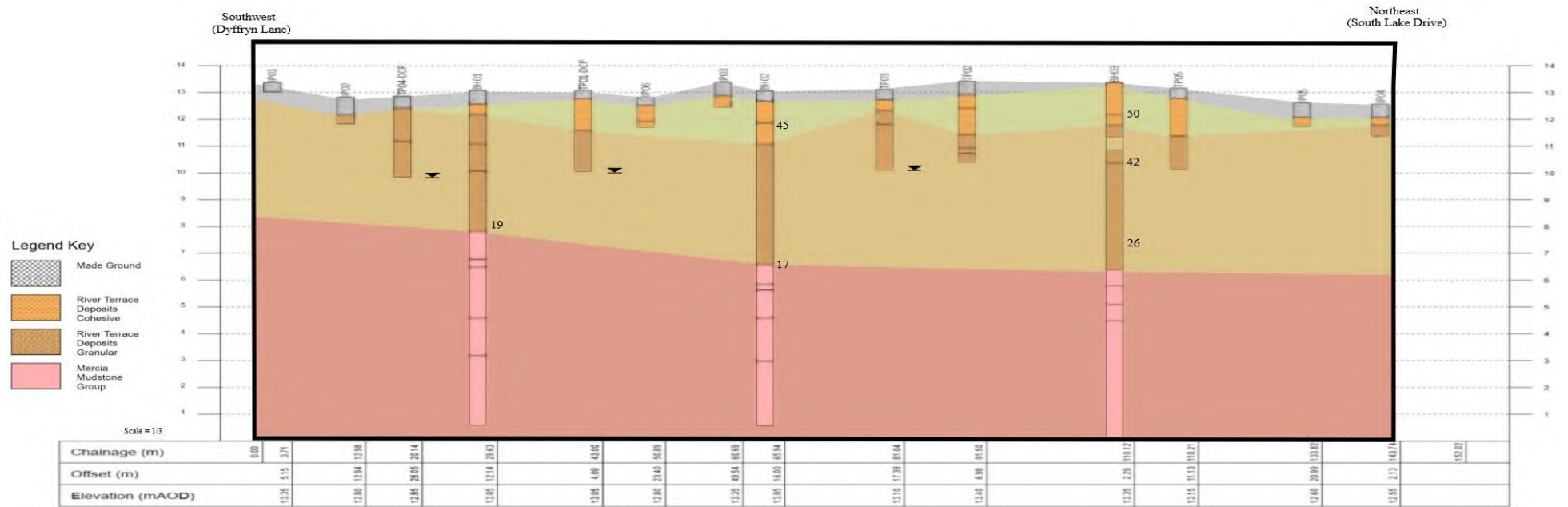


Figure 4-1 - Ground Model cross section showing exploratory holes from southwest to northeast



4.4.2 Made Ground / Topsoil

Made Ground / Topsoil was identified within the majority of exploratory holes, to a maximum thickness of 0.7 m (IP02), with thicknesses being generally similar across the site.

The description typically included grass over very soft to soft slightly sandy slightly gravelly clay, with variable amounts of roots and gravel typically subangular sandstone and quartzite. The descriptions are similar to that of the material classified as cohesive River Terrace Deposits, therefore the top layer may consist of reworked ground. This is inferred due to there being nothing anthropogenic to differentiate between Made Ground and River Terrace Deposits (i.e. no brick, ceramic, metal, rubbish etc.), but Made Ground has been inferred given the developments across the business park, road construction around the site and likely material movements.

4.4.3 River Terrace Deposits

River Terrace Deposits (RTD) are noted to be located underlying the Made Ground across the site, similar to the mapped information from the BGS GeoIndex [12]. The stratum typically consists of a layer of cohesive material (clay), overlying granular sand and gravel. There are two exploratory holes that do not identify cohesive material overlying the gravel, IP02 and TP04, which are at the southwest extent, and IP01 terminated within the Made Ground/Topsoil layer.

Within the parameter derivation sections, the cohesive and granular layers have been considered separately due to the different material properties.

The cohesive RTD ranges in thicknesses between 0.3 – 1.6 m, with the thickest band found across the centre of the site. It is typically described as soft, occasionally very soft (TP02, TP03, TP05) or firm (BH03), brown, slightly sandy gravelly clay (silt in TP02, IP06).

All trial pits and inspection pits terminated within the granular RTD, therefore thicknesses are taken from the boreholes only, which show relatively consistent thicknesses between 4.4 and 4.9 m. The descriptions across all exploratory holes are typically more variable for the granular material, although generally describe a clayey sandy gravel of sandstone, siltstone and quartz. This material is generally logged as very dense, and within IP02 and BH03 is a band of sand.

4.4.4 Mercia Mudstone Group

The Mercia Mudstone Group, identified within BH01, BH02 and BH03, came in at depths of 5.3 m bgl (7.8 m AOD), 6.5 m bgl (6.6 m AOD) and 7.0 m bgl (6.35 m AOD) respectively, showing a slight drop in bedrock level going towards the northeast of the site.

The highly weathered material appears as a stiff to very stiff, reddish-brown clay and is sandy/gravelly towards the top. The thickness was shown as between 1.2 and 3.3 m and is logged as a grade 4/3 soil.

Weathered material is typically an extremely weak mudstone, sub-horizontal fractures and randomly oriented from extremely close to very close. Final thickness was not proven, but based on the depth of the exploratory holes, it is anticipated that the strata has a thickness of greater than 4 m. The grading of this material is a grade 2/1. Grading is based on the categories set out in CIRIA C570 [13].

The base of the stratum was not proved past a maximum depth of 13.3 m.

4.4.5 Visual and Olfactory Evidence of Contamination

No visual and olfactory indicators of potential contamination were identified during the site investigation.

4.4.6 Groundwater

Groundwater was identified at approximately 3 m bgl within TP01, TP03 and TP04, which is an approximate elevation of 10 m AOD.

No water strikes were recorded within the boreholes during drilling.

Groundwater during the monitoring typically ranged between 2.7 and 4.7 m bgl. One measurement within BH02 recorded groundwater at 1.4 m, which is within the cohesive River Terrace Deposits, therefore has the potential to be perched water.

4.4.7 Below Ground Obstructions and Features

No below ground obstructions or features identified during the site investigation.



5. Ground Conditions and Material Properties

Geotechnical parameters for the material underlying the site have been determined in this section based on information from the factual report and appropriate reference texts applicable to these materials.

5.1 Rationale for determining geotechnical characteristic parameters.

The following sections summarise the derivation of characteristic values of geotechnical parameters. The characteristic values for each geology have been collected within Table 5-6.

The characteristic geotechnical parameters have been derived to inform design, currently anticipated to include the following geotechnical applications:

- Material properties, bearing capacity and settlement.

Characteristic Values are defined by BS EN 1997-1:2004+A1:2013 [14] as:

“(1)P The selection of characteristic values for geotechnical parameters has been based on results and derived values from laboratory and field tests, complemented by well-established experience.

“(2)P The characteristic value of a geotechnical parameter has been selected as a cautious estimate of the value affecting the occurrence of the limit state.”

Note: “P” denotes that the clause is a Principal of BS EN 1997-1:2004+A1:2013 [14] which means that no alternative method may be used.

Table 5-1 – Characteristic Parameters to be determined

Unit weight for soil and rock	Unit weight
Classification in soil	Plasticity index
	Particle size distribution
Strength in cohesionless soil	Effective angle of friction, ϕ'
	Effective cohesion, c'
Strength in cohesive soil	Undrained shear strength, c_u
Stiffness in cohesionless soil	Drained Youngs's Modulus, E'
	Poisson's ratio, ν
Stiffness in cohesive soil	Drained Youngs's Modulus, E'

	Undrained Young's Modulus, E_u
	Poisson's ratio, ν
Aggressivity to concrete	Design sulphate class (DS)
	Aggressive Chemical Environment for Concrete (ACEC)

The ranges of values and suggested characteristic values have been assessed to inform the designer's selection of characteristic design values. The designer is required to review and consider the relevant limit states and design requirements to select appropriate values.

The assessment of characteristic values in this report assumes that cautious estimates for strength and stiffness are lower estimates. It should be noted that for some design scenarios, higher estimates may be critical (e.g. piling obstructions), which should be considered by the designer.

5.2 Parameter derivation methodology

Wherever possible, direct testing results have been used to provide characteristic geotechnical parameters. However, where direct testing was not available or the number of available direct tests was insufficient, published empirical correlations have been used to inform the derivation of the required characteristic parameters.

Parameter plots from the provided AGS file have been included in Appendix B.

The parameter derivation methodology is outlined below. Where several methods have been proposed, the results of each will be considered to establish characteristic values.

5.2.1 Critical and Peak Angle of Shearing Resistance

Cohesive soils

Critical angle of shearing resistance values for fine grained soils have been estimated using the correlation given in BS 8002:2015 [15]:

$$\phi'_{cv} = 42^\circ - 12.5 \log_{10} I_p \quad \text{for} \quad 5\% \leq I_p \leq 100\%$$

Where:

I_p is plasticity index expressed as a percentage.

The peak angle of shearing resistance has also been estimated using the correlation given in BS 8002:2015 [15]:

$$\phi'_{pk} = \phi'_{cv} + \phi'_{dil}$$

Where:

ϕ'_{dil} is the contribution from soil dilatancy, specified by BS 8002:2015 [15] as typically in the range $0 - 4^\circ$

5.2.2 Undrained shear strength, c_u (kPa)

Undrained shear strength values were obtained from in-situ hand shear vane testing and standard penetration testing. In addition, values have been estimated from soil stiffness description.

5.2.3 Drained Young's Modulus, E' (MPa)

Drained Young's Modulus has been estimated using empirical relationships detailed below.

Cohesive soils

Drained Young's Modulus values for fine grained soils have been estimated from tables presented within CIRIA 103 [16].

Table 2 Typical values of Young's modulus and Poisson's ratio for various soil types considered as homogeneous elastic solids*

Soil type	Young's modulus, E (MN/m ²)		Poisson's ratio, ν
Loose sand	5 to 20		0.3 to 0.4
Medium dense sand	16 to 20		0.2 to 0.35
Dense sand	30 to 100		0.15 to 0.3
	Undrained	Drained	
Soft clay	2 to 6	1 to 4	0.5 for undrained conditions 0.1 to 0.3 for drained conditions
Firm clay	5 to 12	3 to 8	
Stiff clay	10 to 20	5 to 15	

*It is preferable, but may not be convenient or possible, to idealise sands and soft clays as elastic materials with modulus proportional to depth (Gibson material), rather than homogeneous materials as assumed for this table.

Figure 5-1 Youngs Modulus and Poissons ratio from CIRIA 103

Alternatively, values were estimated from tables presented within Barnes [17], as reproduced below, using undrained shear strength and plasticity index.

Table 5-2 – Drained modulus values (from Stroud et al, 1975), extracted from Barnes [17]

Plasticity Index (%)	E' / c_u
10 – 20	270
20 – 30	200
30 – 40	150
40 - 50	130
50 - 60	110

Granular

For normally consolidated sands and gravels,

$$E = \sim 1 \times N \text{ (MPa)}$$

For over consolidated granular soil,

$$E = \sim 2 \times N \text{ (MPa)}$$



A typical range of Young's Modulus of granular soils based on their type and strength presented in Table 5-3.

Type	Strength of soil	Elastic modulus, E (MPa)	
		Short term	Long term
Gravel	Loose		25-50
	Medium		50-100
	Dense		100-200
Medium to coarse sand	Very loose		<5
	Loose		3-10
	Medium dense		8-30
	Dense		25-50
	Very dense		40-100
Fine sand	Loose		5-10
	Medium		10-25
	Dense		25-50

Table 5-3 – Range of elastic parameters for granular soils [18]

5.2.4 Undrained Young's Modulus, E_u (MPa)

Undrained Young's Modulus has been estimated from SPT N-value and undrained shear strength using the undrained modulus correlation from Jamiolkowski within Barnes [17].

$$\text{Barnes [17]: } E_u = 300 \times c_u$$

These correlations are based on strain levels for shallow foundations (typically 0.1%), for alternative types of engineering solutions the values should be adjusted for the appropriate strains.

5.2.5 Poisson's Ratio, ν

Poisson's Ratio of the soils encountered during the GI have been established based on the typical values for elastic homogenous soils presented within CIRIA 103 [16] and Bowles [19].

5.2.6 Sulphate Classification

Sulphate classification (Design Sulphate (DS) Class and Aggressive Chemical Environment for Concrete classification (ACEC)) has been assessed using direct laboratory testing following the procedures outlined by the BRE Special Digest 1 [20].

5.3 Made Ground

It should be noted that there was a limited number of testing scheduled within Made Ground due to the assumption that the material will be largely stripped / removed as part of the site preparation and clearance. Sections with no testing have been removed.

5.3.1 Classification

5.3.1.1 Moisture content

One moisture content test was undertaken on a sample of Made Ground and gave a moisture content of 26.9 %. A characteristic value of 27% is proposed.

5.3.1.2 Atterberg limit

One Atterberg limit test was undertaken on a sample of Made Ground and confirmed intermediate plasticity with a Plasticity Index of 20%, Liquid Limit of 43% and Plastic Limit of 23%. A characteristic Plasticity Index (PI) of 20%, and Liquid Limit of 40% is proposed for this material.

5.3.2 Aggressivity to Concrete

One test was undertaken in the Made Ground for pH and Sulphate and the results have been used to determine the chemical aggressivity of soil towards buried concrete in accordance with BRE Special Digest 1:2005 [20]. Based on this, it is recommended that a Design Sulphate Class of DS-1 and an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-1 is used for the design of buried concrete.

5.4 River Terrace Deposits - Cohesive

5.4.1 Classification

5.4.1.1 Unit weight

BS8002 [15] suggests a unit weight for soft clay above the water table to be 15 – 19 kN/m³, therefore a characteristic value of 16 kN/m³ is proposed.

5.4.1.2 Particle size distribution

Two tests were conducted within the cohesive band of RTD and the results are summarised in Table 5-4 below.

Table 5-4 – PSD Testing results for cohesive RTD

Hole No. (depth)	Percentage Passing (%)					
	Cobbles	Gravel	Sand	Silt	Clay	Fines
TP02 (0.5)	0	38.7	32.3	22	7.1	29.0
TP05 (1.0)	9.8	15.5	26.2	37.6	11.0	48.5

5.4.1.3 Moisture content

Eight moisture content tests were undertaken on samples of cohesive RTD. The results ranged between 7.9% and 23.5% and a characteristic value of 15% is proposed.

5.4.1.4 Atterberg limit

A total of 7 No. Atterberg limit tests were undertaken on samples of cohesive RTD, one of which was undertaken within material classified as granular (BH01, 5m depth). As this sample gave a result of

intermediate plasticity, it may have been from a clayey lense within the gravel or a section with high fines content. This sample is unlikely to represent the cohesive band.

The remaining 6 samples were all within a Low Plasticity range, with Liquid Limit values ranging between 27 and 31%, and Plasticity index values between 10 and 14%. A characteristic Plasticity Index (PI) of 10% is proposed for this material. Additionally, a characteristic Liquid Limit value of 30% is proposed.

5.4.1.5 SPT N-values

Two SPT tests were undertaken within cohesive RTD, with N-values of 45 and 50, which corresponds to a very stiff to hard material and is unlikely to represent the soft material otherwise identified.

5.4.2 Shear strength parameters

5.4.2.1 Undrained shear strength

SPTs, as previously discussed, undertaken within cohesive RTD, gave c_u values of 293 and 326 kPa. A characteristic value of 300 kPa is proposed for the firm to stiff clay appearing towards the base of these deposits in BH02 and BH03.

The soft material otherwise identified as the cohesive RTD does not have any SPT testing to give an undrained shear strength. Soil stiffness descriptions would give a strength of 15 – 40 kPa, therefore a characteristic value of 20 kPa is suggested.

5.4.3 CBR values

Two plate load tests were undertaken in TP01 and TP04 within the cohesive RTD. CBR values for these were 3.0 and 6.1%.

From the TRL-DCP values, TRL01 shows values of 2-3 % to a depth of 0.7 m, increasing to 10% up to 1m. Within TRL02 values show an average of 5% up to 0.8 m. A characteristic value of 5% is proposed.

At greater depths the values were significantly higher than what would be anticipated, suggesting that the DCP was bouncing on the gravel, therefore the values are not representative.

5.4.4 Effective Stress

5.4.4.1 Angle of Shearing Resistance

Based on a plasticity index of 20%, a proposed characteristic effective angle of shearing resistance is 25°.

5.4.4.2 Cohesion

BS 8002:2015 [15] advises that in the absence of reliable test data, the effective cohesion should be taken as zero; the characteristic effective cohesion shall therefore be taken as zero.

5.4.5 Stiffness parameters

5.4.5.1 Undrained Young's Modulus

An undrained Young's Modulus (E_u) has been correlated from c_u values with an E_u of 6.0 MPa from Barnes [17] for the soft material.

This is in line with the proposed values in CIRIA 103 [16] as 2 – 6 MN/m² for a soft clay.

5.4.5.2 Drained Young's Modulus

CIRIA 103 [16] suggests typical values for an undrained Young's Modulus for soft to firm clay to be 1 – 8 MN/m². In this case, a proposed characteristic value of 1 MN/m² for the soft material is proposed and 5 MN/m² for the firm material.

5.4.5.3 Poisson's Ratio

CIRIA 103 proposes within clay an undrained Poisson's Ratio 0.5 and a drained Poisson's Ratio range of 0.1 to 0.3. Therefore, a characteristic undrained Poisson's Ratio 0.5 and a drained Poisson's Ratio of 0.2 is proposed.

5.4.5.4 Aggressivity to Concrete

Four tests were undertaken on samples of the cohesive RTD for pH and Sulphate and results have been used to determine the chemical aggressivity of soil towards buried concrete in accordance with BRE Special Digest 1:2005 [20]. Based on this, it is recommended that a Design Sulphate Class of DS-1 and an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-1 is used for the design of buried concrete.

5.5 River Terrace Deposits - Granular

5.5.1 Classification

5.5.1.1 Particle size distribution

Eight (8No.) PSD tests were undertaken on samples of granular RTD, however, three of these have limited information other than cobble percentage. The other five results are summarised in the table below.

Table 5-5 – PSD Testing results for granular RTD

Hole No. (depth)	Percentage Passing (%)					
	Cobbles	Gravel	Sand	Silt	Clay	Fines
0	79	17.8	1.9	1.3	3.2	
0	63.8	23.1				13.1
7.1	56.6	31.9	2.7	1.7	4.4	
24.2	34.4	24.7	11.2	5.5	16.7	
0	75.3	18.4	4.5	1.7	6.3	

5.5.1.2 Bulk and dry density

One (1No.) shear box test was undertaken within the granular RTD, which gave a bulk density of 2.12 and dry density of between 1.78 Mg/m³ and 1.82 Mg/m³. A bulk density of 20 kN/m³ proposed.

5.5.1.3 SPT N-Values

13No. SPT tests were undertaken within the granular RTD, with 10 reaching the maximum number of blows (50) before 450 mm penetration. Three that did reach maximum penetration gave results of 19, 26 and 42. The extrapolated N-values for 7 of the remaining tests ranged between 67 and 83, and three values were between 150 and 300. The values between 67 and 83 are typical for a very dense material.

5.5.2 Shear strength parameters

5.5.2.1 Effective shear strength

One (1No.) shear box test was undertaken on a sample of granular RTD from TP04. Peak angle of friction Φ was identified as 40.5 ° and a characteristic value of 40° proposed. Peak cohesion intercept was 0 kPa, although this result should not be used further due to the material being granular.

5.5.3 Stiffness parameters

5.5.3.1 Drained Young's Modulus

Given the relationship for normally consolidated material $E = \sim 1 \times N$ (MPa), the range of values is typically 67 – 300 MPa. A characteristic value of 70 MPa is proposed.

5.5.3.2 Aggressivity to Concrete

Three tests were undertaken on samples of the granular RTD for pH and Sulphate and results have been used to determine the chemical aggressivity of soil towards buried concrete in accordance with BRE Special Digest 1:2005 [20]. Based on this, it is recommended that a Design Sulphate Class of DS-1 and an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-1 is used for the design of buried concrete.

5.6 Mercia Mudstone Group - Soil

5.6.1 Classification

5.6.1.1 Moisture content

Two moisture content tests were undertaken on samples of the Mercia Mudstone Group (soil), with reported values of 18.7 and 20.9%. A characteristic value of 20% is proposed.

5.6.1.2 Atterberg limit

Two Atterberg tests were undertaken on samples of the Mercia Mudstone Group (soil), which showed an intermediate plasticity, although around the boundary of low plasticity. Liquid Limits of both were 36% and Plastic Limits were 22 and 24%, with Plasticity Index of 12 and 14%.

5.6.1.3 Unit weight

Unit weight values from BS8002 [15] suggest typical weight densities for a very high to extremely high strength clay as 18 – 24 kN/m³. A characteristic value of 20 kN/m³ is proposed.

5.6.2 Shear strength parameters

5.6.2.1 Undrained shear strength

Five SPT tests were undertaken within the Mercia Mudstone (soil). One reached full penetration with a N value of 17, although this is considered low for the material described as stiff to very stiff. The remaining 4 did not reach full penetration, with extrapolated results of 54 – 77. A characteristic c_u of 275 kPa is proposed.

One in-situ hand shear vane test was undertaken on the clay soil, which gave a value of 31 kPa, significantly lower than expected and therefore has not been included within the characteristic value, although suggests that soft spots may be present within the material.

5.6.2.2 Critical angle of shearing resistance

Based on a Plasticity Index of 13%, the critical angle of shearing resistance using BS8002 [15] is 28°.

5.6.2.3 Effective Stress Angle

CIRIA C570 [13] suggests that the peak effective stress angle for Mercia Mudstone grade 4 is 32-50°, and grade 3 is 42-32°. A characteristic value of 32° is proposed.

5.6.2.4 Cohesion

BS 8002:2015 [15] advises that in the absence of reliable test data, and in this case multiple test data, the effective cohesion should be taken as zero; the characteristic effective cohesion shall therefore be taken as zero.

5.6.3 Stiffness parameters

5.6.3.1 Undrained Young's Modulus

Based on a c_u value of 275 kPa, an E_u value of 82.5 MPa is proposed for the very stiff clay.

CIRIA 103 [16] suggests typical values for an undrained Young's Modulus for stiff clay at the surface of the weathered mudstone to be 10 – 20 MN/m². In this case a proposed characteristic value for the stiff clay is 15 MN/m², increasing with depth.

5.6.3.2 Drained Young's Modulus

Based on a c_u value of 275 kPa and Plasticity Index of 13%, an E' value for the very stiff clay is proposed as 74.2 MPa.

CIRIA 103 [16] suggests typical values for a drained Young's Modulus for stiff clay at the surface of the weathered mudstone to be 5 – 15 MN/m². In this case a proposed characteristic value for the weathered material is 12 MN/m², increasing with depth.

5.6.3.3 Poisson's Ratio

CIRIA 103 proposes an undrained Poisson's Ratio 0.5 and a drained Poisson's Ratio range of 0.1 to 0.3. Therefore, a characteristic undrained Poisson's Ratio 0.5 and a drained Poisson's Ratio of 0.2 is proposed.

5.6.3.4 Aggressivity to Concrete

No soil chemical testing was undertaken within the weathered Bedrock.

5.7 Mercia Mudstone Group - Rock

5.7.1 Classification

No classification testing was undertaken within the rock of the Mercia Mudstone.

5.7.2 Shear strength parameters

5.7.2.1 Undrained shear strength

Eleven SPT tests were undertaken within the rock portion of the Mercia Mudstone, all of which did not reach full penetration, with extrapolated values between 81 and 120 kPa. Therefore, a c_u value of 450 kPa is proposed.

5.7.2.2 Point Load Tests

Eight (8)no. Point Load tests were undertaken within the mudstone in BH01 and BH03. The corrected point load (I_{s50}) was 0 – 0.07 MPa, where the result was 0 in four out of seven tests, 0.01 twice, both within BH03, and 0.07 twice, both at 9.5 m in BH03.

5.7.2.3 Effective Stress Angle

CIRIA C570 [13] suggests that the peak effective stress angle for Mercia Mudstone grade 1 - 2 is $>40^\circ$. A characteristic value of 40° is proposed.

5.7.3 Stiffness parameters

5.7.3.1 Young's Modulus

Based on a c_u value of 450 kPa, an E_u value of 135 MPa is proposed. This is in line with values identified within C570 Figure 5-2 [13].

5.7.3.2 Aggressivity to Concrete

No soil chemical testing was undertaken within the weathered Bedrock.

5.8 Parameter Summary

The geotechnical parameters as described above have been summarised in Table 5-6 below.

Table 5-6 – Geotechnical Parameter Summary

Test Type	Recommended Characteristic Values				
	Made Ground	River Terrace Deposits (Cohesive)	River Terrace Deposits (Granular)	Highly Weathered Mercia Mudstone Group	Weathered Mercia Mudstone Group
Moisture Content (%)	27	15		20	
Bulk Density (kN/m ³)		16	20	20	
Plasticity Index (%)	20	10		13	
Liquid Limit (%)	40	30		36	
Undrained Shear Strength (kPa)		20		275	450
Effective shear strength (°)		25	40	32	40
Cohesion		0	0	0	0
Undrained Youngs Modulus (MPa)		6		15	
Drained Youngs Modulus (MN/m ²)		1 for soft clay 5 for firm clay	70	12	135
Poisson's Ratio		Undrained 0.5 Drained 0.2		Undrained 0.5 Drained 0.2	

6. Contaminated Land Assessment

6.1 Approach

Land contamination is assessed through development of a Conceptual Site Model (CSM) which describes the links between contamination which may be present from current and historical activities on site (including any off-site activities from which contaminants may migrate onto a site), receptors to that contamination and pathways between the two.

Sources of contamination and associated contaminants, receptors to that contamination and the pathways between are identified and assessed to determine whether all three are present, or are likely to be present. If all three are present, then they form a Potential Contaminant Linkage (PCL). These PCLs can then be subjected to the risk assessment process.

The approach adopted in this assessment is in accordance with the guidance presented in the Environment Agency Land Contamination Risk Management (LCRM) document [21]. LCRM provides a technical framework for identifying and remediating contamination through the application of a risk management process. The decision of whether a risk is unacceptable in a particular case involves not only scientific and technical assessment, but also appropriate criteria by which to judge the risk and conclude exactly what level of risk would be unacceptable. Decisions regarding a site may be informed by:

- Tier 1 Preliminary Risk Assessment (PRA) – typically a desk study review to develop an initial CSM with an assessment of risk considering the likelihood and severity of the potential consequences (associated with the PCLs);
- Tier 2 Generic Quantitative Risk Assessment (GQRA) – typically a review of ground investigation and monitoring data, development/refinement of the CSM with an assessment of risk using precautionary Generic Assessment Criteria (GAC) relevant to the PCLs that represent minimal or tolerable risk; and
- Tier 3 Detailed Quantitative Risk Assessment (DQRA).

The preliminary CSM presented below is a summary of the Tier 1 assessment provided in the AtkinsRéalis 2024 Geo-Environmental and Geotechnical Desk Study [22]

It should be noted that under current health and safety legislation, construction and maintenance workers are required to carry out appropriate risk assessments and instigate appropriate mitigating measures to protect themselves, other human receptors and the environment from contamination that may be present. Such risks must be adequately mitigated by the measures required under current legislation, specifically the Construction Design Management (CDM) Regulations [23], which requires that potential risks to human health and the environment from construction activities are appropriately identified and all necessary steps taken to eliminate / manage that risk.

Potential acute risks resulting from short term exposure of construction workers to contamination involved with the proposed development cannot be assessed using these GACs because they relate to the long term (chronic) risk. Risks to construction workers should be managed by the contractor through the use of appropriate Personal Protective Equipment (PPE) and appropriate working methods.

6.2 Risk Estimation

Through consideration of the potential consequence and likelihood of exposure occurring, a potential risk rating for each PCL has been assigned. Risks have been assessed in accordance with the methodology and

classification system set out in CIRIA C552 Contaminated Land Risk Assessment, A Guide to Good Practice [24].

The definitions of risk, based on C522 guidance, are provided in Table 6-1. The risk matrix linking the probability and consequence to the risk rating is provided in Table 6-2.

Table 6-1 – Definitions of Estimated Risk

Risk Level	Definition
Very High Risk	There is a high probability that severe harm could arise to a designated receptor or there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not already undertaken) and remediation are likely to be required.
High Risk	Harm is likely to arise to a designated receptor. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not already undertaken) is required and remedial works may be necessary in the short term and are likely over the long term.
Medium Risk	It is possible that harm could arise to a designated receptor. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the long term.
Low Risk	It is possible that harm could arise to a designated receptor, but it is likely that this harm, if realised, would be mild. Further investigation is not necessarily required, however should be considered to confirm that there is no unanticipated contamination present.
Very Low Risk	The possibility of harm to the designated receptor is either not plausible or, if the possibility of harm is plausible, risk is considered to be very unlikely with attenuation along the exposure pathway. Further investigation is not necessarily required, however may be considered to confirm that there is no unanticipated contamination present.

Table 6-2 – Estimation of the level of risk by comparison of consequence and probability

Consequence		Severe	Medium	Mild	Minor
Probability (Likelihood)	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate / Low Risk
	Likely	High Risk	Moderate Risk	Moderate / Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate / Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate / Low Risk	Low Risk	Very Low Risk	Very Low Risk

6.3 Preliminary Conceptual Site Model

Based upon the historical and present land uses identified from the information reviewed, a preliminary CSM has been produced, identifying potential sources of contamination, migration or exposure pathways and receptors for the site.

A worst-case scenario has been adopted in the preparation, i.e. all likely potential sources, exposure or migration pathways and sensitive receptors have been assumed to be present.

The following sections are described in terms of the potential source-pathway-receptor PCLs, which are defined by interpretation of the information provided in Sections 1 to 4 of this report and the details of the proposed development.

The development includes a substation which is likely to comprise hardstanding and gravel surfacing with areas of landscaping for Sustainable Urban Drainage Systems (SUDS). For the assessment, it is assumed that occupiable buildings may be developed on the substation as part of the development.

6.3.1 Potential Contamination Sources

Following a review of the available desk-based information, the following potential sources of contamination have been identified and are summarised in Table 6-3.

Table 6-3 – Potential Sources of Contamination

Location	Potential Source of Contamination	Potential Contaminants
On-site	Made Ground on-site associated with the construction of surrounding urban area, roads and roundabouts in Imperial Park.	A range of inorganic and organic contaminants including Total Petroleum Hydrocarbons (TPH) , Polycyclic Aromatic Hydrocarbons (PAH), metals, ground gas and asbestos.
Off-site	Made Ground of unknown provenance associated with infilling of former gravel pit located approximately 180 m south. Pumping station located approximately 300 m south.	A range of inorganic and organic contaminants including TPH, PAHs, metals, ground gas and asbestos.

6.3.2 Potential Receptors and Pathways

The potential receptors, which are relevant to the current and future site use and potential contaminant exposure and migration pathways, have been identified as outlined in Table 6-4.

Table 6-4 – Potential Receptors and Pathways

Receptor Group	Receptor	Potential Contaminant Migration Pathways
Human Health (on-site)	Future substation workers.	Dermal contact / ingestion / inhalation of contaminants in soil and soil-derived dust; Inhalation of asbestos fibres; and

Receptor Group	Receptor	Potential Contaminant Migration Pathways
		Inhalation of ground gas / vapours.
Human Health (off-site)	Workers within the adjacent Imperial Park Residents located approximately 280 m east.	Dermal contact with and ingestion of contaminants in soil-derived dusts and water that may have migrated off-site; and Inhalation of soil-derived dust, fibres, gas and vapours which may have migrated off-site.
Controlled Waters: Surface Water	Off-site: Ponds (nearest located approximately 40 m east) Drains located within 500 m of the site.	Leaching or dissolution of contaminants in soils and subsequent migration of contaminants; Lateral migration of dissolved phase contaminants via preferential pathways such as drains and high permeability strata; Lateral migration of dissolved phase contaminants in groundwater to surface water; and Migration of contaminants entrained in surface water runoff.
Controlled Waters: Groundwater	Groundwater in the superficial River Terrace Deposits (secondary A aquifer). Groundwater in the bedrock Mercia Mudstone Formation (secondary B aquifer).	Leaching or dissolution of contaminants in soils and subsequent migration of contaminants in groundwater; Vertical migration of dissolved phase contaminants to the underlying groundwater; and Lateral migration of dissolved phase contaminants via preferential pathways such as drains and high permeability strata.
Property	On-site existing and future below ground infrastructure.	Direct contact of contaminated soils/water with infrastructure, services and structures and subsequent chemical attack; Direct contact of migrating contaminated groundwater within infrastructure, services and structures; and Migration of ground gas and/or soil vapour along strata and preferential pathways such as service routes or differentially permeable strata leading to accumulation and explosion.

Receptor Group	Receptor	Potential Contaminant Migration Pathways
	Off-site commercial/industrial properties within surrounding Imperial Park.	Migration of ground gas and/or soil vapour along strata and preferential pathways such as service routes or differentially permeable strata leading to accumulation and potentially explosive atmospheres.
	Off-site residential properties (nearest located approximately 280 m east).	

6.4 Generic Quantitative Risk Assessment

6.4.1 Human Health

A human health Generic Quantitative Risk Assessment (GQRA) has been carried out to refine the assessment of the PCLs presented in Section 6 of this report using information obtained during the Geotechnical Engineering Limited 2024 site investigation data.

6.4.2 Methodology

To identify potential contaminants of concern (CoCs), the soil analytical data has been screened against Category 4 Screening Levels (C4SLs) where available. Where C4SLs are not available soil analytical data has been screened against the LQM Suitable for Use S4UL assessment criteria. Where neither C4SLs or S4ULs are available, AtkinsRéalis soil screening values (SSVs) have been derived to be protective of chronic risks to human health.

GACs are liable to change as new policy and technical guidance, including toxicological data, are published by the Environment Agency and other authoritative sources. Further to this, a Detailed Quantitative Risk Assessment (DQRA) may be required to review the level of conservatism in the screening values, depending upon the outcome of the generic data screening exercise.

C4SLs have been derived assuming a sandy loam soil containing 6% soil organic matter (SOM) and are considered appropriate based on the derivation of low levels of toxicological concern (LLTC) in accordance with SP1010 [25] to generate the assessment criteria. C4SLs exist for the following compounds: arsenic, benzene, benzo(a)pyrene, cadmium, chromium VI, lead, vinyl chloride (chloroethene), trichloroethene (TCE), tetrachloroethene (PCE), 1,2, dichloroethene, 1,2-dichloroethane, naphthalene, and inorganic mercury.

S4ULs have been developed for 82 substances and are derived on a sandy loam containing 1%, 2.5% and 6% SOM¹ [26].

C4SLs and S4ULs have been developed for the following land uses; residential with consumption of homegrown produce, residential without consumption of home grown produce, allotments, commercial, public open space (parks) and public open space (residential).

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AtkinsRéalis has produced SSVs based on minimal toxicological risk [27] for a variety of standard land uses at 1% SOM (sand soil type) and 6% SOM (sandy loam soil type) using CLEA v1.071 [28] in accordance with UK Government guidance [29].

To assess risk to on-site current and future use human health receptors, GACs for a commercial land use are considered to be the most appropriate criteria based on the site's proposed operation as an electricity substation.

The current and future land use is commercial and therefore soil data have been screened against GAC deemed protective of a commercial use. The key receptor for the land use is a female worker aged 16 to <65 years. It is assumed that working adults spend on average 8.3 hours per day indoors on working days for 230 days of the year. The exposure pathways considered relevant to working adults include:

- direct ingestions of soil (outdoors) and dust derived from soils (indoors);
- dermal contact with dust derived from soil (indoors);
- dermal contact with soil (outdoors);
- inhalation of dust derived from soil (indoors);
- inhalation of dust derived from soil (outdoors);
- inhalation of vapours (indoors); and
- inhalation of vapours (outdoors).

The soil samples from the 2024 site investigation were analysed for SOM with results indicating a general range of between 0.9% and 4.7% and a geometric mean of 1.3% SOM. the purposes of this assessment a SOM of 1% has therefore been adopted for all screening.

In line with the method to derive the S4ULs, it is considered generally appropriate to use the surrogate marker approach for genotoxic polycyclic aromatic hydrocarbons (PAHs) as described in Public Health England document [30]. This bases the assessment on the ratio of genotoxic PAHs to benzo(a)pyrene.

To be applicable to a site, it is important to understand whether the source of PAH in the soil are representative of coal tar (otherwise the toxicological data is not based on the same source and is not valid). In the first instance, the ratios of PAHs in the soil at a site to those in the coal tar study are reviewed to establish whether they meet the defined, published range as set out in the C4SL guidance [27]. Once this has been confirmed, the concentrations of benzo(a)pyrene in soil can then be compared to the C4SL. No further assessment of other genotoxic PAH in soil is then required.

The genotoxic PAHs assessed through the surrogate marker approach are:

- Benzo(a)anthracene;
- Chrysene;
- Benzo(b)fluoranthene;
- Benzo(k)fluoranthene;
- Indeno(1,2,3-c,d)pyrene;
- Dibenzo(a,h)anthracene; and
- Benzo(g,h,i)perylene.

The GAC for a number of volatile or potentially volatile contaminants (including PAHs) are based on both soil saturation limits (where the contaminant will theoretically reach saturation and from free phase product), and health-based modelled values which can be used where site conditions indicate that saturation has not been reached and no free phase product exists. Free product has not been identified on this site.



6.4.2.1 Soil Assessment Results

A total of 18 soil samples were screened against GAC for a commercial land use (1% SOM). The results show that there were no exceedances of the analysed contaminants for the soil samples collected.

In the absence of GAC for PCBs, glycols and urea analytes, the laboratory limit of detection has been adopted as a conservative screen. No detectable concentrations of the above compounds were recorded in all samples for which they were analysed.

Asbestos screening was completed in all 18 soil samples analysed, and no fibres were identified within the soil matrix.

The soils screening assessment is provided in Appendix F.

6.4.2.2 Ground Gas Assessment

A preliminary ground gas risk assessment has been undertaken in accordance with BS 8485:2015+A1:2019 [31] code of practice for design of protective measures for methane and carbon dioxide ground gases for buildings. This guidance provides a semi-quantitative assessment methodology for assessing the risk of permanent ground gas generation to buildings.

BS8485:2015 states that hazardous gas flow rates (Qhg) should be calculated for methane and carbon dioxide for every borehole for each visit and suggests that the Qhg is presented alongside the gas monitoring results in a database. Qhg is calculated using the maximum gas concentration recorded (unless lower values can be justified) and the steady state flow rate using the formula:

$$Q_{hg} \text{ (l/hr)} = \text{flow rate (l/hr)} \times [\text{gas concentration (\%)} / 100]$$

The Gas Screening Value (GSV) is the flow rate of a specific hazardous gas considered to be representative of a site, following assessment of all borehole concentrations and gas flow rates, whilst taking account of other influencing factors. Such factors being, for example, whether a response zone was completed flooded (which can compromise gas data), the temporal/spatial nature of the data set and the acute one-off nature of the risk.

A decision must be made to determine whether the maximum Qhg in the dataset is appropriate to represent the site (and thereby be selected as the GSV), or whether maximum gas concentrations and maximum steady state flow rates should be combined from any borehole/visit to derive a “worst case GSV”.

The GSV considered representative for the site is then used to select a Characteristic Situation (CS), which is the ground gas regime assumed for design of gas protection measures for new buildings in accordance with BS8485:2015 [31]. The GSVs and CS are presented in Table 6-5.

Adopting a GSV based on peak flow measurements (i.e. those measured initially after the gas tap is opened) might result in a disproportionately high gas hazard prediction and assignment of an over-precautionary GSV and Characteristic Situation (CS), leading to overly conservative gas protection measures being incorporated into the development.

BS8485:2015 does not include an approach for assessing carbon monoxide or hydrogen sulphide. The relevant Workplace Exposure Limits (WELs) as outlined within the HSE EH40/2015 (2011) document (Health and safety executive, 2011) has been adopted for use in a preliminary assessment of carbon monoxide and hydrogen sulphide. The WELs used for carbon monoxide and hydrogen sulphide have been provided below:

- carbon monoxide: 30 parts per million (ppm) for long-term (eight hours) exposure limit and 200 ppm for short-term (15 minutes) exposure limit.
- hydrogen sulphide: 5 ppm for the long-term exposure limit and 10 ppm for the short-term exposure limit.

Table 6-5 - Site Characteristic GSV and Associated Characteristic Situation

CS	Risk Classification	GSV (l/hr)	Additional Factors
1	Very Low Risk	<0.07	Typical methane <1 % and/or carbon dioxide <5 %. Otherwise consider increase to characteristic Situation 2.
2	Low Risk	<0.7	Borehole air flow rate not to exceed 70 l/hr. Otherwise consider increase to Characteristic Situation 3
3	Moderate Risk	<3.5	-
4	Moderate to High Risk	<15	Quantitative risk assessment required to evaluate scope of protective measure
5	High Risk	<70	-
6	Very High Risk	>70	-

Note: '-' denotes where a combination of protective measures are required

Source: BS8485:2015

6.4.2.2.1 Carbon Dioxide and Methane Results

The Qhg of the ground gas wells has been calculated and a summary of the maximum gas concentrations and steady state flow rates for each monitoring location is presented in Table 6-6. Full ground gas monitoring results can be found in the factual report provided in Appendix A.

Table 6-6 - Ground Gas Risk Assessments

Location	Max. Peak Recorded conc. (% v/v) - 11 November 2024 to 7 January 2025 (6 rounds)		Max. Steady State Flow Rate (l/hr)	Qhg (l/hr) calculated for each well		Associated Characteristic Situation (CS)**	Response Zone Flooded?
	Carbon Dioxide	Methane		Carbon Dioxide	Methane		
BH01	9.5	0.1*	0.1*	0.0095	0.0001	(CS1)	No
BH02	5.5	0.1*	0.1*	0.0055	0.0001	(CS1)	No
BH03	10.9	0.1*	0.1*	0.019	0.0001	(CS1)	No

Note: '*' denotes that readings were below the laboratory limit of detection and the minimum detectable concentration has been used for assessment. Where negative flow rate were recorded, the limit of detection of the instrument has been used in calculating the Qhg.

Note 2: ** (CS) refers to definitions as presented in Table 6-3.

Based on the results, the Characteristic Situation for the site has been assessed as CS1 (very low risk) and typically no special precautions against ground gas are required for new development for this category.



6.4.2.2 Carbon Monoxide and Hydrogen Sulphide Results

Hydrogen sulphide was not recorded above the limit of detection (0.1 ppm) during the monitoring period in any of the monitored standpipes. Carbon monoxide was recorded below the limit of detection (0.1 ppm) during the majority monitoring rounds with the exception of BH01 on 21 November 2024 and BH02 on 6 December 2024 which recorded concentrations of 10 ppm. This was recorded in the middle of the monitoring time for this well with concentrations less than the laboratory detection for the time before and after.

6.4.2.3 Discussion of Potential Risks to Human Health

The results indicate that there are no exceedances of the analysed contaminants for the soil samples collected. Therefore, the potential risks to on-site human receptors from direct contact, ingestion and vapour inhalation pathways are considered unlikely to be unacceptable and further assessment or mitigation of the risks is not required. In addition, the materials could be chemically suitable for re-use on site, from a human health risk perspective.

An assessment of potential risk from ground gas has characterised the site as a CS1 scenario (very low risk) from carbon dioxide and methane concentrations in accordance with BS8485. Carbon monoxide and hydrogen sulphide concentrations were below the HSE UK WEL.

Gas monitoring was undertaken over a two month period under different atmospheric conditions including rising, falling and steady barometric conditions. Therefore, the monitoring is considered to be representative of ground conditions. Carbon monoxide was observed during a single monitoring round at 10ppm against a short/long term exposure WEL of 30 ppm and 200 ppm respectively. Taking into account that the recorded carbon monoxide concentration is below the WEL therefore a very low risk characterisation is appropriate. Based on the output of the conservative ground gas risk assessment, no further gas monitoring will be required on-site, nor are specific gas measures required to be utilised on-site.

6.4.3 Controlled Waters

To assess potential risks to the identified controlled water receptors, groundwater laboratory data have been screened against water quality standards (WQS). The screening criteria selected for controlled waters assessment are dependent on the nature of the receptor.

The site is underlain by a secondary A aquifer relating to the superficial River Terrace and by a secondary B aquifer of the Mercia Mudstone and a second secondary A aquifer associated with the St Maughan Formation. The site is not located within a groundwater source protection zone. The nearest surface water feature is an unnamed pond located approximately 40 m east of the site. Several unnamed ponds and drains are also located within 500 m of the site. The area to the south and south east of the site up to the Bristol Channel (3 km south east) has been extensively drained with a large number of drains, reens and ponds controlling shallow water levels. The nearest Main River is located approximately 2 km to the north and east. Groundwater monitoring, as summarised in Section 4.3, records groundwater at relatively similar levels indicating a relatively flat hydraulic gradient. However, it that groundwater is likely following the topographical gradient and nearest surface water features of

Considering the above, groundwater and leachate data have therefore been screened against the following assessment criteria:

- Freshwater Environmental Quality Standards (EQS) to assess the potential risk posed to the surface water receptors; and
- Drinking Water Standards (DWS) to assess potential risk to the underlying secondary A aquifer groundwater receptors.

The bioavailability of certain metals (copper, lead, nickel, zinc) varies depending on the hydrochemical characteristics of the receiving surface water body. Published EQS values are unadjusted values which assume 100% bioavailability and are therefore highly conservative. Therefore, site specific Predicted No Effect Concentrations (PNEC) values have been derived using the WFD-UK rivers and lakes metal bioavailability assessment tool (m-BAT) [32] to define site-specific EQS that accounts for the bioavailability for each relevant metal. The receiving water parameters were defined by surface water samples collected from the nearby Ebbw River located approximately 1.6 km north east of the site, surface water data has been attained from Nation Resources Wales Water Watch Wales [33] and the Water Framework Directive [34]. A pH value for surface water source was unavailable, in the absence, the groundwater pH was used. The m-BAT analysis is presented in Appendix F and is summarised below in Table 6-7.

Table 6-7 - Summary of mBAT Assessment

Average Dissolved Organic Carbon (mg/l)	Average Calcium (mg/l)	Average pH (Groundwater)	Average Site-specific PNEC Dissolved Copper (mg/l)	Average Site-specific PNEC Dissolved Zinc (mg/l)	Average Site-specific PNEC Dissolved Nickel (mg/l)	Average Site-specific PNEC Dissolved Lead (mg/l)
1.18	44.4	7.13	0.00447	0.01557	0.01222	0.00142

6.4.3.1 Soil Leachate Assessment Results

A total of 13 soil leachate samples were recovered from 13 exploratory locations (TP01, TP02, TP03, TP04, TP05, IP02, IP03, IP04, IP05, IP06, BH01, BH02 and BH03) between depths of 0.20 m to 1.20 m within the natural stratum.

The screening results indicate that concentrations of lead, zinc, fluoranthene and benzo(a)pyrene exceeded the EQS as summarised in Table 6-8. Concentrations of benzo(a)pyrene exceeded DWS as summarised in Table 6-9.

Organics (BTEX, TPH CWG, PAH and VOC,) were below the laboratory limit of detection in all samples.

The soil leachate screening assessment is provided in Appendix F.

Table 6-8 – Soil Leachate EQS Exceedances

Determinand	EQS (mg/l)	No. of Samples	No. of Exceedances	Max Concentration (mg/l)	Location of exceedances (m bgl)
Fluoranthene	0.0000063	13	2	0.00014	TP02, 1.00-1.20m; IP05, 0.60-0.80m
Benzo(a)pyrene	0.00000017	13	1	0.00005	IP05, 0.60-0.80m
Lead (dissolved)	0.00142	13	3	0.0036	TP04, 0.50-0.80m ; IP02, 0.20-0.40m; BH03, 0.50-0.70m
Zinc (dissolved)	0.01557	13	1	0.023	BH03, 0.50-0.70m

***Bold** denotes location of the maximum recorded exceedance)

Table 6-9 - Leachate DWS exceedances

Determinand	EQS (mg/l)	No. of Samples	No. of Exceedances	Max Concentration (mg/l)	Location of exceedances (m bgl)
Benzo(a)pyrene	0.0000 1	13	1	0.00005	IP05, 0.60-0.80m

6.4.3.2 Groundwater Assessment Results

Six groundwater samples were recovered from three borehole standpipes over a period of two monitoring rounds installed in BH01, BH02 and BH03 within the natural superficial River Terrace Gravel stratum. The standpipes are located across the site to provide information for determining groundwater flow direction, and to provide a representative dataset of groundwater quality up and down hydraulic gradient.

Groundwater flow direction is interpreted to be south towards the Bristol Channel.

Groundwater was screened against DWS and EQS. The screening results indicate no exceedances of WQS to be recorded.

Organics (BTEX, TPH CWG, VOC and PAH,) were below the laboratory limit of detection in all samples.

6.4.3.3 Discussion of Potential Risks to Controlled Waters

Soil leachate exceedances for EQS comprised metals of lead and zinc and fluoranthene and benzo[a]pyrene. Soil leachate exceedances for DWS comprised one concentration of benzo(a)pyrene recorded in the sample taken from IP05 at 0.60-0.80 m bgl.

Possible Made Ground was recorded to a maximum depth of 1.20 m bgl during the ground investigation although no anthropogenic sign of Made Ground or visual or olfactory evidence of contamination was noted.

Groundwater samples did not identify exceedances of metals against either EQS or DWS which indicates that, although these determinands have the potential to leach from unsaturated soils, there is no available evidence to demonstrate that this is occurring to adversely affect the groundwater chemistry underlying the site.

Based on the identified on-site contaminant concentrations from soil, soil-leachate and groundwater, the following conclusions are drawn:

- Although metal contaminants were identified to exceed the WQS in soil leachate, this assessment is theoretical and conservative and does not typically reflect real site conditions or account for likely attenuation during migration to the controlled water receptors. The results of the groundwater should be used in preference and are considered more representative of site conditions.
- Groundwater analysis identified that no determinands exceeded the EQS or DWS.
- The site is not located in a groundwater SPZ and there are no recorded licensed potable groundwater abstractions located within 500 m of the site. Therefore, there are currently no known active sensitive receptors to contaminants in groundwater.

Therefore, it is considered, from the results from the soil leachate and groundwater samples analysed, that the site soils are unlikely to present an unacceptable risk to controlled waters.

6.4.4 Property

6.4.4.1 Ground Gas

The site has been classified as a Gas Characteristic Situation CS1 for methane and carbon dioxide which relates to a very low risk.

A total of six monitoring rounds has been completed over a two month period between November 2024 and January 2025 and over a period of general stable and falling atmospheric pressures. This provides a long term indication of the gas regime at the time of monitoring.

In accordance with guidance in BS8485:2015, no ground gas protection measures are required for a CS1 site classification.

6.4.4.2 Aggressive Ground Conditions

New foundations and infrastructure required as part of the proposed development should take into account the potential presence of chemicals aggressive to concrete such as sulphate and chloride. Further discussion on this aspect can be found in Section 8.8.

6.5 Revised Conceptual Site Model

A qualitative environmental risk assessment of the PCLs identified has been carried out based on available site-specific ground investigation soil and groundwater analysis. The risk assessment has been completed following current best practice and industry guidance following the principles of risk assessment in Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, 2012 [35] and the DEFRA Land Contamination: Risk Management (LCRM) guidance [36] .

Definitions of probability, consequence and significance have been based on CIRIA C552 [37], which provides general guidance on development and application of the consequence and probability 'matrix approach' to contamination risk assessment. This information has been used to identify the risk classification of the PCLs from which the potential environmental liability can be assessed.

Table 6-10 – Updated Conceptual Site Model

Source	Receptor		Contaminant Exposure / Migration Pathway	Potential Consequence	Probability	Risk Classification	Comments
On-site: Potential for Made Ground on-site associated with the construction of surrounding roads and roundabouts in Imperial Park. <i>A range of metals, fuel oils and hydrocarbons and inorganic compounds (unknown treatment chemicals), pathogens, ground gas and asbestos.</i>	<u>Human Health:</u>	Future substation workers.	Dermal contact / ingestion / inhalation of contaminants in soil and soil-derived dust.	Medium	Unlikely	Low	A total of 18 soil samples were obtained during ground the 2024 site specific ground investigation. No elevated concentrations of commercial generic assessment criteria were identified for a range of inorganic, organic and heavy metal analytes. No asbestos was identified.
	On-site		Dermal contact / ingestion of contaminants in groundwater within excavations.				Post-construction the ground cover at the site will comprise a mixture of hardstanding and gravel for the substation and vegetation in landscaped areas. In areas of hardstanding, soils will be encapsulated and it is unlikely that site users would come into direct contact with or ingest soils. In areas where the ground cover comprises vegetation the vegetation will bind and encapsulate the soils and subsequently reduce the potential for direct contact / ingestion of soils during normal use.
							Any potential risks to ground workers would be managed through robust risk assessments to identify appropriate PPE and working methods.
			Inhalation of ground gas / vapours.	Severe	Unlikely	Moderate/Low	The ground gas assessment concluded the site is of characteristic situation 1 (CS1), the site is therefore categorised as very low risk.
			Inhalation of asbestos fibres.	Medium	Low Likelihood	Low	A total of 18 soil samples were obtained during ground the 2024 site specific ground investigation. No asbestos was identified in the samples tested.
							Post-construction the ground cover at the site will comprise a mixture of hardstanding and gravel for the substation and vegetation in landscaped areas which will bind and encapsulate the soils and subsequently reduce the potential for dust generation and inhalation of fibres.
							Construction and maintenance works may require temporary removal of hardstanding or vegetation clearance, exposing soils and increasing the potential for dust generation and migration to human receptors.
							During development of the site, it is assumed appropriate controls will be implemented to segregate other site users and consideration of good / best practice methodologies, risk assessments and consideration for use of appropriate PPE. Asbestos in soil and its risk to construction workers and future site users should be considered by an experienced and suitably trained asbestos specialist.
							It is assumed that site workers and visitors will wear appropriate PPE and that they have conducted a safety risk assessment which will reduce the risk to human health.
	<u>Human Health:</u>	Workers within the surrounding Imperial Park Residents located approximately 280 m east.	Dermal contact with and ingestion of contaminants in soil-derived dusts and water that may have migrated off-site.	Medium	Unlikely	Low	The ground gas assessment concluded the site is of characteristic situation 1 (CS1), the site is therefore categorised as very low risk.
	Off-site		Inhalation of soil-derived dust, fibres, gas and vapours which may have migrated off-site.				Postconstruction ground cover at the site will comprise a mix of hardstanding and vegetation which will encapsulate and / or bind the on-site soils. Therefore, it is considered that dust generation and off-site migration are unlikely to occur.
							The nearest residential receptor to the site is 280 m from the site and gases/vapours, if present are unlikely to laterally migrate this distance to the receptor.
	<u>Controlled Waters:</u>	Off-site:	Leaching or dissolution of contaminants in soils and subsequent migration of contaminants.	Medium	Unlikely	Low	The 2024 ground investigation recorded exceedances of metals and PAHs in soil leachate samples however, groundwater samples did not identify exceedances of such contaminants which indicates that, although these determinands have the potential to leach from unsaturated soils, there is no available evidence to



Source	Receptor	Contaminant Exposure / Migration Pathway	Potential Consequence	Probability	Risk Classification	Comments
	Surface water	Ponds located approximately 45 m north east. Drains located within 500 m of the site. Lateral migration of dissolved phase contaminants via preferential pathways such as high permeability strata. Lateral migration of dissolved phase and/or dissolved contaminants in groundwater to surface water. Migration of dissolved phase contaminants entrained in surface water runoff.				demonstrate that this is occurring to adversely affect the groundwater chemistry underlying the site and migrating to off-site surface water receptors. The proposed works could result in the mobilisation of contamination in unsaturated soils, if present, through leaching/dissolution of, and subsequent migration into, the surface water features. Where excavation is required, consideration should be given to the potential for generation of preferential pathways during the works where contaminants may potentially leach from unsaturated soils into surface water. River Terrace Gravel underlie the site which typically comprise sands and gravels and are therefore likely to be relatively permeable. Controls should be implemented to mitigate this risk as far as is practicable.
	<u>Controlled Waters:</u> Groundwater	Groundwater in the superficial River Terrace Deposits (secondary A aquifer). Groundwater in the bedrock Mercia Mudstone Formation (secondary B aquifer). Leaching or dissolution of contaminants in soils and subsequent migration of contaminants in groundwater. Vertical migration of dissolved phase contaminants to the underlying groundwater. Lateral migration of dissolved phase contaminants via preferential pathways such as high permeability strata.	Medium	Unlikely	Low	The 2024 ground investigation recorded one exceedance of benzo(a)pyrene in one soil leachate sample however, groundwater samples did not identify exceedances of the contaminant which indicates that, although these determinands have the potential to leach from unsaturated soils, there is no available evidence to demonstrate that this is occurring to adversely affect the groundwater chemistry underlying the site and migrating to off-site surface water receptors. The aquifers underlying the site are receptors to potential contamination which may leach from unsaturated soils on-site and migrate to and within groundwater. The groundwater vulnerability of the site is classed as high. SUDS are proposed as part of the substation, which may increase the potential for leaching of contaminants if present, from shallow soils. Water contained within SUDS systems may also become contaminated due to isolated fuel / oil spills or similar pollution incidents. Designs of the SDS features should consider mitigation such as membranes and filtration systems. All works should be undertaken in accordance with relevant guidance and best practice measures including BRE 365 for the design of the proposed SUDS on-site.
	<u>Property</u>	On-site existing and future below ground infrastructure Direct contact of contaminated soils/water with infrastructure, services and structures and subsequent chemical attack. Direct contact of migrating contaminated groundwater within infrastructure, services and structures.	Mild	Low Likelihood	Low	Soil chemistry may be present which is aggressive to concrete foundations. However, it is assumed that future structures will be designed and constructed with an appropriate concrete classification to mitigate or reduce the severity of this risk.
		Migration of ground gas along strata and preferential pathways such as service routes or differentially permeable strata leading to accumulation and explosion.	Severe	Unlikely	Low / Moderate	The ground gas assessment concluded the site is of characteristic situation 1 (CS1), the site is therefore categorised as very low risk.
	Off-site commercial/industrial properties within surrounding Imperial Park.	Migration of ground gas along strata and preferential pathways such as service routes or differentially permeable strata leading to accumulation and	Severe	Unlikely	Low / Moderate	The ground gas assessment concluded the site is of characteristic situation 1 (CS1), the site is therefore categorised as very low risk.

Source	Receptor		Contaminant Exposure / Migration Pathway	Potential Consequence	Probability	Risk Classification	Comments
		Off-site residential properties (nearest located approximately 280 m east).	potentially explosive atmospheres.				
Off-site: Made Ground of unknown provenance associated with infilling of former gravel pit located approximately 150 m south; and Pumping station located approximately 300 m south; <i>A range of metals, fuel oils and hydrocarbons and inorganic compounds (unknown treatment chemicals), pathogens, ground gas and asbestos</i>	<u>Human Health:</u> On-site	Future substation workers.	Dermal contact / ingestion / inhalation of contaminants in soil and soil-derived dust.	Medium	Unlikely	Low	The areas surrounding the site comprise a mix of hardstanding and vegetation, which will encapsulate or bind soil and reduce potential for dust generation with subsequent on-site migration to affect site users.
			Dermal contact / ingestion of contaminants in groundwater within excavations.				
			Inhalation of ground gas / vapours.	Severe	Unlikely	Moderate / Low	The ground gas assessment concluded the site is of characteristic situation 1 (CS1), the site is therefore categorised as very low risk. There is a potential source of ground gas related to infill of the former gravel pit, 150 m south of the site with material of unknown provenance. However, considering the surrounding predominant unsurfaced ground, ground gases are likely to dissipate to atmosphere before reaching the site through lateral migration.
	<u>Controlled Waters:</u> Groundwater	Groundwater in the superficial River Terrace Deposits (secondary A aquifer).	Leaching or dissolution of contaminants in soils and subsequent migration of contaminants in groundwater.	Medium	Unlikely	Low	Groundwater samples collected during the 2024 site investigation did not record exceedance of WQS. Considering the distance between the potential contaminant sources and the site, dilution and dispersion is likely to occur, reducing the potential impact which would be expected at the site.
		Groundwater in the bedrock Mercia Mudstone Formation (secondary B aquifer).	Vertical migration of dissolved phase contaminants to the underlying groundwater. Lateral migration of dissolved phase contaminants via preferential pathways such as high permeability strata.				Where excavation is required, consideration should be given to the potential for generation of preferential pathways during the works where contaminants may potentially leach from unsaturated soils into groundwater. Controls should be implemented to mitigate this risk as far as is practicable.
	<u>Property</u>	On-site existing and future below ground infrastructure	Direct contact of migrating contaminated groundwater within infrastructure, services and structures.	Mild	Low Likelihood	Low	Appropriate concrete classifications will be adopted for any proposed structures and infrastructure as part of the design of the works.
			Migration of ground gas along strata and preferential pathways such as service routes or differentially permeable strata leading to accumulation and explosion.	Severe	Unlikely	Moderate / Low	Considering the surrounding predominant unsurfaced ground, ground gases are likely to dissipate to atmosphere before reaching the site through lateral migration. The ground gas assessment concluded the site is of characteristic situation 1 (CS1), the site is therefore categorised as very low risk.



7. Material Reuse Potential and Waste Classification

7.1.1 Introduction

The primary aim of the intrusive investigation was to gather data for geo-environmental risk assessment and geotechnical interpretation; the investigation was not designed to provide sufficient data to suitably characterise waste/ materials in accordance with Regulator's Guidance on the classification and assessment of waste (1st Edition v1.2GB) Technical Guidance WM3 (known herein as WM3) for transfer off-site to a waste facility [38].

Preliminary waste classification was undertaken on the geo-environmental data and Waste Acceptance Criteria information was collected during the intrusive investigation, which is summarised below. It is recognised that this should not be considered a robust waste assessment in accordance with WM3; the below sections provide the Client with a preliminary assessment on the potential waste classification of the soils at the site.

Material that the holder discards or intends or is required to discard, or material that has no legal mechanism for re-use either on- or off-site, is classified as a 'waste' and should be managed in accordance with the current relevant regulations and guidance. It is the waste producer's legal responsibility to accurately classify any waste arising from their works.

To classify waste materials, a number of steps should be undertaken in accordance WM3 [1]. The initial steps are to determine:

- i. if the materials are waste and whether classification is required;
- ii. the relevant List of Waste (LoW) codes;
- iii. the assessment needed to select the waste codes;
- iv. the chemical composition of the material; and,
- v. if the substances in the waste are 'hazardous substances' or 'Persistent Organic Pollutants' and if they are present, what hazardous properties, if any, are associated with the waste.

Waste classification in the case of soils and excavated materials is undertaken on laboratory soils analysis, with Waste Acceptance Criteria (WAC) testing often undertaken in tandem to inform the type of landfill which would be considered suitable for the waste should this be the proposed management route. WAC analysis is not suitable to use as a standalone analysis for the assessment of waste.

There are a number of potential systems available to legally manage the re-use of site-won materials as part of any construction works if appropriate, such as CL:AIRE's Definition of Waste Code of Practice [39] through the production of a Materials Management Plan (MMP), specific registered waste exemptions, and/or operating under environmental permits. These approaches all require further consultation and specialist advice, which is outside the scope of this assessment and should be sought by the Client if required.

7.1.2 Waste Classification

A preliminary waste assessment has been undertaken using the HazWasteOnline waste classification tool [40] to provide a potential waste classification of the soils at the site based on the 18 samples collected during the intrusive investigations from the trial pits, inspection pits, boreholes. .

HazWasteOnline has been designed to assess various waste types including those falling under Chapter 17 of the List of Wastes (LoW) “Construction and Demolition Waste (Including Excavated Soil from Contaminated Sites)”.

Chemical data available at the time of this report were assessed to determine the potential hazardous properties of the tested soils using contaminants commonly encountered in similar materials. Where concentrations less than the limits of detection (LOD) were recorded, the value of the LOD was inputted into HazWasteOnline. Where applicable, appropriate metal species were selected based on worst-case hazard statements and the total petroleum hydrocarbons (TPH) have been assessed as an unknown oil. TPH concentrations used in the assessment are the total of all aliphatic and aromatic hydrocarbon fraction concentrations from the sample with carbon chain lengths of C6 to C40.

The results of the HazWasteOnline assessment indicates that the majority of samples recovered across the site were suitable for classification as non-hazardous waste however, elevated calcium in TP03 (0.50 m), TP03 (0.50 m), TP02 (0.20 m), IP04 (0.10 m) and BH03 (0.50 m), resulted in these samples being classified as hazardous. A breakdown of the HazWasteOnline results can be seen within Appendix G.

Table 7-1 – Waste Classification Summary

Sample Locations	Strata	Waste classification (Hazardous Property if hazardous)
TP01-0.50	Clay (RTD)	Non-Hazardous
TP02-0.20	Made Ground	Hazardous (elevated Calcium- HP 12)
TP02-1.00	Clay (RTD)	Non-Hazardous
TP03-0.50	Clay (RTD)	Hazardous
TP03-1.00	Gravel (RTD)	Non-Hazardous
TP04-0.10	Made Ground	Non-Hazardous
TP04-0.50	Gravel (RTD)	Non-Hazardous
TP05-0.50	Clay (RTD)	Hazardous
TP05-2.80	Gravel (RTD)	Non-Hazardous
IP02-0.20	Made Ground	Non-Hazardous
IP03-0.55	Clay (RTD)	Non-Hazardous



Sample Locations	Strata	Waste classification (Hazardous Property if hazardous)
IP04-0.10	Made Ground	Hazardous (elevated Calcium- HP 12)
IP05-0.60	Clay (RTD)	Non-Hazardous
IP06-0.50	Clay (RTD)	Non-Hazardous
BH01-0.50	Clay (RTD)	Non-Hazardous
BH02-0.50	Clay (RTD)	Non-Hazardous
BH03-0.50	Made Ground	Hazardous (elevated Calcium- HP 12)

7.1.3 Waste Acceptance Criteria Results Summary

Two soil samples (TP01 at 0.5-0.7 m bgl and TP05 at 2.8 to 3.0 m) were analysed for waste acceptance criteria (WAC) analyses to assess whether the soil samples could be suitable for disposal at an inert waste landfill facility. Both samples passed the inert WAC thresholds.

7.1.4 Limitations

This assessment provides a preliminary waste classification only and this assessment has been based on samples collected during the intrusive investigation which was not designed in accordance with WM3 and therefore the sampling was not undertaken in line with current standards and guidance specifically applicable for the assessment of waste.

As such, the results above should be taken as a preliminary assessment only. Actual waste materials to be removed off-site will likely need to undergo further sampling with appropriate laboratory analysis, which can then be used for classification by the waste producer as the responsible party.

Should any material from the site be considered for removal off-site, liaison with any receiving facilities should be undertaken prior to transfer of the waste. Copies of the laboratory analysis undertaken to date should be presented to the facility operator(s) alongside any further testing completed by the waste producer so they can confirm their acceptance requirements; certain types of facilities may require further WAC testing to be undertaken prior to acceptance.

In addition to not comprising a full WM3 waste classification, this assessment will not be sufficient to allow accurate estimation of waste removal fees and should be used as a guide only, and as such AtkinsRéalis is not liable for any commercial implications of the above assessment being used in such a manner.

Any material, not solely excavated materials, that needs to be discarded during the project works is potentially designated a waste and should be managed in accordance with the current authoritative regulations, guidance and best practice.



8. Preliminary Engineering Assessment and Recommendations

8.1 Proposed Works

The proposed works under consideration include a new substation, which will require a concrete foundation. The foundation will likely consist of a shallow concrete raft. In addition, there are two proposed roads; one will go around the substation and be 8 m wide, and the second will be the main access point. Design will also utilise SUDS informed from the soakaway testing.

8.2 Site Preparation and clearance

Prior to construction, removal of trees, vegetation and topsoil will be required. It is recommended that removal of any cohesive material is also undertaken to mitigate any shrink-swell potential from removing the existing trees, and the risk from perched water.

8.3 Shallow foundations

It is anticipated that a shallow raft foundation would be deemed suitable for the current proposed works. It is recommended to excavate the soft and very soft clay of the Made Ground and cohesive RTD, in order to minimise the risks from differential or over settlement, as well as create a more appropriate founding condition on the gravels. It is estimated that this will result in an excavation between 1 and 2 m. Engineered fill of 6F5 or similar should be used across the site to bring the ground level up to the required blinding level.

The level of excavation is anticipated to be greatest around the centre and northeast of the site, as shown from TP02 and TP05 which identified cohesive RTD to depths of 1.8 and 2.0 m bgl.

8.4 Excavation stability / Groundwater

Large excavations into the granular RTD is anticipated to interact with groundwater, which at current levels is between 2.7 and 4.7 m bgl. Excavations that are anticipated to be undertaken within the granular RTD will likely require shoring or battering in order to maintain vertical standing.

It is anticipated that the majority of excavations will be undertaken above this level and not interact with the groundwater.

8.5 Perched Water

There is a possibility of perched water within the RTD, based on groundwater monitoring level of 1.4 m bgl. If perched water is encountered during construction dewatering measures may be required.



8.6 Road Pavement construction

The access road will be utilised for moving the substation transformers and providing long term access to and from the substation. Assuming a proposed road depth of 0.5 – 0.6 m, the road construction is anticipated to be within the existing cohesive RTD and above the water table. Based on this level the road is anticipated to be below the frost horizon, typically 450 mm within the UK.

CBR values of 5% are proposed across the construction as shown within the in-situ tests. This is in-line with a sandy clay in a low water table, with average construction conditions (thin) from Table c-1 in LR1132. CBR values from this table propose a value of 20-40% for sand, and 60% in gravel for the granular RTD.

8.7 Soakaways and SUDS

Proposed soakaways should be placed within the granular RTD, as minimal to no infiltration is anticipated to occur within the clay band.

8.1 Classification & Shrink/Swell Potential

Atterberg limit tests undertaken on RTD cohesive samples across the site reported plasticity index values ranging from 10% – 14% with a characteristic value of 10%, and with liquid limit values ranging from 27% – 31%. These results indicate low plasticity material.

Overall, the condition of the site and the limited number of large trees across the site, the shrink-swell risk is considered to be low for the proposed design.

8.2 Aggressive Environment of Concrete

The aggressive environment of concrete was assessed in accordance with the BRE SD1 guidance [10]. The Made Ground and RTD are both confirmed as Class AC-1, therefore there is minimal risk of aggressivity to concrete anticipated at the site.

9. Geotechnical Risk Register

For the purpose of this report, geotechnical risk is defined as the possibility and consequence arising from an of an adverse ground hazard or circumstance.

The Geotechnical Risk Register considers the identified geotechnical constraints, along with additional project details to ensure that all significant geotechnical risks are identified, recorded, analysed and controlled. This risk register identifies significant risks. General construction stage risks, such as would be managed by a competent contractor are not included, except where these can be mitigated through design. The geotechnical risks are discussed in terms of probability, severity and risk, as defined below:

- **Likelihood (L):** Perceived likelihood of the identified geotechnical hazard actually occurring.
- **Severity (S):** The perceived severity, in terms of safety, financial, temporal, legal, or operational consequence, of the occurrence of the identified geotechnical hazard on the identified receptor(s)
- **Risk (R):** The perceived level of concern which should be assigned to the identified hazard, based on the likelihood of occurrence, and taking into due account the perceived severity of the impact.

The risk uses the following equation: Degree of Risk (R) = Likelihood (L) x Severity (S)

The likelihood and severity values are detailed in Table 9-1.

Table 9-1 - Likelihood and Severity rating

Likelihood		Severity			
		Health and Safety		Operational	
5	Certain	5	Fatality	5	Fatality
4	Probable	4	Major injury	4	Irreversible Damage
3	Likely	3	Reportable injury	3	Major Damage
2	Unlikely	2	Lost time injury	2	Minor Damage
1	Negligible	1	Minor injury	1	No Effect

Table 9-2 - Risk Matrix

Likelihood	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
		Severity				

Table 9-3 - Geotechnical Risk Register

Hazard	Impact	Initial Risk Rating			Mitigation Measures	Risk after mitigating measures			Description of Residual Hazard	Risk owner
		P	I	R		P	I	R		
Presence of soft superficial deposits underlying the site resulting in differential or over settlement of foundations and roads	The ground investigation has identified that the top 1 – 2 m is River Terrace Deposits which occurs as a soft or very soft clay. This will be liable to settle and could cause movement or cracking of concrete foundations or road	4	4	16	Excavate to level of granular River Terrace Deposits	2	4	8	Localised deep soft spots	Designer
Unknown or variable ground conditions, in particular related to variation of final design location.	Variable mapped superficial geology in the surrounding area, therefore if proposed works move outside of the initial area the ground model from the GI may not be applicable	4	4	16	TBD based on final design	3	4	12		Designer
Shallow groundwater	Water anticipated at 3 m bgl, but may vary depending on seasonal fluctuations Water ingress could result in instability in excavations	3	4	12	Be prepared to de-water the excavation if perched groundwater is encountered within the cohesive/granular RTD's.	2	2	4	Faster inflow than anticipated resulting in delayed progress	Contractor



					Contractor should have pumps available on site to remove water if necessary.					
Contaminated Ground	Encountering potentially contaminated ground and groundwater leading to programme delays related to encountering unknown areas of contaminated land and / or groundwater. Increased cost to final scheme due to removal or decontamination of contaminated ground. Limited material reuse and disposal options.	2	4	8	GI will address any contaminated land, targeted contamination sampling and laboratory testing has been carried out to investigate the presence of potential contamination and aid the completion of an initial waste classification assessment on material.	1	4	4	Encountering potentially contaminated ground and groundwater leading to programme delays related to encountering unknown areas of contaminated land and / or groundwater. Increased cost to final scheme due to removal or decontamination of contaminated ground. Limited material reuse and disposal options.	Designer



Perched water	Areas of groundwater / groundwater inflow to excavations not otherwise anticipated.	4	4	16	Be prepared to de-water the excavation if perched groundwater is encountered within the cohesive/granular RTD's.	2	4	8	Greater amounts of perched water than anticipated.	Contractor.
Shrink-swell potential following de-vegetation	Ground movement resulting in damage during construction, or resulting in delays between preparation and construction stages.	1	3	3	No further mitigation required. GI showed that RTD cohesive materials are low plasticity, therefore low risk of shrink swell.	1	3	3	Localised areas of high plasticity clay, not identified during GI	Designer/contractor
Aggressiveness of ground to buried concrete	Degradation and failure of any buried concrete elements over intended design life resulting in remedial works cost and disruption.	3	3	9	During the recent GI, chemical testing was undertaken to establish aggressiveness to concrete. Concrete elements to be designed to withstand future degradation/ failure based on a design sulphate class of DS-1 and aggressive chemical environment for concrete class of AC-1.	1	3	3	Localised areas of aggressive ground, not identified during investigation	Designer/contractor



10. Conclusions and Recommendations

10.1 Conclusions

Based on the findings of the site investigation and subsequent assessment detailed in Section 6 and summarised in the CSM, the potential risks are considered to be:

- low/moderate risk to human health;
- low risk to controlled waters; and,
- low to low/moderate risk to property.

An assessment of potential risk from ground gas has characterised the site as a CS1 scenario (very low risk) in accordance with BS8485. Implementation of gas protection measures into the building design would not be required on the basis of the ground gas monitoring completed.

A preliminary material reuse and waste classification assessment, based on the results from the investigation, has determined that there are unlikely to be potential risks to human health or controlled waters receptors from the reuse of material on the site, with the exception of calcium in number of soil samples. The results of the HazWasteOnline assessment indicates that the majority of samples recovered across the site do not contain hazardous properties and the WAC assessment suggests suitability for disposal at an inert landfill facility. It should be noted that a preliminary material classification has been provided in this assessment which is based on a limited number of samples. If material is proposed to be re-used, appropriate sampling of the actual material excavated will be required with concentrations compared to appropriate reuse criteria to confirm suitability for reuse or otherwise.

Any material to be removed off-site for disposal must be appropriately analysed, classified and agreed with the chosen landfill operator. It is the responsibility of the waste producer to classify, treat, manage and dispose of waste appropriately and to ensure the chosen landfill is licensed to accept such material.

10.2 Recommendations

It should be noted that, as with any physical ground investigation involving discrete sampling, test results will only be representative of the point sampled and further ground investigation and analysis may be required should ground conditions differ from those reported.

Based on the above findings, no further ground investigation work is anticipated to be required. However, vigilance should be maintained during future development in the event that unidentified contaminants are identified. In this event, advice should be sought from a land contamination specialist.

Consideration should be given to the cut/fill balance and material movements as part of the proposed development. The requirements for material reuse or disposal or importation of soils may require further assessment through completion of a materials management plan (MMP).

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APPENDICES

Appendix A. Factual Site Investigation Report





VANTAGE DATA CENTERS, 150MVA SUBSTATION

FACTUAL GROUND INVESTIGATION REPORT

Prepared for VANTAGE DATA CENTERS

Report Ref: 37989

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VANTAGE DATA CENTERS, 150MVA SUBSTATION

FACTUAL GROUND INVESTIGATION REPORT

Prepared for VANTAGE DATA CENTERS

Report Ref: 37989

PROJECT: Electrical substation

CONSULTANT: AtkinsRéalis

VOLUME - VERSION	STATUS	ORIGINATOR	CHECKER	APPROVED	DATE
1 of 1 – A	DRAFT	EC	CT	-	10/01/2025
1 of 1 – B	FINAL	EC	CT	CT	24/01/2025
ORIGINATOR			APPROVER		
					
E CRIMP Principal Engineering Geologist			C THOMAS Geotechnical Consultant		

The report is not to be used for contractual or engineering purposes unless this sheet is signed and the report designated "Final".

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



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APPENDIX C	LABORATORY TESTING
APPENDIX D	CHEMICAL ANALYSES



1. INTRODUCTION

It is proposed to construct an electrical substation to serve a new data centre near Newport, Gwent. Geotechnical Engineering Limited (GEL) was instructed by Vantage Data Centers (VDC CWL12 Limited, the Client) to carry out an investigation to determine the ground conditions. AtkinsRéalis were employed by the Client in the capacity of Consultant.

The scope of works and terms and conditions of appointment were specified by the Client and GEL correspondence reference T34892 dated 8th December 2023. The investigation was carried out under direction and supervision of the Consultant.

This report describes the investigation and presents the findings.

2. SITE LOCATION AND GEOLOGY

The site comprises an area of vegetated ground within the Celtic Lakes business park, situated to the southwest of Newport, Gwent. The site is centred on approximate National Grid co-ordinates ST 284 841.

British Geological Survey (BGS) England and Wales (Sheet No. 249, Newport, 1:50 000, 1979) and the BGS online geology (1:50,000) indicate the site is underlain by River Terrace Deposits (sand and gravel) overlying the Mercia Mudstone Group. Made Ground was also anticipated, due to recent development within the area.



3. GROUND INVESTIGATION

3.1 Fieldwork

The fieldwork was carried out in general accordance with BS5930:2015+A1:2020 during the period 21st to 29th October 2024 and comprised three boreholes, six hand excavated inspection pits and five machine excavated trial pits, with soakaway tests in two, two in situ plate loading tests and two dynamic cone penetrometer tests.

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

The boreholes, referenced BH01 to BH03 (Appendix A), were formed using a track-mounted Geotechnical Pioneer Rig. Initially, an inspection pit was hand excavated at each borehole location 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. 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.

On refusal to dynamic sampling, the boreholes were continued by rotary core drilling techniques utilising a water/polymer flush. A double-tube swivel core barrel with semi-rigid plastic liner was utilised to recover a continuous sample of 120mm diameter. Where appropriate, dynamic sampling techniques were carried out to recover dropped core or where rotary core drilling was not suitable (BH01).

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.

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.

Boreholes were monitored for groundwater ingress as dynamic sampling proceeded. 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.

On completion, dual gas/water monitoring standpipes were installed in boreholes BH01, BH02 and BH03. Each installation consisted of a 50mm ID HDPE slotted tube set in a filter response zone of non-calcareous pea gravel and sealed above and below with a bentonite plug. Each pipe was fitted with a valve assembly for gas monitoring. The installations were protected at the surface by a lockable, galvanised, raised steel cover set in concrete. Installation details are given on the relevant borehole log.

The trial pits, referenced TP01 to TP05 (Appendix A), were formed by using a tracked excavator with a 0.60m bucket. Representative disturbed samples were taken and retained in sealed plastic bags, plastic tubs and glass jars.

Soakaway tests were carried out in trial pits TP03 and TP05 in general accordance with BRE DG 365 (2016). The excavation sides were squared using the excavator bucket and the dimensions



recorded within the test section. The trial pit was partially filled with clean water using a dedicated bowser with a 75mm diameter outlet and the fall in level recorded against time. The test was attempted once in TP03 and twice in TP05. Due to limited water take in both pits, it was not possible to calculate an infiltration rate. The results are presented in Appendix A.

Plate loading tests referenced TP01 Test 1 and TP04 Test 2 were carried out to determine equivalent California Bearing Ratio (CBR) values at a depth of 0.80m in each pit. The tests were carried out in general accordance with BS1377:1990: Part 9:4.1 and the equivalent CBR value determined in accordance with HA Interim Advice Note 73/06 (2009). A 300mm diameter plate was used with load transmitted to the plate by jacking against the underside of a 14 tonne excavator. Sequential loads were applied to produce a penetration range of 0 to 2mm at approximately 0.25 to 0.50mm intervals. The load determined from a plate penetration of 1.25mm enabled the calculation of the equivalent CBR value. The testing was undertaken by Kiwa CMT, and the results are presented in Appendix A.

Dynamic Cone Penetrometer tests (DCP), referenced TP01-DCP and TP04-DCP (Appendix A), were carried out adjacent to trial pits TP01 and TP04 using a CNS Farnell A2465 dynamic cone penetrometer. Probe depths were measured with respect to ground level and the number of blows for the penetration of the probe was recorded. Equivalent CBR values have been calculated and presented with the results in Appendix A.

Photographs of the trial pit profile and spoil heap were taken and are presented separately.

On completion, all trial pits were backfilled with arisings compacted in suitable layers by the excavator bucket. The ground surface was left slightly proud to accommodate the future inevitable settlement of the backfill.

Inspection pits, referenced IP01 to IP06 (Appendix A), were hand excavated to observe the soil profile and obtain samples for testing. Representative disturbed samples were taken and



retained in sealed plastic bags, plastic tubs and glass jars. Photographs of the inspection pits were taken and are presented separately. On completion, the inspection pits were backfilled with arisings.

Environmental soil samples (ES) were monitored for the presence of Volatile Organic Compounds (VOC's) using a MiniRAE 3000 Portable Photo-Ionisation Detector (PID) with a 10.6eV gas discharge lamp. The detector uses an ultraviolet light source to break down the chemicals into positive and negative ions (ionisation). The detector measures the charge of the ionised gas and converts the signal into current. The current is then amplified and displayed as "ppm"; after measurement the ions reform the original gas or vapour allowing it to be sampled. The readings are presented on the logs in Appendix A.

Samples for chemical analyses were dispatched daily from site directly to the laboratories of i2 Analytical Limited, Watford, under a Chain of Custody. The remaining samples were brought to this Company'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+A1:2020 and Chandler and Forster (2001). 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 Engineering Geologist. The core was carefully logged and prepared prior to preserving the subsample by wrapping in clingfilm and



aluminium foil 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.

The trial pits were logged in situ to a depth of approximately 1.20m and thereafter from the surface. Detailed descriptions are given in the trial pit logs, Appendix A, along with details of sampling and in situ testing, groundwater ingress and relevant comments on stability and excavatability.

3.3 Monitoring

At the end of the fieldwork period, the water monitoring standpipes were developed by pumping and then purged until at least three well volumes of water had been removed.

Following fieldwork, a gas/water monitoring programme was undertaken, comprising six visits undertaken over a twelve-week period. The installations were monitored for gas flow and then tested for methane, carbon dioxide, oxygen, hydrogen sulphide, and carbon monoxide using a Gas Data GFM 435\6 gas analyser. Additionally, the installations were monitored for Volatile Organic Compounds (VOC's) using a MiniRAE 3000 Portable Photo-Ionisation Detector (PID) with a 10.6eV gas discharge lamp. Subsequent readings, along with water level records, are tabulated in Appendix B.

Water sampling was undertaken on two occasions from the deep installation of each borehole using low-flow methods. Prior to water sampling, temperature, dissolved oxygen levels, pH, resistivity, conductivity, dissolved solids, salinity and redox potential readings



were taken at various levels during well development and the readings are presented in Appendix B.

3.4 Laboratory Testing

A schedule of laboratory tests was prepared by the Consultant, the results are presented in Appendix C.

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

Liquid limit and plastic limit tests were carried out on ten selected samples in accordance with BS EN ISO 17892-12:2018:5.3 & 5.5. An Atterberg line plot has also been presented.

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

One specimen was prepared from a bulk sample, remoulded at received moisture content. Three sub-specimens, each 60mm square in plan, were tested in accordance with BS EN ISO 17892-10:2018 using the small shear box apparatus. The sub-specimens were tested at different normal stresses, specified by the Consultant. Following consolidation, the samples were sheared under drained conditions to give the peak effective shear strength parameters.

Point load index tests were carried out on eight selected lengths of core in accordance with ISRM (2007).



The BRE SD1 (2005) suite of tests was carried out on six samples by Eurofins Chemtest Limited, Newmarket, using in-house methods.

Selected samples were despatched to the laboratories of i2 Analytical Limited, Watford, where chemical analyses were carried out to in-house methods for a suite of contaminants. The results are presented in Appendix D.

GEOTECHNICAL ENGINEERING LIMITED



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Key.

- Borehole
- Dynamic Cone Penetrometer test
- Inspection Pit
- Trial Pit

Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

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Site:

VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Title:

EXPLORATORY HOLE LOCATION PLAN

Drawn By:	AC	Checked By:	EC	Paper Size:	A3
Scale:	1:1000			Date:	January 2025
Contract:	37989			Figure:	1



APPENDIX A

FIELDWORK DATA

KEY TO EXPLORATORY HOLE LOGS



Sample type									
D	Small disturbed	U	Undisturbed	L	Dynamic	ES	Environmental - soil	CS	Core subsample (prepared)
B	Bulk disturbed	UT	Undisturbed thin wall	C	Core	EW	Environmental - water	LS	Dynamic subsample (prepared)
LB	Large bulk disturbed	P	Piston	VC	Vibrocore	W	Water	AMAL	Amalgamated sample

Test type	
S	SPT - Split spoon sampler followed by uncorrected SPT 'N' Value. Arrow length reflects test depth range.
C	SPT - Solid cone followed by uncorrected SPT 'N' Value. Arrow length reflects test depth range. Where full test drive not completed, the result is reported as either: A linearly extrapolated "N" value, e.g. *250. No effective penetration is denoted by ** The summarised blows for the total main drive penetration achieved, e.g. 50/250
H	Hand vane - direct reading in kPa - not corrected for BS1377 (1990). Re* denotes refusal. Where the limit of the equipment is reached during a test, the reported value is the minimum recorded shear strength of the material.
M	Mackintosh probe - number of blows to achieve 100mm penetration
Mx	Mex cone - average reading of equivalent CBR value in %
PP	Pocket penetrometer - calculated reading in kPa
Vo	Headspace vapour reading, uncorrected peak values in ppm, using a PID (calibrated with isobutylene, using a 10.6eV bulb)
TR	In situ thermal resistivity by needle probe in mK/W

Sample/core range/lf	
	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 the beginning of core run, disturbed section of core excluded from SCR and RQD assessment	
lf	- fracture spacing - the modal fracture spacing (mm) over the indicated length of core. Where spacing varies significantly, the minimum, mode and maximum values are also given. NI = non-intact core NA = not applicable NR = no recovery

Instrumentation			
	Piezometer		Perforated standpipe
	Inclinometer		Extensometer

Backfill	Cover
 Granular response zone	 Raised cover
 Bentonite seal	 Stopcock cover
 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+A1:2020

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 identified when, within the natural 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 sample 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.

Where provided, the stratigraphical names/geological rock units are for guidance only and may not be wholly accurate.

BOREHOLE LOG



BH01

CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Sheet 1 of 2

Start Date 21 October 2024 Easting 328403

Scale 1:50

End Date 22 October 2024

Northing 184107

Ground Level 13.05mOD

Depth 12.50 m

sample no & type	sample depth (m) from to	casing depth (m)	samp. /core range	lf	water record depth (m)	instru- ment	test type & value	description	depth (m)	reduced level (m)	legend
1B 1ES 2D	0.00 - 0.20						Vo 0.0	Grass over soft dark brown slightly sandy slightly gravelly CLAY with rare rootlets. Gravel is subrounded fine and medium sandstone and quartzite. (POSSIBLE MADE GROUND)			
2ES 3B 4D	0.50 - 0.70						Vo 0.0	Soft brown slightly sandy gravelly CLAY. Gravel is subangular and subrounded fine to coarse sandstone and quartzite.	0.50	12.55	
3ES 5B 6D 7D 8L 9L	1.00 - 1.20	Nil					Vo 0.0	Very dense brown clayey fine to coarse SAND and GRAVEL. Gravel is subangular to rounded fine to coarse sandstone and quartzite. (RIVER TERRACE DEPOSITS)	0.90	12.15	
10C	2.00 - 3.00	Nil 2.00	70	NA			C *300	Very dense brown sandy subangular to rounded fine to coarse sandstone, siltstone and quartzite GRAVEL with a medium subangular sandstone siltstone and quartzite cobble content. Fines washed away. (RIVER TERRACE DEPOSITS)	2.00	11.05	
4ES	2.50 - 2.60						Vo 0.5				
11C	3.00 - 4.00	2.00 3.00	100	NA			C *200	Very dense brown slightly clayey sandy subangular to rounded fine to coarse sandstone, siltstone and quartzite GRAVEL with a low subangular sandstone, siltstone and quartzite cobble content. (RIVER TERRACE DEPOSITS)	3.00	10.05	
5ES 12C	3.80 - 4.00						Vo 0.5				
6ES	4.30 - 4.60	3.00	100				C *150				
							Vo 0.3	4.30 - 5.25m: Medium cobble content.			
13C	5.00 - 6.50	3.00	100	NA			C 19	Stiff reddish brown locally mottled light greenish grey rarely stained black slightly sandy gravelly CLAY. Gravel is subangular and subrounded fine and medium very stiff clay and extremely weak mudstone lithorelicts. (MERCIA MUDSTONE GROUP) (Grade III)	5.25	7.80	
							H 31	5.80m: Hand vane suggests soft.			
14C	6.50 - 7.00	3.00	80	NA			S *54	Very stiff fissured reddish brown locally mottled light greenish grey gravelly CLAY. Gravel is angular and subangular fine to coarse very stiff clay and extremely weak mudstone lithorelicts. Fissures are subhorizontal and randomly orientated extremely closely to very closely spaced planar smooth locally stained black. (MERCIA MUDSTONE GROUP) (Grade III)	6.30	6.75	
7ES 15L 16C	6.80 - 7.00						Vo 0.1	Very stiff fissured reddish brown locally mottled light greenish grey very gravelly CLAY. Gravel is angular and subangular fine to coarse very stiff clay and extremely weak mudstone lithorelicts. Fissures are subhorizontal and randomly orientated very closely spaced planar smooth locally stained black. (MERCIA MUDSTONE GROUP) (Grade III)	6.60	6.45	
8ES	7.50 - 7.70	3.00	94	NA			Vo 0.0	7.00 - 7.20m: Recovered as clayey angular and subangular fine to coarse mudstone lithorelict gravel.			
17D	8.00 - 8.38	7.50					S *67				

Continued Next Page

HOLE CONSTRUCTION				WATER STRIKE			
TOP (m)	BASE (m)	TYPE	PLANT USED	DEPTH (m)	CASING (m)	ROSE TO (m)	AFTER (min)
0.00	1.20	Inspection Pit	Hand Tools				
1.20	2.00	Windowless Sample	Geotechnical Pioneer Rig				
2.00	7.00	Rotary Core	Geotechnical Pioneer Rig				

CASING DEPTH		BARREL DIAMETER		BACKFILL			INSTRUMENTATION	
DIAM (mm)	BASE (m)	DIAM (mm)	BASE (m)	TOP (m)	BASE (m)	MATERIAL	DEPTH (m)	TYPE
168	7.50	128	2.00	0.00	0.50	Concrete	1.50	Standpipe (50mm) with geosock
		146	7.00	0.50	0.60	Gravel	8.00	Standpipe (50mm) with geosock
		128	7.20	0.60	1.00	Bentonite pellets		
		146	12.50	1.00	1.50	Gravel		

HOLE PROGRESS				REMARKS		CONTRACT	CHECKED
DATE TIME	DEPTH (m)	CASING (m)	WATER (m)				
21-10-2024 10:00	0.00	Nil					
21-10-2024 17:00	6.50	3.00	1.70				
22-10-2024 08:00	6.50	3.00	2.72				
22-10-2024 17:00	12.50	7.50	2.70				

Polymer flush used 2.00-7.00m and 7.20-12.50m. Driller notes reduced flush returns (15%) 2.00-3.00m and (10%) 6.50-7.00m. Driller notes loss of flush returns 7.20-8.00m.

37989

CT

BOREHOLE LOG



BH01

CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Sheet 2 of 2

Start Date 21 October 2024 Easting 328403

Scale 1:50

End Date 22 October 2024 Northing 184107 Ground Level 13.05mOD Depth 12.50 m

sample no & type	sample depth (m) from to	casing depth (m)	samp. /core range	lf	water record depth (m)	instru- ment	test type & value	description	depth (m)	reduced level (m)	legend
18C	8.00 - 9.50		100 0 0								
19D 9ES	8.70 - 8.90 8.70 - 8.90			NI			Vo 0.0	Extremely weak to very weak reddish brown locally mottled light greenish grey MUDSTONE. Fractures are subhorizontal, subvertical and randomly orientated extremely closely and very closely spaced undulating smooth. (MERCIA MUDSTONE GROUP) (Grade II)	8.50	4.55	
20D 21C	9.50 - 9.80 9.50 - 11.00	7.50	100 0 0				S *103	8.90 - 9.90m: Locally disintegrated to very stiff reddish brown very gravelly clay. Gravel is angular and subangular fine to coarse mudstone lithorelicts.			
10ES 22D	10.30 - 10.50 10.30 - 10.50			NI			Vo 0.0	Extremely weak reddish brown MUDSTONE with frequent light greenish grey reduction spots (up to 15mm diam). Fractures are subhorizontal, subvertical and randomly orientated very closely spaced planar and undulating smooth. (MERCIA MUDSTONE GROUP) (Grade II)	9.90	3.15	
23C	11.00 - 12.50	7.50	100 0 0				C *94	10.60m: PLI suggests very weak.			
								11.00 - 11.20m: Locally mottled light greenish grey.			
		7.50					C *100	Borehole Completed at 12.50m	12.50	0.55	

HOLE CONSTRUCTION				WATER STRIKE			
TOP (m)	BASE (m)	TYPE	PLANT USED	Groundwater not encountered prior to use of flush			
7.00	7.20	Windowless Sample	Geotechnical Pioneer Rig	DEPTH (m)	CASING (m)	ROSE TO (m)	AFTER (min)
7.20	12.50	Rotary Core	Geotechnical Pioneer Rig	REMARKS			

CASING DEPTH		BARREL DIAMETER		BACKFILL		INSTRUMENTATION	
DIAM (mm)	BASE (m)	DIAM (mm)	BASE (m)	TOP (m)	BASE (m)	DEPTH (m)	TYPE
				1.50	2.00		
				2.00	8.00		
				8.00	12.50		

HOLE PROGRESS				REMARKS	
DATE	TIME	DEPTH (m)	CASING (m)		
				CONTRACT	CHECKED
				37989	CT

BOREHOLE LOG



BH02

CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Sheet 1 of 2

Start Date 23 October 2024 Easting 328425

Scale 1:50

End Date 24 October 2024

Northing 184148

Ground Level 13.05mOD

Depth 12.50 m

sample no & type	sample depth (m) from to	casing depth (m)	samp. /core range	lf	water record depth (m)	instru- ment	test type & value	description	depth (m)	reduced level (m)	legend
1B	0.10 - 0.30						Vo 0.0	Grass over soft dark brown slightly sandy slightly gravelly			
1ES	0.10 - 0.30							CLAY. Gravel is subangular and subrounded fine to coarse			
2D	0.10 - 0.30						Vo 0.0	sandstone and siltstone. (POSSIBLE MADE GROUND)	0.40	12.65	
3D	0.10 - 0.30							Soft reddish brown slightly sandy slightly gravelly becoming			
2ES	0.50 - 0.70							gravelly CLAY. Gravel is subangular and subrounded fine to			
4B	0.50 - 0.70						Vo 0.0	coarse siltstone and sandstone.			
5D	0.50 - 0.70										
3ES	1.00 - 1.20						S 45	Limited recovery. Very stiff brown mottled yellowish brown	1.20	11.85	
6B	1.00 - 1.20							and reddish brown slightly gravelly sandy CLAY with rare			
7D	1.00 - 1.20	Nil						rootlets. Gravel is subangular to rounded fine to coarse			
8D	1.20 - 1.65							sandstone and quartzite. (RIVER TERRACE DEPOSITS)			
9L	1.20 - 1.50	1.50	20	NA				1.50 - 2.00m: Limited recovery, fines washed away. Recovered			
10C	1.50 - 2.00						C *68	as subangular and subrounded coarse sandstone and siltstone	2.00	11.05	
								gravel with a low rounded sandstone cobble content.			
11C	2.00 - 3.00	2.00	40	NA				Very dense brown subangular to rounded medium and			
							C *64	coarse sandstone, siltstone and quartzite GRAVEL with a			
12C	3.00 - 4.00	3.00	20					medium subangular to rounded sandstone and siltstone			
								cobble content. Limited recovery, fines washed away.			
								(RIVER TERRACE DEPOSITS)			
13C	4.00 - 5.00	3.00 4.00	16				C *81				
14C	5.00 - 6.50	4.00 5.00	17				C *71				
15C	6.50 - 8.00	6.50	87 0 0	NA			C 17	Stiff reddish brown locally mottled light greenish grey			
								slightly sandy slightly gravelly CLAY. Gravel is angular fine			
								and medium very stiff clay lithorelicts. (MERCIA			
								MUDSTONE GROUP) (Grade III)			
								Medium bed of extremely weak reddish brown	6.50	6.55	
								MUDSTONE. Fractures are randomly orientated extremely			
								closely and very closely spaced planar smooth stained			
								black. (MERCIA MUDSTONE GROUP) (Grade II)			
								Very stiff fissured reddish brown locally mottled light			
								greenish grey gravelly locally very gravelly CLAY. Gravel is	7.25	5.80	
								angular and subangular fine to coarse very stiff clay and			
								extremely weak mudstone lithorelicts. Fissures are	7.45	5.60	
								randomly orientated extremely closely and very closely			
								spaced planar smooth locally stained black. (MERCIA			
								MUDSTONE GROUP) (Grade III)			
16D	8.00 - 8.41	6.50					S *58				

Continued Next Page

HOLE CONSTRUCTION				WATER STRIKE Groundwater not encountered prior to use of flush			
TOP (m)	BASE (m)	TYPE	PLANT USED	DEPTH (m)	CASING (m)	ROSE TO (m)	AFTER (min) REMARKS
0.00	1.20	Inspection Pit	Hand Tools				
1.20	1.50	Windowless Sample	Geotechnical Pioneer Rig				
1.50	12.50	Rotary Core	Geotechnical Pioneer Rig				
CASING DEPTH		BARREL DIAMETER		BACKFILL		INSTRUMENTATION	
DIAM (mm)	BASE (m)	DIAM (mm)	BASE (m)	TOP (m)	BASE (m)	MATERIAL	DEPTH (m) TYPE
168	8.00	128	1.50	0.00	0.50	Concrete	1.50 Standpipe (50mm) with geosock
		146	12.50	0.50	0.60	Gravel	8.00 Standpipe (50mm) with geosock
				0.60	1.00	Bentonite pellets	
				1.00	1.50	Gravel	
HOLE PROGRESS				REMARKS			
DATE TIME	DEPTH (m)	CASING (m)	WATER (m)	Polymer flush used 1.50-12.50m. Driller notes reduced flush			
23-10-2024 12:10	0.00	Nil		returns (50-700%) 1.50-8.00m. Driller notes loss of flush returns			
23-10-2024 17:30	3.00	3.00	0.20	8.00-9.50m.			
24-10-2024 09:00	3.00	3.00	0.29				
24-10-2024 16:55	12.50	8.00	2.25				
				CONTRACT		CHECKED	
				37989		CT	



BH02

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Depth 12.50 m

HOLE PROGRESS				REMARKS
DATE TIME	DEPTH (m)	CASING (m)	WATER (m)	
				 CONTRACT 37989 CHECKED CT

BOREHOLE LOG



BH03

CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Sheet 1 of 2

Start Date 25 October 2024 Easting 328471

Scale 1:50

End Date 29 October 2024 Northing 184154 Ground Level 13.35mOD Depth 13.34 m

sample no & type	sample depth (m) from to	casing depth (m)	samp. /core range	lf	water record depth (m)	instru- ment	test type & value	description	depth (m)	reduced level (m)	legend
1B 1ES 2D	0.10 - 0.30						Vo 0.0	Grass over soft becoming firm dark brown slightly sandy slightly gravelly becoming gravelly CLAY. Gravel is subangular and subrounded fine to coarse sandstone and siltstone. (POSSIBLE MADE GROUND)			
2ES 3B 4D	0.50 - 0.70						Vo 0.0				
3ES 5B 6D	1.00 - 1.20						Vo 0.0				
7D 8L	1.20 - 1.65						S 50	Firm becoming stiff brown and grey slightly sandy slightly gravelly CLAY. Gravel is subangular to rounded fine to coarse sandstone.	1.20	12.15	
10D 4ES	1.50 - 1.60	1.60	50	NA				Limited recovery. Brown and grey slightly sandy subangular to rounded fine to coarse quartzite and sandstone GRAVEL. (RIVER TERRACE DEPOSITS)	1.60	11.75	
11C 12C	1.60 - 2.00	1.60	45	NR			C *77	Assessed zone of core loss.	2.00	11.35	
	2.00 - 3.00										
13D 14C	2.80 - 3.00	3.00	30	NA			C 42	Orangish brown, yellowish brown and grey slightly gravelly medium and coarse SAND. Gravel is subrounded and rounded fine sandstone. (RIVER TERRACE DEPOSITS)	2.55	10.80	
	3.00 - 4.00							Dense becoming very dense reddish brown and yellowish brown subrounded and rounded fine to coarse sandstone GRAVEL with a medium to high subrounded to locally rounded sandstone cobble content. Limited recovery, fines washed away. (RIVER TERRACE DEPOSITS)	3.00	10.35	
15C	4.00 - 5.00	3.00	30				C *67				
C	5.00 - 6.00	3.00	0				C *83	5.00 - 6.00m: No recovery.			
16C	6.00 - 7.00	6.00	20				C 26	6.00 - 7.00m: Medium dense. Clayey. Rare lenses of red clay. Limited recovery (0.20m).			
17D 18C	7.00 - 7.35	6.00	80	NA			S *77	Very stiff thickly laminated to very thin bedded reddish brown locally mottled light grey slightly sandy slightly gravelly CLAY. Gravel is subangular fine and medium very stiff clay and extremely weak mudstone lithorelicts. (MERCIA MUDSTONE GROUP) (Grade III)	7.00	6.35	
19D	7.50 - 7.60							Extremely weak to very weak thin and thickly laminated reddish brown MUDSTONE. Fractures are subhorizontal and randomly orientated extremely closely and very closely spaced planar and undulating smooth locally rough rarely stained dark grey. (MERCIA MUDSTONE GROUP) (Grade II)	7.60	5.75	
20D 21D	7.80 - 7.90										
	8.00 - 8.30	6.00					S *103				

Continued Next Page

HOLE CONSTRUCTION				WATER STRIKE			
TOP (m)	BASE (m)	TYPE	PLANT USED	DEPTH (m)	CASING (m)	ROSE TO (m)	AFTER (min)
0.00	1.20	Inspection Pit	Hand Tools				
1.20	1.60	Windowless Sample	Geotechnical Pioneer Rig				
1.60	13.34	Rotary Core	Geotechnical Pioneer Rig				

CASING DEPTH		BARREL DIAMETER		BACKFILL			INSTRUMENTATION	
DIAM (mm)	BASE (m)	DIAM (mm)	BASE (m)	TOP (m)	BASE (m)	MATERIAL	DEPTH (m)	TYPE
168	6.00	128	1.60	0.00	0.50	Concrete	1.50	Standpipe (50mm) with geosock
		146	13.00	0.50	0.60	Gravel	7.00	Standpipe (50mm) with geosock
				0.60	1.00	Bentonite pellets		
				1.00	1.50	Gravel		

HOLE PROGRESS				REMARKS Dynamic sampling undertaken to recover dropped core 2.00-3.00m. Polymer flush used 1.60-13.00m.	AGS
DATE TIME	DEPTH (m)	CASING (m)	WATER (m)		
25-10-2024 06:00	0.00	Nil			
25-10-2024 16:05	2.00	1.60	0.29		
28-10-2024 08:45	2.00	1.60	Dry		
28-10-2024 17:00	9.00	6.00	1.60		
29-10-2024 08:30	9.00	6.00	2.30		
29-10-2024 12:30	13.34	6.00	1.95		
				CONTRACT 37989	CHECKED CT

BOREHOLE LOG



BH03

CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Sheet 2 of 2

Start Date 25 October 2024 Easting 328471

Scale 1:50

End Date 29 October 2024

Northing 184154

Ground Level 13.35mOD

Depth 13.34 m

sample no & type	sample depth (m) from to	casing depth (m)	samp. /core range	lf	water record depth (m)	instru- ment	test type & value	description	depth (m)	reduced level (m)	legend
22C	8.00 - 9.00		95 11 11	NI				8.00 - 8.30m: Disintegrated to clayey angular and subangular fine to coarse gravel sized extremely weak mudstone lithorelicts.	8.30	5.05	
				NA				Stiff to very stiff very thinly bedded fissured reddish brown mottled light grey very gravelly CLAY tending to slightly clayey angular and subangular fine to coarse gravel. Gravel is subangular fine and medium very stiff clay and extremely weak mudstone lithorelicts. Fissures are randomly orientated extremely closely and very closely spaced undulating rough stained dark grey. (MERCIA MUDSTONE GROUP) (Grade III)	8.90	4.45	
23CS	8.89 - 9.00			NI			S *86	Extremely weak locally very weak very thinly to thinly bedded reddish brown MUDSTONE. Fractures are subhorizontal and subvertical locally randomly orientated very closely and closely spaced planar and undulating rough locally stained dark grey. (MERCIA MUDSTONE GROUP) (Grade II)			
24D	9.00 - 9.33	6.00	100 55 35	60				9.70 - 9.90m: Thin bed of very stiff reddish brown gravelly clay. Gravel is angular and subangular fine and medium extremely weak mudstone lithorelicts.			
25C	9.00 - 10.00			200							
26CS	9.25 - 9.40										
27D	10.00 - 10.28	6.00	100 37 20				S *100				
28C	10.00 - 11.50										
29CS	10.60 - 10.77										
30CS	10.90 - 10.98										
31D	11.50 - 11.79	6.00	100 41 30				S *107				
32C	11.50 - 13.00										
33D	11.50 - 11.60										
34CS	11.80 - 12.05										
35CS	12.40 - 12.60										
36D	13.00 - 13.34	6.00					S *81				
								Borehole Completed at 13.34m	13.34	0.01	

HOLE CONSTRUCTION				WATER STRIKE Groundwater not encountered prior to use of flush			
TOP (m)	BASE (m)	TYPE	PLANT USED	DEPTH (m)	CASING (m)	ROSE TO (m)	AFTER (min) REMARKS
CASING DEPTH				BARREL DIAMETER		BACKFILL	
DIAM (mm)	BASE (m)			DIAM (mm)	BASE (m)	TOP (m) BASE (m) MATERIAL	INSTRUMENTATION
						1.50 2.00 Bentonite pellets	DEPTH (m) TYPE
						2.00 7.00 Gravel	
						7.00 13.34 Bentonite pellets	
HOLE PROGRESS				REMARKS			
DATE TIME	DEPTH (m)	CASING (m)	WATER (m)				
						CONTRACT	CHECKED
						37989	CT

Geotechnical Engineering Limited

STANDARD PENETRATION TEST



CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

borehole no.	borehole depth (m)	s.w.p (mm)	base depth (m)	casing depth (m)	water level (m)	seating drive		test drive				test type	N	energy ratio %						
						blows	pen (mm)	blows		pen (mm)										
BH01	1.20		1.58	Nil	Dry	9	16	75	75	14	16	20	75	75	75	S	67	75		
BH01	2.00		2.15	Nil	Dry	12	11	75	25	50			50			C	300	75		
BH01	3.00		3.20	2.00	1.12	12	13	75	45	50			75			C	200	75		
BH01	4.00		4.25	3.00	1.51	7	17	75	75	38	12		75	25		C	150	75		
BH01	5.00		5.45	3.00	1.66	4	4	75	75	3	4	5	7	75	75	75	75	C	19	75
BH01	6.50		6.93	3.00	1.80	1	6	75	75	8	9	18	15	75	75	75	53	S	54	75
BH01	8.00		8.38	7.50	2.30	2	8	75	75	10	19	21		75	75	75		S	67	75
BH01	9.50		9.80	7.50	2.21	7	16	75	75	23	27			75	70			S	103	75
BH01	11.00		11.31	7.50	2.31	11	13	75	75	20	22	8		75	75	10		C	94	75
BH01	12.50		12.80	7.50	2.50	6	14	75	75	18	32			75	75			C	100	75
BH02	1.20		1.65	Nil	Dry	3	3	75	75	4	11	14	16	75	75	75	75	S	45	87
BH02	2.00		2.37	2.00	0.12	10	8	75	75	8	17	25		75	75	70		C	68	87
BH02	3.00		3.39	3.00	0.18	1	6	75	75	11	14	22	3	75	75	75	10	C	64	87
BH02	4.00		4.34	3.00	0.30	2	7	75	75	10	28	12		75	75	35		C	81	87
BH02	5.00		5.36	4.00	0.35	6	13	75	75	18	21	11		75	75	60		C	71	87
BH02	6.50		6.95	6.50	0.26	1	3	75	75	2	4	5	6	75	75	75	75	C	17	87
BH02	8.00		8.41	6.50	1.35	5	6	75	75	7	13	22	8	75	75	75	35	S	58	87
BH02	9.50		9.78	8.00	0.20	5	19	75	75	30	20			75	50			C	120	87
BH02	11.00		11.27	8.00	2.50	15	10	75	70	25	25			75	50			C	120	87
BH02	12.50		12.81	8.00	2.25	11	12	75	75	23	21	6		75	75	5		C	97	87

- 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
37989	CT

Geotechnical Engineering Limited

STANDARD PENETRATION TEST



CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

borehole no.	borehole depth (m)	s.w.p (mm)	base depth (m)	casing depth (m)	water level (m)	seating drive		test drive				test type	N	energy ratio %						
						blows	pen (mm)	blows		pen (mm)										
BH03	1.20		1.65	Nil	Dry	2	1	75	75	5	10	15	20	75	75	75	75	S	50	87
BH03	2.00		2.35	1.60	0.15	5	14	75	75	16	20	14		75	75	45		C	77	87
BH03	3.00		3.45	3.00	0.00	3	3	75	75	4	5	21	12	75	75	75	75	C	42	87
BH03	4.00		4.38	3.00	0.30	4	15	75	75	15	20	15		75	75	75		C	67	87
BH03	5.00		5.33	3.00	0.40	7	16	75	75	20	22	8		75	75	30		C	83	87
BH03	6.00		6.45	6.00	0.00	8	7	75	75	8	7	4	7	75	75	75	75	C	26	87
BH03	7.00		7.35	6.00	2.00	4	4	75	75	7	23	20		75	75	45		S	77	87
BH03	8.00		8.30	6.00	2.35	3	18	75	75	28	22			75	70			S	103	87
BH03	9.00		9.33	6.00	1.55	5	12	75	75	19	27	4		75	75	25		S	86	87
BH03	10.00		10.28	6.00	2.38	12	13	75	50	21	29			75	75			S	100	87
BH03	11.50		11.79	6.00	2.51	11	13	75	75	25	25			75	65			S	107	87
BH03	13.00		13.34	6.00	1.95	7	12	75	75	15	22	13		75	75	35		S	81	87
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			
															37989		CT			

Geotechnical Engineering Limited

IN-SITU HAND VANE/POCKET PENETROMETER



CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Borehole /trial pit no.	Depth (m)	Hand vane peak (kPa)	Average hand vane peak (kPa)	Hand vane remoulded (kPa)	Average hand vane remoulded (kPa)	Pocket penetrometer (kg/cm ²)	Average pocket penetrometer (kPa)	Remarks
BH01	5.80	31	31	11	11			
Hand vane and pocket penetrometer test results reported as undrained shear strength							CONTRACT 37989	CHECKED CT

TRIAL PIT LOG



TP01

CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Sheet 1 of 1

Start Date 23 October 2024 Easting 328409

Scale 1:25

End Date 23 October 2024 Northing 184128 Ground Level 13.05mOD

Depth 3.00 m

sample no & type	sample depth (m) from to	test type & value	water record (m)	description	depth (m)	reduced level (m)	legend
1B 2D 1ES	0.00 - 0.30 0.00 - 0.30 0.10 - 0.30	Vo 0.1		Grass over very soft to soft dark brown slightly sandy slightly gravelly silty CLAY with frequent roots (up to 3mm diam) and rootlets. Gravel is subangular to rounded fine to coarse sandstone and quartzite. (POSSIBLE MADE GROUND)	0.30	12.75	
2ES 3B 4D	0.50 - 0.70 0.50 - 1.00 0.50 - 0.80	Vo 0.0		Soft orangish brown slightly sandy slightly gravelly silty CLAY with rare roots (up to 3mm diam) and frequent rootlets. Gravel is subangular and subrounded fine to coarse sandstone.			
5D	1.20 - 1.50						
6D	1.90 - 2.20			Brown clayey very sandy subangular to rounded fine to coarse sandstone, siltstone and limestone GRAVEL with a medium subangular sandstone cobble content and rare rootlets. (RIVER TERRACE DEPOSITS)	1.50	11.55	
7B 8D 3ES	2.50 - 3.00 2.50 - 3.00 2.70 - 3.00	Vo 0.0					
			▼	Trial pit Completed at 3.00m	3.00	10.05	

Equipment: Pit excavated by 14 tonne tracked excavator.
Pit width x length: 2.20m x 3.70m with long side orientated 045°
Sidewall stability: Spalling
Groundwater: Groundwater seepage encountered at 3.00m

Backfill: Arisings 0.00 - 3.00m.

Remarks: CBR test undertaken 0.80m depth. DCP undertaken adjacent to trial pit. Results presented separately.



CONTRACT 37989	CHECKED CT
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EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

TRIAL PIT LOG



TP02

CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Start Date 21 October 2024 Easting 328452 Sheet 1 of 1
End Date 21 October 2024 Northing 184150 Ground Level 13.40mOD Scale 1:25
Depth 3.00 m

sample no & type	sample depth (m) from to	test type & value	water record (m)	description	depth (m)	reduced level (m)	legend
1B 2D 1ES	0.00 - 0.30 0.00 - 0.30 0.20 - 0.30	Vo 0.1		Grass over very soft to soft dark brown slightly sandy slightly gravelly CLAY with frequent roots (up to 10mm diam) and rootlets. Gravel is subangular to rounded fine to medium sandstone and siltstone. (POSSIBLE MADE GROUND)	0.50	12.90	
2ES 3B 4D	0.50 - 0.70 0.50 - 0.70 0.50 - 0.70			Very soft brown slightly gravelly sandy clayey SILT with frequent roots (up to 10mm diam) and rootlets. Gravel is subangular to rounded fine to coarse sandstone and siltstone.			
3ES 5B 6D	1.00 - 1.20 1.00 - 1.20 1.00 - 1.20			Very soft light brown slightly sandy gravelly silty CLAY with a medium subangular sandstone and siltstone cobble content and frequent roots (up to 5mm diam) and rootlets. Gravel is subangular to rounded fine to coarse sandstone and siltstone.			
7D	1.50 - 1.70	Vo 0.0			2.00	11.40	
4ES 8B	2.00 - 2.20 2.00 - 2.30			Light brown silty very sandy subangular to rounded fine to coarse siltstone and sandstone GRAVEL. (RIVER TERRACE DEPOSITS)			
9D	2.30 - 2.70						
10B 11D 5ES	2.70 - 3.00 2.70 - 3.00 2.80 - 3.00	Vo 0.0		Yellowish brown sandy subangular to subrounded fine to coarse sandstone GRAVEL with a medium sandstone cobble content. (RIVER TERRACE DEPOSITS)	2.50	10.90	
				Brownish grey silty sandy subangular and subrounded fine to coarse sandstone and siltstone GRAVEL. (RIVER TERRACE DEPOSITS)	2.70	10.70	
				Trial pit Completed at 3.00m	3.00	10.40	

Equipment: Pit excavated by 14 tonne tracked excavator.
Pit width x length: 1.00m x 2.00m
Sidewall stability: Stable
Groundwater: Not encountered
Backfill: Arisings 0.00 - 3.00m.



CONTRACT	CHECKED
37989	CT

TRIAL PIT LOG



TP03

CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Sheet 1 of 1

Start Date 22 October 2024 Easting 328452

Scale 1:25

End Date 24 October 2024 Northing 184124 Ground Level 13.10mOD

Depth 3.00 m

sample no & type	sample depth (m) from to	test type & value	water record (m)	description	depth (m)	reduced level (m)	legend
1B 2D 1AES 1ES	0.00 - 0.30 0.00 - 0.30 0.10 0.10 - 0.30	Vo 0.0		Grass over very soft to soft dark brown slightly sandy slightly gravelly silty CLAY with abundant roots (up to 5mm diam) and rootlets. Gravel is subangular and subrounded fine and medium sandstone. (POSSIBLE MADE GROUND)			
2ES 3B 4D	0.50 - 0.70 0.50 - 0.70 0.50 - 0.70	Vo 0.0		Very soft to soft brown slightly sandy slightly gravelly silty CLAY with frequent rootlets and with frequent pockets (up to 100x200x400mm) of stiff light brown silty clay. Gravel is angular to rounded fine to coarse sandstone, siltstone and rare limestone.	0.40	12.70	
5D	0.80 - 1.00			Light brown silty sandy subrounded and rounded fine to coarse sandstone, limestone and quartzite GRAVEL with a medium subangular sandstone cobble content. (RIVER TERRACE DEPOSITS)	0.80	12.30	
3ES 6B 7D	1.00 - 1.20 1.00 - 1.20 1.00 - 1.20	Vo 0.0		Brown slightly clayey very sandy subangular to rounded fine to coarse sandstone, siltstone and quartzite GRAVEL with a medium subrounded sandstone cobble content. (RIVER TERRACE DEPOSITS)	1.30	11.80	
4ES 8B 9D	2.00 - 2.30 2.00 - 2.50 2.00 - 2.50	Vo 0.0					
10B 11D 5ES	2.70 - 3.00 2.70 - 3.00 2.70 - 3.00	Vo 0.0					
			▼	Trial pit Completed at 3.00m	3.00	10.10	

Equipment: Pit excavated by 14 tonne tracked excavator.
Pit width x length: 1.00m x 3.50m with long side orientated 055°
Sidewall stability: Stable
Groundwater: Groundwater seepage encountered at 3.00m

Backfill: Arisings 0.00 - 3.00m.

Remarks: Soakaway test undertaken at 1.00m depth. Results presented separately.



CONTRACT	CHECKED
37989	CT

TRIAL PIT LOG



TP04

CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Sheet 1 of 1

Start Date 23 October 2024 Easting 328401

Scale 1:25

End Date 23 October 2024 Northing 184089 Ground Level 12.85mOD

Depth 3.00 m

sample no & type	sample depth (m) from to	test type & value	water record (m)	description	depth (m)	reduced level (m)	legend
1B 2D 1ES	0.00 - 0.35 0.00 - 0.35 0.10 - 0.35	Vo 0.1		Grass over very soft to soft brown slightly sandy slightly gravelly silty CLAY with abundant roots (up to 6mm diam) and rootlets. Gravel is subrounded to rounded fine to coarse sandstone and siltstone. (POSSIBLE MADE GROUND)			
3D 2ES 4B 5D	0.35 - 0.45 0.50 - 0.80 0.50 - 0.80 0.50 - 0.80	Vo 0.0		0.35 - 0.45m: Very soft orangish brown slightly sandy slightly gravelly silty clay. Gravel is subangular to subrounded fine to coarse sandstone and quartzite. Light brown very clayey very sandy subangular to rounded fine to coarse sandstone, siltstone and rare limestone GRAVEL with a medium subangular and subrounded sandstone cobble content and frequent rootlets. (RIVER TERRACE DEPOSITS)	0.45	12.40	
6D	1.70 - 2.00			Brown silty sandy subangular to rounded fine to coarse sandstone and siltstone GRAVEL with a low subrounded and rounded sandstone and siltstone cobble content. (RIVER TERRACE DEPOSITS)	1.70	11.15	
7D 3ES	2.30 - 2.75 2.50 - 2.75	Vo 0.0		2.30 - 2.75m: Greyish brown. Gravel is subrounded and rounded fine to coarse sandstone and siltstone.			
8B 4ES	2.75 - 3.00 2.80 - 3.00	Vo 0.0					
			▼	Trial pit Completed at 3.00m	3.00	9.85	

Equipment:	Pit excavated by 14 tonne tracked excavator.
Pit width x length:	0.80m x 2.00m with long side orientated 105°
Sidewall stability:	Stable
Groundwater:	Groundwater seepage encountered at 3.00m
Backfill:	Arisings 0.00 - 3.00m.
Remarks:	CBR test undertaken at 0.80m depth. DCP undertaken adjacent to trial pit. Results presented separately.
EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS	
CONTRACT	CHECKED
37989	CT

TRIAL PIT LOG



TP05

CLIENT VANTAGE DATA CENTERS

SITE VANTAGE DATA CENTERS, 150 MVA SUBSTATION

Sheet 1 of 1

Start Date 21 October 2024 Easting 328483

Scale 1:25

End Date 24 October 2024 Northing 184145 Ground Level 13.15mOD

Depth 3.00 m

sample no & type	sample depth (m) from to	test type & value	water record (m)	description	depth (m)	reduced level (m)	legend
1B 2D 1ES	0.00 - 0.30 0.00 - 0.30 0.10 - 0.30	Vo 0.1		Grass over very soft to soft greyish brown slightly sandy slightly gravelly silty CLAY with frequent roots (up to 5mm diam) and rootlets. (POSSIBLE MADE GROUND)	0.40	12.75	
3B 4D 2ES	0.50 - 0.70 0.50 - 0.70 0.60 - 0.80	Vo 0.0		Very soft to soft brown slightly gravelly slightly sandy silty CLAY with a medium subangular sandstone and quartzite cobble content and rare rootlets. Gravel is subangular to rounded fine to coarse sandstone and quartzite.			
5D	0.80 - 1.00						
3ES 6B 7D	1.00 - 1.20 1.00 - 1.20 1.00 - 1.20	Vo 0.0					
8B 4ES	1.80 - 2.40 1.90 - 2.20	Vo 0.0		Brown silty sandy subangular to rounded fine to coarse sandstone, siltstone and quartzite GRAVEL with a medium subangular to rounded sandstone cobble content. (RIVER TERRACE DEPOSITS)	1.80	11.35	
10B 5ES 9D	2.80 - 3.00 2.80 - 3.00 2.80 - 3.00	Vo 0.0			3.00	10.15	
				Trial pit Completed at 3.00m			

Equipment: Pit excavated by 14 tonne tracked excavator.

Pit width x length: 0.80m x 3.00m with long side orientated 100°

Sidewall stability: Spalling

Groundwater: Not encountered

Backfill: Arisings 1.00 - 3.00m.

Remarks: Soakaway test undertaken at 1.00m depth. Results presented separately.



CONTRACT	CHECKED
37989	CT

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

Date: 23/01/2025

Lab Ref: 231024-04 Rev. 1

Originator: Harjoyt Sehmi

Order Ref: 9888

Site: Vantage Data Centres
Celtic Way, Marshfield
Newport
NP10 8PE

Kiwa CMT
Unit 5 Prime Park Way
Prime Enterprise Park
Derby
DE1 3QB

T +44 (0)1332 383333
E uk.cmt.enquiries@kiwa.com

www.kiwa.co.uk/cmt

Requirements:

Attend the above site on 23/10/2024 in order to carry out 2 Plate bearings for equivalent CBR% tests to evaluate the modulus of sub-grade reaction 'k' and estimate the equivalent CBR percentage in accordance with Interim Advice Note (IAN) 73/06 Revision 1 (2009).

Results:

The individual result sheets may be viewed on pages 2 to 3 of this report.

Comments

Test depths added

Kiwa CMT

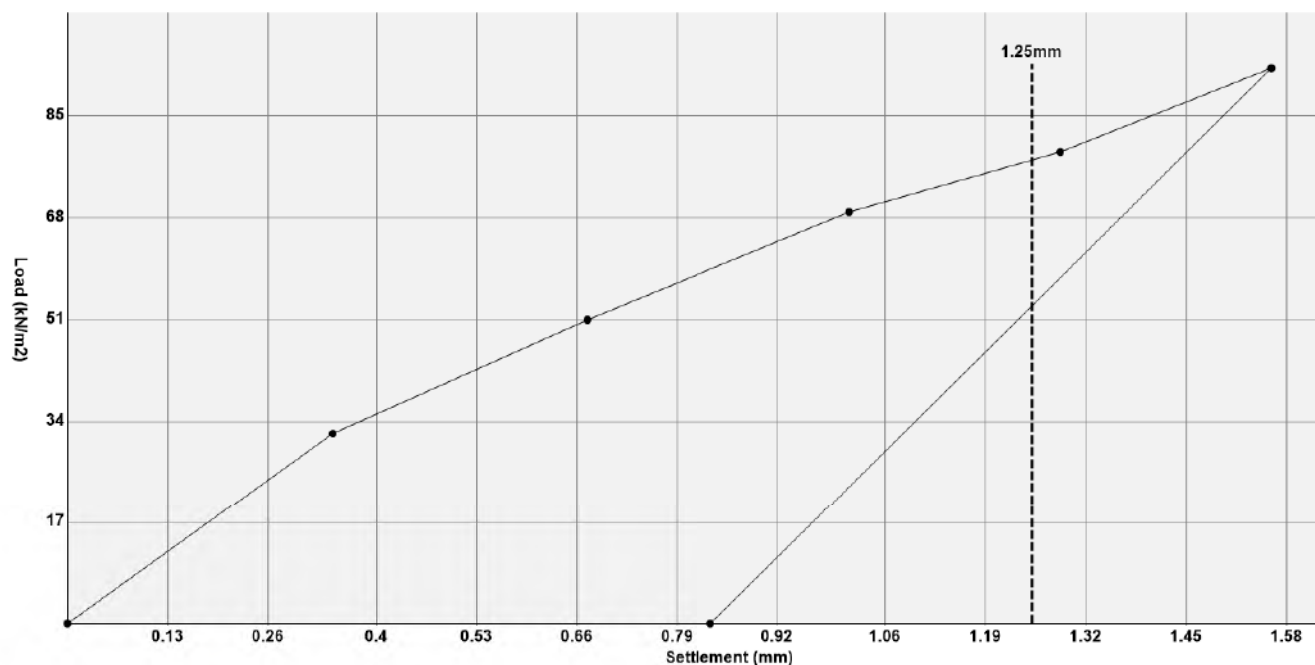
A handwritten signature in black ink, appearing to read "L. Anaz", with a horizontal line extending to the left.

Checked and Authorised by: Linda Anaz
Technical Administrator

300mm Diameter Plate Test

Client:	Geotechnical Engineering Ltd	Material Type:	Reddish/light brown silty sandy CLAY
Site:	Vantage Data Centres Celtic Way, Marshfield Newport	Test No:	CBR Test 1
Lab Ref.:	231024-04 Rev. 1	^ Test Location:	TP 01 @ 0.80m
Kentledge:	14 Tonne Digger	Layer:	Formation
Conditions:	Dry	^ Road No:	^ Chainage:
		Date of Test:	23/10/2024

Pressure (kN/m ²)	Settlement (mm)
0	0.00
32	0.34
51	0.67
69	1.01
79	1.29
93	1.56
0	0.83



Test Method: Interim Advice Note (IAN) 73/06 Revision 1 (2009)

Result: Modulus of Sub grade Reaction k_{762} = 27524 kN/m²/m
 Equivalent CBR = 3 %

Comments: Information marked by ^ supplied by the client can affect the validity of the results, these apply only to the locations provided.