

WEPCo | Cardiff and Vale Colleges (CAVC)

Cardiff and Vale College - Advanced Technology Centre (ATC)

Ground Investigation Report

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Executive Summary

Site description	The Advanced Technology Centre (ATC) development site (National Grid Reference ST 07472 67768) is located immediately east of Cardiff Airport Business Park, approximately 1.85km northeast of Rhoose village centre. The site covers an area of approximately 9ha and comprises agricultural fields bounded and bisected by a range of semi mature to mature trees and hedgerows. Records indicate the site has always been used as agricultural land comprising fields with no previous development identified and is therefore considered to be effectively greenfield.
Proposed development	The proposed development comprises the design of a new college campus including multi-storey buildings and at-grade car parking areas, civil engineering site design and landscaping throughout. The design is subject to ongoing development and detailed design through subsequent project stages.
Ground investigation	Ground investigations have been undertaken for the development of the proposed site and its surroundings. The recent site investigation was designed and scheduled by Arup and undertaken by HSP Consulting from September to October 2023 and January 2024, followed by groundwater and ground gas monitoring. The investigation included machine excavated trial pits and rotary core drilling boreholes, with soil and groundwater lab testing.
Ground conditions	<p>The ground conditions encountered during the intrusive investigations on site are generally consistent with those of the published geology and detailed in previous studies comprising the Porthkerry Member (interbedded limestone and mudstone) with no significant thickness of natural deposits across the site.</p> <p>The Porthkerry Member Limestone was encountered throughout the site at shallow depths, with the depth to the bedrock top level varying between 0.3 and 1.7m. Superficial soils between the Topsoil and basal Porthkerry Member Limestone have been classified as Head Deposits.</p>
Groundwater	Groundwater was not encountered during the drilling and pitting works of the investigation. The records from post field monitoring works are indicate groundwater level values between 1.0 and 6.0m bgl, which are likely associated with percolated rainwater within the standpipes and are not representative of groundwater sources.
Geo-environmental considerations	<p><u>Human health</u></p> <p>The completed investigations and assessments confirmed a very low level of risk that the site may pose to the end site users. Therefore, no mitigation measures are required. Isolated areas of Made Ground may be encountered in the southeastern corner of the site. These will require testing and assessment should they remain at surface e.g. in the ‘digging area’.</p> <p><u>Groundwater</u></p> <p>The completed desk study and ground investigations have not identified potential significant sources of contamination within the site area with respect to controlled waters. The assessment of results of the completed soil leachate and groundwater testing confirmed very low level of risks. Therefore, no remediation measures are required, and the soils present on site are likely to be suitable for reuse. However, should unexpected contamination be encountered during the construction works, these materials will require separate management and assessment with respect to suitability for reuse or disposal.</p> <p><u>Ground gas</u></p> <p>The calculated gas screening values (GSV) for the proposed development area falls within the threshold for Characteristic Situation 1, which means that there is a very low risk from ground gas and no gas protection measures are required. In addition, no radon protection measures are required.</p>
Geotechnical considerations	<p><u>Foundations</u></p> <p>Due to the presence of relatively shallow Porthkerry Member Limestone, it is envisaged that shallow foundations will be preferred for supporting buildings at the site. Shallow foundations in the overlying Head Deposits are not recommended due to their prior disturbance by agricultural activities. Foundations extending to the top of the limestone, with deleterious material removed from the rock surface, can expect a permissible foundation pressure in the range of 10,000 kPa.</p> <p><u>Chemical environment for concrete</u></p> <p>Results from BRE sulfate testing suggest where material is natural ground a design sulfate class of DS-1 and an ACEC class AC-1 can be used.</p> <p><u>Earthworks</u></p> <p>The superficial topsoil and Head Deposits are expected to be easily excavated by hydraulically operated plant such as excavators and backhoe loaders. Excavation into the Limestone will however be very challenging and reliant on the ability of the excavation plant to identify and work into the joint sets of the rock to achieve any meaningful excavation penetration. It is recommended that site</p>

excavation trials and rippability assessments be undertaken by the contractor well in advance of the contract works.

Drainage

The soakaway test results conducted during the ground investigation on site indicated the northeastern boundary of the site is characterized by extremely low values of permeability, likely due to minimal jointing of the rock mass in that area. The results suggest this area, which corresponds to the proposed car park location, is not suited for infiltration.

UXO

A site specific UXO risk assessment carried out by SafeLane Global in 2020 indicated that the southeast zone of the site sits at medium risk of UXO contamination, with the remaining of the site at low risk. Risk mitigation measures suggested by SafeLane Global are outlined.

1. Introduction

Ove Arup & Partners Limited ('Arup') have been commissioned by WEPCo | Cardiff and Vale Colleges (the Client) to provide multi-disciplinary engineering support for the Advanced Technology Centre (ATC), a proposed development of a new college facilities located to the east of Cardiff Airport Business Park.

As part of the appointment at the feasibility stage and based on previous studies conducted by others, Arup have produced a site-specific ground investigation specification to be carried out to confirm the ground conditions and the extent of any contamination at the site and inform the design of the proposed development.

HPS Consulting Engineers Ltd undertook an intrusive ground investigation (as designed by Arup) between 25th September and 2nd October 2023, followed by a period of post works monitoring and subsequent additional field tests in January 2024. This report summarises the findings of these investigations and provides interpretation of the factual information to support the design of the proposed development.

This report is prepared for and on behalf of WEPCo | Cardiff and Vale Colleges in response to their particular instructions and requirements. The information in this report is not intended for and should not be relied upon by any third party. Any other party using this information for any purpose does so at their own risk and any duty to that party is excluded.

2. The site

2.1 Site location and description

The site is at National Grid Reference ST 07472 67768, located immediately east of Cardiff Airport Business Park, approximately 1.85km northeast of Rhoose village centre. Its location is shown on Drawing 1.

The site is approximately 9 hectares in area and is bounded to the:

- South West by the Cardiff Airport access road and Long Stay carparking beyond;
- South by Port Road and agricultural land beyond;
- North East by Blackton Lane with agricultural land and storage hardstanding beyond;
- North by residential dwellings and agricultural lands;
- North East by light industrial property.

Ground levels across the site vary between +61.8mOD and +63.5mOD, with gradients between 1:10 and 1:50 throughout the site.

The site is currently in use as agricultural fields bounded and bisected by a range of semi mature to mature trees and hedgerows. There is a small landscape bund within the site, running along the southern boundary separating the site from the public highway to the south, which extends to a height of +65.4mOD. The site is accessed off Blackton Lane along the eastern boundary.

Records indicate the site has always been used as agricultural land comprising fields with no previous development identified and is therefore considered to be effectively greenfield.

2.2 Proposed development

The proposed development is for the design of a new college campus including multi-storey buildings and at-grade car parking areas, civil engineering site design and landscaping throughout.

2.3 Geology

Geology mapping published by the British Geological Survey (BGS) indicates the site is underlain by the Porthkerry Member comprising of interbedded limestone and mudstone, with no mapped evidence of natural deposits and Made Ground deposits near the site.

2.4 Hydrogeology

The Porthkerry Member geological unit is designated as Secondary A aquifer. The groundwater vulnerability throughout the site is assessed as high, pertaining to areas that easily transmit pollution to groundwater, mainly associated with the mudstones and limestones of the Porthkerry Member encountered on site.

Based on the topography of the site and surrounding area and the nearby surface water features it is anticipated that the groundwater flow direction on site is to the south of the site.

2.5 Hydrology and flooding

The site is located within 250m from tributaries of the River Waycock which runs to the northeast. For flooding risk details refer to other civils documents.

3. Previous land contamination assessments

HSP have undertaken land contamination risk assessments informed by the 2020 ground investigations. These are presented in their Phase I Geo-environmental desk study and subsequent Phase II geo-environmental assessment report. The Phase I and Phase II assessments covered a wider area with the current site comprising the western and central parts of that area. The assessments are summarised in the sections below.

3.1 HSP Preliminary Risk Assessment 2020

The desk study review indicated the site to be largely a greenfield site historically and currently used as agricultural land. The review of historical maps has not identified storage or farm buildings within the site, and therefore any significant spillages or leakages of chemical or oils/petrol within the site area are unlikely to have occurred. Historical maps do however show the south-eastern corner of the site and the field extending further to the east to had been developed from the 1930s until the 1960s before returning to agricultural use. Demolition materials may have been left on site post site clearance and these may be a source of asbestos and heavy metals.

The site is located in an immediate vicinity of Cardiff Airport Business Park and Cardiff airport facilities such as car parking. Land immediately to the east and north of the site is currently mostly used as agricultural land, with a hotel and caravan park located further to the east. In addition, a number of historical quarries were presented to the west of the site. These are likely to have been infilled as they form part of the airport site. These off-site sources may have potentially impacted groundwater, which may potentially migrate into the site area.

The Preliminary Risk Assessment (PRA) identified overall low risk to the proposed end use as well as to the identified controlled waters receptors from the identified sources.

3.2 HSP Ground investigation 2020

HSP scoped and completed intrusive ground investigations within the site area, which included soil sampling and testing of one Made Ground, one topsoil and six natural ground samples. All samples were analysed for metals, PAHs and TPHs. The Made Ground sample was analysed for the presence of asbestos. No soil leachate testing or ground gas monitoring was undertaken.

Made Ground was encountered in only one location, WS7, located in the area of previous development, to the east of the site. It was described to contain brick fragments and masonry inclusions. Topsoil was also

described to contain occasional brick, masonry, glass and ceramic fragments. No other evidence of potential contamination was recorded.

3.3 HSP Risk Assessments 2020

The results of the 2020 investigations were quantitatively assessed with respect to potential risks to the end site users (college). The applied assessment scenario was a conservative residential without plant uptake. No exceedances of the assessment criteria were identified. HSP concluded that the risk is acceptably low, and no mitigation measures were required.

No risk assessments to controlled waters or from ground gas was undertaken.

The completed risk assessments concluded the overall risk to the proposed end use receptors to be very low, risk from ground gas and controlled waters remaining as low.

4. Ground investigation

This section describes the recent and relevant historical ground investigations undertaken within the site.

4.1 Historical ground investigations

In June 2020, an intrusive ground investigation was carried out within the proposed development boundaries comprising No.12 windowless sampling boreholes conducted to a maximum depth of 2.0m bgl and No.8 trial pits. The findings from these investigations indicate the bedrock was encountered within all boreholes at shallow depths as sandy gravelly clay with mudstone and limestone fragments.

Refer to the Geo-environmental Assessment Reports conducted by HSP Consulting in 2020 for further findings from these historical investigations.

4.2 Site specific ground investigation

The site investigation designed and scheduled by Arup was undertaken by HSP Consulting between 25th September and 2nd October 2023 and between 22nd and 24th January 2024. A summary of the investigation is provided in the following sections. The factual report of this investigation is included as Appendix A in this report.

4.3 Scope of works

The purpose of the investigation was to provide geotechnical and geo-environmental information to supplement previous ground investigations and inform the design of the proposed development. The intrusive ground investigation works on site comprised the following:

- 26No. machine excavated trial pits across the site to a maximum of 2.0mbgl to confirm the ground conditions and groundwater level, and collect soil samples for laboratory analysis;
 - soakaway infiltration testing within 21No. of the above-mentioned trial pit locations;
 - plate load tests undertaking within four of the above-mentioned trial pit locations;
- Three rotary open hole boreholes conducted to a maximum depth of 2.0mbgl with rotary core drilling follow-on to a maximum depth of 7.0mbgl distributed across the site;
 - standard penetration tests carried out within the exploratory holes to 5.0mbgl;
 - falling head tests carried out in the competent limestone encountered within the exploratory holes.
- Soil and rock sampling and associated laboratory testing for geotechnical and chemical purposes.

The locations of exploratory holes are displayed in Drawing 1.

4.4 Limitations on investigation

The initial investigation specification comprised exploratory holes that were descope from the site works due to limiting factors, including available budget / technical constraints, and site conditions which was not fully available at the time of scoping.

4.5 Laboratory testing

Both geotechnical and geoenvironmental testing have been undertaken by a UKAS accredited laboratory as part of the works at the site. The suite of geotechnical and geo-environmental analyses undertaken on selected soil and groundwater samples and the geotechnical tests are summarised in Table 1 and Table 2 below.

Table 1 – Geotechnical laboratory testing schedule

Geotechnical tests	No. of tests
Natural moisture content	25
Organic matter	6
Atterberg limits	15
Particle size distribution (PSD) – Wet sieve	8
Particle size distribution (PSD) – Pipette	8
Compaction using 2.5kg rammer	3
BRE Suite A	11
Uniaxial compressive strength test (rock)	5
Point load strength index test (rock)	4

Table 2 – Geoenvironmental laboratory testing schedule

Geoenvironmental tests	No. of tests
General suite (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, antimony, beryllium, vanadium, cyanide, pH, boron, phenols, total organic carbon)	9
Asbestos screen (quantification if detected)	5
TPHCWG	9
PAH and BTEX	9
Hexavalent chromium	6
Waste Acceptance Criteria Soils	5
Waste Acceptance Criteria Leachability	5
Leachable general suite	4
Leachable PAH and BTEX	4

4.6 Monitoring installations

During the ground investigation, dual use gas and groundwater monitoring installations were constructed within all three boreholes across the site to allow for post site works monitoring. Every installation was constructed with 50mm diameter HDPE pipes and raised round lockable stopcock covers. The installation details are provided in Table 3 below.

Table 3 – Groundwater and ground gas monitoring installations details

Exploratory hole	Installation type	Response zone (m bgl)	Response zone (mOD)	Targeted geological formation
BH1	SP	2.0 to 7.0	+60.85 to +55.85	Porthkerry Member
BH2	SP	2.0 to 7.0	+60.92 to +55.92	Porthkerry Member

Exploratory hole	Installation type	Response zone (m bgl)	Response zone (mOD)	Targeted geological formation
BH3	SP	2.0 to 7.0	+61.37 to +56.37	Porthkerry Member

The groundwater levels and ground gas flow rates have been recorded in three occasions, detailed in Sections 5.3 and 7.4, respectively.

5. Ground conditions

This section details the ground model developed for the site, comprising the description of the strata encountered and appropriate characteristic parameters derived from the in-situ and laboratory testing and relevant values published in the literature.

The ground conditions encountered during the intrusive investigations on site are generally consistent with those of the published geology and detailed in previous studies comprising the Porthkerry Member (interbedded limestone and mudstone) with no significant thickness of natural deposits across the site.

Geological cross-sections across the site are included in Drawing 4 and Drawing 5, these cross-sections show general trends in stratigraphy but may not be representative of localised variations between exploratory hole locations.

5.1 Assumptions and correlations

Characteristic geotechnical parameters have been derived for the materials based on the findings of the recent ground investigation, consideration of the historical ground investigations and relevant values published in the literature. These characteristic parameters are described in the following sections and summarised in Section 8.1.

The following data sources and published correlations were used to help derive characteristic parameters:

- BS EN 1997-1:2004+A1:2013 (Eurocode 7) contains recommendations for the assessment and interpretation of geotechnical parameters;
- BS 8002:2015 contains many correlations, and ranges of expected values for different geotechnical parameters;
- The uniaxial compressive strength (UCS) of the rock was determined using both direct UCS tests and point load (PL) tests.

5.2 Ground model

This section provides a summary interpretation of the site-specific ground investigation results.

5.2.1 Summary of stratigraphy

The characteristic levels listed in the table represent a generalised sitewide stratigraphy. However, it should be noted that there is variation in strata levels encountered across the site.

Table 4 – Summary of the site stratigraphy

Stratum	Depth to top level encountered [mbgl]	Thickness [m]	Description
Topsoil	Typically from ground level	0.2 to 0.3	Grass over sandy gravelly clayey TOPSOIL with the presence of many rootlets
Head Deposits	0.2 to 0.3	0.1 to 1.4	Firm to stiff sandy gravelly CLAY with cobbles of limestone. <i>underlain by</i>

			Dense clayey sandy GRAVEL and COBBLES with boulders of limestone.
Porthkerry Member	0.3 to 1.68	Not proven	Very weak and weathered to very strong and competent LIMESTONE, with intermittent banding of weak MUDSTONE

5.3 Groundwater observations

The types and locations of groundwater monitoring installations are shown in Section 4.6. Groundwater monitoring installations were positioned within the limestone of the Porthkerry Member and the groundwater levels measured across the site are summarized in Table 5 below.

Table 5 – Groundwater levels measured across the site

Exploratory hole	Round 01 (16.10.2023)		Round 01 (16.10.2023)		Round 01 (16.10.2023)	
	Depth [m bgl]	Depth [mOD]	Depth [m bgl]	Depth [mOD]	Depth [m bgl]	Depth [mOD]
BH01	2.22	+60.63	1.05	+61.80	1.00	61.85
BH02	6.20	+56.72	3.13	+59.79	2.84	60.08
BH03	3.92	+59.45	2.28	+61.09	1.92	61.45

Groundwater was not encountered during the drilling and pitting works of the investigation. The ground investigation factual report states that it is likely the groundwater levels measured during post field monitoring works are associated with percolated rainwater within the standpipe and are not representative of groundwater sources.

5.4 Infiltration

In situ soakaway tests were undertaken in two different occasions to inform the drainage design of the proposed development. The infiltration tests targeted the Porthkerry Member Limestone. The calculated infiltration rates from these tests are displayed in the Table 6 below.

Table 6 – Summary of infiltration rates

Trial Pit	Date	Refusal [mbgl]	Embedment into bedrock [m]	Top of stratum [mbgl]	Stratum description	Soil infiltration rate [m/s]		
TP02	09/2023	1.30	0.05	1.25	Very weak grey limestone	3.55E-05	4.21E-06	3.76E-06
TP04	09/2023	1.50	0.50	1.00	Very weak grey limestone	4.30E-06	4.48E-06	4.52E-06
TP10	09/2023	1.00	0.05	0.95	Very weak grey limestone	1.17E-05	1.40E-05	1.25E-05
SK201	01/2024	1.65	0.05	1.60	Grey limestone	1.98E-06	1.75E-06	1.64E-06
SK202	01/2024	1.10	0.05	1.05	Grey limestone	Impervious stratum (rate below 10 ⁻¹¹ m/s)		
SK204	01/2024	1.70	0.05	1.65	Grey limestone	Impervious stratum (rate below 10 ⁻¹¹ m/s)		
SK205	01/2024	1.10	0.10	1.00	Grey limestone	Impervious stratum (rate below 10 ⁻¹¹ m/s)		
SK206	01/2024	1.45	0.15	1.30	Grey limestone	Impervious stratum (rate below 10 ⁻¹¹ m/s)		
SK207	01/2024	1.50	0.00	1.50	Limestone	2.03E-06	1.85E-06	1.73E-06
SK208	01/2024	1.35	0.05	1.30	Grey limestone	Impervious stratum (rate below 10 ⁻¹¹ m/s)		
SK209	01/2024	1.10	0.05	1.05	Grey limestone	2.02E-06	1.89E-06	1.63E-06
SK210	01/2024	1.40	0.00	1.40	Limestone	1.86E-06	1.72E-06	3.51E-06
SK211	01/2024	1.10	0.05	1.05	Grey limestone	Impervious stratum (rate below 10 ⁻¹¹ m/s)		
SK212	01/2024	1.30	0.05	1.25	Grey limestone	1.67E-06	2.03E-06	1.86E-06
SK213	01/2024	1.20	0.05	1.15	Grey limestone	1.77E-06	1.77E-06	1.89E-06
SK214	01/2024	1.30	0.05	1.25	Grey limestone	2.06E-05	1.75E-05	1.92E-05
SK215	01/2024	1.20	0.05	1.15	Grey limestone	1.59E-06	1.73E-06	1.67E-06
SK216	01/2024	1.15	0.05	1.10	Grey limestone	1.53E-06	1.62E-06	2.10E-06
SK217	01/2024	1.10	0.05	1.05	Grey limestone	1.17E-06	1.21E-06	1.39E-06

SK218	01/2024	1.40	0.05	1.35	Grey limestone	8.13E-06	8.28E-06	9.81E-06
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The infiltration tests were conducted within trial pits with a minimum penetration into the limestone due to limitations of the equipment during the excavation works. The results indicate that infiltration rate values across the site vary between 10^{-5} and 10^{-6} m/s as a function of the jointing of the rock.

It is likely that the tests with values in the order of 10^{-11} m/s were carried out within a rock zone characterized by very little jointing that water can infiltrate to, indicatively along the northeastern boundary of the site. This area corresponds to the proposed car park location and the test results suggest the area is not suitable for effective infiltration.

5.5 Ground aggressivity

Water soluble sulfate and pH testing was carried out on eight samples of Topsoil and three samples of Head Deposit clays to allow the aggressivity of the ground to buried concrete to be assessed and inform site-specific concrete design. In accordance with Table C1 of BRE Special Digest 1, the Chalk is given a DS-1 design sulfate class and AC-1.

6. Material characteristics

This section interprets measured geotechnical properties and behaviour from in situ or laboratory measurements. Stratigraphical classification and data analysis is based on the factual report provided by the GI Contractor.

The derived and characteristic values are discussed for each geological layer in the following sections and summarised as characteristic values in Section.

6.1 Topsoil

Topsoil was encountered throughout the entire site, recorded typically from ground level to 0.3m of depth. The topsoil was generally described as grass over brown slightly sandy slightly gravelly clayey material.

Due to its limited depth, organic nature, and intermixing with the underlying Head Deposits by agricultural activities, no geotechnical laboratory testing was undertaken on these materials.

6.2 Head Deposits

Superficial soils between the Topsoil and basal Porthkerry Member Limestone have been classified as Head Deposits.

The Head Deposits typically comprise sandy clay which appear to have been disturbed and basally intermixed with gravels and cobbles ripped from the underlying limestone by agricultural activities such as tilling.

6.2.1 Classification

6.2.1.1 Particle Size Distribution

Eight particle size distribution tests were undertaken on the Head Deposits and are summarised below.

- Cobbles/boulders 0 to 14%
- Gravel 2 to 36%
- Sand 1 to 19%
- Silt 26 to 50%
- Clay 23 to 43%

It can be seen from the above data that the Head Deposits samples are generally dominated by their fines (silt + clay) content, which ranged from 55 to 91%.

6.2.1.2 Atterberg Limits

15no. suites of Atterberg Limits testing were undertaken on the Head Deposits. The Plasticity Index ranged from 23-43%, and Liquid Limit from 43-69%. The Plastic Limit ranged from 20 to 30%.

These characteristics indicate the silt and clay fraction of these soils to be medium to high plasticity.

6.2.1.3 Field moisture content

Moisture content was determined for 15No. samples of the Head Deposits and ranged from 9.1% to 32.2% (i.e. typically drier than the Plastic Limit and therefore expected to be friable at that time).

6.2.2 Earthworks tests

6.2.2.1 Plate Load tests

Four plate load tests were undertaken in the Head Deposits, with values ranging from 2.1 to 8.9%.

For the purposes of design of pavements, a lower-bound value of 2% should be used.

6.2.2.2 *Compaction tests*

Laboratory compaction tests to determine the moisture:density relationship were undertaken on three samples recovered at 0.5m depth from TP2, 7, and 11.

The tests indicate an optimum moisture content of 23-24%, and maximum dry density of 1.47 to 1.56t/m³.

6.3 **Porthkerry Member**

6.3.1 **Classification**

The geotechnical testing undertaken throughout the site is summarized below.

6.3.2 **Unconfined compressive strength (q_u)**

Five unconfined compressive strength tests were undertaken of intact core samples from the limestone. The results ranged from 31.8 to 96.2MPa.

For the purposes of design, a limiting characteristic value of 10MPa is recommended for the rock mass, accounting for the potential influence of joint sets.

6.3.3 **Stiffness (E)**

Based on experience, a characteristic value for Young's modulus, E of 10GPa is expected as a lower bound value.

7. Land contamination assessments

The 2023 ground investigations have provided supplementary data allowing for confirmation of the level of risk concluded by previously completed risk assessments, as summarised in Section 3. The scope of these investigations is presented in Section 4.

7.1 Conceptual Site Model

A conceptual site model (CSM) describes the scenario in which the risks to human health and the environment (posed by contaminated land) are assessed. The preliminary CSM is presented within the Phase I Desk Study for the site and updated CSM – in the Phase II assessment report, which is based on desk study information and the findings from the 2020 ground investigations. This is summarised below, reviewed and updated with the findings of the 2023 investigations.

7.1.1 Sources of Contamination

The below table presents the potential sources of contamination on the site based on the site historical setting and land use and information gathered through completed ground investigations.

Table 7 – Potential sources of contamination

Potential source	Location	Potential Contaminants
Onsite		
Potential Made Ground associated with the 1930-1960s development – none encountered in the site area during completed GIs in 2020 and 2023. Made Ground encountered in 2020 GI approximately 50m away from the site boundaries.	South-eastern corner	Asbestos, metals, hydrocarbons
Agricultural land although no storage or farm building present therefore unlikely to be present at significant concentrations	Across site	Fertilisers, pesticides
Limestones (carbonate-rich strata)	Across site	Carbon dioxide
Offsite		
Infilled historical quarries	From approximately 30m west	Ground gas, leachable contaminants (metals)
Business park	Adjacent to the west	Hydrocarbons
Airport infrastructure such as car parking	Adjacent to the west	Hydrocarbons
Airport terminal and runways	250m west	Hydrocarbons, PFAS, PFAO

7.1.2 Potential Receptors

The receptors considered to be relevant to the potential sources of contamination are identified as follows:

Construction phase:

- Construction workers involved in the development;
- Site neighbours (commercial workers);
- Controlled waters, i.e. onsite A aquifer, offsite surface waters (unnamed stream and Bullhouse Well tributary to Whitelands Brook, issuing approximately 300m south, unnamed tributaries to River Waycock 200m and 400m north and east respectively).

Operational phase:

- Site end users (students, workers);
- Site maintenance workers post development;

- Building materials used in the proposed development (concrete, potable water pipes);
- Controlled waters, i.e., onsite aquifers, offsite surface waters.

7.1.3 Potential Pathways

For a risk to exist the source and receptor must be connected by a viable pathway. Potential pathways by which human and environmental receptors may be impacted upon are as identified below:

- **Ingestion of contaminated soils and dust:** During construction of the proposed development, site workers who are dealing closely with excavated soils may come into contact with contaminants through ingestion of soils and dust. Occupants of the neighbouring areas (workers at nearby hotel and car park users) may be impacted by the ingestion of soils and dust created during development in the construction phase. This risk is however considered to be low on the basis that construction works will involve suitable dust suppression in accordance with best practice measures. It is not anticipated that the ingestion pathway will be active during the operational phase due to the site soils being covered with either vegetation or hardstanding or building footprint. There may be a risk through the ingestion pathway should site soils be left at surface within areas of soft landscaping e.g. ‘digging area’ and raingardens.
- **Dermal contact with soils, dust and groundwater:** During site development, site workers who are engaged in ground works and handling of excavated soils/earthworks materials may come into skin contact with potentially impacted soils and groundwater. Following redevelopment, maintenance workers may also come into direct skin contact with shallow soils and groundwater during any intrusive works. It is not anticipated that the dermal pathway will be active during the operational phase due to the site soils being covered with either vegetation or hardstanding or building footprint. There may however be a dermal pathway linkage should site soils be left at surface in areas of soft landscaping e.g. ‘digging area’ and raingardens.
- **Inhalation of vapours, dust (including asbestos) and gases:** Volatilisation of hydrocarbon products may occur within the subsurface from impacted soils and perched/groundwaters and be present in indoor air (particularly where organic contamination is present) which has the potential to build up and impact site end users within confined spaces within the building. Ground gas, potentially generated by any Made Ground beneath the site as well as the carbonate-rich limestones underlying the site may migrate into confined spaces within the proposed building although the risk is likely to be low based on very limited presence of Made Ground and no observed evidence of contamination on site as per completed investigations at the site. There is however a risk of off-site gas migration. Generation of dust through excavation works may impact construction workers and site neighbours during the construction phase. There may also be dust generation in areas of soft landscaping should site soils be left at surface in these areas.
- **Lateral and vertical migration of contaminants:** Contaminants mobilised from the ground from impacted Made Ground may migrate vertically or laterally through the underlying strata. As detailed in Section 6.5, the site is underlain by groundwater contained within the bedrock (limestones). The monitored levels ranged from 1.0 to 6.2m bgl (approx. 61.0 – 56.7 mOD). The site is located at a topographical high point, a local catchment boundary between Whitelands Brook catchment and the River Waycock catchment. Based on the site setting and topography, groundwater from the southern part is likely to be flowing in the south-southwestern direction towards topographical lows like deep valley of the Whitelands Brook and its unnamed tributaries such as unnamed stream and associated Bullhouse Well; whereas groundwater from the northern part is likely to be flowing towards the north-northeast, towards the Waycock River and its tributaries. Therefore, the site is unlikely to be significantly impacted by the identified off-site sources located to the west of the site (the airport, business park and car parking).
- **Leachate generation and migration:** There is potential for the generation and migration of leachate from impacted soils, which may enter and migrate within underlying groundwater bodies and preferential pathways as identified above. Currently there is limited intact hardstanding at the site and no drainage system in place meaning there is potential for leaching as surface waters are not being controlled and can freely percolate through the Made Ground.

7.2 Human health risk assessment

The conceptual model identified a potential plausible pollutant linkage between soil potentially impacted by contamination and the end use receptors.

On this basis soil testing was undertaken as part of the 2023 investigation on site to assess the contaminative nature of the site soils and the risk potential.

Results of the chemical analysis undertaken on soil samples obtained from 2023 investigations have been reviewed and compiled in Appendix A of this report. The assessment in relation to human health for the end site user is presented below.

7.2.1 Methodology

In order to facilitate the most appropriate assessment of the chemical analyses, consideration is required with regards to the end use of the site and the exposure pathways identified as part of the CSM.

The current development proposals include the following:

- Development of a multi-use College building with facilities for lecturing, teaching and dining. Building is likely to have shallow foundations.
- Hardstanding in the form of car parking covering the majority of the northern site area, which includes permeable surfacing and raingardens.
- Soft landscaping on the fringes of the site.

End site users will comprise collage aged students (aged 16+) and workers, forming teachers and other day time staff. There is not considered to be any children using the site, or overnight stays or working.

The CSM indicates that a large proportion of the site is to be covered by hardstanding, forming either car parking or building footprint, however landscaped areas with picnic tables will be formed on the fringes of the site around the perimeter of the site. Therefore, there will be a potential for the end users to be exposed to the soils via the dermal, ingestion inhalation (dusts) pathways, particularly should site soils are left exposed at the surface.

Ground gas will be freely venting within the car parking and soft landscaping areas; however, gases can build up in the proposed school building and may pose a risk to the end user.

Based on the proposed development, and in the absence of any 'school/college' Generic Assessment Criteria (GACs), it is considered a 'commercial' screening criterion is suitable for the assessment of risk to the end site user from the site soils.

7.2.2 Averaging Areas

On account of the likely difference in chemical nature between the Made Ground soils and the underlying natural soils, these strata will be assessed in isolation. This will help identify whether contamination within the Made Ground has impacted the natural soils below and/or if there are any natural background concentrations of contaminants within the natural soils.

7.2.3 Results of Tier 1 Soil Screen

The following assessment is based on the applied 'commercial' criteria for the assessment of risk to site end users through reuse of onsite materials.

11 No. soil samples were tested for heavy metals, TPHs and PAHs, out of which seven (obtained from topsoil) were tested for the presence of asbestos. The results of the chemical screen are presented in Appendix A.

No exceedances of the applied assessment criteria have been identified. No asbestos was detected in tested samples.

7.2.4 Conclusion and Recommendations

The completed investigations and assessments confirmed the very low level of risk that the site may pose to the end site users. Therefore, no mitigation measures are required. Isolated areas of Made Ground may be encountered in the south-eastern corner of the site. These will require testing and assessment should they remain at surface e.g. in the ‘digging area’.

7.3 Controlled waters risk assessment

The conceptual model identified a potential plausible pollutant linkage between potentially mobile soil contamination and the underlying groundwater bodies, and between onsite groundwater bodies and nearby surface water receptors.

On this basis leachate analysis and groundwater testing was undertaken as part of the 2023 investigation on site to assess the contaminative nature of the site soils and the potential for leaching.

Results of the soil leachate and groundwater testing obtained from the 2023 investigations have been reviewed and compiled in Appendix A to this report. The assessment in relation to controlled waters is presented below.

7.3.1 Methodology

Groundwater contained within the bedrock Secondary A aquifer at the site is considered to be of low potential as a drinking water resource as there are no historical or current abstraction licences in site proximity. In addition, the presence of the airport and business park to the west may have had an impact on the background water quality. Based on the site setting groundwater is likely to recharge the surface water courses in the site vicinity.

The primary controlled waters receptor is considered to be the Secondary A aquifer beneath the site and surface water courses such as Whitelands Brook and the Waycock River, and their tributaries. On this basis, Freshwater Environmental Quality Standards (FEQS) screening criteria are considered to be the most suitable to assess the risk. Where no FEQS are available for certain analytes, the UK Drinking Water Standard (DWS) assessment criteria have been used.

EQS values are typically subject to bioavailability using data from the receiving waters. These are used to predict the potential risk posed by metals in the aquatic environment. As no data is currently available from the receiving waters, data obtained from groundwater testing has been used to provide an indicative assessment.

7.3.2 Results of Tier 1 Leachate Screen

Eight soil samples were subject to leachate testing. Soil leachate was tested for metals, PAHs and BTEX.

The 2:1 L/S leachate results were screened against the relevant assessment criteria and are presented within the chemical results tables appended as Appendix A. The exceedances of the applied criteria are summarised in the below tables.

Table 8 – Tier 1 leachate exceedances

Determinant (µg/l)	Screening Criteria	Measured concentrations (No of exceedances / No of samples)	
		Topsoil	Natural
Copper dissolved	1	1.9 - 4 (8/8)	<0.5 – 2 (1/3)
Copper bioavailable	1	0.2 – 0.5 (0/8)	0.1 – 0.2 (0/3)
Zinc dissolved	12.3	<2.5 - 13 (1/8)	<2.5 - <3 (0/3)
Zinc bioavailable	12.3	1.2 – 6.5 (0/8)	1.5 – 2.7 (0/3)

Copper and zinc were measured in the soil leachate at concentrations above the applied assessment criteria with maximum dissolved Copper concentrations of 4µg/l and dissolved Zinc of 13 µg/l. Calculated bioavailable fractions of these metals indicate potentially acceptable levels of risk with respect to controlled waters.

7.3.3 Results of Tier 1 Groundwater Screen

Two groundwater samples were recovered over monitoring period due to low recharge rate of the boreholes. The samples were subject to laboratory testing for metals, PAHs, speciated TPH, BTEX, PCBs, sVOCs and VOCs.

The groundwater results were screened against the relevant assessment criteria and are presented within the chemical results tables appended as Appendix A. Dissolved Copper concentrations were measured slightly above the applied assessment criterion of 1ug/l at 1.1 to 1.2ug/l. These are not considered significant and unlikely to be indicative of significant risk to controlled waters quality.

7.3.4 Conclusion and Recommendations

The completed desk study and ground investigations have not identified potential significant sources of contamination within the site area with respect to controlled waters. The assessment of results of the completed soil leachate and groundwater testing confirmed very low level of risks. Therefore, no remediation measures are required, and the soils present on site are likely to be suitable for reuse. However, should unexpected contamination be encountered during the construction works, these materials will require separate management and assessment with respect to suitability for reuse or disposal.

7.4 Ground gas risk assessment

The revised CSM identified the underlying carbonate - rich limestones as potential source of ground gas – carbon dioxide. Generated ground gas may migrate into the building and accumulate in confined spaces potentially impacting end site users. The HSP Phase I report did not identify potential risks from radon gas.

Three rounds of fortnightly gas monitoring from boreholes BH01 -03 were undertaken between October and November 2023, as detailed in Table 4. The results are presented in the HSP Factual Report and summarised in Table 5 below.

7.4.1 Atmospheric Pressure

The monitoring has been undertaken during periods of rising and falling atmospheric pressure, as summarised in Table 9 below.

Table 9 – Monitoring dates and recorded atmospheric pressure conditions

Monitoring date	Monitoring round	Atmospheric pressure trend
16/10/2023	1	Steady
06/11/2023	2	Steady
21/11/2023	3	Rising

7.4.2 Groundwater Levels

As mentioned in Section 5.3, the onsite groundwater levels ranged between 1 – 6.2 (approximately 57-62mOD), with response zones within the monitored boreholes flooded during some of the monitoring rounds. In this scenario, the standpipe will provide a pathway for dissolved gases to reach the surface only and may result in gas accumulation in the plain section of the standpipe resulting in monitored levels not representative ground atmosphere. Therefore, the results obtained from the flooded standpipes will not be applied into the assessment.

7.4.3 Baseline Gas Monitoring Results

On each monitoring visit to a given standpipe eight gas readings were taken over a two-minute period. The final reading (steady) has been taken to represent the stable gas conditions, as there is potential that gases may have accumulated within the capped standpipe. The steady readings obtained from not flooded response zones have been applied within the assessment. The results are summarised in Table 10.

Table 10 – Summary of ground gas monitoring results

Monitoring date	BH01	BH02	BH03
Response zone depth	1.5 to 7.0	2.0 to 7.0	2.0 to 7.0
Stratigraphy	LST	LST	LST
Water level (mbgl)	1.0 to 2.2	2.8 to 6.2	1.9 to 3.9
Carbon Dioxide (%)	3.4	3.3 to 4.6	4.0 to 4.1
Methane (%)	<0.1	<0.1	<0.1
Oxygen (%)	4.3	1.3 - 7.5	7.4 to 9.0
Hydrogen sulphide (ppm)	<1.0	<1.0	<1.0
Carbon monoxide (ppm)	<1.0	<1.0	<1.0
Gas flow (ltr/hr)	0.3	0.1 – 0.7	0.1

Carbon dioxide

Steady concentrations of carbon dioxide were recorded between 3.3 and 4.6% v/v. The monitored concentrations are in line with expected range of concentrations within a carbonate-rich strata¹.

Methane

Methane was not measured above the detection level of 0.1%v/v in the monitored installations.

Oxygen

Depleted levels of oxygen were recorded in all installations ranging between 1.3% and 9%, which is well below the typical atmospheric oxygen concentrations of approximately 21%. The reason for such low levels of oxygen is likely to be linked to the bedrock permeability within the monitored zone.

Carbon monoxide

Carbon monoxide was not detected in any of the gas monitoring rounds.

Hydrogen Sulphide

No hydrogen sulphide was detected in any of the monitoring installations.

Flow

Steady state gas flow rates ranged from 0.1 to 0.7 l/hr. The highest flows were recorded in BH02 during the third round of monitoring with steady atmospheric pressures.

7.4.4 Gas Screening Value

Gas screening values (GSV) for the site have been calculated for methane and carbon dioxide using the maximum representative encountered concentrations as reported in Table 11 below.

Table 11 – Gas screening values

Ground gas	Max Concentration (% Vol)	Flow Rate (l/hr)	Gas Screening Value GSV (l/hr)	Characteristic Situation (CIRIA 665)
Methane	0.1	0.7	0.0007	1
Carbon dioxide	4.6		0.0322	1

¹ Assessing risks posed by hazardous ground gases to buildings, Ciria 665,

7.4.5 Recommended Protection Measures

The site has been classified for gas protection measures in accordance with both CIRIA 665 guidance and BS8485:2015, using the ground gas monitoring results obtained from the completed gas monitoring.

The calculated GSVs for the proposed development area (Situation A development) falls within the threshold for Characteristic Situation 1, which means that there is a very low risk from ground gas and no gas protection measures are required. In addition, no radon protection measures are required.

7.5 Geo-environmental considerations

The completed desk study and ground investigations have not identified potential significant sources of contamination within the site area. The completed risk assessments confirmed the very low level of risk that the site may pose to the end site users and controlled waters. Therefore, no remediation or specific control measures are considered to be required. Ground gas risk assessment identified a very low level of risk and therefore no ground gas protection measures would be required. In addition, no radon protection measures are required.

The completed assessments indicate that the soils present within the site are likely to be suitable for reuse subject to there being a volume of material required in the cut/fill balance of the site. Any surplus materials will require off-site removal for either recycling or disposal in accordance with the Waste Regulations in force at the time. The materials destined for disposal will require classification in accordance with waste management guidance.

Isolated areas of Made Ground may however be encountered associated with the agricultural land use (e.g. drainage or access tracks) and in the south-eastern corner of the site (area previously developed). These materials will require testing and assessment should they remain at surface e.g. in the 'digging area'.

Should unexpected contamination be encountered during the construction works, these materials will require separate management and assessment with respect to suitability for reuse or disposal.

8. Engineering considerations

8.1 Characteristic parameters for design

The following parameters characterise the site soils and rock.

Unit	Density (kN/m ³)	Undrained shear strength (kPa)	Drained shear strength (°)	Unconfined compressive strength (kPa)	Young's modulus (MPa)
Topsoil	15	-	--	-	-
Head Deposits	15	50 ^[1]	22	-	10 ^[2]
Porthkerry Limestone	23	-	-	10,000	10,000 ^[3]

1 – Assumed from material descriptions
2 – Estimated from 200 x c_u
3 – Typical value estimated relative to UCS

8.2 Foundations

Due to the presence of relatively shallow Porthkerry Member Limestone, it is envisaged that shallow foundations will be preferred for supporting buildings at the site.

Foundations extending to the top of the limestone, with deleterious material removed from the rock surface, can expect a permissible foundation pressure in the range of 10,000 kPa. Settlement performance can be expected to be within 0.5% of the foundation width up to these permissible pressures.

Foundation sizes are therefore expected to be a function of the practical size they can be excavated and constructed at.

Shallow foundations in the overlying Head Deposits are not recommended due to their prior disturbance by agricultural activities.

8.3 Groundwater

Groundwater was not encountered during the drilling and pitting works of the investigation. The records from post field monitoring works are indicate groundwater level values between 1.0 and 6.0m bgl, which are likely associated with percolated rainwater within the standpipes and are not representative of groundwater sources.

8.4 Earthworks

The superficial topsoil and Head Deposits are expected to be easily excavated by hydraulically operated plant such as excavators and backhoe loaders.

Excavation into the Limestone will however be very challenging and reliant on the ability of the excavation plant to identify and work into the joint sets of the rock to achieve any meaningful excavation penetration.

Hard digging conditions approaching refusal for light to medium hydraulic plant should therefore be expected by the groundworks contractor for any work in the Limestone.

It is recommended that site excavation trials and rippability assessments be undertaken by the contractor well in advance of the contract works. This will also be beneficial in confirming that the rockhead level inferred from the trial pits persists across the site and is not the presence of boulders or a widely jointed disturbed rock mass.

8.5 Buried concrete

The results pertaining to ground aggressivity testing discussed in Section 5.5 indicate a design sulfate class of DS-1 in all soils tested. This corresponds to an ACEC class of AC-1 according to the BRE Special Digest 1.

8.6 Drainage

The soakaway test results conducted during the ground investigation on site indicated the northeastern boundary of the site is characterised by extremely low values of permeability, likely due to minimal joining of the rock mass in that area. The results suggest this area, which corresponds to the proposed car park location, is not suited for infiltration.

8.7 Unexploded ordnance (UXO)


A site specific UXO risk assessment carried out by SafeLane Global in 2020 indicated that the southeast zone of the site sits at medium risk of UXO contamination, with the remaining of the site at low risk. The following risk mitigation measures have been recommended by this UXO risk assessment:

- site specific safety instructions (SSSI);
- explosive ordnance disposal (EOD) Engineer for on-site support;
- explosive ordnance disposal (EOD) Engineer to support site investigation works;
- site specific explosive ordnance safety and awareness briefings (UXO toolbox briefing) to all personnel conducting intrusive works;
- intrusive magnetometer survey of all pile locations across the medium risk zone down to the maximum bomb penetration depth (between 10 and 12mbgl).

Drawings

Drawing 1 – Site location plan



 Site boundary



Drawing 2 – Exploratory hole location plan



- Site boundary
- Exploratory holes (GI 2023):
 - + Rotary borehole
 - Trial pit

Drawing 3 – Geological plan

EASTING

307,350 307,400 307,450 307,500 307,550

LEGEND

Stratum plotted is **Head Deposits**
Depth to top (m)
Hole ID ● Ground level (mOD)
Depth to base (m)

> or < denotes proved to (ie. base not proved)

In the case of intermittent strata top is taken to be the highest occurrence and base the lowest with thickness as the difference.

- Full thickness of stratum encountered
- ◐ Top of stratum encountered but base not proved
- Stratum not encountered

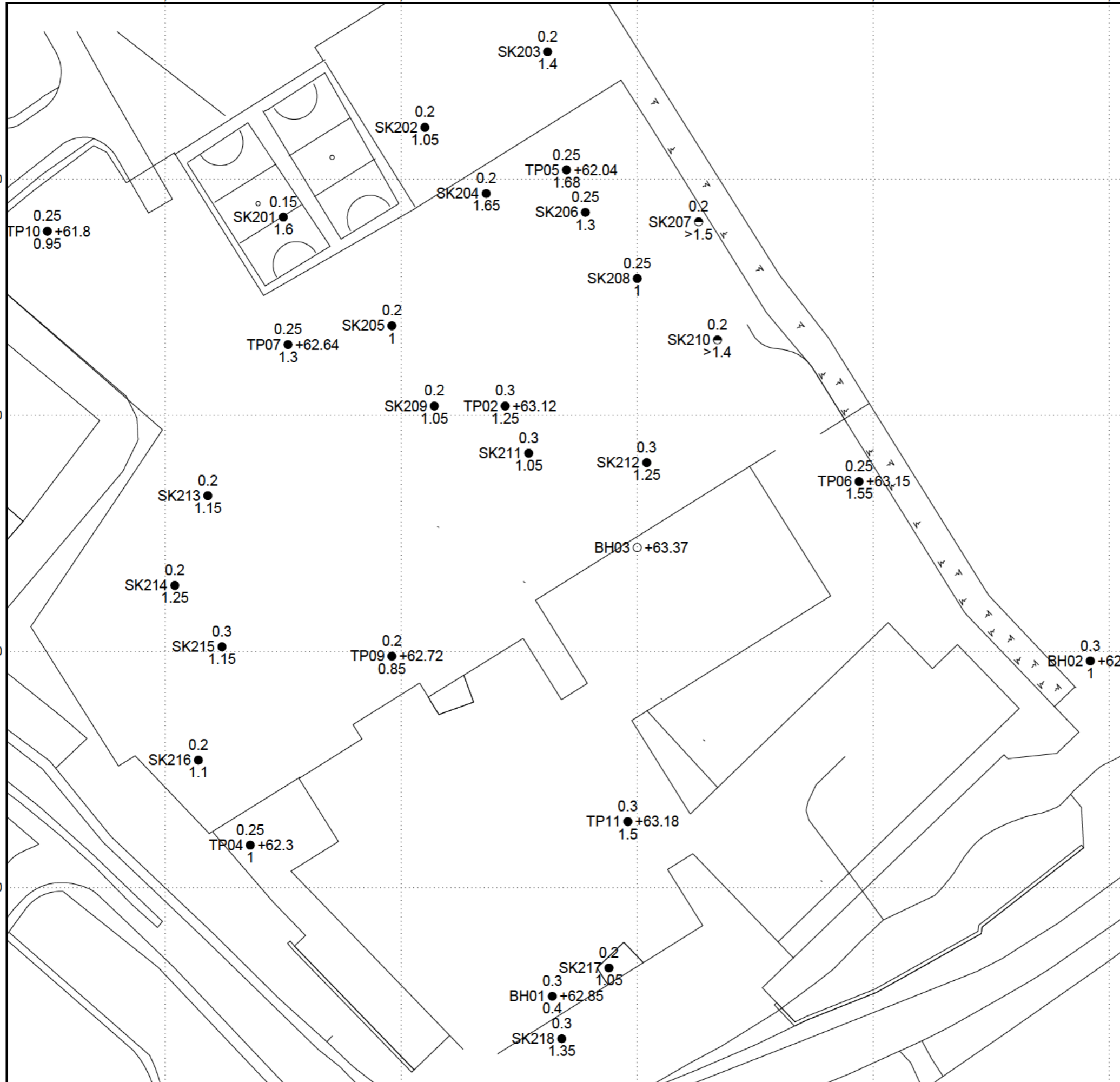
NORTHING

167,750

167,700

167,650

167,600



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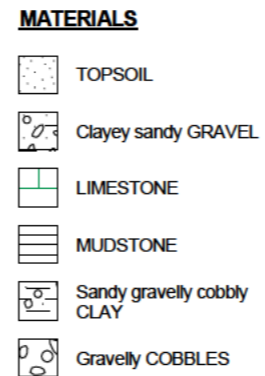
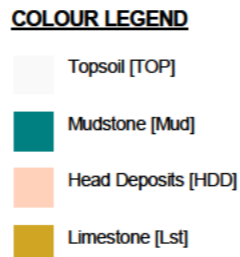
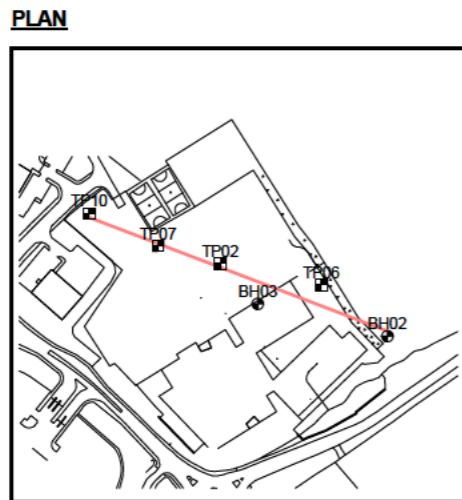
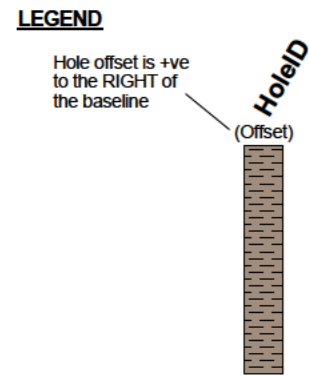
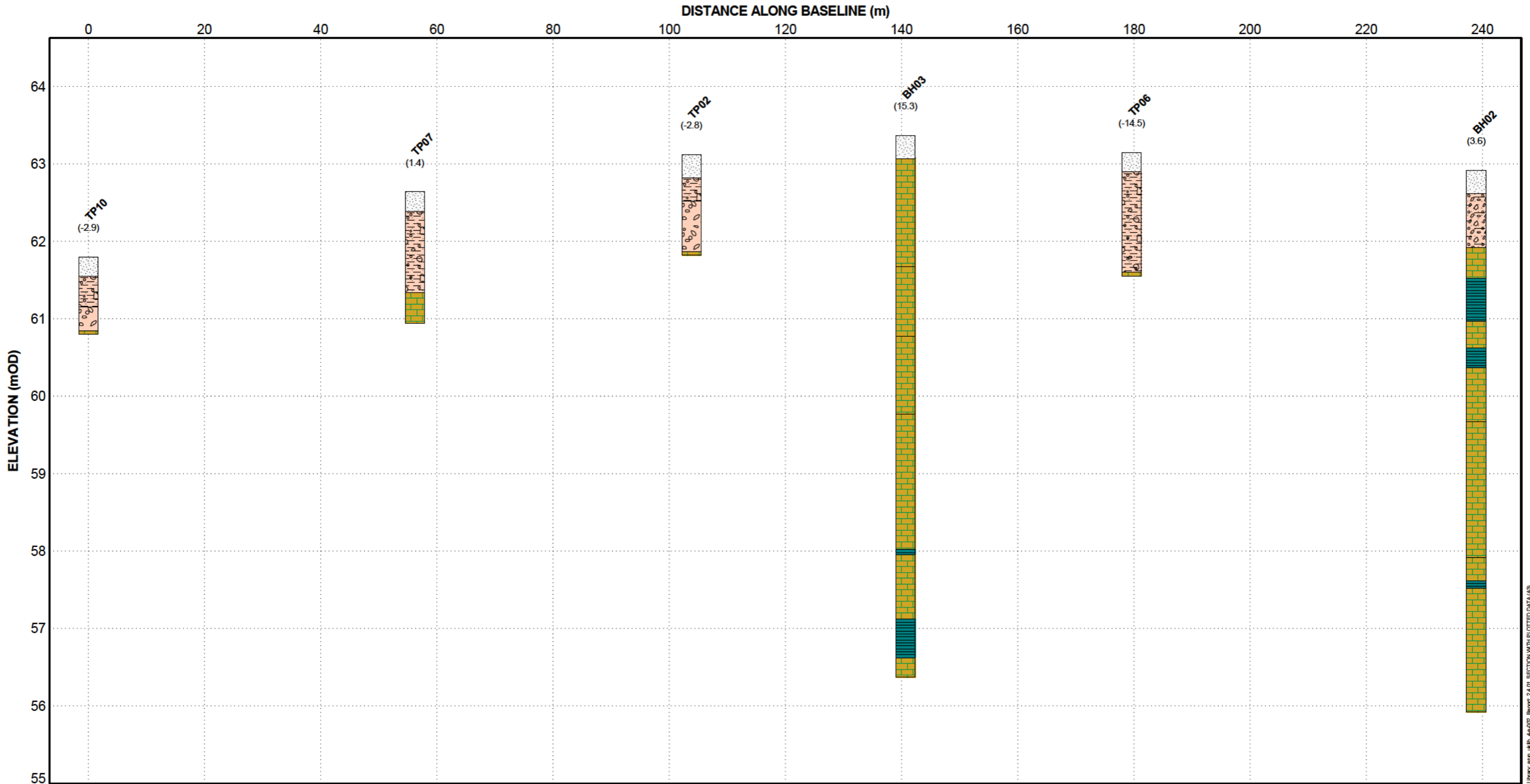
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Drawing 3 - Geological plan (Head Deposits)
03/2024

Drawing 4 – Stratigraphic cross section NW-SE



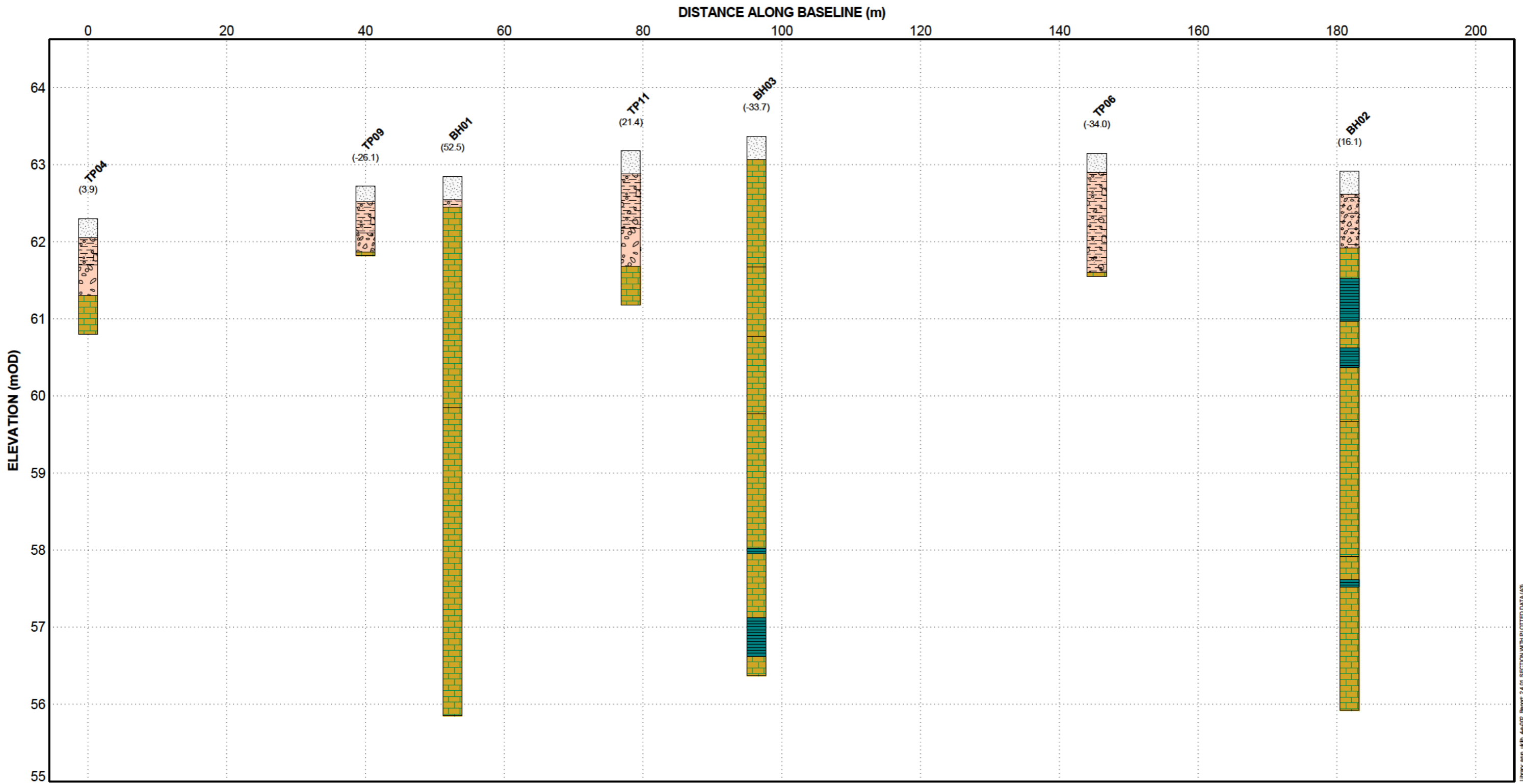
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Drawing 4 - Stratigraphic cross section NW-SE
03/2024

Drawing 5 – Stratigraphic cross section SW-NE

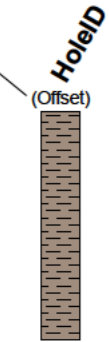
Drawing 6 – Stratigraphic cross section W-E



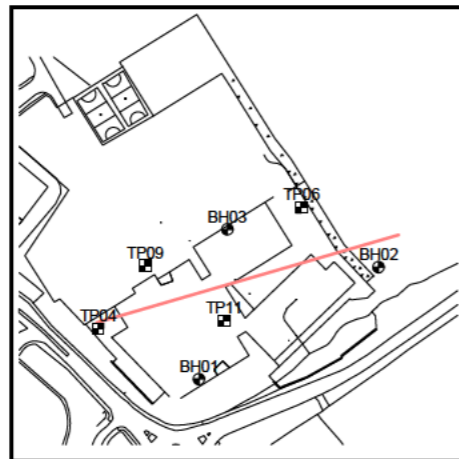
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LEGEND

Hole offset is +ve to the RIGHT of the baseline



PLAN



COLOUR LEGEND

- Topsoil [TOP]
- Mudstone [Mud]
- Head Deposits [HDD]
- Limestone [Lst]

MATERIALS

- TOPSOIL
- Sandy gravelly CLAY
- LIMESTONE
- Clayey sandy GRAVEL
- MUDSTONE
- Sandy gravelly cobbly CLAY
- Gravelly COBBLES
- Cobbly GRAVEL

SCALE 1:50 1:556H @ A3-L

Drawing 6 - Stratigraphic cross section W-E
03/2024

Appendix A

HSP Consulting Ground Investigation Factual Report

INTRUSIVE GEO-ENVIRONMENTAL FACTUAL REPORT

FINAL

Cardiff and Vale College – Advanced Technology Centre (ATC)

February 2024

HSP2023-C3296-G-GFP11-1854

REV B



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Cardiff and Vale College - Advanced Technology Centre (ATC)

Ground Investigation Factual Report

This report was produced by HSP Consulting Engineers Ltd for WEPCo on behalf of Cardiff and Vale College as the Factual Supplementary Ground Investigation Report for a proposed sixth form college development.

This report may not be used by any person other than WEPCo on behalf of Cardiff and Vale College and must not be relied upon by any other party without the explicit written permission of HSP Consulting Engineers Ltd. In any event, HSP Consulting Engineers Ltd accepts no liability for any costs, liabilities or losses arising as a result of the use or reliance upon the contents of this report by any person other than WEPCo on behalf of Cardiff and Vale College.

All parties to this report do not intend any of the terms of the Contracts (Rights of Third Party Act 1999) to apply to this report. Please note that this report does not purport to provide definitive legal advice.

Issue & Revision History

Revision	Status	Originated	Checked	Approved	Date
-	INTERIM	L.Jones B.Sc (Hons) FGS, MIEnvSci	K. Murray BSc (Hons), MSc FGS, MIMMM	H.Pratt B.Eng (Hons), C.Eng, F.Cons.E, M.I.C.E, MI Mgt.	13.11.2023
A	INTERIM	L.Jones B.Sc (Hons) FGS, MIEnvSci	K. Murray BSc (Hons), MSc FGS, MIMMM	H.Pratt B.Eng (Hons), C.Eng, F.Cons.E, M.I.C.E, MI Mgt.	22.12.2023
B	FINAL	L.Jones B.Sc (Hons) FGS, MIEnvSci	K. Murray BSc (Hons), MSc FGS, MIMMM	H.Pratt B.Eng (Hons), C.Eng, F.Cons.E, M.I.C.E, MI Mgt.	08.02.2024
Project Number: C3296				Document Reference: HSP2023-C3296-G-GFP11-1854	

This document is available electronically please contact the author to obtain a copy.

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Appendix VII	- Infiltration Testing Results
Appendix VIII	- CBR Plate Load Test Results
Appendix IX	- Ground Gas and Water Monitoring Results
Appendix X	- Photographs of the site and rotary core samples
Appendix XI	- Chemical Analysis of Groundwater and Extract of ARUP Testing Suites



Executive Summary

HSP Consulting Engineers Ltd has been commissioned by WEPCo on behalf of the Cardiff and Vale College to undertake an intrusive ground investigation at the site to investigate the existing ground conditions, identify any buried obstructions or fuel tanks and provide information on likely constraints to the development.

The site is located immediately east of Cardiff Airport Business Park, approximately 1.85km north east of Rhoose village centre. The approximate National Grid Reference for the centre of the site is (NGR) 307473, 167768.

The physical methods of investigation employed were 8No mechanically excavated trial pits to a maximum depth of 2.50m begl and 3No. rotary cored boreholes to 7m begl. In-situ plate load testing and infiltration testing was conducted within the trial pits. The scope of works has been prepared by Ove Arup & Partners Limited ref: VG0101-ARP-ZZ-ZZ-SP-G-00001, 16th June 2023.

The ground conditions encountered on site generally comprised grass over brown slightly sandy slightly gravelly clayey TOPOSIL with many rootlets to a maximum depth of 0.30m begl. Weathered deposits of the Porthkerry Member were encountered from a minimum depth of 0.20m and comprised firm to stiff yellow grey brown slightly sandy gravelly cobbly CLAY with abundant boulders of Limestone overlying cobbles and boulders of weathered LIMESTONE to 2.00m begl. Competent strong LIMESTONE was encountered from a minimum depth of 2.00m begl. No groundwater was encountered during the advancement of the exploratory holes.

Twelve soil samples were scheduled for chemical analysis. In addition, disturbed, bulk and undisturbed samples were scheduled for geotechnical testing from the development area. Testing schedules were prepared by the design engineers Ove Arup and Partners. Three rounds of ground gas and water monitoring has been completed at the site. Ground water samples were collected during each monitoring visit and submitted for chemical analysis.

The executive summary contains an overview of key findings. However, no reliance should be placed on the executive summary until the whole of the report has been read. Other sections of the report may contain information which puts into context the findings noted within the executive summary.



1. Introduction

1.1 Background

WEPCo on behalf of the Cardiff and Vale College propose to construct a multi-use 2 storey college building, car park, access roads and areas of landscaping and attenuation.

This investigation forms a supplementary ground investigation and the scope of works has been prepared by Arup Ref: VG0101-ARP-ZZ-ZZ-SP-G-00001, 16th June 2023.

1.2 Client Brief & Scope

HSP Consulting Engineers Ltd has been commissioned by WEPCo on behalf of Cardiff and Vale College to undertake an intrusive ground investigation at the site to investigate the existing ground conditions and geoenvironmental setting. The scope of the investigation was provided by Arup, the clients engineer.

The ground investigation scope included the following:

- 8No. Machine excavated trial pits to a maximum of 2.5m begl. This is to confirm the ground conditions and groundwater level, and collect soil samples for laboratory analysis;
- 3No. exploratory holes to a depth of 7m into the bedrock using rotary drilling methods, to confirm ground conditions and groundwater level and complete collection of soil samples for laboratory analysis;
- In situ strength and stiffness testing such as Standard Penetration tests and Plate Load tests;
- In situ infiltration testing in trial pits and boreholes;
- Soil sampling and laboratory analysis for geotechnical and geo-environmental purposes from all exploratory holes;
- Monitoring of groundwater if encountered;
- Sampling and contamination testing of groundwater if encountered;
- Ground gas monitoring if significant thickness of made ground is encountered;
- Dry weight and waste acceptance criteria (WAC) of soil samples to inform disposal options;
- Laboratory analysis of topsoil and subsoil to inform potential for reuse on other sites.

The following specialists were employed on site during the intrusive works:

- A suitably qualified ecologist to attend site for works in ecologically sensitive areas as access was made onto site and into exploratory locations.

The report presents the following information:

- details of the ground investigation undertaken and the ground conditions encountered,
- details and results of the environmental analysis and geotechnical testing.

Where applicable, the fieldwork was undertaken in accordance with BS5930:2015+A1:2020 Code of Practice for Site Investigations and BS10175:2011+A2:2017 Investigation of Potentially Contaminated Sites.

1.3 Limitations

The recommendations made in this report are based on the findings of the intrusive ground investigation undertaken by HSP Consulting Engineers Ltd from the 25th September to the 2nd October 2023.

1.4 Previous Reports

HSP Consulting Engineers Ltd has produced the following reports for the site:

- HSP Consulting Engineers Limited – Cardiff and Vale College Site - Phase I Geo-Environmental Desk Study Report, June 2020, Ref: C3296/PI. (Ref 1.)
- HSP Consulting Engineers Limited – Cardiff and Vale College Site, Cardiff Airport Business Park, Phase II Geo-Environmental Assessment Report, July 2020, Ref C3296/PII. (Ref 2.)

The following third party reports are also available for the site:

- Advanced Technology Centre Existing Drainage and Utilities (VG0101-ARP-ZZ-OO-RD-C-00021-C01). (Ref 3).

Please note the current site boundary has reduced in size since the 2020 site investigation. The current site location plan is presented within Appendix I.

2. Review of Existing Information & Geoenvironmental Setting

2.1 The Site

2.1.1 Location

The site is located immediately east of Cardiff Airport Business Park, approximately 1.85km north east of Rhoose village centre. The approximate National Grid Reference for the centre of the site is (NGR) 307473, 167768. A Site Location Plan is included in Appendix I.

2.1.2 2020 Description

The site is irregular in shape and approximately 9.05Ha in area. The majority of the site comprises agricultural land accessed off Blackton Lane to the north. The fields have a range of semi mature and mature trees/hedgerows at the boundaries and during the May walkover the vegetation was dense, making it difficult to determine if there are other viable access points to the fields. At the time of the walkover the fields had recently been planted with maize crop that was beginning to germinate. The northern two thirds of the site generally falls towards the north from a low ridge which strikes east west, within the southern third of the site levels fall slightly adjacent to Port Road.

The most southerly field has been left fallow and is overgrown with the exception of the boundaries. The southeast, southwest, and north western boundaries of this area have been landscaped with bunds which vary in height with a number of sparse semi mature trees adjacent to the highway (airport / business park access).

2.1.3 2023 Description Update

The 2023 site comprises the western and central quadrant of the 2020 site boundary. The site is comprised of three fields. The western and central fields have been fallow for many years and were densely overgrown with vegetation and the eastern and southern field were planted with winter crop. The boundaries of each field are marked by dense hedgerows. The southeast, southwest and northwestern boundaries of this area have been landscaped with bunds which vary in height with a number of semi mature trees adjacent to the highway.

2.1.4 Surrounding Land Use

The main features of interest identified are:

North:	Access road to Cardiff Airport Business Park, with agricultural fields beyond.
East:	Agricultural land with Blackton Lane beyond.
South:	Port Road with agricultural land beyond.
West:	Cardiff Airport long stay car parking with Cardiff Airport beyond.

2.1.5 Site Access

The site was accessed via a gated entrance from a turning head off Port Road. The site is extremely overgrown and vegetation clearance was required to provide access onto site and to the location of each exploratory hole location.

2.1.6 Proposed End Use

WEPCo on behalf of the Cardiff and Vale College propose to construct a multi-use 2 storey college building, car park and access roads and areas of landscaping and attenuation. A site development plan is presented in Appendix II.

2.2 Geology

2.2.1 Made Ground

The BGS mapping does not indicate any Made Ground deposits on the site.

2.2.2 Superficial Deposits

The BGS mapping does not indicate any superficial deposits on the site.

2.2.3 Bedrock Geology

BGS bedrock mapping indicates the site is underlain by the Porthkerry Member – Limestone and Mudstone, Interbedded of the Jurassic Period, there is no current BGS description of the unit. The BGS description of the Blue Lias Parent Unit is as follows '*Thinly interbedded limestone (laminated, nodular, or massive and persistent) and calcareous mudstone or siltstone (locally laminated). Individual limestones are typically 0.10-0.30m thick. In some areas, intervening mudstone units with relatively few limestone beds. Also includes littoral limestone facies of the Radstock Shelf - Mendip area and South Wales.*'

2.3 Pertinent Site Sensitivity Information

Based on the information collated for the desk study, the geo-environmental setting of the site is summarised as follows:

- The site is recorded as part of five fields on the 1st Edition mapping (1884), with a small development noted in the east of the site from 1938 until the mid 1960's where it is no longer present. With no significant changes noted to the present day.
- Historically, the surrounding land use is predominantly agricultural. With limited development until the mid 1960's where the airport is recorded to the west of the site, with moderate expansion noted through the 1970's and 1980's until the 1990's where the Business Park immediately adjacent to the west of the site is noted.
- The bedrock geology is designated as a Secondary A Aquifer.

Based on the above, the environmental sensitivity of the site can be considered to be Low at this stage.

2.4 HSP 2020 Intrusive Site Investigation Summary

The ground investigation comprised 12No window sample boreholes to a maximum depth of 2.00m begl and 8No. mechanically excavated trial pits to 0.40m begl. The ground conditions encountered on site generally comprised topsoil, overlying deposits belonging to the Porthkerry Member – Limestone and Mudstone. The solid deposits comprised brown grey slightly sandy gravelly CLAY with interbedded mudstone and limestone fragments to a

maximum depth of 0.40m begl overlying brown orange grey very slightly sandy gravelly CLAY with fragments of mudstone and limestone and occasional limestone cobbles.

Made ground deposits were encountered locally within WS7 to a maximum depth of 0.65m begl. These deposits comprised brown grey sandy slightly gravelly Clay with brick fragments, masonry and sand and were encountered in a firm condition.

HSP would recommend that all foundations are taken down to bear upon the competent natural deposits that have been encountered across the site. Traditional pad foundations would be considered appropriate and should be at a minimum depth of 1.20m. Relative soft spots were encountered and localised deepening of foundations may be required to ensure they are consistently bearing upon competent strata. Once the layout has been confirmed HSP would recommend rotary coring with SPTs (where possible) and unconfined compressive strength testing of recovered core to determine the competency and strength of the near surface soils to confirm the ABP for design.

The underlying geology consists of very weak weathered interbedded limestone and mudstone (clay near surface). During the intrusive ground investigation, the excavation of the trial pits using a 2tonne machine proved to be difficult. Consideration should be given to using larger machinery for the excavation of foundations and also a breaker or rock ripper for deep service trenches.

A ground bearing slab may be appropriate at the site subject to the likely loadings and locations of the proposed buildings. However, should the development be located within close proximity to trees a suspended floor slab may be required.

The concentrations of potential contaminants recorded at the site indicates an acceptably low risk and therefore mitigation measures are not required as part of the development. It is recommended that any reuse of topsoil on site will likely need to meet the requirements of the landscape architect and topsoil testing to the British Standard will be required to determine if the topsoil is suitable or can be made suitable with amelioration.

The results of sulphate and pH testing carried out on selected soil samples taken during this investigation have been compared with the recommendations outlined in BRE Special Digest 1. On the basis of the above, results associated the soils on site have been considered and it is appropriate to adopt a basic Design Sulphate Class of DS-1 together with an Aggressive Chemical Environment for Concrete (ACEC) of AC-1s.

Based on the chemical analysis report it is considered that specialist materials are not likely to be required for water supply pipes. However, confirmation of supply pipes should be sought from utility providers.

Plausible sources of ground gas were not identified as part of the Phase I Desktop or during the site works. Therefore, ground gas monitoring was not undertaken as part of the investigation.

3. Fieldwork & Factual Information

Site work was carried out between the 25th September and 2nd October 2023. Where applicable, the fieldwork was undertaken in accordance with BS5930:2015+A1:2020 Code of Practice for Site Investigations (Ref. 6) and BS10175:2011+A2:2017 Investigation of Potentially Contaminated Sites (Ref. 7).

3.1 Exploratory Methods

The physical methods of investigation employed were 8No mechanically excavated trial pits to a maximum depth of 2.00 begl. 3No. of the trial pits were utilised for soakaway infiltration testing. 4No. plate load tests were also undertaken within 4No. trial pit locations. 3No. rotary open hole boreholes were conducted to 2.00m begl with rotary core follow on to 7.00m begl.

The exploratory holes were logged and sampled by an engineer from HSP Consulting Engineers Ltd. The exploratory hole logs are presented in Appendix III. The exploratory hole locations are shown on the Ground Investigation Layout Plan presented in Appendix IV. Photographs of the site and rotary cores are presented within Appendix X.

Fragmentary bulk and disturbed samples were recovered from materials revealed within all of the exploratory holes. Geo-environmental samples, placed in plastic tubs and glass jars supplied by the laboratory, were also obtained specifically for chemical analysis. The samples were taken to UKAS accredited laboratories for further examination and testing.

3.2 In-situ Testing

3.3.1 Standard Penetration Tests

Standard Penetration Tests (SPTs) were carried out within the rotary cored boreholes to 5.00m depth. The SPTs were undertaken in accordance with EN ISO 22476-2 2005: A1 2011 and the results are included on the appended borehole logs (Appendix III).

3.3.2 Soil Infiltration Tests

Soil Infiltration Tests were conducted within TP02, TP04 and TP10. The tests were undertaken in accordance with BRE Digest 365 Soakaway Design. The results are included within Appendix VII.

3.3.3 Falling Head Borehole Tests

Falling head tests were conducted within the competent Limestone encountered within the 3No boreholes. The tests were undertaken in accordance with BS EN ISO 22282-2 and guidance in the BS5930 Section 48 and the results are included on the appended soakaway logs (Appendix III).

3.3.4 In-situ Plate Load Tests

In-situ plate load tests were conducted within TP05, TP06, TP07 and TP09 in accordance with BS 1377-9 Section 4.1 using a 300mm diameter plate. The results are presented in Appendix VIII.

3.3 Laboratory Testing

The laboratory testing schedules were prepared by Arup, the Clients Engineer.

3.3.1 Geotechnical Testing

Geotechnical testing has been undertaken by a UKAS accredited laboratory as part of the works at the site:

- 8 No. Particle Size Distributions (Wet Sieving)
- 3No. Compaction using 2.5kg rammer
- 25 No. Natural Moisture Contents
- 15 No. Atterberg Limits
- 8 No. Sedimentation by Pipette
- 6 No. Organic Matter
- 11 No. BRE Suite A (Greenfield site – pyrite absent)
- 4 No. Recompacted CBR Testing*
- 5No. Uniaxial Compressive Strength (rock)
- 4No. Point Load Strength Index (rock)

*Due to the nature of the excavated material (large cobbles of Limestone) it was not possible to complete the recompacted CBR tests. In-situ plate load testing was successfully completed and results are presented in Appendix VIII.

The laboratory testing has been carried out by Apex Testing Solutions (ATS) (UKAS accredited, laboratory No. 7771) and KIWA CMT (UKAS accredited, laboratory No. 0529) in accordance with BS1377:1990 using calibrated equipment specifically for the British Standard. The results are presented in Appendix VI.

3.3.2 Chemical Analysis - Soils

The geo-environmental samples retained specifically for chemical analysis were stored in cooled containers until delivery to the laboratory by courier.

Twelve soil samples were analysed by the laboratory for the presence of a selected suite of potential contaminants as outlined in the table below. Please refer to the Arup specification (presented in Appendix V) for further details regarding the specifics of each suite:

Table 1 – Chemical Analysis

Exploratory Hole Location & Depth	Sample Description
TP11, G.L. – 0.30m	TOPSOIL ^{1,2,3,4,5,7,8,11}
TP10, G.L. – 0.30m	TOPSOIL ¹¹
TP02, G.L. – 0.30m	TOPSOIL ^{1,2,3,4,5,7,8,11}
TP04, G.L. – 0.30m	TOPSOIL ^{1,2,3,4,9,10,11}

Exploratory Hole Location & Depth	Sample Description
TP05, G.L. – 0.30m	TOPSOIL ^{1,2,3,4,5,7,8,11}
TP05, 1.00 – 1.20m	CLAY ^{1,3,4,9,10,11}
TP06, G.L. – 0.30m	TOPSOIL ¹¹
TP06, 1.00 – 1.20m	CLAY ^{1,3,4,5,7,8,11}
TP07, G.L. – 0.30m	TOPSOIL ^{1,2,3,4,9,10,11}
TP07, 1.00 – 1.20m	CLAY ^{1,3,4,5,7,8,11}
TP09, G.L. – 0.30m	TOPSOIL ¹¹
BH02, 0.1 – 0.50m	Weather LIMESTONE Gravels ^{1,3,4,5,9,10}

¹ Suite E1 – Soil, ² Suite E2 – Asbestos, ³ Suite E3 - TPHCWG + BTEX, ⁴ Suite E4 – PAH, ⁵ Suite E9 – Hexavalent Chromium, ⁶ Suite E16 - Other (Loss on Ignition), ⁷ Suite H - WAC soils, ⁸ Suite I – WAC leachability, ⁹ Suite J1 – Leachability General, ¹⁰ Suite J2 Leachability PAH / BTEX ¹¹ Suite A BRE (Greenfield site – pyrite absent)

The contamination analysis was carried out by Chemtest Environmental Ltd (UKAS accredited, laboratory No. 2183) during the period 27th September to 9th October 2023. The results are presented in Appendix V.

3.3.3 Chemical Analysis – Groundwaters

The groundwater samples were extracted using a low-flow technique and retained specifically for chemical analysis. The samples were stored in cooled containers until delivery to the laboratory by courier. The samples were delivered to the laboratory with 24 hours of abstraction.

Three rounds of ground water monitoring were undertaken between the 15th December 2023 and the 23rd January 2024. It was not possible to collect groundwater samples during the visit on the 15th December due to low recharge rates in the boreholes during the monitoring visit. On the two subsequent visits it was only possible to obtain samples from BH01 and BH03. Insufficient groundwater was encountered within BH02.

Prior to extraction each borehole was purged for three times the well volume and given ample time to recharge prior to extraction via low flow.

The groundwater samples were analysed by the laboratory for the presence of a selected suite of potential contaminants. Please refer to the Arup specification (presented in Appendix XI) for further details regarding the specifics of each suite.

The contamination analysis was carried out by Chemtest Environmental Ltd (UKAS accredited, laboratory No. 2183) during the period 15th December 2023 to 31st January 2024. The results along with low flow data are presented in Appendix XI.

3.4 Ground Conditions

3.4.1 Published Geology

The published geology indicates the site is not underlain by Made Ground or superficial deposits as described in section 2.2.1 and 2.2.2 The site is underlain by the bedrock geology of the Porthkerry Member – Limestone and Mudstone, described in section 2.2.3 above.

3.4.2 Ground Conditions on site or General Geology & Revealed Strata

The exploratory hole data does conform with the published information, the strata across the site generally comprises:

Table 2 – Encountered Ground Conditions

	Strata	Depth (m begl)	Thickness (m)	Description
—	TOPSOIL	G.L. – 0.30	0.30	Grass over brown slightly sandy slightly gravelly clayey TOPOSIL with many rootlets.
Bedrock	PORTHERRY MEMBER – LIMESTONE AND MUDSTONE	0.20 – 1.55	1.35	Firm to stiff yellow grey brown slightly sandy gravelly CLAY with abundant cobbles of Limestone.
		0.60 – 1.68	1.08	Dense yellow brown grey sandy GRAVELS and COBBLES of Limestone with pockets of Clay.
		0.85 – 2.00	1.15	Very weak grey LIMESTONE. Recovered as cobbles and boulders of Limestone.
		2.00 – 6.25	4.25	Strong blue grey LIMESTONE
		6.25 – 6.75	0.50	Weak dark grey strongly weathered MUDSTONE.
		6.75 – 7.00	0.25	Very strong blue grey LIMESTONE.

3.5 Ground Gas and Groundwater Monitoring

Dual use gas and groundwater monitoring installations were constructed within three of the boreholes at the site during ground investigation (BH01, BH02 and BH03). Each well has been constructed using 50mm diameter HDPE pipe. All of the borehole installations have a 6mm pea gravel surround to the slotted pipe with a bentonite seal above and a gas tap. The covers are raised round lockable stopcock covers.

HSP Consulting uses a GFM 436 Gas Analyser. Prior to its use a calibration check can be performed against gas readings in air. It is recommended that this check is undertaken once on each day the analyser is used. Annual calibration is undertaken on the unit and a copy of this certificate has been included within Appendix IX.

Three rounds of ground gas and ground water monitoring have been completed on the site. The results are presented within Appendix IX.

3.6 Groundwater Levels

No groundwater was encountered during the advancement of the exploratory holes.

Groundwater was recorded during the 3No. rounds of ground gas and groundwater monitoring that was conducted at the site. Table 3 provides further details. The table will be updated upon the completion of ground gas and groundwater monitoring.

Table 3 – Groundwater Levels

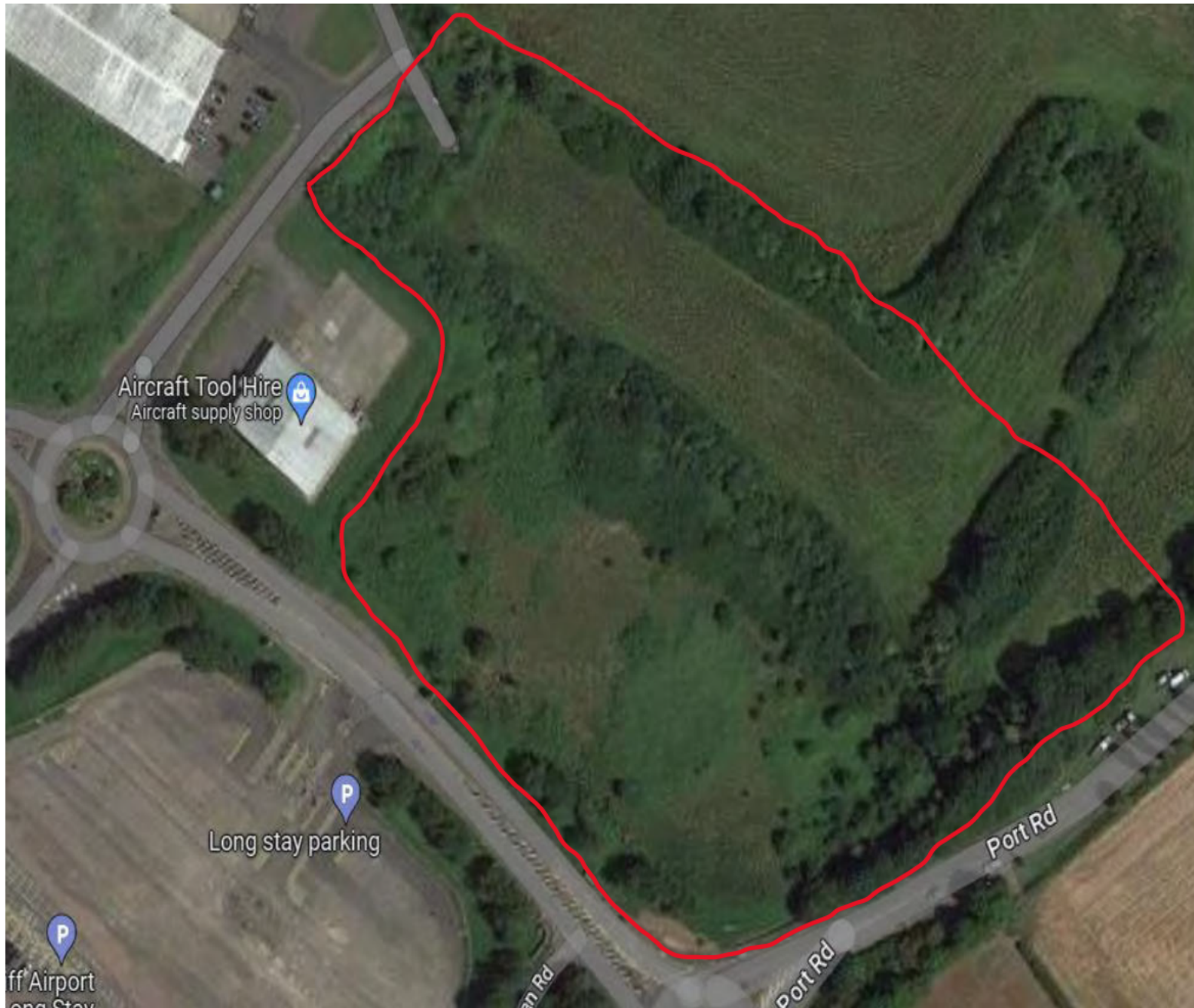
Exploratory Location	Round 1 (16.10.23)		Round 2 (06.11.2023)		Round 3 (21.11.2023)	
	Depth (m begl)	Depth (m AOD)	Depth (m begl)	Depth (m AOD)	Depth (m begl)	Depth (m AOD)
BH01	2.22	60.63	1.05	61.80	1.00	61.85
BH02	6.20	56.72	3.13	59.79	2.84	60.08
BH03	3.92	59.45	2.28	61.09	1.92	61.45

From observations it is believed that the above water levels are due to percolating rainwater trapped within the standpipe and not representative of a groundwater source.

4. References

1. HSP Consulting Engineers Limited – Cardiff and Vale College Site - Phase I Geo-Environmental Desk Study Report, June 2020, Ref: C3296/PI.
2. HSP Consulting Engineers Limited – Cardiff and Vale College Site, Cardiff Airport Business Park, Phase II Geo-Environmental Assessment Report, July 2020, Ref C3296/PII.
3. Advanced Technology Centre Existing Drainage and Utilities (VG0101-ARP-ZZ-OO-RD-C-00021-C01).
4. BRITISH GEOLOGICAL SURVEY. 1996. Cardiff. England and Wales Sheet 263. Solid and Drift. 1:50 000 (Keyworth, Nottingham: British geological Survey).
5. British Geological Survey Lexicon Search - <http://www.bgs.ac.uk/lexicon/>
6. BS5930:2015+A1:2020 Code of Practice for Site Investigations
7. BS10175:2011 +A2:2017 Investigation of Potentially Contaminated Sites - Code of Practice.
8. Ove Arup & Partners Limited ref: VG0101-ARP-ZZ-ZZ-SP-G-00001, 16th June 2023.

Appendix I



DO NOT SCALE
NOTES:



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Eastwood, Nottingham, NG16 3SB
Tel: 01773 535 555 Fax: 0870 600 6091
www.hspconsulting.com

CLIENT:
WEPCo

PROJECT:
**Cardiff Airport
Technology College**

TITLE:
Site Location Plan

SCALE@SIZE :	ISSUE:
NTS	FINAL

DESIGN/DRAWN:	DATE:
LEJ	Nov 2023

PROJECT No:	DRAWING No:
C3296	502

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Appendix II



Note
 1. Do not scale from this drawing
 2. To be read in conjunction with Project Risk Register REF. XXX
 3. To be read in conjunction with all other Landscape Architect's drawings

- KEY**
- (A) Entrance Plaza to Building
 - (B) Social Space
 - (C) Car Park
- 294 standard parking spaces (inc. 32no. as EVCPs and 14 Accessible Parking Spaces)
 - (D) Service area for workshop students
 - (E) 2 Court MUGA
 - (F) Meadow Planting and Habitat Area
 - (G) Sprinkler Tank System
 - (H) Air Source Heat Pump
 - (I) Bin Store
 - (J) Swale with Hedgerow and tree planting
 - (K) Cycle Parking (Double Stacked)
- Total 284 long stay bicycle spaces
 - (L) Pick up / Drop off / Delivery bay
 - (M) Access through car park to MUGA
 - (N) Retaining Wall
 - (O) Access controlled vehicular entrance
 - (P) External HV Unit
 - (Q) Motorcycle parking
10 spaces
 - (R) Motor Vehicle Workshop parking spaces
8 spaces
 - (S) New native buffer planting
 - (T) External digging area
 - (U) Cherry Tree Walk
Pedestrian access route
 - (V) Dust extractor

ID	RISK	MITIGATION	DATE MITIGATED
RESIDUAL PROJECT RISKS			

DATE	REV	DESCRIPTION OF REVISION	DRAWN BY	APPROVED BY
14/12/2023	P05	1. Issued for Pre-Application Consultation	MDS	MH
13/12/2023	P04	1. Tree shown as retained 2. Colours updated to accurately reflect proposals 3. Bench graphics updated	MH	-

REVISIONS

STATUS
S2 - Issued for Pre-Application Consultation

ares
 LANDSCAPE ARCHITECTS

Ares Landscape Architects LTD
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 t: 0114 276 2000
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 w: ares.eu.com

CLIENT:
Cardiff and Vale College

PROJECT TITLE:
Advanced Technology Centre

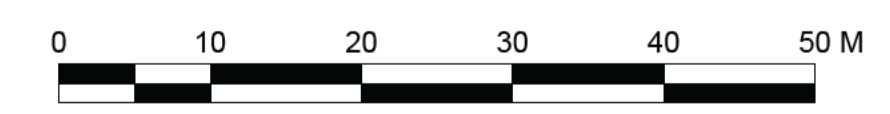
DRAWING TITLE:
Landscape Illustrative Masterplan

DRAWING SCALE: 1:500
 PAPER SIZE: A1

DRAWN BY: MDS
 APPROVED BY: HT

DRAWN DATE: 15/06/2022
 ALA PROJECT CODE: ALAT23

DRAWING NUMBER: **VG0101-ALA-00-XX-DR-L-00001**
 STATUS: **S2**
 REVISION: **P05**



Appendix III

Borehole Log

Borehole No.

BH01

Sheet 1 of 1

Project Name: Cardiff Airport Technology College

Project No. C3296a

Co-ords: 307432.00 - 167577.00

Hole Type CP

Location: Cardiff

Level: 62.85

Scale 1:50

Client: WEPCo

Dates: 27/09/2023 - 28/09/2023

Logged By LH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10 - 0.50							
		0.10 - 0.50			0.30	62.55			
		0.50 - 1.00	C		0.40	62.45			
		1.00		50 (18,7/50,,)				1	
		1.00 - 2.00	C						
		2.00		50 (25,/50,,)				2	
		2.00 - 3.00	C						
		3.00 - 4.00	C		3.00	59.85		3	
		4.00 - 5.00	C					4	
		5.00		50 (25,/50,,)				5	
		5.00 - 6.00	C						
		6.00 - 7.00	C					6	
					7.00	55.85		7	
								8	
								9	
								10	

Remarks

- No groundwater was encountered during the drilling process.
- Borehole was terminated at 7.00m depth and used for falling head test.

Rotary Core Log

Borehole No.

BH01

Sheet 1 of 1

Project Name: Cardiff Airport Technology College

Project No. C3296a

Co-ords: 307432.00 - 167577.00

Hole Type RC

Location: Cardiff

Level: 62.85

Scale 1:50

Client: WEPCo

Dates: 27/09/2023 - 28/09/2023

Logged By LH

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		0.10 - 0.50									
		0.10 - 0.50					0.30	62.55		Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.	
		0.50 - 1.00	C	44	40	0	0.40	62.45		Yellowish brown sandy very gravelly CLAY. Sand is fine to coarse. Gravel is fine to medium sub-rounded to rounded of limestone.	
		0.30 - 1.00								Strong bluish grey LIMESTONE. Very closely to widely spaced 20-30° rough planar fractures.	1
		1.00 - 2.00	C							<i>Band of stiff orange and grey mottled sandy CLAY.</i>	
		1.00 - 2.00		93	82	11					
		2.00 - 3.00	C								2
		2.00 - 3.00		61	59	26					
		3.00 - 4.00	C				3.00	59.85		Strong bluish grey mottled with orange staining. Widely spaced to closely spaced 0-20° rough open planar and 80-90° vertical fractures with occasional clay infill.	3
		3.00 - 4.00		93	85	36					
		4.00 - 5.00	C								4
		4.00 - 5.00		79	77	11					
		5.00 - 6.00	C								5
		5.00 - 6.00		85	82	22					
		6.00 - 7.00	C								6
		6.00 - 7.00		100	100	65					
		6.00 - 7.00					7.00	55.85		<i>Band of weak dark grey mudstone.</i>	7
										End of borehole at 7.00 m	
											8
											9
											10

Remarks

- No groundwater was encountered during the drilling process.
- Borehole was terminated at 7.00m depth and used for falling head test.

Borehole Log

Borehole No.

BH02

Sheet 1 of 1

Project Name: Cardiff Airport Technology College

Project No. C3296a

Co-ords: 307546.00 - 167648.00

Hole Type CP

Location: Cardiff

Level: 62.92

Scale 1:50

Client: WEPCo

Dates: 28/09/2023 - 02/10/2023

Logged By LH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.30	62.62		Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.	
		1.00		50 (20,5/50,,)	1.00	61.92		Yellowish brown and grey mottled slightly sandy very clayey medium to coarse sub-angular to sub-rounded GRAVEL of limestone. Sand is fine to coarse.	1
					1.40	61.52		Strong bluish grey LIMESTONE. Fractures are 80-90° vertical rough planar.	
								Weak bluish grey and orange mottled MUDSTONE	
		2.00		50 (19,6/50,,)	1.95	60.97		Very strong bluish grey LIMESTONE	2
					2.30	60.62		Weak bluish grey and orange mottled MUDSTONE.	
					2.55	60.37		Very strong bluish grey LIMESTONE with orange staining. Fractures closely to very closely spaced 0-20° rough open planar.	3
					3.25	59.67		Very strong bluish grey LIMESTONE with orange staining and occasional bands of weak dark grey mudstone. Fractures are closely spaced 0-20° rough open planar and 70-90° vertical undulating.	4
					5.00	57.92		Very strong bluish grey LIMESTONE with orange staining and calcite veins. Fractures very closely to widely spaced 10-30° rough open undulating and 80-90° vertical rough planar with occasional clay infill. <i>Band of dark grey weak mudstone.</i>	5
					7.00	55.92		End of borehole at 7.00 m	7

Remarks

- No groundwater was encountered during the drilling process.
- Borehole was terminated at 7.00m depth and used for falling head test.



Rotary Core Log

Borehole No.

BH02

Sheet 1 of 1

Project Name: Cardiff Airport Technology College

Project No. C3296a

Co-ords: 307546.00 - 167648.00

Hole Type RC

Location: Cardiff

Level: 62.92

Scale 1:50

Client: WEPCo

Dates: 28/09/2023 - 02/10/2023

Logged By LH

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		0.30 - 1.00		34	0	0	0.30	62.62		Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.	
		1.00 - 2.00		71	25	0	1.00	61.92		Yellowish brown and grey mottled slightly sandy very clayey medium to coarse sub-angular to sub-rounded GRAVEL of limestone. Sand is fine to coarse.	1
		2.00 - 3.00		96	91	14	1.40	61.52		Strong bluish grey LIMESTONE. Fractures are 80-90° vertical rough planar.	
		3.00 - 4.00		92	82	38	1.95	60.97		Weak bluish grey and orange mottled MUDSTONE	
		4.00 - 5.00		94	94	36	2.30	60.62		Very strong bluish grey LIMESTONE	2
		5.00 - 6.00		94	92	15	2.55	60.37		Weak bluish grey and orange mottled MUDSTONE.	
		6.00 - 7.00		94	93	0	3.25	59.67		Very strong bluish grey LIMESTONE with orange staining. Fractures closely to very closely spaced 0-20° rough open planar.	3
							5.00	57.92		Very strong bluish grey LIMESTONE with orange staining and occasional bands of weak dark grey mudstone. Fractures are closely spaced 0-20° rough open planar and 70-90° vertical undulating.	4
							7.00	55.92		Very strong bluish grey LIMESTONE with orange staining and calcite veins. Fractures very closely to widely spaced 10-30° rough open undulating and 80-90° vertical rough planar with occasional clay infill. <i>Band of dark grey weak mudstone.</i>	5
										End of borehole at 7.00 m	6
											7
											8
											9
											10

Remarks

- No groundwater was encountered during the drilling process.
- Borehole was terminated at 7.00m depth and used for falling head test.

Borehole Log

Borehole No.

BH03

Sheet 1 of 1

Project Name: Cardiff Airport Technology College

Project No. C3296a

Co-ords: 307450.00 - 167672.00

Hole Type CP

Location: Cardiff

Level: 63.37

Scale 1:50

Client: WEPCo

Dates: 26/09/2023 - 27/09/2023

Logged By LH

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.10 - 0.50	ES	50 (25,/50,,)	0.30	63.07	Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.	
		0.10 - 0.50	ES					
		0.50	C	50 (25,/50,,)	1.70	61.67	Strong bluish grey Limestone. Fractures 80-90° vertical open.	
		0.50 - 1.00	C					
		1.00 - 2.00	C	50 (25,/50,,)	2.60	60.77	Strong bluish grey Limestone with orange staining. Fractures are closely spaced 0-30° undulating.	
		2.00	C					
		2.00 - 3.00	C	50 (25,/50,,)	3.60	59.77	Strong bluish grey Limestone with red and orange staining. Fractures are closely to widely spaced 10-30° rough open and 80-90° vertical rough undulating.	
		3.00 - 4.00	C					
		4.00 - 5.00	C	50 (25,/50,,)	6.25	57.12	Weak dark grey strongly weathered MUDSTONE.	
		5.00 - 6.00	C					
	6.00 - 7.00	C	50 (25,/50,,)	6.75	56.62	Very strong bluish grey Limestone with orange staining.		
	6.00 - 7.00	C						
				7.00	56.37	End of borehole at 7.00 m		

Remarks

- No groundwater was encountered during the drilling process.
- Borehole was terminated at 7.00m depth and used for falling head test.

Rotary Core Log

Borehole No.

BH03

Sheet 1 of 1

Project Name: Cardiff Airport Technology College

Project No. C3296a

Co-ords: 307450.00 - 167672.00

Hole Type RC

Location: Cardiff

Level: 63.37

Scale 1:50

Client: WEPCo

Dates: 26/09/2023 - 27/09/2023

Logged By LH

Well	Water Strikes	Depth (m)	Type / FI	Coring			Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD					
		0.10 - 0.50	ES				0.30	63.07		Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.	
		0.10 - 0.50	ES								
		0.50 - 1.00	C	42	26	14	1.70	61.67		Strong bluish grey LIMESTONE. Fractures 80-90° vertical open.	1
		0.30 - 1.00									
		1.00 - 2.00	C								
		1.00 - 2.00	C	71	44	0	2.60	60.77		Strong bluish grey LIMESTONE with orange staining. Fractures are closely spaced 0-30° undulating.	2
		2.00 - 3.00									
		2.00 - 3.00	C								
		2.00 - 3.00	C	68	65	24	3.60	59.77		Strong bluish grey LIMESTONE with red and orange staining. Fractures are closely to widely spaced 10-30° rough open and 80-90° vertical rough undulating.	3
		3.00 - 4.00									
		3.00 - 4.00	C								
		3.00 - 4.00	C	98	68	10	6.25	57.12		Band of weak dark grey MUDSTONE	4
		4.00 - 5.00									
		4.00 - 5.00	C								
		4.00 - 5.00	C	100	98	24	6.75	56.62		Weak dark grey strongly weathered MUDSTONE.	5
		5.00 - 6.00									
		5.00 - 6.00	C								
		5.00 - 6.00	C	95	93	14	7.00	56.37		Very strong bluish grey LIMESTONE with orange staining	6
		6.00 - 7.00									
		6.00 - 7.00	C								
		6.00 - 7.00								End of borehole at 7.00 m	7
											8
											9
											10

Remarks

- No groundwater was encountered during the drilling process.
- Borehole was terminated at 7.00m depth and used for falling head test.

Trial Pit Log

Trialpit No
TP02
Sheet 1 of 1

Project Name: Cardiff Airport Technology College	Project No. C3296a	Co-ords: 307422.00 - 167702.00 Level: 63.12	Date 25/09/2023
Location: Cardiff	Client: WEPCo	Dimensions (m): Depth 1.30	Scale 1:25 Logged M. Kent

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.30	62.82		Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.
	0.50 - 0.70 0.50 - 0.80	D B		0.60	62.52		Firm to stiff yellowish brown with grey slightly sandy gravelly CLAY with cobbles of limestone. Sand is fine to coarse. Gravels and cobbles are fine to coarse sub angular of Limestone. Occasional boulders of subangular Limestone.
	1.25 - 1.30 1.25 - 1.30	B D		1.25 1.30	61.87 61.82		Dense yellow brown clayey sandy GRAVELS and COBBLES with frequent boulders of limestone. Sand is fine to coarse. Gravels cobbles and boulders are subangular of Limestone and thin tabular Mudstone.
							Very weak grey LIMESTONE. End of pit at 1.30 m

Remarks: 1. Trial pit terminated at 1.30m begl due to machine refusal.
2. No groundwater was encountered.
3. Side walls remained stable.

Stability: Sides Stable



Trial Pit Log

Project Name: Cardiff Airport Technology College	Project No. C3296a	Co-ords: 307368.00 - 167609.00 Level: 62.30	Date 25/09/2023
Location: Cardiff	Dimensions (m): Depth 1.50		Scale 1:25 Logged M.Kent
Client: WEPCo	2.1		

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.25	62.05		Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.
	0.50 - 0.70 0.50 - 0.80	D B		0.60	61.70		Firm to stiff yellowish brown with grey slightly sandy gravelly CLAY with cobbles of limestone. Sand is fine to coarse. Gravels and cobbles are fine to coarse sub angular of Limestone. Occasional boulders of subangular Limestone.
				1.00	61.30		Dense yellow brown clayey sandy GRAVELS and COBBLES with frequent boulders of limestone. Sand is fine to coarse. Gravels cobbles and boulders are subangular of Limestone and thin tabular Mudstone.
	1.30 - 1.50 1.30 - 1.50	B D		1.50	60.80		Very weak grey LIMESTONE.
							End of pit at 1.50 m

Remarks: 1. Trial pit terminated at 1.50m begl due to machine refusal.
2. No groundwater was encountered.
3. Side walls remained stable.

Stability: Sides Stable



Trial Pit Log

Project Name: Cardiff Airport Technology College	Project No. C3296a	Co-ords: 307435.00 - 167749.00 Level: 62.04	Date 26/09/2023
Location: Cardiff	Dimensions (m): Depth 1.70		Scale 1:25 Logged M.Kent
Client: WEPCo			

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.50 - 0.70 0.50 - 0.80	D B		0.25	61.79		Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.
	1.50 - 1.70 1.50 - 1.70	B D		1.50 1.68 1.70	60.54 60.36 60.34		Firm to stiff yellowish brown with grey slightly sandy gravelly CLAY with cobbles of limestone. Sand is fine to coarse. Gravels and cobbles are fine to coarse sub angular of Limestone. Occasional boulders of subangular Limestone.
							Dense yellow brown clayey sandy GRAVELS and COBBLES with frequent boulders of limestone. Sand is fine to coarse. Gravels cobbles and boulders are subangular of Limestone and thin tabular Mudstone.
							Very weak grey LIMESTONE. End of pit at 1.70 m

Remarks: 1. Trial pit terminated at 1.70m begl due to machine refusal.
2. No groundwater was encountered.
3. Side walls remained stable.

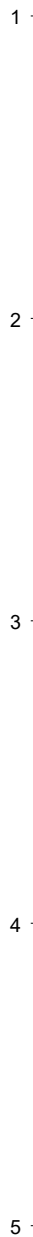
Stability: Side Stable



Trial Pit Log

Project Name: Cardiff Airport Technology College	Project No. C3296a	Co-ords: 307497.00 - 167686.00 Level: 63.15	Date 26/09/2023
Location: Cardiff	Dimensions (m): Depth 1.60		Scale 1:25 Logged M.Kent
Client: WEPCo			

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.50 - 0.70 0.50 - 0.80	D B		0.25	62.90		Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.
	1.50 - 1.60 1.50 - 1.60	B D		1.55 1.60	61.60 61.55		Firm to stiff yellowish brown slightly sandy gravelly CLAY with cobbles of limestone. Sand is fine to coarse. Gravels and cobbles are fine to coarse sub angular of Limestone.
							Very weak grey LIMESTONE. ----- End of pit at 1.60 m



Remarks: 1. Trial pit terminated at 1.60m begl due to machine refusal.
2. No groundwater was encountered.
3. Side walls remained stable.

Stability: Sides Stable



Trial Pit Log

Project Name: Cardiff Airport Technology College	Project No. C3296a	Co-ords: 307376.00 - 167715.00 Level: 62.64	Date 26/09/2023
Location: Cardiff	Dimensions (m): Depth 1.70		Scale 1:25 Logged M.Kent
Client: WEPCo			

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.50 - 0.70 0.50 - 0.80	D B		0.25	62.39		Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.
	1.50 - 1.70 1.50 - 1.70	B D		1.30	61.34		Firm to stiff yellow grey brown slightly sandy gravelly CLAY with abundant boulders and cobbles of limestone. Sand is fine to coarse, Gravel / Cobble and Boulders are fine to coarse subangular of Limestone.
				1.70	60.94		Very weak grey LIMESTONE. Recovered as cobbles and boulders of LIMESTONE with occasional yellow grey brown horizons of Clay.
							End of pit at 1.70 m

Remarks: 1. Trial pit terminated at 1.70m begl due to machine refusal.
2. No groundwater was encountered.
3. Side walls remained stable.

Stability: Sides Stable



Trial Pit Log

Project Name: Cardiff Airport Technology College	Project No. C3296a	Co-ords: 307398.00 - 107649.00 Level: 62.72	Date 26/09/2023
Location: Cardiff	Dimensions (m): Depth 0.90		Scale 1:25 Logged M.Kent
Client: WEPCo			

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.50 - 0.70 0.50 - 0.80	D B		0.20 0.60 0.85 0.90	62.52 62.12 61.87 61.82		<p>Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.</p> <p>Stiff yellow brown sandy gravelly to very gravelly CLAY. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone. Occasional cobbles and boulders of sub angular Limestone.</p> <p>Dense yellow brown grey sandy GRAVELS and COBBLES with pockets of Clay. Gravels, cobbles and boulders are subangular of Limestone.</p> <p>Very weak grey LIMESTONE. End of pit at 0.90 m</p>

Remarks: 1. Trial pit terminated at 0.90m begl due to machine refusal.
2. No groundwater was encountered.
3. Side walls remained stable.

Stability: Sides Stable



Trial Pit Log

Project Name: Cardiff Airport Technology College	Project No. C3296a	Co-ords: 307325.00 - 167739.00 Level: 61.80	Date 25/09/2023
Location: Cardiff	Dimensions (m): Depth 1.00		Scale 1:25 Logged M.Kent
Client: WEPCo		2.5	

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.25	61.55		Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.
	0.50 - 0.70 0.50 - 0.80	D B		0.65	61.15		Firm to stiff yellowish brown with grey slightly sandy gravelly CLAY with cobbles of limestone. Sand is fine to coarse. Gravels and cobbles are fine to coarse sub angular of Limestone. Occasional boulders of subangular Limestone.
	0.95 - 1.00 0.95 - 1.00	B D		0.95 1.00	60.85 60.80		Dense yellow brown clayey sandy GRAVELS and COBBLES with frequent boulders of limestone. Sand is fine to coarse. Gravels cobbles and boulders are subangular of Limestone and thin tabular Mudstone.
							Very weak grey LIMESTONE. End of pit at 1.00 m

Remarks: 1. Trial pit terminated at 1.00m begl due to machine refusal.
2. No groundwater was encountered.
3. Side walls remained stable.

Stability: Sides Stable



Trial Pit Log

Project Name: Cardiff Airport Technology College	Project No. C3296a	Co-ords: 307448.00 - 167614.00 Level: 63.18	Date 25/09/2023
Location: Cardiff	Client: WEPCo	Dimensions (m): Depth 2.00	Scale 1:25 Logged M.Kent

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
	0.50 - 0.70 0.50 - 0.70	B D		0.30	62.88		Grass over brown slightly sandy slightly gravelly clayey TOPSOIL. Sand is fine to coarse, Gravel is fine to coarse sub angular of Limestone and Quartzite.
				1.00	62.18		Firm to stiff yellowish brown with grey slightly sandy gravelly CLAY with cobbles of limestone. Sand is fine to coarse. Gravels and cobbles are fine to coarse sub angular of Limestone. Occasional boulders of subangular Limestone.
	1.50 - 1.70 1.50 - 1.80	D B		1.50	61.68		Dense yellow brown clayey sandy GRAVELS and COBBLES with frequent boulders of limestone. Sand is fine to coarse. Gravels cobbles and boulders are subangular of Limestone and thin tabular Mudstone.
				2.00	61.18		Very weak grey LIMESTONE.
							End of pit at 2.00 m

Remarks: 1. Trial pit excavated to 2.00m using a mechanical breaker.
2. No groundwater was encountered.
3. Side walls remained stable.

Stability: Sides Stable



Appendix IV