Greenhead College

Phase II Geotechnical and Geoenvironmental Assessment

Dunelm Geotechnical & Environmental Ltd on Behalf of Galliford Try Building Ltd.

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Executive Summary

Executive summary	
The Site	The site is currently occupied by Greenhead College and campus which occupies an area of approximately 2.5Ha and is located some 500m west of Huddersfield Town Centre.
The Scheme	The proposed scheme involves the redevelopment of the existing Greenhead College including the construction of a new, multi storey college building in the south eastern part of the site and replacement of a smaller existing building in the central part of the site. Proposals also include construction of an artificial sports pitch, car parking and associated infrastructure and soft landscaping.
Objectives and Scope	Dunelm Geotechnical & Environmental has been appointed by Galliford Try to complete an intrusive ground investigation and interpretive reporting to supplement the existing ground investigation data. Cundall has been commissioned by Dunelm to undertake the Phase II Geotechnical and Geoenvironmental Assessment and CMRA interpretative reporting elements.
Ground Conditions	Ground conditions typically comprise macadam underlain by granular then cohesive made ground, which extends to a maximum depth of 2.20m bgl. Made ground was underlain by engineering soils comprising the upper and lower completely weathered Pennine Lower Coal Measures (PLCM), encountered up to 5mbgl and generally described as firm to stiff gravelly clay and occasionally clayey sand. This was underlain by competent PLCM which was typically recorded as extremely weak to weak mudstone with some thin sandstone in the west. Within the PLCM a worked coal seam – the Soft Bed Coal was encountered at between 16.3 and 17mbgl, up to 1.3m thick and underlain by mudstone and sandstone.
Groundwater	Post fieldwork monitoring suggests perched groundwater within the completely weathered PLCM during the 2020 and 2021 investigations with groundwater recorded at between 0.96 and 2.57m bgl.
Coal Mining Risk	The 2021 GI recorded evidence of mine workings in the Soft Bed Coal in three rotary boreholes under the footprint of the proposed college building in the southeast corner of the site. Sufficient rock cover to coal seam thickness was not demonstrated and therefore a risk of ground instability at surface exists. Ground stabilisation in the form of drilling and grouting is recommended.
Geoenvironmental Risk Assessment	Risks to construction operatives and site end users were identified from PAH. The PAH exceedances relate to a thin layer of granular made ground. Remediation options include source removal in soft landscaping zones or placement of a clean cover system to mitigate the risk.
Ground Gas Protection Measures	The site classifies as gas characterisation situation 2 (CS-2) and as such ground gas protection measures will be required for the new building. Reference should be made to Section 8.0 of this report for more detailed discussion.
Preliminary Waste Classification	22 samples from the 2020 and 2021 investigations were assessed for preliminary waste classification. Five of the samples were classed as hazardous (all from the granular made ground) with the remaining 17 testing as non-hazardous. Seven samples of the granular made ground were tested in total. WAC testing on eight samples revealed 5 samples being classed as hazardous (granular made ground), one sample as stable non-reactive hazardous and the remaining two samples classed as inert.
Foundation Recommendations	Pad foundations founding on the completely weathered PLCM are considered appropriate for both proposed buildings. Based on the prescribed loadings, pad sizes of 4.5x4.5m to 3.1x3.1m at 120m to 119m AOD are appropriate for the main proposed college building. Pad sizes of 2x2m to 1.5x1.5m founded at between 122.7 and 121.8m AOD are appropriate under the proposed infill structure. Ground bearing floor slabs are considered feasible if founded on the completely weathered PLCM.
Ground Aggressivity	The design sulphate class should be taken as DS-1 and the Aggressive Chemical Environment for Concrete (ACEC) is classified as AC-1s (static groundwater). All buried concrete should be designed in accordance with BRE Special Digest 1:2005.
This Executive Summary is intended as a summary of the geoenvironmental and geotechnical assessment of the site in the context of the current development proposals based on information received by Cundall at the time of production and should be read in conjunction with the main Report text.	

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1.0

Introduction

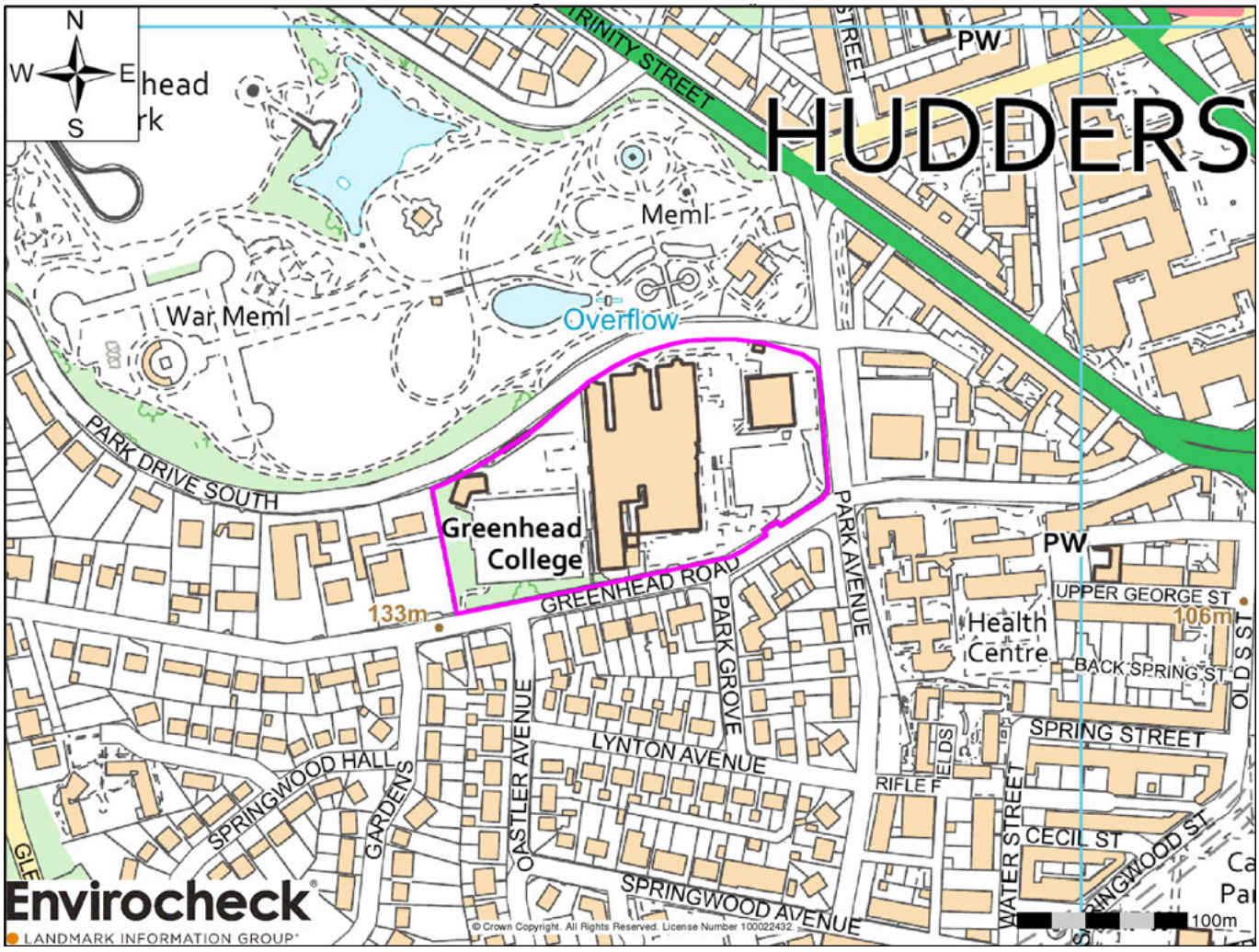
Introduction

1.1 The Site

Galliford Try Building Ltd. (Galliford Try) propose to redevelop parts of the existing Greenhead College in Huddersfield. The site covers an area of approximately 2.5Ha and is located some 500m west of Huddersfield Town Centre, centred at NGR 413746E, 416747N. The site is currently an operational college and includes car parking and recreational space.

Figure 1 shows the site location and the extent of the development boundary.

Figure 1: Site Location Plan

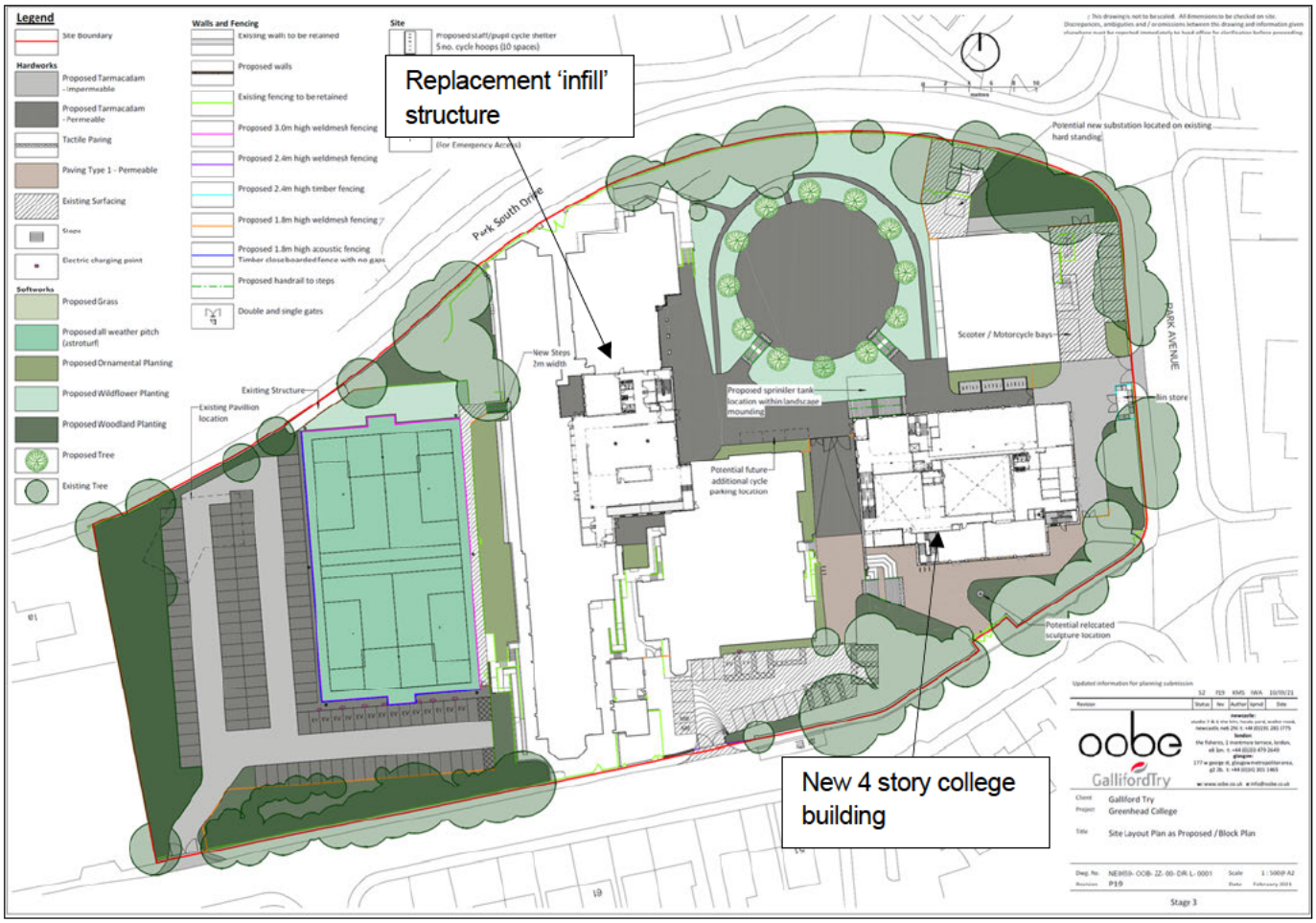


1.2 The Scheme

The proposed scheme includes the demolition of part of the existing Greenhead College, and the construction of a new college building up to four storeys high in the location of the existing car park in the southeast corner of the site and a small infill structure in the location of the demolished building area. Proposals also include replacement of the existing all weather pitch with a resized and relocated all weather pitch, and relocated car parking. Elsewhere on the site ancillary landscaping features and associated infrastructure are proposed.

Most of the proposed development will include surface cover comprising building footprints, hardstanding or an artificial sports pitch and it is anticipated that less than 10% of the surface area will comprise landscaping. An extract of the current development layout is included within Figure 2.

Figure 2: Proposed Development Plan (Drawing ref. NE8659-OOB-ZZ-00-DR-L-0001-P19)



1.3 Objectives & Scope of Assessment

Galliford Try commissioned Dunelm Geotechnical & Environmental Ltd (Dunelm) to undertake an intrusive investigation to supplement the existing ground investigation data obtained by EPS in 2020. The additional data was required to inform the associated Phase II Geo-environmental and Geotechnical reporting and Coal Mining Risk Assessment (CMRA) for the site. Subsequently, Dunelm commissioned Cundall to undertake the Phase II and CMRA interpretative reporting elements on their behalf.

This report will summarise and interpret factual information recovered from both the Dunelm 2021 ground investigation and a previous investigation undertaken by EPS in September 2020.

1.4 Sources of Information

This report is based upon a review of published and readily available information and the factual elements from a site-specific, phase I desk study and associated ground investigation, undertaken by EPS in the Autumn of 2020. The data from Dunelm's site specific 2021 ground investigation is also included. Where additional background information has been used, these are stated within the text.

1. British Geological Survey, 2000 1:10,000 Series, Sheet SE11NW (Huddersfield West), Solid & Drift Edition
2. British Geological Survey Geology of Britain Viewer (https://mapapps.bgs.ac.uk/geologyofbritain/home.html) accessed 24th May 2021.

3. The Coal Authority. Interactive Viewer (https://mapapps2.bgs.ac.uk/coalauthority/home.html), accessed 24th May 2021.
4. EPS (September 2020) Greenhead College, Phase 1 Geo-Environmental Desk Study (Report ref. UK20.5113)
5. EPS (November 2020) Greenhead College, Phase II Geo-environmental Assessment. (Report ref. UK20.5113b) Issue 1
6. Cundall (March 2021) Coal Mining Risk Assessment at Greenhead College, Kirklees (Report ref. 1029739.RPT.GL.001) Rev0
7. Dunelm (2021) Exploratory Hole Records
8. DETS (2021) Chemical Testing Results, ref. 21-08321 and 21-08980-1.
9. Solmek (2021) Geotechnical Lab test results ref. D10377
10. Cundall (March 2021) Foundation General Arrangement Drawing No. NE8659-CCS-XX-BF-DR-S-30021
11. Cundall (March 2021) Combined Services Site Layout, Drawing No. NE8659-CME-ZZ-ZZ-DR-Z-95002
12. Oobe (May 2021) Site Plan Drawing No. NE8659-OOB-ZZ-00-DR-L-0001

1.5 Limitations

The investigation of the site has been carried out to provide sufficient information on the geotechnical and geoenvironmental characteristics of the ground and groundwater at the development site to allow a reasonable assessment of the environmental risks together with engineering and development implications.

The opinions provided and recommendations given in this report are based on a visual site inspection, reference to accessible historical records, the information provided by third parties, the results of ground investigations as detailed in the text and the factual data provided by the specialist ground investigation contractor. Whilst every effort has been made to interpret the conditions between the investigation locations, such information is only indicative and liability cannot be accepted for its accuracy. There may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been considered in this report. The test results that have been obtained can only be regarded as a limited but likely representative sample range, assessed against current guidelines. The possibility of the presence of contaminants, possibly in higher concentrations elsewhere on the site or the presence of encountering ground conditions at variance with the logs elsewhere on the site cannot be discounted.

The scope of the investigation was selected based on the preliminary development proposals provided by the Client and may be inappropriate to another form of development. The assessments carried out and recommendations made in this report with regard to foundation and infrastructure design are based on the preliminary details provided by the Client (Dunelm Geotechnical and Environmental Ltd on behalf of Galliford Try) and the results of ground investigation at discrete locations. If further investigations indicate the ground conditions vary from those revealed by the existing investigation or the structural details and the proposed end use or layout of the proposed buildings, structures and infrastructure are revised, Cundall reserves the right to carry out further assessments and revise their recommendations in line with the revised scheme details.

2.0

Site Setting and Historical Investigation Review

Site Setting and Historical Investigation Review

2.1 Site Details

A detailed review of the site setting is included within the EPS reports and Cundall's CMRA, both of which are referenced in Section 1.4, and should be read in conjunction with the information included in this section. Table 1 includes a summary of the information included within these reports and includes relevant information pertaining to the site area, shape, topography and existing and adjacent land uses

Table 1: Site Details

Site Area & Shape	The site comprises an irregular shaped parcel of land approximately 2.5Ha in size and is approximately centred around NGR 413746E, 416747N. The site is located to the west of Huddersfield Town Centre.
Site Boundaries & Adjacent Land Use	North: Park Drive South, beyond which is Greenhead Park East: Park Avenue, beyond which are some commercial and residential properties. South: Greenhead Road, beyond which are residential properties. West: Residential properties.
Site Topography	The site is located on ground which is gently falling to the east but is formed at predominantly two levels and is split centrally by a slope and / or a north-south gabion retaining wall, with land in the western part of the site being retained above the lower lying east. Along the retained, western part of the site, the site lies at approximately 130.5mAOD and the eastern part of the site sits at around 127mAOD. At its highest, the topographical level is approximately 131mAOD, sloping gently towards the retaining wall. The site continues to slope gently towards the eastern boundary that lies at approximately 122mAOD.
Existing Land Uses & Features	The site is currently in use as Greenhead College and includes a cluster of buildings in the centre and east of the site, an artificial sports pitch in the western part, a main car park in the south east and other associated infrastructure including additional car parking, access roads and landscaping. The perimeter of the site is generally formed by soft landscaping including mature deciduous trees.
Surface Cover	Approximately 90% of the site surface cover consists of buildings, car parking / access roads and an artificial sports pitch. The remaining site area is soft landscaping including mature trees.

2.2 Historical Land Use

2.2.1 On-Site

Early mapping (1851) shows the site to be recorded as a school (Greenhead Hall) and comprises a building in the central part of the site surrounded by woodland. By 1918 it is referenced as a 'High School for Girls'. Mapping from 1960 shows a new building in the central western part of the site along with a slope where the current retaining wall lies. Two sports pitches are also present in the east. By 1975 the central building development resembles the current layout and more recently, a building was constructed in the north eastern part of the site and another building has been constructed in the far west with historical aerial photos constraining the construction of the two recent additions to between 2003 and 2009.

2.2.2 Off-Site

Earliest available mapping from 1893 shows Greenhead Park to the north, open fields to the south and dwellings to the west and east. By 1960, the maps show residential dwellings to the south and a mixture of commercial and residential dwellings to the west and east.

2.3 Geology

A review of the available information, including the BGS 1:50,000 and 1:10,000 maps referenced within Section 1.4, has been undertaken and indicated the following;

2.3.1 Superficial Geology

No made ground or superficial deposits are recorded on site.

2.3.2 Solid Geology

Geological maps show the site is underlain by the Pennine Lower Coal Measures (PLCM) consisting of mudstones, siltstones and sandstones. The BGS 1:10,000 map indicates that the closest coal seam, named as the 'Soft Bed Coal Seam' outcrops approximately 300m west of the site and dips east below the site. It is stated to be approximately 0.60m thick in this area.

A review of BGS historic borehole records (summarised within Cundall's CMRA) identified eight boreholes located between 150m and 250m south east of the site boundary that record the following generalised ground conditions:

- Made ground varying in thickness from 0.50m to 3.00m.
- Superficial deposits comprising a thin layer of silty, sandy clay (possibly highly weathered bedrock) varying in thickness from 1.20m to 2.05m.
- Bedrock described as either mudstone, shale or sandstone recorded between ground level and 3.2m bgl. The base of this stratum was not proven in any exploratory hole.
- Coal – Encountered at depths between 7.00m bgl and 19.00m bgl and varies in proven thickness between 0.42m and 0.60m. Evidence of historic coal workings was recorded as either very loose ground with total air loss or a 'void' in three of the eight boreholes .

A summary of the site specific ground investigation information, including a summary of the ground conditions encountered and the geotechnical and geoenvironmental testing undertaken, is included in Section 0.

2.4 Hydrogeology & Hydrology

The solid geology of the site is classified as a Secondary A Aquifer.

The nearest surface water feature is a small lake located approximately 30m north of the site. The nearest discharge consent is located approximately 370m south west of the site and comprises the release of trade effluent into the River Colne.

2.5 Landfill & Waste

No active or historic landfills are recorded within 1km of the site boundary.

The nearest waste management facility is located approximately 475m to the south west and has been active since 2005.

Some areas of infilled land and water are recorded within 250m of the site boundary, the nearest of which comprises an infilled pond roughly 25m to the north.

2.6 Radon

The site is located in an area where the percentage of homes above the radon action level is less than 1% and no radon protection measures are necessary in the construction of new buildings.

2.7 EPS Site Investigation Review

The following section summarises the factual information included within the EPS site investigation report (referenced in Section 1.4) undertaken in the Autumn of 2020.

2.7.1 Background Information & Fieldworks

Ground investigation was undertaken between 19th and 23rd October 2020 by EPS.

The investigation comprised the following:

- The drilling of 5 No. exploratory holes using dynamic windowless sampling to rockhead, followed by either rotary cored or rotary open hole drilling to a maximum depth of 15mbgl.
- The drilling of eleven window sample holes to a maximum depth of 5.20mbgl.
- 2 No. hand excavated inspection pits excavated alongside the existing building footprints to a maximum depth of 1.20m bgl to recover information on the structure foundations.
- 5 No. Combined gas and groundwater monitoring wells were installed into selected window sample holes (WS01, WS03, WS04, WS08 and WS11) to facilitate a programme of gas and groundwater monitoring.
- Geotechnical and geoenvironmental analysis of representative samples recovered from both the windowless sampling boreholes and the dynamic sampling boreholes.
- In-situ testing including 42 hand shear vane tests (HSVs) and 37 Standard Penetration Tests (SPTs) within the completely weathered and competent PLCM.
- 11 Dynamic Cone Penetrometer (DCP) tests to determine a representative CBR value of the shallow ground to inform road and pavement design.

The borehole locations were restricted given the location of the existing building, existing services and on-going operational use.

Relevant factual information from the EPS site investigation is included in Appendix A.

2.7.2 Ground Conditions

The ground conditions identified were as follows:

- Hardstanding / Topsoil –Bituminous hardstanding (as described by EPS) was recorded within 12 exploratory holes to a maximum depth of 0.20m bgl and topsoil was recorded in 3 exploratory holes, to a maximum depth of 0.40m bgl. Topsoil was described as silty sandy gravelly clay with rare brick fragments in WS07.
- Made Ground – Made ground was recorded across most of the site, with the exception of WS07 and WS09 and extended to a maximum depth of 2.00m bgl. Made ground was both granular and cohesive in composition.
- Head deposits – Head deposits were recorded in all exploratory holes by EPS and was typically described as stiff sandy gravelly clay. The Head deposits were recorded to a maximum depth of 4.80m bgl and varied in thickness from 0.30m to 4.70m.
- Bedrock – Bedrock was recorded as sandstone and / or mudstone. Generally, material described as sandstone was recorded directly below the material described as Head deposits by EPS in the western part of the site and was described as light brown to orange weathered / fractured sandstone, this layer was reported in the north and eastern parts of the site with the thickness decreasing towards the south and east. Mudstone was recorded below the material described as Head Deposits in three boreholes and below the sandstone in the remaining rotary boreholes and WS05. The depth to bedrock was recorded to be between 0.40m bgl and 4.80m bgl.

2.7.3 Geotechnical Laboratory Testing

The geotechnical testing undertaken by EPS was carried out in general accordance with BS 1377 and BS EN ISO 17892-1.

The geotechnical laboratory testing included:

- 15 Moisture Contents
- 15 Atterberg Limits
- Two Particle Size Distributions (PSDs)
- Three California Bearing Ratios (CBRs)
- 15 pH and sulphates
- Six Point load tests on bedrock

The results of the geotechnical testing are included within this assessment and discussed within Section 6.

2.7.4 Environmental Laboratory Testing

A summary of the environmental testing undertaken by EPS as part of their assessment is as follows:

- 12 soil samples were recovered and tested for the following:
  – Heavy Metals, Speciated PAH, Total TPH, MTBE, BTEX, PCBs, VOCs, phenols, cyanide, asbestos and pH;
- Six samples were submitted for leachate preparation and analysis;
- One sample of the bituminous (as described by EPS) hardstanding was recovered and scheduled for coal tar analysis;
- Waste Acceptance Criteria (WAC) testing was undertaken on samples of made ground, natural clay and topsoil;

Further discussion and assessment of the testing results stated above is included within Section 0

2.7.5 Gas and Groundwater Monitoring

Gas and groundwater monitoring was undertaken in five boreholes (WS01, WS03, WS04, WS08 and WS11) over three visits between 30th October and 13th November 2020.

The gas monitoring results above have been combined with data recovered during the Dunelm 2021 investigation and a full gas risk assessment is included within Section 0.

3.0

Intrusive Site Investigation

Intrusive Site Investigation

3.1 2021 Dunelm Geotechnical and Environmental Ltd.

An intrusive investigation was undertaken by Dunelm in March and April 2021.

The purpose of this investigation was to provide supplementary data on the ground and groundwater conditions of the site to support detailed design of the current proposals, and to address residual coal mining legacy risks that were identified by the Cundall Coal Mining Risk Assessment (Ref.6, Section 1.4) .

The investigation and laboratory testing were carried out in general accordance with BS 5930:2015+A2 2010 Incorporating Amendment 1, BS 1377, BS EN 1997 and BS 10175, BS EN ISO 14688, BS EN ISO 14689 and BS EN ISO 22475-1. The overall scope of works was specified by Cundall and comprised:

- Three rotary boreholes (RC101 to RC103) extending to a maximum depth of 25.0m using both rotary cored and open hole techniques.
- Four mechanically excavated trial pits (SA101 to SA104) to allow for the completion of four soakaway tests, undertaken in general accordance with BRE 365.
- In situ testing:
  - SPTs at 1m intervals within superficial deposits and 2m centres within bedrock to a maximum depth of 15m within each of the rotary boreholes.
  - Two falling head tests undertaken in one rotary borehole (RC102).
  - Four soakaway tests undertaken in accordance with BRE 365.
  - Four in situ Clegg Hammer tests to determine CBR values.
- Gas and groundwater monitoring wells were installed in the three rotary boreholes with response zones located within the weathered PLCM (RC101 & RC103) and the competent PLCM (RC102).
- Geotechnical and Geoenvironmental lab testing;

For descriptions of ground conditions at individual exploratory hole locations, reference should be made to the exploratory hole logs appended to this report. The exploratory hole locations from both the EPS and Dunelm Ground Investigation are included on Drawing NE8659-CDL-ZZ-XX-DR-GE-60801.

4.0

Ground and Groundwater Conditions

Ground and Groundwater Conditions

4.1 Findings of the Ground Investigations

A summary of the ground conditions encountered during both the EPS and Dunelm Ground Investigations is presented in Table 2 with detailed descriptions of each stratum thereafter. The exploratory hole logs are included within Appendix A.

Table 2: Summary of Ground Conditions

Strata	From mbgl (mAOD)	To mbgl (mAOD)	Thickness m	Identified in exploratory hole position
Topsoil	0 (130.8 – 124.45)	0.10 to 0.40 (124.35 to 130.50)	0.10 to 0.40	WS06, WS07, WS09
Hardstanding	0 (131.05 -120.8)	0.10 to 0.25 (120.70 to 131.05)	0.10 to 0.25	R02, R04, R05, RC102, RC103, SA101, WS01 to WS05, WS08, WS10, WS11
Granular Made Ground	0 to 0.25 (120.7 to 130.90)	0.2 to 1.10 (120.20 to 130.90)	0.10 to 1.00	All boreholes except WS06, WS07 and WS09
Cohesive Made Ground	0.20 to 1.10 (120.20 to 130.75)	0.40 to 2.20 (119.80 to 130.30)	0.20 to 2	R01, RC101, SA101 to SA104, WS01 to WS03, WS05, WS06, WS08, WS10, WS11
Completely Weathered Pennine Lower Coal Measures*	0.10 to 2.00 (119.80 to 130.70)	1.2 - 5.00 (116.90 to 129.80)	0.55 to 4.70	All boreholes except SA103 and WS107
Pennine Lower Coal Measures	0.40 to 5.90 (116.90 to 130.40)	0.50+ to 25.0+ (97.03 to 130.30+)	0.01 to 14.70+	R01 to R05, WS02, WS06 to WS11
Soft Bed Coal Seam (Void)	15.50 to 16.30 (105.73 to 106.78)	16.80 to 17.70 (104.33 to 105.48)	1.30 to 1.40	RC101, RC102**, RC103

*Completely Weathered PLCM is subdivided into two units; 'upper' and 'lower' based on changing engineering properties with depth later in the report.
**RC102 did not record a void but recorded 'complete loss of flush' between 17.0m bgl and 19.0m bgl and zones of non-intact core between 17.5 and 18.7m. The recovered core samples are described as a 'carbon rich' mudstone.

4.2 Detailed Ground Conditions

The following descriptions of strata identified at the site are based upon the exploratory hole descriptions from both the EPS and Dunelm investigations on site.

Exploratory hole locations are indicated on Drawing NE8659-CDL-ZZ-XX-DR-GE-60801 and indicative geological cross sections are included on Drawing NE8659-CDL-ZZ-XX-DR-GE-60802 and NE8659-CDL-ZZ-XX-DR-GE-60802.

4.2.1 Hardstanding

Hardstanding was recorded in 16 of the exploratory holes and described as bituminous hardstanding or macadam. Hardstanding of the current car park is present below the proposed building footprint in the south east.

4.2.2 Topsoil

Topsoil was recorded within three exploratory holes (WS06, WS07 & WS09) and ranged in thickness between 0.1 and 0.4m. The exploratory holes recording topsoil were all located at the site margins within areas of existing soft landscaping WS06 & WS07 in the southwest corner, and WS09 on the northern edge of the site. It is described as dark brown to black, silty sandy clay with frequent rootlets and occasional evidence of brick fragments. Topsoil / made ground topsoil was typically recorded in the western part of the development.

4.2.3 Granular Made Ground – Subbase

Granular made ground, representative of a subbase material, was recorded within eleven exploratory holes below the hardstanding and was typically described as either yellow, grey, or black sandy gravel of sandstone with rare fragments of brick and macadam. This layer was generally less than 0.30m thick, although in the area under the proposed main college building it ranged from 0.25 to 0.4m in thickness.

4.2.4 Lower Granular Made Ground

Another granular made ground layer was recorded across most of the site except the southwestern area (R02, WS06, WS07, & SA104) and the southern margin (WS03 & SA102). The material is generally described as dark grey or black, silty sandy gravel of brick, coal, clinker, concrete and ash or gravelly, clayey sand. Similar material was encountered down to 2m bgl in WS10 and was described as black, gravelly sand with gravel of clinker and coal, this exploratory hole is located close to and behind (west of) the retaining wall in the centre of the site.

Below the proposed college building in the south east, under the subbase layer of between 0.25 and 0.4m thickness, the top horizon of the lower granular made ground is encountered at approximately 0.55m bgl, with the top level ranging in elevation between 121.48m and 121.72m AOD. This layer extends to a maximum depth of 0.90m bgl (121.1m AOD) and is between 0.25m and 0.4m thick.

4.2.5 Cohesive Made Ground

Cohesive made ground was present below the granular made ground across most of the site and was generally described as firm to soft, light brown or dark grey, sandy, gravelly clay. Gravel was described as sandstone, coal, clinker and brick with rare ceramic fragments. The cohesive made ground was generally less than 0.50m thick but deepened within the western part of the site to 0.90m in WS11. Cohesive made ground was encountered directly below the topsoil in WS06 in the south west.

In boreholes RC101 to RC103, R05 and WS01 in the vicinity of the proposed college building in the south east, the cohesive made ground was encountered below the granular made ground and extended to a maximum depth of 1.40m bgl.

4.2.6 Completely Weathered Pennine Lower Coal Measures

Underlying the made ground, deposits of completely weathered Pennine Lower Coal Measures (PLCM) were recorded in most of the boreholes. The deposits were predominantly cohesive, although granular deposits were recorded in R03 to R05, WS03, SA102 and SA104. The stratum was encountered as two distinct units based on consistency descriptions and in-situ testing, the boundary between these two sub-units was most prominent in the southeast part of the site under the proposed main college building. The two sub-units are described separately below.

Upper Weathered PLCM

This unit was typically recorded as occasionally soft, usually firm, orange brown sandy gravelly clay. The gravel component was described as fine to coarse, subangular to subrounded of sandstone. Infrequent Granular deposits were typically recorded as clayey gravelly sand with low to medium cobble content.

Below the proposed college building footprint in the south east, the upper completely weathered PLCM is between 0.9 and 1.5m thick with the lower boundary being at 119.60 to 120.03m AOD.

Lower Weathered PLCM

The lower completely weathered PLCM was described as stiff to very stiff brown sandy, occasionally gravelly clay and in the eastern half of the site was between 1.1 and 1.9m thick. Under the proposed college building footprint the lower level is at between 117.70m and 118.83m AOD.

The deposits described above were identified as Head Deposits by EPS in the 2020 investigation and interpretive reporting. However, no evidence to support this interpretation, such as signs sediment migration/transportation were observed, either in the exploratory hole logs from the 2020 investigation or Dunelm's 2021 investigation. Published

mapping also suggests Head Deposits are absent in this area. Therefore, the engineering soils encountered have been interpreted here as completely weathered PLCM.

4.2.7 Competent Pennine Lower Coal Measures

Rockhead across the site is the PLCM which were predominantly encountered as mudstone, which was typically described as dark grey / brown, extremely weak to medium strong thinly laminated Mudstone. A thin band of sandstone was encountered in the western end of the site which has been interpreted as the Middle Band Rock – a subordinate unit of sandstone within the Pennine Lower Coal Measures. It was typically described as yellow grey, fine to medium grained weathered / fractured sandstone. Where encountered, the sandstone was noted as having a highly fractured / weathered upper surface.

Deeper sandstone was recorded in borehole RC101 at 20.30m bgl (101.73mAOD) and was recorded as medium strong light grey fine-grained sandstone.

Below the proposed college building footprint in the south east, Rockhead was present at depths between 2.70m bgl and 4.30mbgl and was described as weak to medium strong, thinly laminated Mudstone.

4.2.8 Soft Bed Coal Seam

Within the competent bedrock a suspected worked coal seam, likely the ‘Soft Bed Coal’ was encountered in the Dunelm 2021 ground investigation. Boreholes RC102 & RC103 encountered voids at between 15.5 and 16.3m bgl (105.73 – 106.78m AOD). RC102 reported ‘complete loss of flush’ at 17 to 19m bgl.

4.3 Groundwater

Groundwater was encountered in RC102, with the strike and the standing level both being recorded at 3m during the Dunelm Ground Investigation and it is likely that this is related to perched groundwater within the completely weathered mudstone.

5.0

Coal Mining Risk Assessment

Coal Mining Risk Assessment

5.1 Context

The decision on whether a feature related to coal mining poses a potentially unacceptable risk is based upon professional judgement. The significance of a feature associated with the coal mining legacy will also be determined dependant on the context of the proposed site development. An identification and assessment of the site's coal mining risks has been undertaken from existing desk-based information together with intrusive investigation data where appropriate.

Assessing risks from coal mining is based upon guidance provided by the Coal Authority following a 'risk-based' approach implemented through the National Planning Policy Framework (NPPF).

Identification of potential coal mining risks to the proposed development had been made within the Cundall Coal Mining Risk Assessment for the site (Ref. 6, Section 1.4). This section presents an updated consideration of the potential coal mining risk, based on additional and relevant intrusive investigation data.

5.2 Potential Coal Mining Legacy Issues

The preliminary assessment by Cundall concluded that the site lies within a 'Development High Risk Area', where a risk of shallow unrecorded coal mining is present. The potential risks identified within the Cundall CMRA are reproduced in Table 3.

Table 3: Summary of Potential Coal Mining Risks

Coal Mining Issue	Yes	No	Risk Assessment
Underground coal mining (recorded at shallow depths)		X	Not required
Underground coal mining (probable at shallow depths)	X		Required
Mine entries (shafts and adits)		X	Not required
Coal mining geology (voids / evidence of workings)	X		Required
Records of past mine gas emissions or potential		X	Not required
Recorded coal mining surface hazards		X	Not required
Surface mining (opencast workings)		X	Not required

Consequently, Dunelm undertook ground investigation works to identify the extent, depth and condition of the Soft Bed Coal Seam underlying the site. The investigation consisted of three rotary (cored and open hole at various depths to ensure reliable recovery over the anticipated depth of the coal seam and/or historic workings) boreholes using water flush (RC101, RC102 and RC103) to a maximum depth of 25.0m bgl.

5.3 Proven Ground Conditions

The borehole logs are included in Appendix A and the strata encountered are summarised in Table 4.

Table 4: Summary of Proven Shallow Coal Geology

Borehole Name / No.	Depth to top of Rockhead (mbgl)	Depth to top of coal seam/workings (mbgl)	Depth to base of coal seam/workings(m bgl))	Coal seam/working Thickness (m)	Approximate Solid Rock Cover (m) (Ratio of cover to seam thickness)	Notes
RC101	3.20	16.30	17.70	1.40	9.4:1	'Void'
RC102*	4.30	17.00*	19.00	NA	8.8:1	Complete loss of flush between 17 & 19m
RC103	3.80	15.50	16.80	1.30	9.0:1	'Void'

*RC102 recorded complete loss of flush between 17 and 19m and 'non-intact' core recovery between 17.3 and 18.7m. Core was recorded as mudstone.

The three rotary boreholes drilled below the footprint of the proposed development (RC101 to RC103) recorded evidence of historical mine workings at shallow depth. Within RC101 and RC103 a void up to 1.40m thick was recorded at between 15.5 and 16.3m bgl. Complete loss of flush was noted within RC102 between 17 and 19m, and, recorded non-intact core recovery between 17.3 and 18.7m. It should be noted that RC102 recorded 100% core recovery between 16m and 19m, with all core being logged as mudstone. It is possible the loss of flush and non-intact core recovery is indicative of coring through a localised roof collapse of the mine workings. However, no 'soft drilling' (the observation from drillers of suddenly encountering soft ground when drilling through mineworking collapse deposits) or poor recovery was noted in the several meters of coring above the anticipated seam depth. Another possible explanation is a localised 'pinching out' of the coal seam, this can occur due to variations in depositional environment or glacial overburden stresses causing structural thinning of the seam. However, the fact that complete flush loss was recorded across the zone in which the seam was recorded in two other proximal holes at least corroborates the lateral extent of mine workings under the site.

5.4 Risk Assessment

The intrusive investigation identified evidence of historical workings within the shallow underlying Soft Bed Coal Seam. With voids in two boreholes and complete loss of flush and non-intact/broken core recovery in a third.

It is generally accepted by CIRIA 578 (Abandoned Mine Workings) that where workings are present and the proposed development will be employing shallow foundations bearing within overlying strata, a thickness of competent rock greater than ten times the worked seam thickness must be present to adequately mitigate the risk of surface instability due to mine working collapse. Table 4 shows that where evidence, or potential of historical mine workings were encountered, the rock cover to seam thickness ratio of 10:1 could not be demonstrated in any of the exploratory holes.

Therefore, based on the findings of the investigation it is considered there is a risk of potential ground instability at surface and damage to future structures resulting from the collapse of historical mine workings. Consequently, ground stabilisation, in the form of drilling and injection of grout into the historic unrecorded mine workings, or a sleeved pile to a depth of 25m is recommended.

6.0

Geotechnical Parameters

Geotechnical Parameters

Laboratory and in situ test results from both the EPS and Dunelm Ground Investigations have been used to determine the geotechnical parameters of the soils / rock encountered. The test results are contained within the EPS Phase 2 Geo-environmental Assessment and Dunelm factual results (Ref 5 and Ref 9 in Section 1.4) and are included in Appendix A and Appendix B respectively.

The characteristic geotechnical parameters for the completely weathered PLCM and competent bedrock of the PLCM are presented in Table 5 of this chapter. The made ground is not considered suitable as a bearing stratum but is likely to be re-used as an engineered fill across the site and thus relevant geotechnical testing was undertaken. As discussed in section 4.2.4 the completely weathered PLCM has been split into two sub units; the 'upper' and the 'lower' PLCM for the purposes of deriving characteristic engineering properties.

The values in Table 5 should only be used for the specific engineered application proposed (as described in Section 1.2 of this report). Should the proposed end use change, the parameters presented may no longer be suitable.

Table 5: Summary of Characteristic Parameters

Engineering Properties	Stratum				
	Granular Made Ground	Cohesive Made Ground	Upper Completely Weathered PLCM	Lower Completely Weathered PLCM	Competent PLCM
Bulk Density kN/m^3	18	18	18.5	19	23
Plasticity Index (%)	9	14	20	15	-
Peak Angle of Friction (°) ϕ_{pk}	28	25	25	25	34
Effective Cohesion c' (kPa)	0	0	0	0	-
Undrained Shear Strength (Cu)	-	-	60	250	--
Uniaxial Compressive Strength (MPa)	-	-	-	-	4 (Mudstone) 40 (Sandstone)
Coefficient of Volume Compressibility Mv (m^2/MN)	-	-	0.15	0.07	-
Young's Modulus E (MPa)	-	-	6	15	90

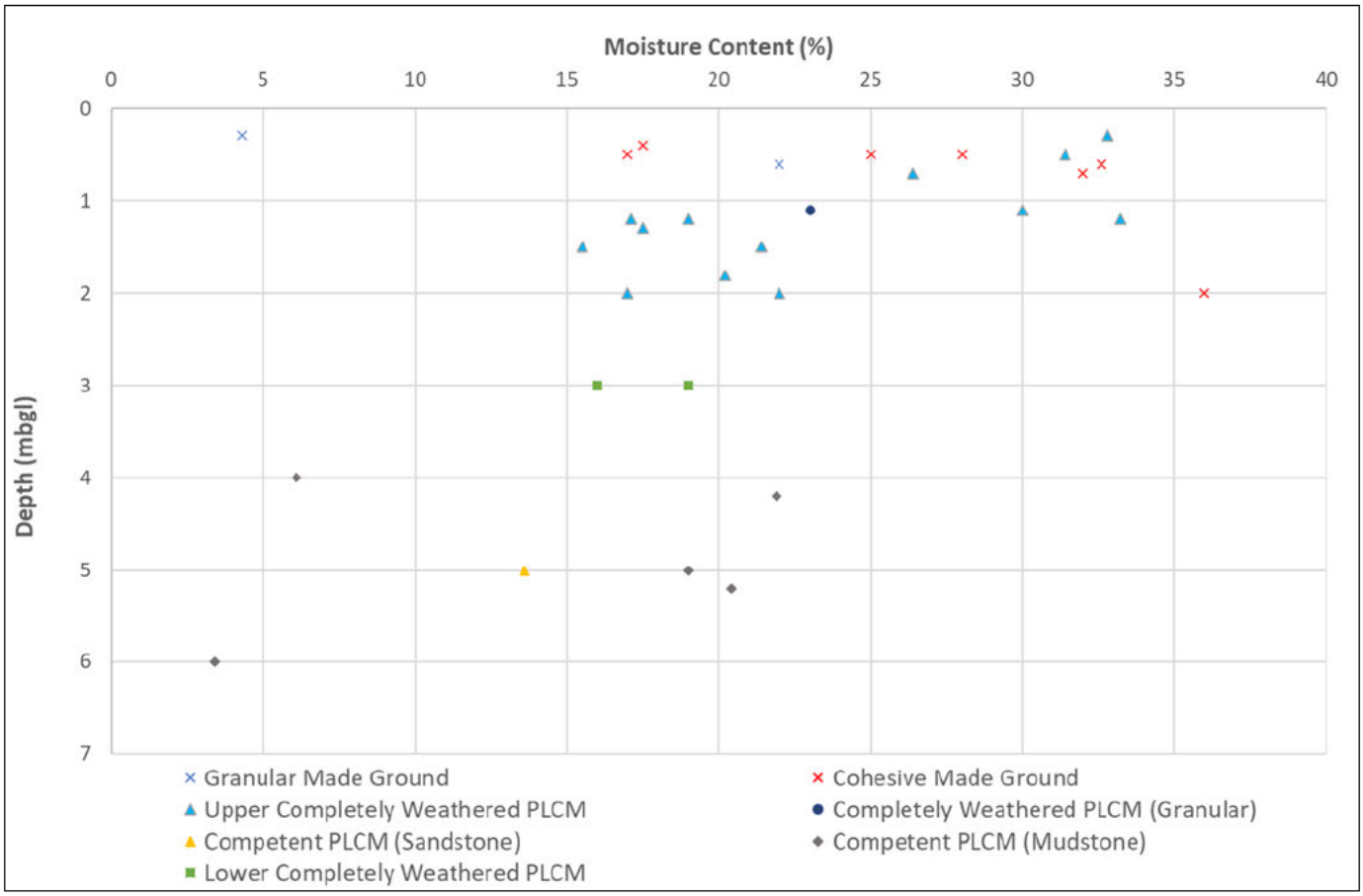
6.1 Bulk Unit Weight

The characteristic values for bulk weight density were determined through a combination of laboratory testing and correlations with typical bulk weight density ranges provided in BS8002:2015. The characteristic values are presented in Table 5.

6.2 Moisture Content

A plot of the moisture contents of all strata encountered is presented as Figure 3 with each stratum discussed separately in the following sections.

Figure 3: Moisture Content against Depth



6.2.1 Granular made ground

Two tests were undertaken on the granular made ground and recorded moisture contents of 4.3% and 22.0%. The moisture content of 4.3% was recorded on a sample described as sandy gravelly cobbles and is not considered representative of the site wide granular made ground.

6.2.2 Cohesive made ground

Seven tests were undertaken on the cohesive made ground and recorded moisture contents ranging from 17% to 36%.

6.2.3 Completely Weathered PLCM

6.2.3.1 Upper Completely weathered PLCM

13 tests were undertaken on the upper weathered PLCM and recorded moisture contents ranging from 15.5% to 33%. A further two tests were undertaken on the granular deposits and these both recorded a moisture content of 23%.

6.2.3.2 Lower Completely Weathered PLCM

Two tests were undertaken on the lower unit and recorded moisture contents of 16% and 19%.

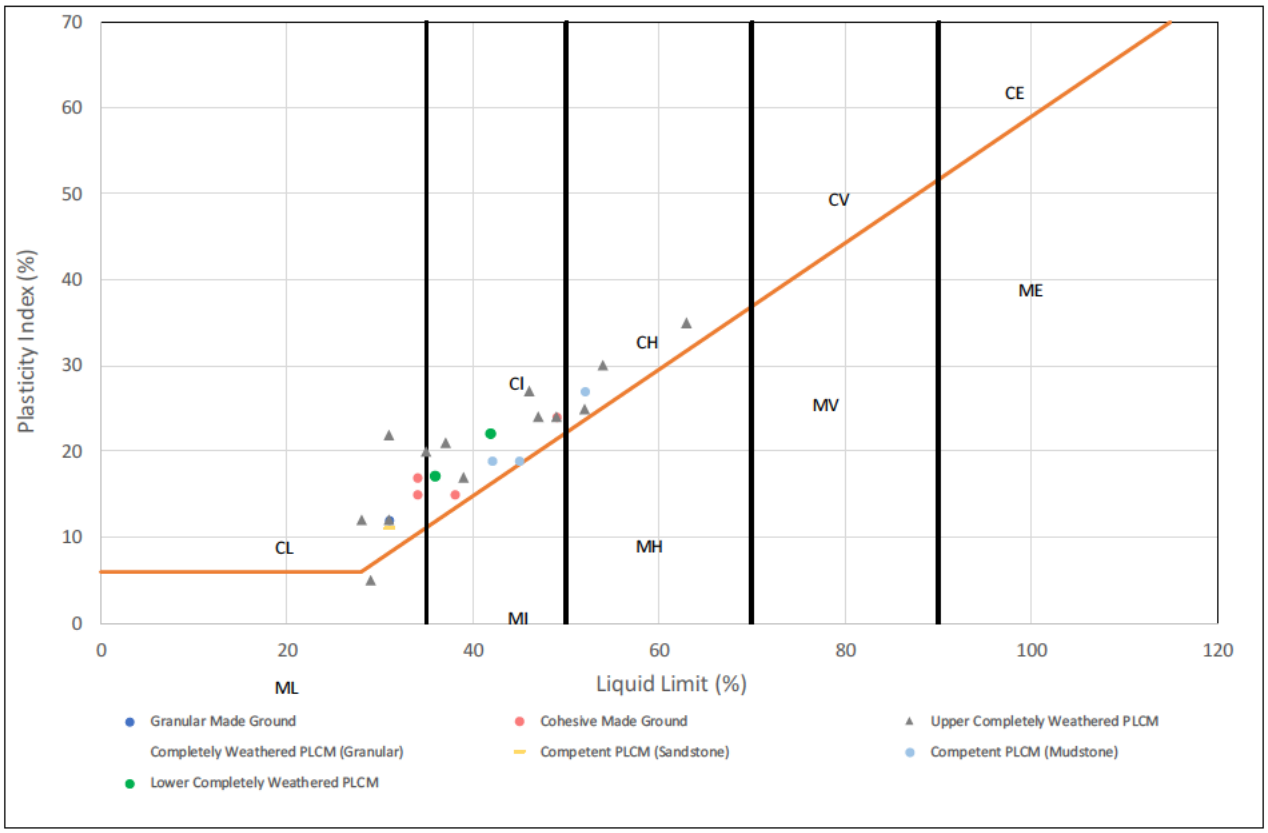
6.2.4 Competent PLCM

Six tests were undertaken on the competent PLCM, five of which were undertaken on mudstone and one on sandstone. The moisture contents of the mudstone ranged from 3.4% to 21.9% and a moisture content of 13.6% was recorded on the sample of sandstone.

6.3 Plasticity Indices

Atterberg Limits testing was scheduled within all cohesive strata encountered and a small number were undertaken in material descried as cohesive which proved to be granular in nature during testing. The testing results (modified to account for percentage passing a 425um sieve) is shown in Figure 4 and results are subsequently discussed for each strata.

Figure 4: Modified Plasticity Indices for Strata Encountered



6.3.1 Cohesive made ground

Atterberg Limits testing was completed on four samples of cohesive made ground and returned modified plasticity indices between 8% and 18% indicating it to be a low plasticity clay or silt of intermediate plasticity.

6.3.2 Completely Weathered PLCM

6.3.2.1 Upper Completely Weathered PLCM

13 Atterberg Limit tests were undertaken on this unit, which recorded modified plasticity indices of between 4% and 35%. The results indicate the stratum ranges from a low to high plasticity clay, with one result classifying as a silt of low plasticity. However, most of the testing results show the completely weathered PLCM to be representative of a clay of low to intermediate plasticity. An appropriate characteristic Plasticity Index for this material of 20% has been adopted.

6.3.2.2 Lower Completely Weathered PLCM

Two Atterberg Limit tests were completed on this unit with results of 13 and 22% and when plotted on the chart indicate the soil is an intermediate plasticity clay. An appropriate characteristic Plasticity Index for this material of 20% has been adopted for this unit as well.

6.3.3 Competent PLCM

Four Atterberg Limit tests were undertaken on the competent PLCM, three of which were on the mudstone and one on the sandstone. Modified plasticity indices range from 11% to 23%.

6.4 Particle Size Distribution (PSD)

PSD tests were scheduled on eight samples and are discussed subsequently for each strata unit below.

6.4.1 Cohesive made ground

Two PSD tests were undertaken on samples from shallow depth (i.e. less than 1.0m) and both recorded material proportions describing a gravelly clayey sand. Sample SA102 at 0.50m can be classified as a Class 2A Wet Cohesive material and sample SA103 at 0.50m can be classified as a Class 2C Stony Cohesive Material when compared to the Specification for Highways Works Series 600 (SHW600).

6.4.2 Granular made ground

One PSD was undertaken in the granular made ground with grain size proportions describing a slightly clayey slightly sandy, GRAVEL with frequent cobbles, in accordance with BS5930.

6.4.3 Completely Weathered PLCM

Five PSDs were undertaken on the completely weathered PLCM and the results are summarised in Table 6

Table 6: Summary of PSD Test Results

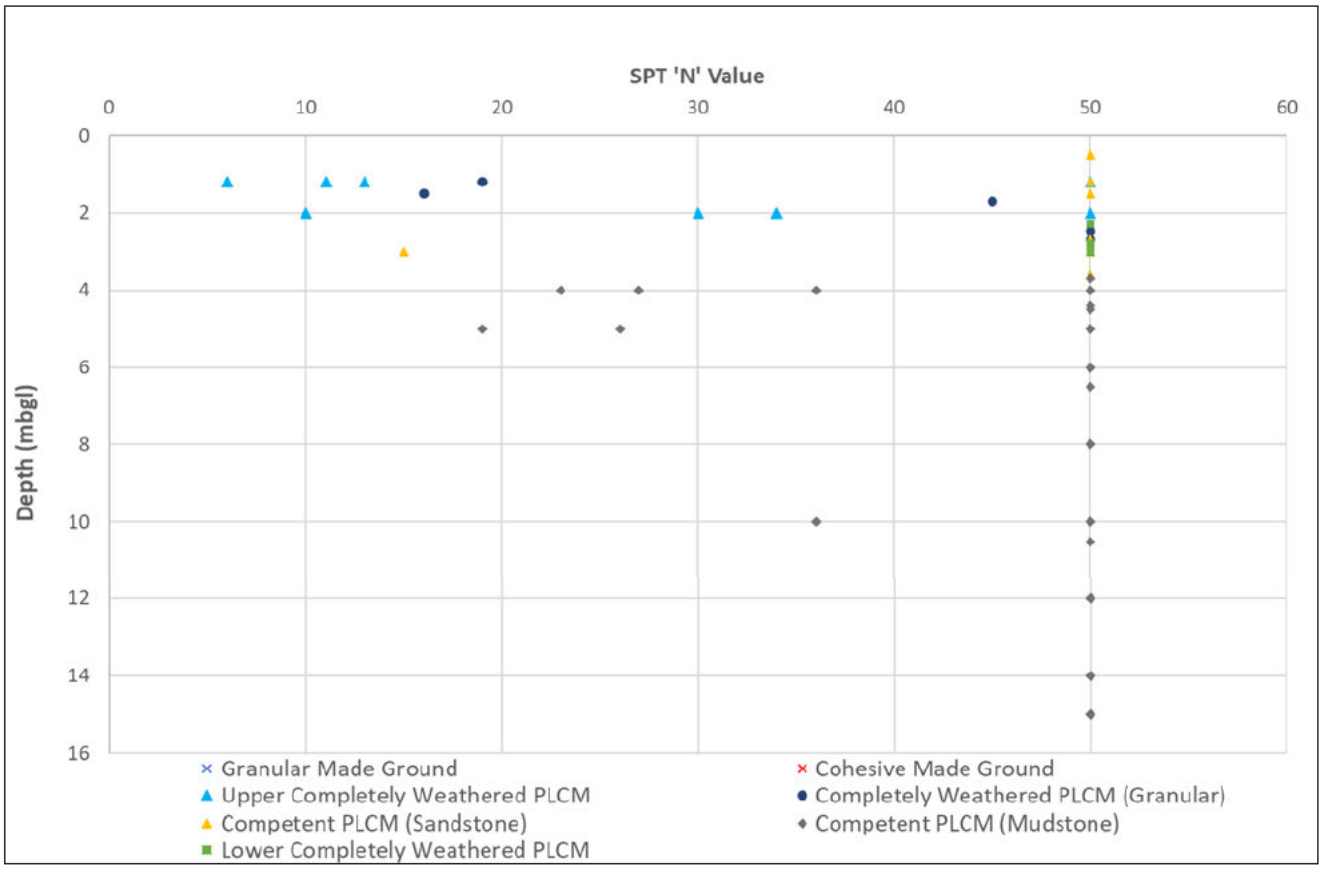
Borehole No.	Depth (mbgl)	Grading			SHW Series 600 Classification
		Gravel	Sand	Silt / Clay	
R03	1.4	27	29	44	Class 2C
WS06	2	40	38	22	Class 2C
SA102	1.1	1	60	40	Class 2A
RC103	1.2	44	38	18	Class 2C
SA101	1.1	7	18	74	Class 2A

All tests were undertaken on samples from the upper completely weathered PLCM. The results show the variable nature of the Completely Weathered PLCM with PSD derived descriptions ranging from a clayey, sandy, GRAVEL and clayey SAND to a sandy, gravelly CLAY, with cohesive soils recorded in three of the five tests. Based on the PSD derived soil descriptions and site wide log descriptions, it is considered likely the material will predominantly behave as a cohesive material.

6.5 SPT 'N' Values

65 Standard Penetration Tests (SPTs) were undertaken during the 2020 and 2021 ground investigations and are shown in Figure 5, plotted against depth. Results of each individual strata are discussed in the following sections.

Figure 5: SPT 'N' Values Against Depth



6.5.1 Completely Weathered PLCM

Upper Completely Weathered PLCM

Nine SPTs were undertaken within the upper completely weathered PLCM during both ground investigations. The SPT 'N' values ranged from 6 to 50, with one refusal (N = 50. The remaining nine SPT 'N' values ranged from 6 to 45.

Lower Completely Weathered PLCM

Seven SPTs were completed in this stratum with all recording a minimum value of 50. The SPT refusals are likely to represent the transition between completely weathered material and the competent bedrock of the PLCM, confirming the log descriptions which report cohesive deposits becoming very stiff to hard with depth in the transition to the competent bedrock of the PLCM.

6.5.2 Competent PLCM

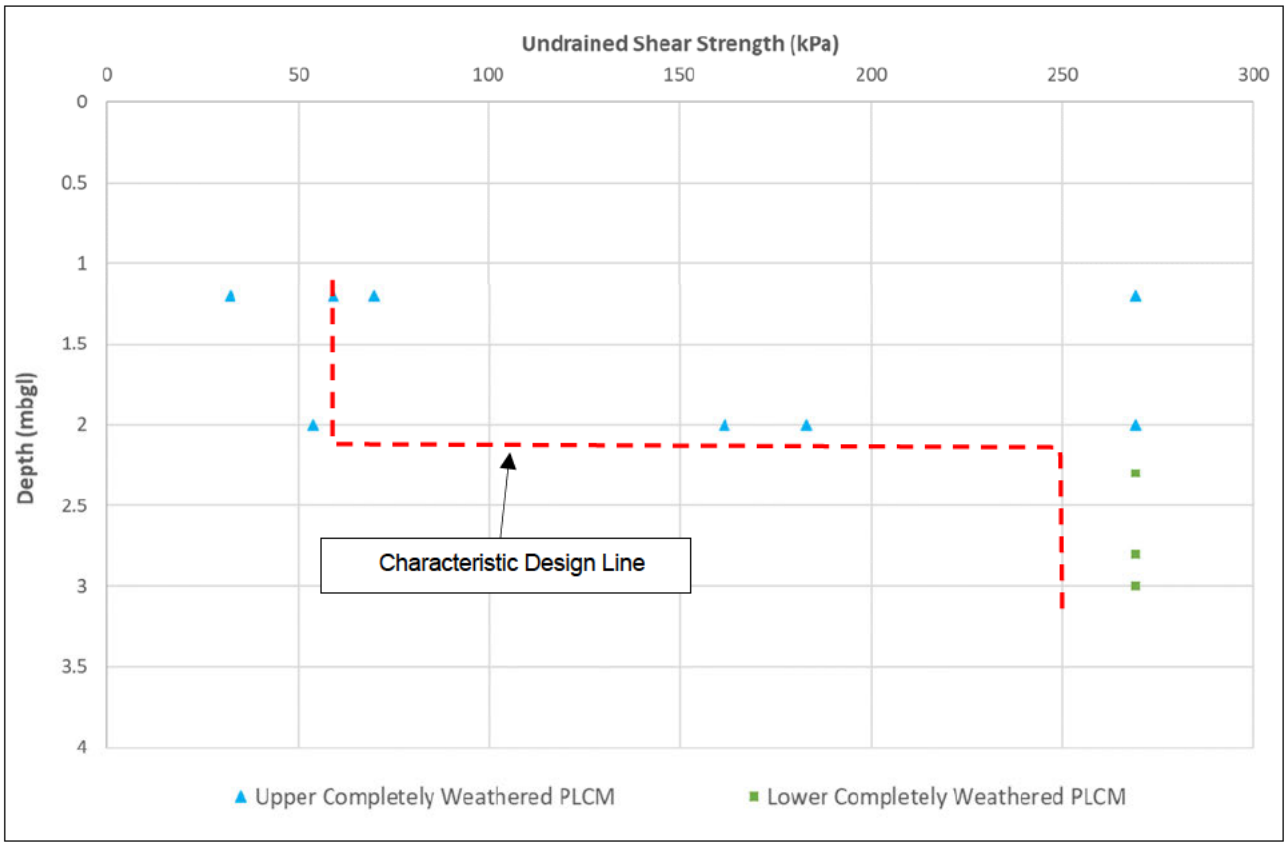
A total of 49 SPTs were undertaken within the PLCM during both ground investigations. The SPT 'N' values ranged from 15 to 50, with 41 of these recording SPT refusals (N values = 50+).

All SPT's recorded as being undertaken in sandstone were completed in the western half of the site at between 1.2 and 3.6m bgl. Figure 5 shows that all but one SPT refused when undertaken on sandstone and a suitable, characteristic N value of 50 is considered appropriate.

6.6 Undrained Shear Strength

Based on Stroud, M. A., 1975, SPT 'N' values may be used along with Plasticity Index to estimate undrained shear strength, values derived in this way are plotted in Figure 6 below.

Figure 6: Undrained Shear Strength Against Depth



6.6.1 Completely Weathered PLCM

6.6.1.1 Upper Completely Weathered PLCM

Nine SPTs were undertaken within the upper completely weathered PLCM and, using a characteristic plasticity index of 20%, the corresponding undrained shear strengths ranged from 32kPa to 269kPa. A characteristic undrained shear strength value of 60kPa within the upper completely weathered PLCM is considered appropriate

6.6.1.2 Lower Completely Weathered PLCM

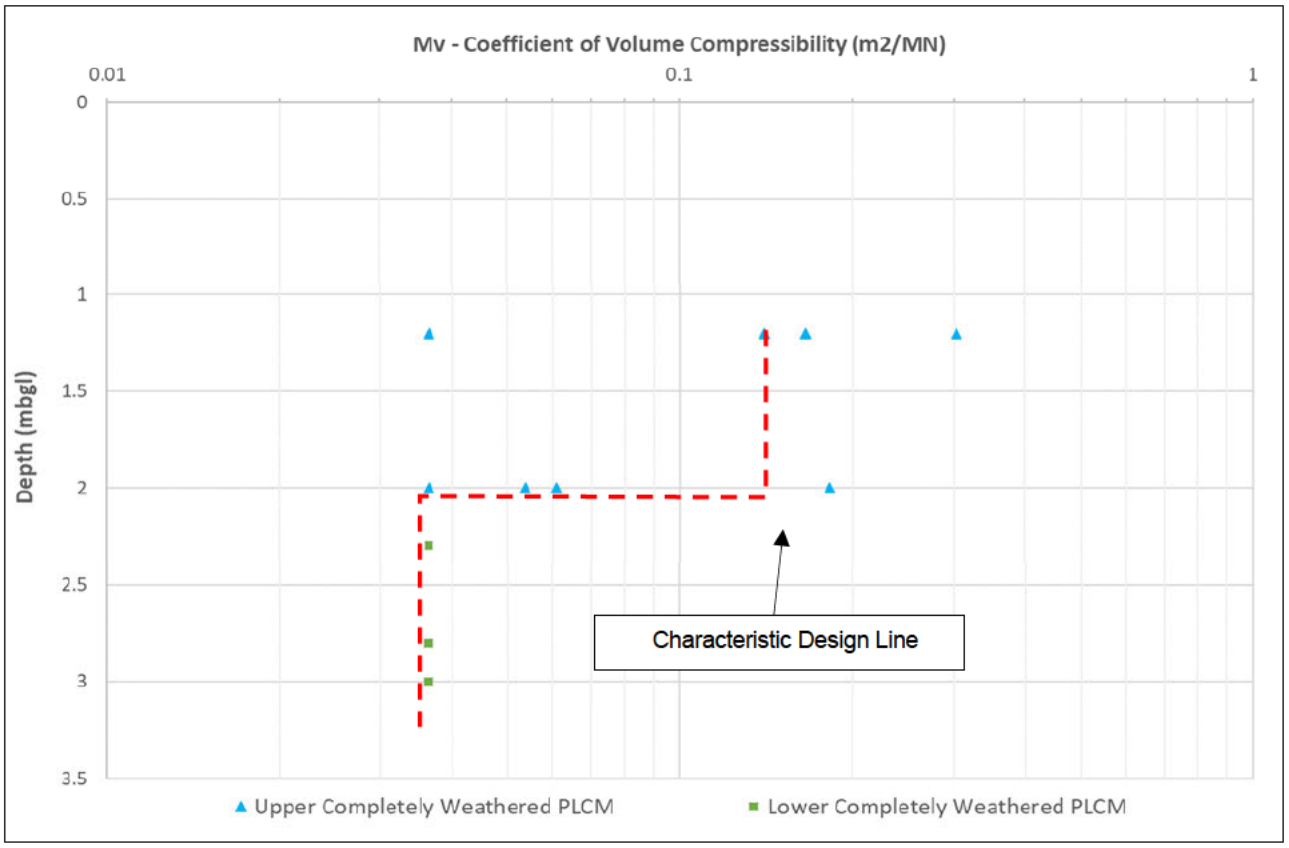
Three SPTs were undertaken within the lower completely weathered PLCM and, using a characteristic plasticity index of 20%, the corresponding undrained shear strengths were all calculated as 269kPa.

A large number of hand shear vanes were undertaken during the EPS ground investigation within the liner core samples and the results ranged from 48kPa to 182kPa. However, given the testing methodology was not in accordance with best practice, i.e. from a thin, disturbed window sample core, the results have been disregarded when deriving a characteristic undrained shear strength value. A characteristic undrained shear strength of 250kPa has been adopted for the lower completely weathered PLCM.

6.7 Modulus of Volume Compressibility

Using Stroud, M. A., 1975, SPT 'N' values may be used to derive the modulus of volume compressibility (M_v) using factors f_1 and f_2, determined from the characteristic plasticity index. Based on this relationship, M_v values have been derived from the available data and plotted in Figure 7 below.

Figure 7: Modulus of Volume Compressibility (Mv) versus Depth / Elevation



6.7.1 Completely Weathered PLCM

6.7.1.1 Upper Completely Weathered PLCM

Eight Mv values ranging from 0.036 to 0.30m^2/MN were derived in the upper weathered PLCM. A characteristic Mv value of 0.15 m^2/MN is considered appropriate for the upper weathered PLCM

6.7.1.2 Lower Completely Weathered PLCM

In the lower weathered PLCM, all data yielded the same value of 0.030 m^2/MN. And therefore 0.036 m^2/MN has been adopted for the lower weathered PLCM.

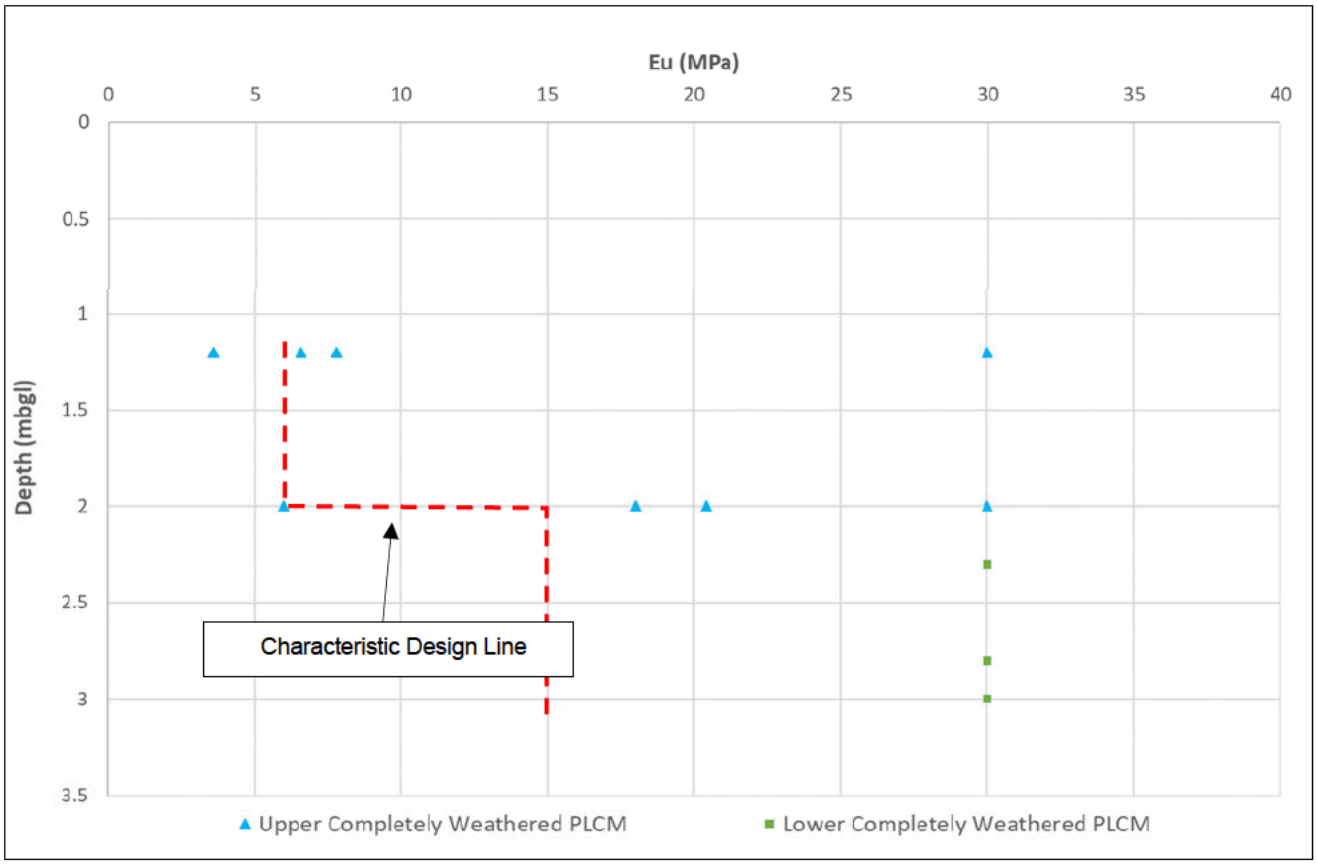
6.8 Young's Modulus

The Elastic modulus (Young's Modulus) for the cohesive weathered PLCM has been calculated based upon empirical relationships between SPT testing and material descriptions obtained during the ground investigations and the results are shown in Figure 8 . This approach is described below:

The undrained Young's Modulus for the cohesive completely weathered PLCM has been estimated using SPT *N* values using the following formula (CIRIA 143 (1995)):

$$E_u = (0.6) \, . N$$

Figure 8: Young's Modulus Vs Depth



6.8.1 Completely Weathered PLCM

The derived stiffness values range from 3.6MPa to 30MPa.

6.8.1.1 Upper Completely Weathered PLCM

Based on the derived data a representative characteristic value of 6MPa has been adopted for the upper completely weathered PLCM.

6.8.1.2 Lower Completely Weathered PLCM

A value of 15MPa is considered appropriate for the lower unit.

6.8.2 Competent PLCM

Due to the sandstone at shallow depths occurring almost exclusively west of the main building complex, the Young's Modulus for mudstone and sandstone have been calculated together based on equation 2.54 (presented below) from *Tomlinson's 'Foundation Design and Construction'* using the relevant data collated from the ground investigations.

$$E_m = jM_r q_{uc}$$

$j = mass\ factor\ relating\ to\ discontinuity\ spacing$

$M_r = ratio\ between\ deformation\ modulus\ and\ unconfined\ compressive\ strength\ q_{uc}\ of\ intact\ rock$

Based on an intact compressive strength of 4MPa, a mass factor of 0.2 corresponding to RQD values of 0-25 and a Modulus Ratio of 150 corresponding to 'uncemented mudstones' a characteristic value of Young's Modulus of 120MPa is calculated. Based on the occasional low SPT 'N' values recorded within the competent mudstone of the PLCM an appropriately conservative stiffness of 90MPa has been adopted.

6.9 Angle of Shearing Resistance

The characteristic values for the angle of shearing resistance were determined through the available testing results and a combination of recommendations within technical references, Including BS8004:2015 and '*Tomlinson's 'Foundation Design and Construction'*. The characteristic values are presented in Table 5.

6.10 Uniaxial Compressive Strength

The correlation between Uniaxial Compressive Strength (UCS) and point load strength is well documented. Six point load tests were completed on competent rock during the 2020 EPS investigation at depths ranging from 1.4m to 6.1m and the results are summarised in Table 7.

Table 7: Summary of Point Load Test Results on PLCM

Exploratory Hole ID	Depth (m)	Is50 (MN/m^2)	Unconfined Compressive Strength (MPa)	Description
R01	5.7	0.2	4.7	Mudstone
R01	6.1	-	-	Mudstone
R02	1.4	3.4	80.6	Sandstone
R02	2	2.1	49.8	Sandstone
R02	2.25	0.7	16.6	Sandstone
R02	2.35	1.3	30.8	Sandstone

Two samples of mudstone and four samples of sandstone were subject to point load testing. One sample of mudstone did not record an I_{s50} value as it failed at a load of less than 0.1kN. Published values of the correlation factor between point Load index and UCS of a rock were used to derive UCS values of rock. Based on a published value of 23 by Broch & Franklin, a single UCS value of 4.7MPa for the mudstone can be derived. The UCS of the sandstone varies from 16.6MPa to 80.6MPa with an average value of 44MPa. Based on the results above and in line with available guidance documents, a characteristic value of 4MPa for the PLCM Mudstone and 40MPa for the PLCM Sandstone are deemed appropriate.

6.11 2.5kg Compaction Testing

Compaction testing was undertaken on five samples and the results are shown in Table 8 and are discussed subsequently in Section 7.10.

Table 8: Summary of Compaction Test Results

Strata	BH No.	Depth (mbgl)	Natural Moisture Content (%)	Optimum Moisture Content (%)	Maximum Dry Density (Mg/m^3)	Particle Density (Mg/m^3)
Cohesive made ground	SA102	0.5	28	18	1.53	2.37
Cohesive made ground	SA103	0.5	17	13	1.77	2.65
Completely Weathered PLCM	SA101	1.1	30	18	1.70	2.67
Completely Weathered PLCM	SA102	1.1	23	16	1.76	2.66
Completely Weathered PLCM	RC103	1.2	19	8.9	1.98	2.62

6.11.1 Cohesive made ground

Two samples of made ground were recovered and scheduled for 2.5kg compaction tests, which indicated optimum moisture contents between 13% and 18% and maximum dry densities between 1.53Mg/m^3 and 1.77Mg/m^3. The dry density value of 1.53mg/m^3 appears to be lower than anticipated for the material type and it may represent a slightly organic subsoil.

The as dug moisture content of the material was wet of optimum in both cases.

6.11.2 Completely Weathered PLCM

Three samples of the upper completely weathered PLCM were subjected to 2.5kg compaction tests to determine the optimum moisture content and the maximum dry density of the material. The results returned optimum moisture contents of 8.9, 16 and 18%, and maximum dry densities of 1.98, 1.76 and 1.70mg/m^3 respectively. In all cases, the as-dug material was wet of optimum.

6.12 Soakaway Testing

Four soakaway tests were undertaken in each of the four trial pits (SA101, SA102, SA103 and SA104) to inform the potential for soakaway drainage at the site. Three of the four tests (SA101, SA102 and SA104) were undertaken within the completely weathered PLCM. Due to access constraints in the west, trial pit SA103 was excavated within an area of thick made ground with the completely weathered PLCM unable to be reached, therefore the soakaway test was conducted within the cohesive made ground stratum.

The testing recorded soil infiltration rates of between 1.07 x 10^{-6} and 7.08 x 10^{-7} m/s. These results are inferred because in all three tests in the completely weathered PLCM, the water level did not fall by 75% of the original volume. In all tests the water level fell by an average of 10mm during the first 60 minutes. If 10mm per hour is taken as a constant rate of standing water level fall, the soakaway would take more than 24 hours to completely discharge which would signify the stratum is not appropriate for soakaway drainage according to BRE365. This would suggest soakaway drainage at this site is unlikely to be feasible.

A single test SA105 was undertaken on an existing soakaway drain at the site. This recorded a level fall of 40mm over the first 60 minutes and an inferred infiltration rate of 2.33x10^{-5} m/s. As built records of the existing soakaway drainage system at the site were not available at time of writing, therefore it is unclear what stratum these soakaways may be discharging into or how large they are.

6.13 Falling Head Tests

During the 2021 Dunelm investigation, two falling head tests were undertaken in the competent PLCM in RC102. The response zones were 3.95 to 4.5m and between 5m and 10m bgl. One was undertaken during the drilling works and the second after the monitoring well had been installed. The tests recorded permeability (k) values of between 1.6x10^{-8} and 3.57x10^{-9} m/s. The data is concordant with typical values expected in a homogenous clay or un-fissured mudstone which describes the ground conditions these tests were completed in, also indicative, that soakaway drainage is unlikely to be feasible at the site.

6.14 California Bearing Ratio (CBR)

Three testing methods were used to derive CBR values across both the 2020 and 2021 ground investigations, which included CBR laboratory testing, in-situ Dynamic Cone Penetrometer (DCP) testing and in-situ Clegg Hammer testing methods. The results are summarised in

Table 9 overleaf.

Table 9: Summary of CBR Values

Stratum	Exploratory Hole	Depth (mbgl)	CBR Value (%)	Technique
Granular Made Ground	FE02	0.5	6.6	Laboratory
	SA101	0.3	5	Clegg Hammer
	DCP2	0 to 0.9	4.5	DCP
	DCP5	0 to 0.4	2	DCP
	DCP8	0 to 0.4	6	DCP
	DCP10	0 to 0.4	20	DCP
	DCP10	0.4 to 0.7	5	DCP
	DCP11	0 to 0.3	30	DCP
	DCP11	0.3 to 0.5	10	DCP
Cohesive Made Ground	SA102	0.50	1	Laboratory
	SA104	0.50	14	Laboratory
	CBR102	0.30	4	Clegg Hammer
	CBR103	0.25	4	Clegg Hammer
	CBR104	0.40	4	Clegg Hammer
	DCP1	0.00 to 0.40 0.40 to 0.80	5 15	DCP
	DCP3	0.0 to 0.50 0.50 to 0.60	5 30	DCP
	DCP5	0.40 to 0.70	10	DCP
	DCP6	0 to 0.40	4	DCP
	DCP8	0.40 to 0.80	12	DCP
Completely Weathered PLCM	R04	0.55	1.2	Laboratory
	WS09	0.50	6.6	Laboratory
	SA102	1.1	1.6	Laboratory
	DCP4	0.30 to 0.9	4.5	DCP
	DCP5	0.70 to 0.95	6.0	DCP
	DCP6	0.40 to 0.80	8.0	DCP
	DCP9	0.0 to 0.70 0.70 to 0.90	4 15%	DCP

A total of six CBR laboratory tests, four Clegg Hammer tests and sixteen DCPs were undertaken in the made ground (both cohesive and granular) and weathered PLCM.

An assessment of the results in

Table 9 has considered the testing methodology used and the soil descriptions presented in the exploratory hole records to derive a characteristic CBR value. Several of the high CBR values (particularly those greater than 15%) derived from the DCP tests have been disregarded as they are considered a result of large gravels and / or cobbles within the material skewing the calculated CBR. Based on the relatively small size of the site and the typically thin distributions of made ground stratum in parts of the site, a CBR of value of 3% is considered to be appropriate and representative across the site for the underlying strata and is discussed further in 7.9.

6.15 Ground Aggressivity

Water soluble sulphate (2:1 water soluble as SO_4) and pH tests were undertaken on seven samples of granular made ground, five samples of cohesive made ground and 11 samples of the coal measures. The results are summarised in

Table 10.

Given the high volume of ground aggressivity testing undertaken, the following testing assessment deviates slightly from the approach adopted within BRE SD1. This method of assessment does not consider a characteristic value for water soluble sulphate and / or pH and simply bases the concrete classification on the highest elevation of water soluble sulphate and the highest pH that is recorded.

Table 10: Summary of Ground Aggressivity Results

Material Type	Exploratory Hole	Depth	pH	Water Soluble Sulphate (mg/l)
Granular Made Ground	R01	0.3	8.25	421.1
	WS01	0.1	8.51	15.8
	WS10	0.5	7.44	48.2
	RC101	0.65	8.6	130
	RC102	0.3	10	96
	RC102	0.6	6.8	110
	RC102	0.65	7.9	51
	RC103	0.6	8	35
Cohesive Made Ground	WS03	0.5	8.48	41.3
	WS11	0.6	8.05	40.1
	WS11	1.6	7.44	144.1
	RC101	1	6.8	40
	SA101	0.75	6.6	34
Completely Weathered Coal Measures / Coal Measures	R01	1.8	7.49	39
	WS02	1.5	7.69	29.2
	WS02	4	6.84	32.6
	WS03	1.5	8.19	39.7
	WS04	1.5	5.35	36.7
	WS05	0.8	5.29	28.1
	WS08	1.4	7.71	18.3
	WS08	2.4	7.88	13.8
	WS09	0.8	5.89	41.8
	RC101	2	6.4	67
	RC101	4	6.4	13
	RC101	6	7.3	35
	RC103	3	6.9	<10
	RC103	1.2	8.2	<10

The highest value for water soluble sulphate and pH was recorded as 421.1mg/l and 8.25 respectively. In accordance with BRE Special Digest 1, the design sulphate class for concrete in contact with underlying soils is assessed to be DS-1 with an aggressive chemical environment for concrete (ACEC) of AC-1.

6.16 Groundwater

Groundwater encountered During Fieldwork

No groundwater strikes were recorded during the 2020 EPS investigation. A single groundwater strike in RC102 at 3m which remained static was recorded during the 2021 ground investigation.

Post Fieldwork Monitoring

The five groundwater and ground gas wells installed during the 2020 EPS investigation were monitored three times during the Autumn of 2020.

The three groundwater and ground gas wells installed during the 2021 Dunelm ground investigation have been monitored four times, with the EPS installations also being monitored on the last two visits. The groundwater level data retrieved from both post fieldwork monitoring periods is summarised in Table 11.

Table 11 Post Fieldwork Groundwater Monitoring

Investigation		EPS 2020	EPS 2020	EPS 2020	EPS 2020	EPS 2020	Dunelm 2021	Dunelm 2021	Dunelm 2021
BH ID		WS01	WS03	WS04	WS08	WS11	RC101	RC102	RC103
Response Zone		Made ground and Weathered PLCM	Made ground and Weathered PLCM	Weathered PLCM	Made ground, Weathered PLCM and PLCM	Made ground and Weathered PLCM	Weathered PLCM	PLCM	Weathered PLCM
30/10/20	m bgl	2.43	2.13	0.97	1.94	Dry	NA	NA	NA
	m AOD	119.47	122.47	121.5	124.86	Dry	NA	NA	NA
05/11/20	m bgl	2.25	Dry	1.18	2.36	Dry	NA	NA	NA
	m AOD	119.65		121.29	124.44	Dry	NA	NA	NA
13/11/20	m bgl	2.57	2.49	1.34	2.4	Dry	NA	NA	NA
	m AOD	119.33	122.11	121.13	124.4	Dry	NA	NA	NA
23/04/21	m bgl	NA	NA	NA	NA	Dry	2.31	6.62	2.47
	m AOD	NA	NA	NA	NA	Dry	119.72	115.38	119.81
05/05/21	m bgl	NA	NA	NA	NA	Dry	2.26	7.02	1.52
	m AOD	NA	NA	NA	NA	Dry	119.77	114.98	120.76
24/05/21	m bgl	1.41	1.78	1.1	2.28	Dry	2.17	7.17	1.13
	m AOD	120.49	122.82	121.37	124.52	Dry	119.86	114.83	121.15
11/06/21	m bgl	2.57	Dry	NR	2.4	Dry	2.06	7.28	1.77
	m AOD	119.33	Dry	NR	124.4	Dry	119.97	114.72	120.48

Completely Weathered PLCM

The monitoring data indicates shallow water within the completely weathered PLCM. The single installation located in the western half of the site on the upper level (WS11) was consistently observed to be dry. The EPS installations when monitored in 2020, showed a gentle decrease in standing water levels from October to November, this correlates with rainfall trends observed from local weather station data which recorded October having twice the rainfall compared to November.

The shallow installations by Dunelm in 2021 (RC101 & RC103) show a trend of increasing standing water levels between late April and late May. This again corresponds with observed rainfall trends with May recording approximately four times more rainfall than April in the Huddersfield area. This trend is reversed in RC102 & RC103 as the weather became drier going into June but not in RC101 which continued to record an increase in groundwater level. The EPS installations could only be monitored on the last two monitoring visits after the 2021 ground investigation and all installations recorded a fall in groundwater levels over that time. This data broadly agrees with rainfall trends, which have seen weekly rainfall rates decrease significantly between late May and June.

No groundwater ingress was reported in the soakaway test pits which in the eastern half of the site extended to between 1.4 and 1.5m bgl. The soakaway pit undertaken in the western half of the site extended to 2.2m bgl and reported no groundwater ingress but was logged to be entirely within made ground.

It is likely the shallow standing water recorded within the completely weathered PLCM is the result of a shallow perched groundwater surface within this stratum. Although the possibility of surface water runoff filling the installations exists.

Competent PLCM

The installation screening the PLCM bedrock in 2021 recorded a steady drop in groundwater levels. This suggests the standing water within this installation represents legacy water from the water flush drilling methodology employed to advance the hole. It is considered unlikely to represent the regional groundwater table for a number of reasons, including the elevation and sloping topography of the site but also because complete loss of flush was reported when the coal mine workings were encountered in the soft bed coal, and at the end of the shifts during which the holes had encountered the workings, the holes were dipped and reported to be dry.

7.0

Geotechnical Assessment

Geotechnical Assessment

7.1 General

Based on the findings of both recent phases of ground investigation reviewed in this report, the following section provides a geotechnical assessment of the ground and groundwater conditions in relation to the proposed development.

7.2 Development Details

The structural loadings associated with the proposed multi storey college building in the south east part of the site are included in Drawing NE8659-CCS-XX-BF-DR-S-30021 listed as reference 11 in section 1.4. A summary of the foundation loadings is included in Table 12. It should be noted these loads are preliminary and may be subject to change during detailed design.

Table 12: Pad Foundation Summary

Ref	Maximum Load (kN)
PF1	2325*
PF2	2800*
PF3	No loading available
'Infill' Structure Replacement Building in central area	450*

*Values include dead, imposed and wind loading

7.3 Ground Conditions

Proposed New College Building

The ground conditions under the main college building development are summarised in the table below.

Table 13 Main College Building Foundation Assessment Ground Model

Strata	Depth to top (m bgl)	Elevation at top (m AOD)	Thickness (m)
Hard standing (macadam)	0	122 – 122.28	0.15 – 0.25
Granular Made Ground	0.15 – 0.25	121.75 – 122.12	0.65 – 0.85
Upper Completely Weathered PLCM (firm clay)	0.8 – 1.1	120.93 – 121.48	0.9 – 1.5
Lower Completely Weathered PLCM (stiff clay)	2 – 2.5	119.6 – 120.03	1.1 – 1.9
Competent PLCM* (Mudstone)	3.2 – 4.3	117.7 – 118.83	No proven

*A worked coal seam was also encountered however in the context of shallow foundation assessment this has been ignored as it is assumed it will have been drilled and grouted as part of the ground improvement/enabling works.

Evidence of the 'Soft Bed Coal Seam' was identified in two out of three deep boreholes as a 'void' at depths of between 15.5mbgl and 16.3mbgl.

Infill Replacement Building

Ground investigation data could not be recovered from the location of the proposed 'infill' building within the central part of the College as the existing building was still in use during both site investigations and access was prohibited. However, using the nearest exploratory holes the top levels of the completely weathered PLCM and intact rockhead can be interpolated and inferred. Based on this approach, Table 14 below summarises the inferred ground conditions for the infill structure. At time of writing, current floor levels in this part of the college were not known, and thickness of made ground could be highly variable, therefore only the inferred levels of the proposed founding strata have been provided based on the closest exploratory hole at a similar level (R04 form the 2020 EPS investigation).

Table 14 Ground Model for 'Infill' Structure

Strata	Inferred Elevation at top (m AOD)	Thickness (m)
Completely Weathered PLCM (firm to stiff clay)*	123.7	1.2
Intact PLCM* (Sandstone and Mudstone)	121.8	Not proven

*The relatively thin layer of completely weathered PLCM in this area meant identifying upper and lower sub-units was not possible.

If ground conditions are found to be markedly different from those indicated in Table 14 following the demolition works and formation excavation, further assessment by a geotechnical engineer may be required.

7.3.1 Groundwater

It is likely perched groundwater may be locally present within the completely weathered PLCM at between 1 and 2.5m bgl. Installations screening the weathered PLCM within the main college building footprint reported groundwater levels of between 119.72 and 120.86m AOD. The single installation screening the competent PLCM recorded a groundwater level of between 6 and 7.5m bgl (114.72 – 115.38m AOD).

7.4 Possible Development Constraints

Several development constraints were noted during the intrusive works that need to be considered when undertaking the proposed development works, which include:

- The presence of shallow unrecorded coal mine workings within the Soft Bed Coal Seam at between 15.5 and 17m bgl;
- The presence of shallow (<1m bgl (130.4m AOD) sandstone in the west part of the site, may require hard digging techniques to be adopted;
- The anticipated presence of relict foundations, particularly below the proposed 'infill' building within the central part of the College;
- The presence of existing services across the site.

7.4.1 Coal Mining Risk

Given the shallow unrecorded workings within the Soft Bed Coal Seam and the insufficient rock head cover (referenced in Section 0), there remains a risk of potential ground instability at surface and damage to future development from mine working collapse. To mitigate this risk, and comply with planning requirements, ground stabilisation will be required and a programme of drilling and injection of grout into the worked coal seam under the main college building and infill building are recommended.

7.5 Shrinkage / Swelling Potential

The completely weathered PLCM was predominantly recorded as cohesive in nature and varied from a low plasticity through to a high plasticity clay. In accordance with NHBC Standards Chapter 4.2: Building Near Trees, the cohesive soils exhibit low to medium volume change potential.

Given the presence of large, mature trees around the periphery of the site and also in isolated locations within the proposed multi storey building footprint in the south east, the foundations are considered to be at risk from shrinkage and/or swelling cycles within the cohesive soils if founded at shallow depths (<1.2m bgl).

The influence of existing and proposed trees should be considered during the detailed foundation design and it is recommended that a tree survey is undertaken prior to the removal of any trees and / or vegetation. An assessment of the appropriate depth for shallow pad foundations is provided in section 7.6 below.

7.6 Foundation Design Considerations

For the following assessment, in deriving the serviceability limit state bearing pressures, a settlement threshold of 25mm has been adopted based on the current structural designs.

It is considered likely that the proposed main college building and 'infill' building can be supported by traditional shallow pad foundations.

Due to the inherent variability of the made ground and poor engineering properties, the made ground has been discounted as a potential founding stratum.

Piles could be considered as an alternative foundation solution for the main college building assuming the mine workings are drilled and grouted and the piles are sleeved from ground surface to penetrate fully the grouted zone. However, this approach would necessitate a further coal mining risk assessment to look at the risks from potentially worked seams below the Soft Bed Coal due to the piles having to toe into the bedrock a significant depth below the Soft Bed Coal seam. In addition, the cost of rotary bored piles (extending to significant depth below the worked coal seam) in conjunction with drilling and grouting the mine workings (which will be a planning requirement regardless of foundation type), would be far greater than drilling and grouting combined with a shallow pad foundation solution.

7.6.1 Shallow Pad Foundations within the Completely Weathered PLCM

Ultimate limit state (ULS) and serviceability limit state (SLS) bearing pressures for pad footings have been considered using the geotechnical properties presented in Section 0, the form of calculations is presented in Appendix D. The serviceability limit state is based on the maximum allowable settlement, therefore the SLS bearing resistance has been taken to the maximum allowable bearing pressure exerted before the settlement tolerance of the structure has been exceeded. The maximum settlement tolerance adopted is 25mm.

SLS bearing pressures have been evaluated using the Oasys programme PDISP, which estimates vertical ground movements at a specified level due to imposed vertical pressures.

Based on the appreciable thickness of the completely weathered PLCM and the variable engineering properties of this stratum with depth, the column loads have been evaluated at 120.0m AOD (~1m below top of the weathered PLCM) and at two successive 0.5m increments below that, 119.5 and 119m AOD. The founding depths have started at 120m bgl to ensure the softer upper weathered PLCM is avoided and to ensure the foundations are beyond the influence of tree root induced volume change. The maximum load for both foundations (PF1 & PF2) were evaluated at the three depths to determine the minimum size of the pad at each depth. The sizes and allowable bearing pressure are presented in the table below.

Table 15 Allowable Bearing Pressure Summary

Pad ref and max load	Size and $q_{Allowable}$ at 120m-AOD founding depth (kPa)	Size and $q_{Allowable}$ at 119.5m-AOD founding depth (kPa)	Size and $q_{Allowable}$ at 119m-AOD founding depth (kPa)
PF1 **2325kN**	4m x 4m (145kPa)	3.5m x 3.5m (190kPa)	3.1m x 3.1m (240kPa)
PF2 **2800kN**	4.5m x 4.5m (135kPa)	4m x 4m (175kPa)	3.5m x 3.5m (225kPa)

The same process was applied to the foundations for the infill replacement building with the ground model from Table 14 being used. The highest founding level has been taken as 1m below the top of the natural weathered PLCM due to the material in this area not having been exposed to weather for several decades and consolidation from the surcharge of the existing building. The inferred ground model suggests at the deepest founding level, the foundations may be seated on rock, however it has been assumed here the lowest founding level remains within weathered PLCM in acknowledgement of the appreciable lateral distance of the closest exploratory holes to the proposed building.

Table 16 Infill Structure Allowable Bearing Capacities

Building and max load	Size and $q_{Allowable}$ at 122.7m-AOD founding depth (kPa)	Size and $q_{Allowable}$ at 122.2m-AOD founding depth (kPa)	Size and $q_{Allowable}$ at 121.8m-AOD founding depth (kPa)
Infill Structure **450kN**	2m x 2m (110kPa)	1.75m x 1.75m (145kPa)	1.5m x 1.5m (200kPa)

7.6.2 Shallow Pad Foundations within the Intact PLCM

For pad foundations constructed upon the mudstone bedrock, for a maximum total column load of 2800kN, pad foundations of a minimum of 2.7m x 2.7m would be required to keep settlements below 25mm. Rockhead was recorded at between 118.8 and 117.7m AOD under the location of the proposed main college building. Therefore, taking foundations down to rockhead will require exceptionally deep foundation excavations in some areas of the building footprint. These would require shoring and potentially, groundwater control. In addition, foundations to this depth would mean a significant volume of mass concrete would be required.

Conclusion

Shallow pad foundations within the completely weathered PLCM are likely to be a viable foundation solution.

Due to the improvement of the engineering properties of the weathered PLCM with depth, pad sizes will reduce with increasing founding depth. It is expected a balance between minimising concrete and steel volumes and minimising depth of excavations will determine the appropriate founding depth. Based on the prescribed loads, it is likely shallow pads between 120 and 119m AOD will be suitable.

7.7 Floor Slab

The finished floor level of the proposed main college building in the south east is 121.00mAOD. Based on this, it is anticipated that the majority, if not all, the made ground will be removed as part of the construction to accommodate a 150mm floor slab with 150mm granular subbase. The maximum loading of the floor slab is 10kN/m^2, based on

information from the structural team, and provided it is founded onto the underlying completely weathered PLCM, a ground bearing floor slab is considered feasible.

Once the formation level for the floor slab is exposed, it should be proof rolled and any soft spots noted, removed to full depth and replaced with properly compacted granular fill.

7.8 Chemical Attack on Buried Concrete

Based on the results included in Section 0 and in accordance with BRE Special Digest 1, the design sulphate class for concrete in contact with underlying soils and or rock is assessed to be DS-1 with an aggressive chemical environment for concrete (ACEC) of AC-1.

7.9 Road Pavement Design

Based on the data obtained, an equilibrium CBR design value of 3% is recommended. This should be confirmed through in situ testing at the formation level following proof rolling but prior to construction and any soft spots in the formation should be excavated to full depth and replaced with suitable, properly compacted granular fill.

7.10 Earthworks

7.10.1 Re-use of Site Won Material

Cut and fill preparatory earthworks are anticipated to be required to facilitate the proposed development. Any cut and fill must consider the waste classification of the site won soils as soils classifying as Hazardous cannot be re-used without treatment to render them Non-Hazardous.

The as dug moisture contents of the cohesive made ground ranges from 17 to 36%, with the optimum moisture content for compaction recorded to be between 13% and 18%. The results indicate that the cohesive made ground is typically wet of optimum and may require conditioning or stabilisation to allow it to be suitable for reuse as engineered fill.

The as dug moisture contents of the completely weathered PLCM range from 15.5% to 33%, with the optimum moisture content for compaction recorded to be between 9 and 18%. The results indicate that the completely weathered PLCM is typically wet of optimum and may also require conditioning or stabilisation to allow it to be suitable for reuse as engineered fill.

Following the demolition of parts of the existing college to make way for the infill structure, there remains a possibility that relict concrete structures including floor slabs and foundations may be present and may require excavation, depending on final designs. Allowances should be made for encountering previously unrecorded obstructions. Consideration could be given to the crushing and processing on site of excavated relict concrete obstructions for reuse as granular fill.

7.10.2 Excavations and Groundwater Control

Excavations within the vicinity of the proposed building are likely to include the excavation of made ground soils and completely weathered PLCM and should be feasible using conventional excavation methods. However, provision should be made for hard digging conditions for deeper excavations where bedrock is anticipated. This provision should also be considered at relatively shallow depths in the western half of the site where sandstone was encountered at depths as shallow as 0.4m bgl (130.4m AOD). Although deep excavations are not anticipated within this part of the site, local excavations for drainage associated with the artificial sports pitch and the car parking may require digging below 130.4m AOD.

Excavations within the natural soil are likely to be stable but within areas of deep, granular made ground are likely to be unstable so allowance for shoring or temporary support of excavations should be made.

Shallow groundwater recorded across the site during monitoring and the presence of spatially localised granular completely weathered PLCM, mean limited volumes of perched water may be encountered during excavation. Therefore provision for groundwater control should be made. The regional groundwater table is anticipated to be at a significant depth below proposed excavations therefore strong inflows of groundwater are not expected.

If groundwater is encountered in excavations during the construction works, it is considered likely that flows will be of limited volume and will be managed by traditional sump pumping methods.

7.11 Soakaway Drainage

Of the three tests undertaken in the completely weathered PLCM, all three reported water level falls of 10mm over the course of 60 minutes. Extrapolating this as a typical and constant rate of soakage, the soakaway would take more than 24 hours to discharge 75% of the soakaway test pit volume. The testing indicates the completely weathered PLCM was not a suitable medium for soakaway drainage. Falling head tests were also undertaken in the competent mudstone of the PLCM which returned very low permeability values of between $x10^{-8}$ and $x10^{-9}$ m/s. While these values are not technically the same as infiltration rates, they serve as a useful indicator of how quickly water will drain away at depths below those tested in the soakaway pits, and, suggest deeper soakaway drainage is unlikely to be viable.

All testing data taken together would suggest soakaway drainage at this site is unlikely to be feasible.

8.0

Ground Gas Risk Assessment

Ground Gas Risk Assessment

8.1 Ground Gas Introduction and Monitoring

This section summarises the information collated during both the EPS and Dunelm Ground Investigations. Monitoring wells were installed in five window sample boreholes (WS01, WS03. WS04, WS08 and WS11) as part of the EPS investigation and a further three monitoring wells were installed in rotary boreholes RC101, RC102 and RC103 as part of the Dunelm investigation.

Three gas and groundwater monitoring visits were completed by EPS between 30th October and 13th November 2020 and at the time of writing this report, four gas and groundwater monitoring visits had been undertaken on the Dunelm installations.

The results of the monitoring visits are summarised in Table 17 and Table 18.

Table 17: Summary of gas monitoring data (EPS Site Investigation)

Date	Atmospheric Pressure (mb)	CO_2	O_2	CH_4	H_2S	CO	Gas Flow (l/hr0	Gas Screening Value	
								CO_2	CH_4
Borehole No.	**WS01**								
30/10/2020	994	10.5	0.1	0.9	-	-	<0.1	0.0105	0.0009
05/11/2020	1024	7.3	5.6	<0.1	-	-	<0.1	0.0073	<0.0001
13/11/2020	992	10.7	0.1	<0.1	-	-	<0.1	0.0107	<0.0001
11/06/21	1000	4.8	11.4	<0.1	-	-	<0.1	0.0048	<0.0001
Borehole No.	**WS03**								
30/10/2020	994	2.3	17.5	<0.1	-	-	<0.1	0.0023	<0.0001
05/11/2020	1024	<0.1	20	<0.1	-	-	<0.1	<0.0001	<0.0001
13/11/2020	992	<0.1	20.3	<0.1	-	-	<0.1	<0.0001	<0.0001
11/06/21	1000	0.1	20.5	<0.1	-	-	<0.1	<0.0001	<0.0001
Borehole No.	**WS04**								
30/10/2020	994	<0.1	20.3	<0.1	-	-	<0.1	0.0014	<0.0001
05/11/2020	1024	0.8	20.0	<0.1	-	-	<0.1	0.0008	<0.0001
13/11/2020	992	0.7	19.5	<0.1	-	-	<0.1	0.0007	<0.0001
11/06/21	1000	-	-	-	-	-	<0.1	0.0014	<0.0001
Borehole No.	**WS08**								
30/10/2020	994	<0.1	20.4	<0.1	-	-	<0.1	<0.0001	<0.0001
05/11/2020	1024	<0.1	20.6	<0.1	-	-	<0.1	<0.0001	<0.0001
13/11/2020	992	<0.1	20.3	<0.1	-	-	<0.1	<0.0001	<0.0001
11/06/21	1000	0.8	19.7	<0.1	-	-	<0.1	0.0008	<0.0001
Borehole No.	**WS11**								
30/10/2020	994	1.5	18.4	<0.1	-	-	<0.1	0.0015	<0.0001
05/11/2020	1024	0.8	20.4	<0.1	-	-	<0.1	0.0008	<0.0001
13/11/2020	992	0.2	20.1	<0.1	-	-	<0.1	0.0002	<0.0001
11/06/21	1000	1.7	18.3	<0.1	-	-	<0.1	0.0017	<0.0001

Table 18: Summary of Gas Monitoring Results (Dunelm 2021)

Date	Atmospheric Pressure	CO_2	O_2	CH_4	H_2S	CO	Gas Flow (l/hr0	Gas Screening Value	
								CO_2	CH_4
Borehole No.	**RC101**								
23/04/21	1009	1.50	16.5	<0.1	<0.1	<0.1	<0.1	0.0015	<0.0001
07/05/21	998	3.80	11.3	<0.1	<0.1	<0.1	<0.1	0.0038	<0.0001
21/05/21	969	5.00	6.40	<0.1	<0.1	<0.1	<0.1	0.0050	<0.0001

Date	Atmospheric Pressure	CO_2	O_2	CH_4	H_2S	CO	Gas Flow (l/hr0	Gas Screening Value	
								CO_2	CH_4
11/06/21	1000	6.6	1.2	<0.1	<0.1	<0.1	<0.1	0.0066	<0.0001
Borehole No.	**RC102**								
23/04/21	1009	<0.1	20.8	<0.1	<0.1	<0.1	<0.1	<0.0001	<0.0001
07/05/21	998	1.30	18.4	<0.1	<0.1	<0.1	<0.1	0.0013	<0.0001
21/05/21	969	2.70	14.40	<0.1	<0.1	<0.1	<0.1	0.0027	<0.0001
11/06/21	1000	3.8	11.3	<0.1	<0.1	<0.1	<0.1	0.0038	<0.0001
Borehole No.	**RC103**								
23/04/21	1009	<0.1	20.4	<0.1	<0.1	15	<0.1	<0.0001	<0.0001
07/05/21	998	<0.1	19.5	<0.1	<0.1	<0.1	<0.1	<0.0001	<0.0001
21/05/21	969	<0.1	19.5	<0.1	<0.1	<0.1	<0.1	<0.0001	<0.0001
11/06/21	1000	0.7	0.7	<0.1	<0.1	<0.1	<0.1	0.0007	<0.0001

8.2 Ground Gas Monitoring Results

The response zones targeted during the Dunelm ground investigation comprised both the completely weathered coal measures and the PLCM. The monitoring wells installed within WS04 and WS08 during the EPS investigation also include response zones that target the completely weathered PLCM. However, the monitoring wells installed within WS01, WS03 and WS11 during the EPS investigation straddle both the made ground horizon and the completely weathered PLCM.

8.3 Preliminary Ground Gas Risk Assessment

This risk assessment is undertaken in the context of the design proposals and is based upon guidance including CIRIA C665 and BS8485:2019.

The critical gas concentrations and maximum flow rate recorded across the site to date are as follows:

- Elevated concentrations of CO_2 were recorded during the monitoring visits. The maximum CO_2 concentration recorded was 10.7% in WS01 during the EPS 2020 monitoring v/v (RC101).
- No detectable concentrations of CH_4 were recorded.
- Minimum O_2 concentration are recorded to be 1.2% (RC101).
- No detectable gas flow was recorded.
- Maximum CO reading was recorded as 15ppm (RC103)

To determine the maximum Gas Screening Value (GSV) for the site, the highest recorded gas concentration and the highest flow rate has been used as follows: GSV = 0.1 x (10.7/100) = 0.010 l/hr.

8.4 Preliminary Conclusion

Based on the calculated GSV, the site characterises as Characteristic Situation 2 (CS-2) under which scenario ground gas protection measures are required. Although CO_2 levels in WS01 have fallen from the 10.7% peak recorded in 2020 to below 5% in 2021, the three installations added during the 2021 ground investigation have been recording steady increases in CO_2 over the supplementary monitoring period, throughout both increasing and falling pressure weather conditions.

Although development proposals include for the excavation of made ground soils below the building footprint in their entirety, the monitoring data suggests the source strata for the hazardous ground gas is (likely mine workings within) the bedrock.

It should be noted that a programme of stabilisation by drilling and grouting the underlying void within the coal seam below the proposed main college building and infill structure is recommended and will be undertaken prior to construction. However, the coal seam is understood to be dipping to the east, as such, the grouting of the seam could drive hazardous ground gas up dip and to the west under the existing buildings in the centre of the site.

The infill structure is to be constructed surrounded by existing buildings of different construction dates extending back at least 50 years. As-built records for the existing buildings are not available, therefore it is unfeasible to determine if any of the existing buildings include ground gas protection measures. It is highly unlikely such measures will have been installed in the older buildings. In the likely scenario the infill structure is surrounded by buildings without ground gas protection measures, it would be problematic to install ground gas protection measures in the infill structure. Therefore it is recommended CO_2 and CH_4 gas detectors are installed in all existing buildings as well as the proposed infill structure during the construction phase and to remain in place during the service life of the buildings.

Taking all this into consideration and the proposed Characteristic Situation is CS-2. It is possible this could be revised if additional monitoring wells are installed to the west of the proposed areas of drilling and grouting to assess the impact of the grouting works on the ground gas characteristic situation once all grouting works are completed.

9.0

Land Quality Assessment

Land Quality Assessment

9.1 Visual and Olfactory Evidence of Hydrocarbon Contamination

No visual or olfactory evidence of any significant contamination was identified during either intrusive investigations.

9.2 Geoenvironmental Preface and Assumptions

The development proposal for the site includes the demolition and construction of educational facilities at Greenhead College. It also includes for the construction of a replacement artificial sports pitch and relocated car parking. It has been assumed that a 'Commercial' end use is appropriate and justification for this is included within Section 9.4.2.

9.3 Environmental Testing and Sampling Strategy

The suite of analysis focused on commonly occurring contaminants as well as targeting several contaminants that can act as surrogate markers for other less common contaminants.

A total of 12 representative soil samples were subject to environmental testing during the EPS investigation and these results are included in Appendix A. A further 10 representative soil samples were subject to environmental testing as part of the Dunelm investigation and these results are included in Appendix B.

9.4 Risk Assessment Methodology

9.4.1 General

Reference should be made to the detailed information on the geoenvironmental risk assessment framework and methodology presented in Appendix C.

The risk assessments undertaken are based on current UK legislative framework and best practice in the context of the proposed development. In order to put the laboratory chemical analysis results for the development site in context, the chemical data obtained during this investigation has been assessed in relation to published values and other criteria commonly used for the assessment of land contamination, as summarised subsequently.

9.4.2 Land (Soil) Quality Assessment

For this assessment, a 'Commercial' end use has been considered appropriate for the proposed development. These threshold values have been considered the most appropriate for the proposed development which consists of a multi storey unit that will provide an educational setting for its end users. The 'Commercial' end use model is based on the following:

- The model considers indoor exposure frequency which is considered to be appropriate for assessing the risk within areas of proposed buildings.
- The frequency for any indoor exposure is 230 days a year which is appropriate for the proposed buildings based on an employee or student's exposure (worst case scenario).
- The occupancy period indoors is 8.3 hours a day, which is considered to be appropriate for an employee or student.
- The most sensitive receptor is a female aged 16 years which is considered appropriate as the most sensitive receptor for staff or students in the proposed buildings.

Should the nature of the proposed development significantly change that would alter the proposed end use, further geoenvironmental assessment may be warranted.

In undertaking the Tier 1 risk assessment the laboratory analysis results for soil samples have been considered in the context of a 'Commercial' scenario, using the LQMs (Land Quality Management) along with C4SLs (Category 4

Screening Levels). Additionally, the S4ULs (Suitable 4 Use Levels) screening criteria have been used in the absence of an LQM C4SL.

13 soil organic matter (SOM) tests were undertaken during both phases of ground investigation with the distribution and SOM content ranges as follows:

- 1 x Topsoil - >25%
- 1 x granular made ground subbase – 3.9%
- 4 x granular made ground – 2.7% to 8%
- 4 x cohesive made ground – 3.1 to 5.9%
- 2 x completely weathered PLCM – 0.5%
- 1 x competent PLCM – 1.9%

Based on these results, a SOM of 1% for the PLCM (weathered and competent) and an SOM of 2.5% for the made ground and topsoil is considered reasonable. However, an appropriately conservative approach has been adopted for this assessment and all material types have been assessed based on an SOM of 1%.

9.4.3 Controlled Waters Assessment

The closest surface water feature comprises a small pond approximately 30m north of the site. The nearest named watercourse is the River Colne, located approximately 500m south of the site boundary, which flows east to west and is some 50m lower than site levels.

The solid geology of the PLCM is classified as a Secondary A Aquifer and is considered to be a potentially sensitive receptor. However, the site is not located within a groundwater source protection zone and there are no groundwater abstractions located within 500m of the site boundary. In addition to this, the PLCM bedrock is known for its legacy of underground historical mine workings that has had a detrimental impact on the water quality within the aquifer.

A conservative Tier 1 assessment has been undertaken by comparing recorded soil leachate concentrations and ground water samples against the UK Drinking Water Standards (DWS), where threshold values for analytes are not available within the DWS suite, reference has been made to the corresponding analyte thresholds from the Environmental Quality Standards (EQS) for Freshwater within the UK.

Where the limits of detection for test results are above screening threshold values, an assumed value of 50% of the limit of detection has been used in the assessment, as per good practice for non-detects.

The site is considered to have a 'hard' water hardness level, as such, a water hardness range of 151 mg/l to 200 mg/l $CACO_3$ has been adopted for the Tier 1 Water Assessment.

9.5 Soil Analytical Test Results & Tier 1 Screening Assessment

Table 19 summarises the analytical test data and includes a Tier 1 assessment in the context of 'Commercial' land use.

Table 19: Summary of Soil Chemical Analysis Results and Tier 1 Assessment

Test	Threshold Value		No. of Samples	Range	No. of Exceedances
Asbestos					
Asbestos	Presence		22	n/a	0
Metals					
Arsenic	640	mg/kg	22	BD to 96.7	0
Cadmium	410	mg/kg	22	BD to 0.8	0
Chromium	No Value	mg/kg	12	3 to 347.5	--
Chromium III	8600	mg/kg	22	BD to 107.6	0
Chromium, Hexavalent	49	mg/kg	16	BD	0
Copper	68000	mg/kg	22	4 to 6113	0
Lead	2330	mg/kg	22	BD to 1107	0

Test	Threshold Value		No. of Samples	Range	No. of Exceedances
Asbestos					
Inorganic Mercury	1100	mg/kg	18	BD to 1.1	0
Nickel	980	mg/kg	22	1 to 123.2	0
Selenium	12000	mg/kg	22	BD to 2	0
Zinc	730000	mg/kg	22	29 to 1091	0
Inorganics					
pH	No Value		30	5.29 to 10	--
Cyanide, Total	No Value	mg/kg	17	BD to 0.9	--
Organic matter	No Value	%	13	BD to 8	--
Sulphate Aqueous Extract as SO4	No Value	mg/l	24	13 to 421.1	--
Sulphate as SO4, Total	No Value	%	10	0.02 to 628	--
TPH					
Aliphatic C5-C6	3200	mg/kg	12	BD	0
Aliphatic C6-C8	7800	mg/kg	12	BD	0
Aliphatic C8-C10	2000	mg/kg	12	BD	0
Aliphatic C10-C12	9700	mg/kg	12	BD to 8.2	0
Aliphatic C12-C16	59000	mg/kg	12	BD to 21	0
Aliphatic C16-C21	No Value	mg/kg	12	BD to 25	--
Aliphatic C21-C35	No Value	mg/kg	12	BD to 706	--
Aliphatic C5-C35	No Value	mg/kg	12	BD to 706	--
Aromatic C5-C7	26000	mg/kg	12	BD	0
Aromatic C7-C8	56000	mg/kg	12	BD	0
Aromatic C8-C10	3500	mg/kg	12	BD	0
Aromatic C10-C12	16000	mg/kg	12	BD to 104.8	0
Aromatic C12-C16	36000	mg/kg	12	BD to 375	0
Aromatic C16-C21	28000	mg/kg	12	BD to 2002	0
Aromatic C21-C35	28000	mg/kg	12	BD to 4651	0
Aromatic C5-C35	No Value	mg/kg	12	BD to 7133	--
TPH Ali/Aro Total	No Value	mg/kg	12	BD to 7679	--
EPH (C10-C20)	No Value	mg/kg	10	BD	--
EPH (C6-C40)	No Value	mg/kg	10	BD	--
BTEX & MTBE					
Benzene	98	mg/kg	14	BD to 5	0
Toluene	56000	mg/kg	10	BD to 17	0
Ethylbenzene	5700	mg/kg	10	BD to 38	0
Xylene	No Value	mg/kg	10	BD to 83	--
MTBE	No Value	mg/kg	10	BD	--
Phenols					
Phenol - Monohydric	440	mg/kg	16	BD to 6	0
PAHs					
Naphthalene	190	mg/kg	22	BD to 85.9	0
Acenaphthylene	83000	mg/kg	22	BD to 9.2	0
Acenaphthene	84000	mg/kg	22	BD to 63.71	0
Fluorene	63000	mg/kg	22	BD to 47.85	0
Phenanthrene	22000	mg/kg	22	BD to 360.85	0
Anthracene	520000	mg/kg	22	BD to 88.03	0
Fluoranthene	23000	mg/kg	22	BD to 332.26	0

Test	Threshold Value		No. of Samples	Range	No. of Exceedances
Asbestos					
Pyrene	54000	mg/kg	22	BD to 280.32	0
Benzo(a)anthracene	170	mg/kg	22	BD to 124.87	0
Chrysene	350	mg/kg	22	BD to 137.46	0
Benzo(b)fluoranthene	44	mg/kg	22	BD to 152.9	**1**
Benzo(k)fluoranthene	1200	mg/kg	22	BD to 59.46	0
Benzo(a)pyrene	77	mg/kg	22	BD to 123.34	**1**
Indeno(1,2,3-c,d)pyrene	500	mg/kg	22	BD to 73.5	0
Dibenzo(a,h)anthracene	4	mg/kg	22	BD to 15.32	**3**
Benzo(g,h,i)perylene	3900	mg/kg	22	BD to 79.04	0
PAH Total	No Value	mg/kg	22	BD to 2026.1	--

9.5.1 Asbestos, Heavy Metals, Inorganics, TPH, BTEX, MTBE & Phenols

No evidence of asbestos containing material (ACMs) or asbestos fibres were detected within any of the samples.

No elevated concentrations of metals, inorganics, TPH, BTEX, MTBE or phenols were recorded within the chemical testing when compared against the threshold values for a 'Commercial' end use.

9.5.2 Polycyclic Aromatic Hydrocarbons

One sample (R01 from 0.3m bgl) recorded elevated concentrations of Dibenzo(a,h)anthracene, Benzo(a)pyrene and Benzo(b)fluoranthene and a further two samples (RC101from 0.65m and RC102 from 0.30m) recorded elevated Dibenzo(a,h)anthracene. Drawing No. NE8659-CDL-ZZ-XX-DR-GE-60804 'Contamination Exceedance Plan' depicts the spatial distribution of chemical exceedances from soil testing.

These exceedances were identified all within the granular made ground in the north west (R01) and in the south east (RC101 and RC102), below the proposed main building footprint. The threshold level for Dibenzo(a,h)anthracene is 4mg/kg and in R01, a concentration of 15.32mg/kg was recorded. Meanwhile, concentrations of Benzo(a)pyrene and Benzo(b)fluoranthene were recorded to be 123.34mg/kg and 152.9mg/kg respectively, both significantly exceeding the threshold values of 77mg/kg and 44mg/kg.

Within RC101 and RC102, concentrations of Dibenzo(a,h)anthracene were recorded at levels of 4.5mg/kg and 4.1mg/kg, marginally exceeding the 4mg/kg threshold.

9.5.3 Coal Tar Testing

The current car park contains a layer of macadam hardstanding indicated by EPS to be bituminous. Consequently, this material was tested for the presence of coal tar using Polycyclic Aromatic Hydrocarbon (PAK) detection methods. All samples tested returned negative results. In addition, one sample of this material was recovered during the EPS investigation and scheduled for a 'Coal Tar Suite'. That testing also indicated that coal tar is not present within the current asphalt hardstanding.

9.6 Soil Leachate Results

Table 20 summarises the analytical test data for the soil leachate testing.

Table 20: Summary of Soil Leachate Threshold Exceedances

Test	Threshold Value		No. of Samples	Range	No. of Exceedances
Metals					
Arsenic, Dissolved	10	ug/l	6	BD to 24	1
Boron, Dissolved	1000	ug/l	0	0	0
Cadmium, Dissolved	5	ug/l	6	BD	0
Chromium, Total	50	ug/l	6	BD to 1.8	0
Copper, Dissolved	2000	ug/l	6	BD to 7	0
Lead, Dissolved	10	ug/l	6	BD	0
Mercury, Dissolved	1	ug/l	6	BD	0
Nickel, Dissolved	20	ug/l	6	BD to 3	0
Selenium, Dissolved	10	ug/l	6	BD	0
Vanadium, Dissolved	No Value	ug/l	0	0	0
Zinc, Dissolved	No Value	ug/l	6	BD to 15	0
Inorganics					
pH	9*		6	7.88 to 9.12	1
Cyanide, Total	50	ug/l	6	BD	0
Sulphate as SO4	250	mg/l	6	BD to 35.3	0
Sulphide	No Value	mg/l	0	0	0
BTEX & MTBE					
Benzene	1	ug/l	0	0	0
Toluene	No Value	ug/l	0	0	0
Ethylbenzene	No Value	ug/l	0	0	0
Xylene	No Value	ug/l	0	0	0
MTBE	No Value	ug/l	0	0	0
PAHs					
Naphthalene	No Value	ug/l	6	BD to 0.8	NA
Acenaphthylene	No Value	ug/l	6	BD to 0.222	NA
Acenaphthene	No Value	ug/l	6	BD to 2.317	NA
Fluorene	No Value	ug/l	6	BD to 1.255	NA
Phenanthrene	No Value	ug/l	6	BD to 9.162	NA
Anthracene	No Value	ug/l	6	BD to 2.103	NA
Fluoranthene	No Value	ug/l	6	BD to 17.305	NA
Pyrene	No Value	ug/l	6	BD to 14.577	NA
Benzo(a)anthracene	No Value	ug/l	6	BD to 6.904	NA
Chrysene	No Value	ug/l	6	BD to 7.564	NA
Benzo(b)fluoranthene	No Value	ug/l	6	BD to 8.05	NA
Benzo(k)fluoranthene	No Value	ug/l	6	BD to 3.13	NA
Benzo(a)pyrene	0.010	ug/l	6	BD to 6.175	NA
Indeno(1,2,3-c,d)pyrene	No Value	ug/l	6	BD to 2.782	NA
Dibenzo(a,h)anthracene	No Value	ug/l	6	0	NA
Benzo(g,h,i)perylene	No Value	ug/l	6	0	NA
PAH Total	0.100**	ug/l	6	0	3
Phenols					

Test	Threshold Value		No. of Samples	Range	No. of Exceedances
Phenol	No Value	ug/l	6	BD	0

*Where DWS states 'no value', reverted to EQS threshold exceedance value.
**Cumulative value is the sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene & indeno(1,2,3-cd)pyrene.

In total four samples recorded exceedances from the leachate testing. Three samples (R01, WS01, WS09) identified exceedances of PAH analytes and another sample recorded an exceedance of Arsenic (WS10). One exceedance of pH was also recorded in WS01 when compared to a EQS screening criteria. All exceedances relate to the shallow granular made ground, described as dark grey / black sandy gravel and no detections were identified within the underlying completely weathered PLCM.

9.7 Risk Assessment Discussion and Summary

9.7.1 Land (soil) quality risk

Elevated concentrations of PAH compounds (Dibenzo(a,h)anthracene, Benzo(a)pyrene and Benzo(b)fluoranthene) have been identified in three samples of granular made ground. One exceedance was noted within the north western part of the site below the proposed artificial sports pitch and two exceedances were recorded in the south east below the proposed main college building. The elevated concentrations were all within the granular made ground at the site (discussed in Section 4.2.4) with 3 out of 7 samples of this material that were tested recording elevated concentrations.

Based on the proposed development, which will include localised cut and fill earthworks, some of the granular made ground from below the proposed new building footprints will be removed, representing source removal in these areas. Where the granular made ground remains in situ, where new buildings or hardstanding are constructed, the nature of the development will break the potential pollutant pathway linkages. Where granular made ground remains in situ below proposed soft landscape areas, a risk remains, and remedial action will be required.

During earthworks and construction this material also presents a plausible risk to construction workers and adjacent site users and further action will be required to mitigate this risk. This could include measures such as dust control and the adoption of appropriate PPE and hygiene practices.

The chemical testing undertaken on the remaining material, including topsoil, granular made ground (subbase), cohesive made ground, completely weathered PLCM and competent PLCM, indicate that these materials are chemically suitable for reuse within the development, where appropriate.

9.7.2 Controlled Waters risk

Cumulative PAH readings for (benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene and indeno(1,2,3-cd)pyrene) and Arsenic all exceed the threshold values when compared to the UK DWS screening criteria. pH also exceeded the threshold value when compared to the EQS threshold values.

The nearest controlled water receptor is the Secondary A aquifer of the competent Pennine Lower Coal Measures which underlie the engineering soils under the site. However, It is likely the quality of the water locally in this aquifer will have been degraded due to the impact from coal mining legacy. The site is also more than 1000m from any source protection zones. The completely weathered cohesive PLCM that covers the site have been proven to be relatively impermeable and will likely inhibit the migration of leachate into the underlying aquifer. The current proposals include for sealed drainage and most external spaces will be sealed hardstanding. In addition, the current proposals would see much of the source material in the areas of these threshold exceedances removed from site.

All these factors taken together mean a source pathway receptor linkage is unlikely to be established, but it is still possible and that if a linkage is established, the likelihood of significant harm being caused to the aquifer is low. Therefore, the risk to the underlying Secondary A aquifer is considered **low**.

No remedial measures are considered necessary with respect to Controlled Waters.

9.7.3 Ground Gas Risk

Monitoring results indicate the site characterises as Characteristic Situation (CS-2) under which scenario ground gas protection measures are required. For the main proposed college building this will entail measures as recommended in BS8485. Assuming the new college building represents a Type C building, a gas protection score of 2.5 points is required.

For the infill structure, due to the adverse effect ground gas protection measures would have when surrounded by buildings that most likely lack ground gas protection measures, it is instead recommended that CO_2 and CH_4 gas detectors are installed in all existing buildings and the proposed infill structure during the construction phase and for these to be maintained throughout the service life of the buildings.

9.7.4 Risk to New Water Supply Pipes

As part of this assessment, Drawing NE8659-CME-ZZ-ZZ-DR-Z-95002 (Ref. 11 in Section 1.4) has been reviewed to determine the location and depth of the proposed potable water supply pipe. The drawing shows the pipework enters the site through the eastern boundary, heading due west and entering the proposed multi-story college building through the east side. Based on this it is possible the pipe could be laid in a zone of the granular made ground. As such the general chemical testing within the soil was compared to the WIR screening values and is presented in Table 21.

Table 21 UKWIR Potable water pipe Screening

Parameter Group	PE Pipe	PVC Pipe	Barrier Pipe (PE-AL-PE)	Wrapped Steel Pipe	Wrapped Ductile Iron Pipe	Copper Pipe
Conductivity, pH, Redox Potential	PASS	PASS	PASS	FAIL	PASS	PASS
Mineral Oil(C11-C20)	FAIL	PASS	PASS	PASS	PASS	PASS
Mineral Oil(C20-C40)	FAIL	PASS	PASS	PASS	PASS	PASS
Total VOCs	PASS	PASS	PASS	PASS	PASS	PASS
BTEX + MTBE	FAIL	FAIL	PASS	PASS	PASS	PASS
Total SVOCs	FAIL	FAIL	PASS	PASS	PASS	PASS
Phenol	FAIL	FAIL	PASS	PASS	PASS	PASS
Cresols and Chlorinated Phenols	NA	NA	NA	NA	NA	NA
TICs (Ethers,Ketones,Aldehydes,Amines,Nitrobenzene)	NA	NA	NA	NA	NA	NA
It is recommended that a Barrier Pipe (PE-AL-PE) is selected for this site's utilities						

Based on the general chemical testing results of the made ground and the underlying natural soils, it is considered likely that barrier pipe will be required when potable water supply pipes come into contact with granular made ground, given the elevated concentrations of hydrocarbons detected within some samples. Should the granular made ground be removed as part of the cut and fill earthworks and the potable water supply pipes are placed in naturally occurring soils, barrier pipe is unlikely to be necessary and standard polyethylene water pipes may be adopted.

Once the cut and fill earthworks are complete and there is certainty on the ground conditions within the proposed water supply service trench, further assessment should be undertaken and the supply pipe material agreed with the statutory supplier.

9.8 Refined Conceptual Site Model

A semi-quantitative risk assessment (Tier 1 / 2) approach has been undertaken for the site, based on the available site information. This is based upon the “source – pathway – receptor” conceptual risk model in accordance with current UK guidelines and establishes the likelihood and severity of potentially active pollutant linkages at the site.

A Preliminary Conceptual Site Model was defined within the EPS Phase 1 Desk Study and following the phases of ground investigation, a refined conceptual site model (assuming no remedial action is implemented) has been produced and is presented as Table 22.

Table 22: Refined Conceptual Site Model

Source	Pathway	Receptor	Potential Consequence of Pollutant Linkage	Likelihood of Pollutant Linkage	Overall Risk
Made Ground Soils (PAHs)	(1) Dermal contact / Ingestion	Construction workers / site end users / adjacent end users	Severe	Likely	**High Risk**
	(2) inhalation	Construction workers / site end users / adjacent end users	Severe	Likely	**High Risk**
	(3) Inhalation of fugitive dust	Construction workers / site end users	Severe	Likely	**High Risk**
	(4) Permeation of potable water supply pipes	Site end users	Medium	Likely	**Moderate Risk**
	(5) Migration of Leachate	Secondary A Aquifer	Medium	Unlikely	**Low Risk**

9.9 Outline Remediation Requirements.

A risk associated with elevated concentrations of PAH analytes within the granular made ground soils has been identified.

However, the proposed development includes for the construction of two college buildings, areas of hardstanding and an artificial sports facility and therefore provides a pathway interruption to the site end users from the made ground that will remain in situ. Risks are likely to mainfest during the construction phase of the cut and fill preparatory earthworks but these can be managed using suitable mitigation measures, such as the use of dust suppression and appropriate PPE. The contractor shall produce a risk assessment and method statement detailing these measures.

In areas of new soft landscaping, outwith the new building or hardstanding footprint, there remains a risk to site end users where granular made ground remains in situ. This can be mitigated with the provision of a suitable clean cover system.

The cover system could be formed by:

- 150mm topsoil underlain by an erosion mat (NAUE SecuMat or similar) underlain by a geotextile separator layer, or;
- 300mm thickness of clean topsoil/subsoil underlain by a geotextile separator layer

In areas of new tree / shrub planting, the cover system thickness may need to be increased, or tree pits formed to provide a suitable growing medium. These should be constructed using chemically suitable soil and lined with a geotextile separator layer. The required depth of the planting beds and/or tree pits should be confirmed with the landscape architect.

Prior to any development activities taking place, a Remediation Strategy should be produced, submitted to and approved by the regulators.

10.0

Preliminary Waste Classification

Preliminary Waste Classification

10.1 Introduction and Summary of Waste Classification

The waste classification assessment was conducted in accordance with current good practice and waste legislation, including WM3. Data was screened and processed using the HazWasteOnline ™ software, the full findings of which are presented in Appendix E.

It should be noted that topsoil, where present, will fall into a separate waste stream. This is also true of certain hard surfacing materials, for example should bituminous macadam containing coal-tar be present on site in locations not tested to date.

Based upon the recorded ground conditions, most of the soils at the site are likely to be considered as '17 05 04 or 17 05 03 (soil and stones other than those mentioned in 17 05 03 or soil and stones containing hazardous substances)'. These waste codes have been considered the most appropriate under the current scenario, however, it is the waste producer's responsibility to check that the arisings from the site are correctly classified.

A total of 22 samples from both the current and historical investigations were analysed using the HazWasteOnline ™ software.

In all scenarios it remains the waste producer's responsibility to demonstrate that they have adequately characterised their waste in line with relevant legislation and guidance.

10.2 Preliminary Waste Classification Assessment

The outputs of HazWasteOnline ™ software on representative soil samples are summarised on Table 23.

Table 23: Summary of HazWasteOnline ™ Waste Classification Results

Exploratory Hole No.	Depth	Stratum	Non-Hazardous	Potentially Hazardous	Hazardous
WS09	0.1	Topsoil	X		
SA102	0.1	Topsoil	X		
WS05	0.1	Bituminous Hardstanding	X		
R01	0.3	Granular Made Ground			X
WS01	0.1	Granular Made Ground			X
WS10	0.5	Granular Made Ground			X
RC101	0.65	Granular Made Ground			X
RC102	0.30	Granular Made Ground			X
RC102	0.60	Granular Made Ground	X		
RC103	0.60	Granular Made Ground	X		
WS03	0.5	Cohesive Made Ground	X		
WS11	0.6	Cohesive Made Ground	X		
SA101	0.75	Cohesive Made Ground	X		
SA102	0.4	Cohesive Made Ground	X		
SA104	0.45	Cohesive Made Ground	X		
RC101	1.00	Cohesive Made Ground	X		
WS03	1.5	Weathered Coal Measures	X		
WS08	1.4	Weathered Coal Measures	X		
WS08	2.4	Weathered Coal Measures	X		
WS09	0.8	Weathered Coal Measures	X		
SA104	0.80	Weathered Coal Measures	X		
WS02	4	Bedrock	X		

The results indicate that 5 out of seven samples of the shallow granular made ground, recovered as a black sandy gravel classified as a hazardous waste. The remaining samples all classified as non-hazardous, including the granular made ground recorded as a clayey, gravelly, sand, Drawing No. NE8659-CDL-ZZ-XX-DR-GE-60805 Waste Classification Results illustrates the spatial distribution of the samples that classified as hazardous.

10.3 Waste Acceptance Criteria (WAC) Testing

Landfills are classified according to whether they can accept Hazardous, Non-Hazardous or Inert Wastes. Wastes can only be accepted at a landfill if they meet the waste acceptance criteria (WAC) for that class of landfill.

WAC analyses is intended to indicate how a waste will behave in a landfill cell, not to determine waste classification. WAC analysis is required under the following circumstances:

- For soils containing Non-Hazardous properties where there is a consideration to dispose of waste soils into an Inert cell.
- For all soils classified as containing Hazardous properties.

For example, if a material is classified as Non-Hazardous, there is a choice of disposing of the material in either a Non-Hazardous or an Inert landfill (subject to meeting Inert Waste acceptance levels). Where the material is classified as Hazardous, WAC analysis will be required to demonstrate that it meets the acceptance levels for Hazardous landfill or Stable Non-Reactive Hazardous Waste (SNRHW) landfill.

Note that whilst technically wastes that are demonstrated to contain Non-Hazardous properties do not necessarily require WAC analyses, without WAC analysis wastes classified as Non-Hazardous cannot be disposed of into an Inert cell.

A total of eight WAC analyses have been undertaken on representative soil samples and the results are summarised in Table 24.

Table 24: Summary of WAC Testing Results

Sample Reference (and depth below ground level)	Stratum	Inert	Stable Non-Reactive Hazardous Waste	Hazardous Waste
R01-ES2 (0.30-0.90)	Granular Made Ground			X
WS03-ES1 (0.50)	Cohesive Made Ground			X
WS05-ES1 (0.10)	Made Ground Subbase	X		
WS08-ES3 (2.40)	Completely Weathered Coal Measures	X		
WS09-ES1 (0.0)	Topsoil			X
RC101 (0.65)	Granular Made Ground			X
RC102 (0.30)	Granular Made Ground			X
RC102 (0.65)	Granular Made Ground		X	

Three of the five samples that classed as hazardous from the WAC testing are from the same granular made ground. The granular made ground samples recorded WAC exceedances of PAH and TPH. The cohesive made ground sample and topsoil (WS03 &WS09) classed as hazardous from the WAC testing because of exceedances of total organic carbon and loss on ignition only.

Based on the results, the granular made ground horizon, which is typically identified at shallow depth below the surface covering, can be classified and disposed of as hazardous waste. It is recommended that **all** characterisations are substantiated by the relevant supply chains and licensed waste disposal / landfill operators.

There may also be localised (both vertically and laterally) variations in the material which cannot be fully quantified until excavation takes place. Consequently, there may be a requirement for further characterisation during material removal.

Drawings

scale

0m 50m 100m

1029739 | A3

DO NOT SCALE FROM THIS DRAWING

Notes

- Windowless Sampler Borehole (2020 EPS Ground Investigation)
- Dynamic Cone Penetration Test (2020 EPS Ground Investigation)
- Rotary Borehole (2020 EPS Ground Investigation)
- Trial Pit (2020 EPS Ground Investigation)
- Rotary Borehole (2021 Dunelm Ground Investigation)
- Soakaway Location (2021 Dunelm Ground Investigation)
- Site Boundary
- Existing Buildings and Topography
- Proposed Site Plan
- Cross Section Alignment

Issue	Date	Description	By	Chkd	Verfd
-	24/5/21	For Information	MG	CL	JA

Project
Greenhead Sixth Form College

Client
Dunelm Geotechnical and Environmental on behalf of Galliford Try Building - North East & Yorkshire

Title
As Built Exploratory Hole Location Plan

Drawing No.	Drawing Status
NE8659-CDL-ZZ-XX-DR-GE-60801	Final
Job No.	**Scale**
1029739	1:1000

Originator	Checked	Verified	Issue.
MG	CL	JA	-

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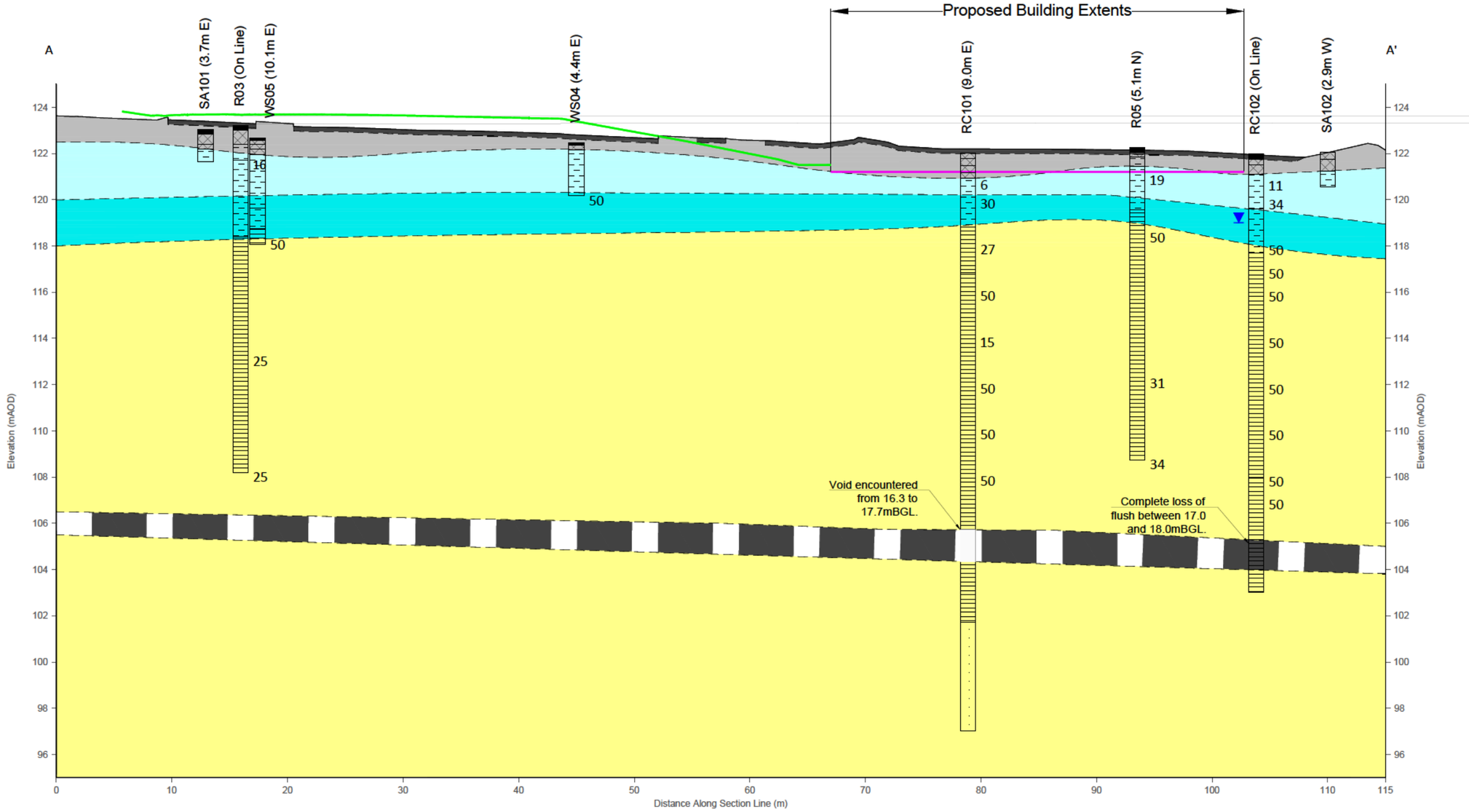
Cross Section A-A'
2x Vertical Exaggeration



1029739 | A3

DO NOT SCALE FROM THIS DRAWING

Notes

- Hardstanding
- Made Ground
- Upper Completely Weathered Pennine Lower Coal Measures
- Lower Completely Weathered Pennine Lower Coal Measures
- Mudstone (Pennine Lower Coal Measures)
- Sandstone (Pennine Lower Coal Measures)
- Inferred Workings in Soft Bed Coal Seam
- Inferred Geological Boundary
- Proposed Finished Development Level
- Proposed Formation Level
- Water Strike
- (Xm) Denotes Offset From CS Line
- 14 SPT N Value

Issue	Date	Description	By	Chkd	Verfd
-	24/5/21	For Information	MG	CL	JA

Project
Greenhead Sixth Form College

Client
Dunelm Geotechnical and Environmental on behalf of Galliford Try Building - North East & Yorkshire

Title
Geological Cross Section A-A'

Drawing No.	Drawing Status
NE8659-CDL-ZZ-XX-DR-GE-60802	Final
Job No. 1029739	**Scale** As Shown

Originator	Checked	Verified	Issue.
MG	CL	JA	-

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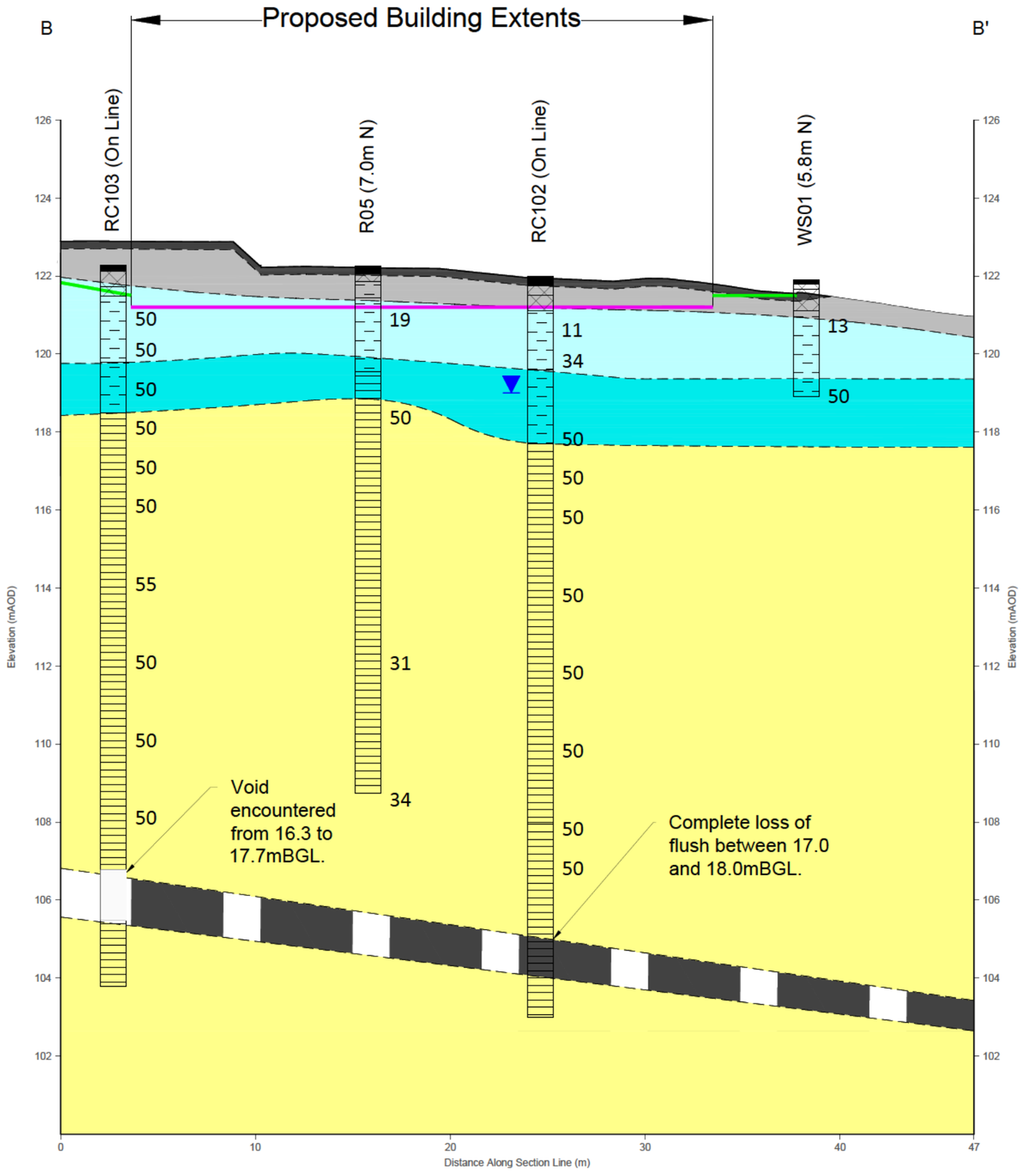
Website: www.cundall.com

Cross Section B-B'
2x Vertical Exaggeration



1029739 | A3

DO NOT SCALE FROM THIS DRAWING

Notes

- Hardstanding
- Made Ground
- Upper Completely Weathered Pennine Lower Coal Measures
- Lower Completely Weathered Pennine Lower Coal Measures
- Mudstone (Pennine Lower Coal Measures)
- Sandstone (Pennine Lower Coal Measures)
- Inferred Workings in Soft Bed Coal Seam
- Inferred Geological Boundary
- Proposed Finished Development Level
- Proposed Formation Level
- Water Strike
- (Xm) Denotes Offset From CS Line
- 14 SPT N Value

Issue	Date	Description	By	Chkd	Verfd
-	24/5/21	For Information	MG	CL	JA

Project
Greenhead Sixth Form College

Client
Dunelm Geotechnical and Environmental on behalf of Galliford Try Building - North East & Yorkshire

Title
Geological Cross Section B'B'

Drawing No.	Drawing Status
NE8659-CDL-ZZ-XX-DR-GE-60803	Final
Job No.	**Scale**
1029739	As Shown

Originator	Checked	Verified	Issue.
MG	CL	JA	-

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scale

0m 50m 100m

1029739 | A3

DO NOT SCALE FROM THIS DRAWING

Notes

- Windowless Sampler Borehole
- Rotary Borehole
- Trial Pit
- Rotary Borehole
- Site Boundary
- Existing Buildings and Topography
- Proposed Site Plan
- Samples from Granular Made Ground that recorded chemical exceedances:
  - RC101 - 0.65m
  - RC102 - 0.30m
  - R01 - 0.30m
- Granular Made Ground recorded within the following exploratory holes:
  - RC101 0.55m - 0.85m
  - RC102 0.25m - 0.90m
  - RC103 0.55m - 0.80m
  - R01 0.40m - 1.00m
  - R03 0.20m - 0.80m
  - WS01 0.10m - 0.25m
  - WS02 0.25m - 0.60m
  - WS05 0.25m - 0.45m
  - WS08 0.40m - 0.70m
  - WS10 0.40m - 1.10m

Hatched/Coloured Region highlighting exploratory holes does not indicate lateral extent of Granular Made Ground.

Issue	Date	Description	By	Chkd	Verfd
-	11/6/21	For Information	MG	JM	JA

Project
Greenhead Sixth Form College

Client
Dunelm Geotechnical and Environmental on behalf of Galliford Try Building - North East & Yorkshire

Title
Contamination Exceedance Plan

Drawing No.	Drawing Status
NE8659-CDL-ZZ-XX-DR-GE-60804	Final
Job No.	**Scale**
1029739	1:1000

Originator	Checked	Verified	Issue.
MG	JM	JA	-

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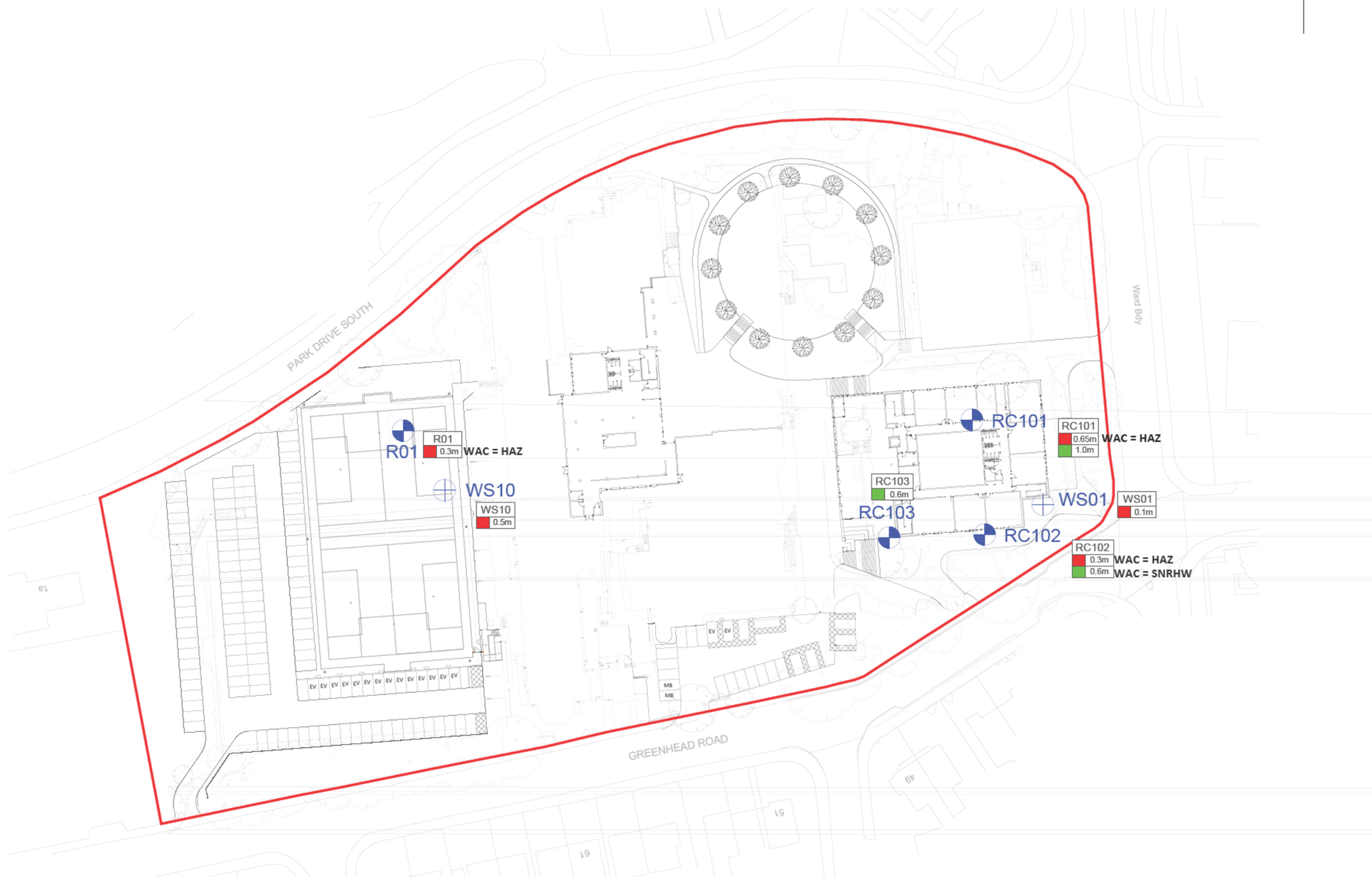

1029739 | A3

DO NOT SCALE FROM THIS DRAWING

Notes

- Rotary Borehole
- Windowless Sampler Borehole
- Site Boundary
- Existing Buildings and Topography
- Proposed Site Plan

Waste Classification Results from Analysis of HazardousWasteOnline

- Sample classified as Non-Hazardous in accordance with WM3.
- Sample classified as Potentially-Hazardous in accordance with WM3.
- Sample classified as Hazardous in accordance with WM3.

WAC = Waste Acceptance Criteria Testing

HAZ = Hazardous Test Result

SNRHW = Stable Non-Reactive Hazardous Waste

Issue	Date	Description	By	Chkd	Verfd
-	11/6/21	For Information	MG	JM	JA

Project
Greenhead Sixth Form College

Client
Dunelm Geotechnical and Environmental on behalf of Galliford Try Building - North East & Yorkshire

Title
Waste Classification Results

Drawing No.	Drawing Status
NE8659-CDL-ZZ-XX-DR-GE-60805	Final
Job No.	**Scale**
1029739	1:1000

Originator	Checked	Verified	Issue.
MG	JM	JA	-

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Appendix A – Factual Data from the EPS 2020 Investigation

- Approximate Site Boundary
- Rotary Borehole Locations
- Window Sampler Borehole Locations
- Foundation Exposure Locations
- Dynamic Cone Penetrometer (DCP) Locations

Title: Borehole Location Plan

Project: Greenhead College, Huddersfield

Fig No: **

Scale	NTS
Drawn By	LA
Approved By	SB
Job No	UK20 5113
Dwg No	Greenhead/1120/**
Date	November 2020

Borehole Log

Borehole No. **R01**

Sheet 1 of 2

Project Name: Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords: -199755.03 - 7103587.52	Hole Type BH
Location: Greenhead College. Huddersfield, HD1 4ES		Level: 130.85	Scale 1:45
Client: Mace Group		Dates: 19/10/2020 - 20/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.00 - 0.30	ES					MADE GROUND. Clayey cobbly GRAVEL including coarse brick, concrete and sandstone. Occasional metal and plastic observed.
		0.30 - 0.90	ES	PID=1	0.40	130.45		MADE GROUND. Dark grey to black slightly clayey sandy GRAVEL with frequent clinker, coal fragments and fine brick.
		1.00 - 1.30	ES		1.00	129.85		MADE GROUND. Soft to firm dark grey/black slightly silty slightly sand gravelly CLAY. Gravels mainly fine to medium sandstone and coal/ clinker.
				HVP=95 HVP=88 PID=0	1.30	129.55		*Dynamic Sampled - Good Recovery*
		1.50 - 1.80	D	HVP=114 HVP=99				Firm to stiff orange/brown slightly gravelly CLAY with grey mottling. Gravels predominantly medium subrounded sandstone.
		1.80 - 2.00	ES	HVP=154 HVP=161				
		2.00		N=10 (2,1/2,2,3,3)				
		3.00		N=15 (2,4/3,4,4,4)	3.00	127.85		Light brown to orange fine to medium grained weathered/fractured SANDSTONE.
		3.00 - 3.90	C					*Rotary Cored - Poor Recovery*
		3.90 - 5.00	C					*Rotary Cored - Poor Recovery*
		5.00 - 5.20	C					*Rotary Cored - Good Recovery*
		5.20 - 6.50	C					
		6.20 - 6.50	ES		5.90	124.95		Dark grey black fissile MUDSTONE. Iron staining frequently observed between fractures and fossiliferous bands observed where coring possible.
		6.50		100 (4,8/100 for 160mm)				*Rotary Cored - No Recovery*
		8.00		50 (6,12/50 for 25mm)				*Rotary Open Hole*

Continued on next sheet

Remarks

Located within area of made ground in the west of the site. No groundwater strike logged by drillers. Flush type = Water. No loss of flush recorded. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **R01**
Sheet 2 of 2

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords:	-199755.03 - 7103587.52	Hole Type BH
Location:	Greenhead College. Huddersfield, HD1 4ES		Level:	130.85	Scale 1:45
Client:	Mace Group		Dates:	19/10/2020 - 20/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		15.00		50 (5,10/50 for 30mm)	15.00	115.85		End of borehole at 15.00 m

Remarks
Located within area of made ground in the west of the site. No groundwater strike logged by drillers. Flush type = Water. No loss of flush recorded. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **R02**

Sheet 1 of 2

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords: -199806.24 - 7103563.11	Hole Type BH
Location:	Greenhead College. Huddersfield, HD1 4ES		Level: 131.00	Scale 1:45
Client:	Mace Group		Dates: 20/10/2020 - 20/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.15	130.85		BITUMINOUS HARDSTANDING.
					0.30	130.70		MADE GROUND. Light grey sandy slightly clayey medium subangular GRAVEL (subbase).
								Firm to stiff orange brown slightly gravelly and sandy CLAY with grey mottling. Gravels are medium subrounded sandstone.
		1.20		30 (0 for 0mm/30 for 85mm)	1.20	129.80		Grey to yellow/orange medium grained fractured SANDSTONE.
		1.20 - 2.70	C					*Rotary Cored - Good Recovery*
		2.70		25 (0 for 0mm/25 for 10mm)				*Rotary Open Hole*
		4.50		60 (5,10/60 for 105mm)	4.50	126.50		Dark grey fissile MUDSTONE.
		8.00		25 (0 for 0mm/25 for 30mm)				

Continued on next sheet

Remarks

No groundwater strike logged by drillers. Flush type = Water. No loss of flush recorded. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **R02**

Sheet 2 of 2

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords:	-199806.24 - 7103563.11	Hole Type BH
Location:	Greenhead College. Huddersfield, HD1 4ES		Level:	131.00	Scale 1:45
Client:	Mace Group		Dates:	20/10/2020 - 20/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.50		30 (0 for 0mm/30 for 105mm)				
		15.00		50 (7,12/50 for 30mm)	15.00	116.00		End of borehole at 15.00 m

Remarks

No groundwater strike logged by drillers. Flush type = Water. No loss of flush recorded. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **R03**

Sheet 1 of 2

Project Name: Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords: -199579.15 - 7103672.03	Hole Type BH
Location: Greenhead College. Huddersfield, HD1 4ES		Level: 123.20	Scale 1:45
Client: Mace Group		Dates: 21/10/2020 - 21/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.00 - 0.10	ES		0.20	123.00		BITUMINOUS HARDSTANDING.
								MADE GROUND. Dark grey silty sandy GRAVEL with fine brick and coal/clinker.
					0.80	122.40		Firm to stiff brown/orange CLAY with grey mottling and occasional medium sandstone gravel.
		1.30 - 1.50	D		1.20	122.00		Firm to stiff brown/orange gravelly CLAY. Frequent medium coarse sandstone gravel.
		1.50		N=16 (4,4/5,2,4,5)	1.50	121.70		*Rotary Cored - Good Recovery*
		1.50 - 1.60	D					Yellow to grey medium grained fractured SANDSTONE.
								Rotary Cored - Poor Recovery
								Rotary Open Hole
					4.80	118.40		Dark grey fissile MUDSTONE.
								Continued on next sheet

Remarks

No groundwater strike logged by drillers. Flush type = Water. No loss of flush recorded. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **R03**
Sheet 2 of 2

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords:	-199579.15 - 7103672.03	Hole Type BH
Location:	Greenhead College. Huddersfield, HD1 4ES		Level:	123.20	Scale 1:45
Client:	Mace Group		Dates:	21/10/2020 - 21/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.00		25 (0 for 0mm/25 for 30mm)				
		15.00 15.00	D	25 (0 for 0mm/25 for 20mm)	15.00	108.20		End of borehole at 15.00 m

Remarks
No groundwater strike logged by drillers. Flush type = Water. No loss of flush recorded. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **R04**

Sheet 1 of 2

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords: -199601.41 - 7103625.08
Location:	Greenhead College. Huddersfield, HD1 4ES		Level: 124.20
Client:	Mace Group		Dates: 22/10/2020 - 22/10/2020

Hole Type: BH

Scale: 1:45

Logged By: LA

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.20	124.00		BITUMINOUS HARDSTANDING. *Dynamic Sampled - Poor Recovery*
		0.50 - 0.60 0.60 - 0.70	B D		0.50	123.70		MADE GROUND.
					1.20	123.00		Stiff brown to grey CLAY. Poor recovery.
		2.70		30 (0 for 0mm/30 for 95mm)	2.70	121.50		Stiff brown to grey CLAY/weathered sandstone/ gravels of sandstone. *Rotary Cored - Moderate Recovery*
		5.00		N=26 (2,4/5,5,6,10)	5.00	119.20		Weathered yellow SANDSTONE. *Rotary Open Hole*
								Dark grey MUDSTONE.

Continued on next sheet

Remarks

Driller's Logging. No groundwater strike logged by drillers. Flush type = Water. No loss of flush recorded. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **R04**

Sheet 2 of 2

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords: -199601.41 - 7103625.08
Location:	Greenhead College. Huddersfield, HD1 4ES		Level: 124.20
Client:	Mace Group		Dates: 22/10/2020 - 22/10/2020

Hole Type: BH

Scale: 1:45

Logged By: LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.00		36 (0 for 0mm/36 for 90mm)				
		15.00		40 (0 for 0mm/40 for 85mm)	15.00	109.20		End of borehole at 15.00 m

Remarks

Driller's Logging. No groundwater strike logged by drillers. Flush type = Water. No loss of flush recorded. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **R05**

Sheet 1 of 2

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords: -199546.87 - 7103566.86
Location:	Greenhead College. Huddersfield, HD1 4ES		Level: 122.25
Client:	Mace Group		Dates: 22/10/2020 - 23/10/2020

Hole Type: BH | Scale: 1:45 | Logged By: LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20	122.05		BIRUMINOUS HARDSTANDING. *Dynamic Sampled - Poor Recovery*
					0.40	121.85		MADE GROUND.
					0.80	121.45		Stiff brown and grey CLAY.
		1.20		N=19 (1,2/3,4,5,7)				Very weathered yellow clayey SANDSTONE. *Rotary Cored - Poor Recovery*
		2.70 - 3.20	C		2.70	119.55		Dark grey MUDSTONE. *Rotary Cored - Moderate Recovery*
		3.70		50 (5,14/50 for 20mm)				*Rotary Open Hole*

Continued on next sheet

Remarks

Driller's Logging. No groundwater strike logged by drillers. Flush type = Water. No loss of flush recorded. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **R05**
Sheet 2 of 2

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords:	-199546.87 - 7103566.86	Hole Type BH
Location:	Greenhead College. Huddersfield, HD1 4ES		Level:	122.25	Scale 1:45
Client:	Mace Group		Dates:	22/10/2020 - 23/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.00		31 (0 for 0mm/31 for 105mm)				
		15.00		34 (0 for 0mm/34 for 85mm)				
					13.50	108.75		End of borehole at 13.50 m

10 11 12 13 14 15 16 17 18

Remarks
Driller's Logging. No groundwater strike logged by drillers. Flush type = Water. No loss of flush recorded. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **WS01**

Sheet 1 of 1

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords:	-199507.90 - 7103561.23	Hole Type WS
Location:	Greenhead College. Huddersfield, HD1 4ES		Level:	121.90	Scale 1:27
Client:	Mace Group		Dates:	20/10/2020 - 20/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
				PID=1	0.10	121.80		BITUMINOUS HARDSTANDING.
		0.10 - 0.25	ES					MADE GROUND. Dark grey/black silty sandy medium coarse GRAVEL with frequent ash and clinker/coal fragments.
		0.30 - 0.50	ES		0.25	121.65		MADE GROUND. Soft to firm dark grey silty sandy gravelly CLAY with frequent rootlets.
				PID=0				
					0.80	121.10		Firm orange/brown slightly sandy slightly gravelly CLAY with grey mottling. Gravels are medium to coarse sandstone.
		1.00		N=13 (1,1/2,3,3,5)				
		1.00 - 1.10	D					
				HVP=66				
		1.10 - 1.30	ES					
				HVP=105				
				HVP=84				
				HVP=79				
		1.80 - 2.00	D					
				HVP=79				
				HVP=91				
		2.80		N=50 (25 for 80mm/16,15,15,4)				
		2.80 - 3.00	D					
					3.00	118.90		End of borehole at 3.00 m

Remarks

Refusal on sandstone. No groundwater strike recorded by driller. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **WS02**

Sheet 1 of 1

Project Name: Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords: -199495.66 - 7103625.08	Hole Type WS
Location: Greenhead College. Huddersfield, HD1 4ES		Level: 120.80	Scale 1:27
Client: Mace Group		Dates: 20/10/2020 - 20/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.00 - 1.00	B		0.10	120.70		BITUMINOUS HARDSTANDING.
		0.10 - 0.25	ES		0.25	120.55		MADE GROUND/SUBBASE. Orange/brown sandy medium to coarse subangular to angular GRAVEL.
					0.60	120.20		MADE GROUND. Black medium coarse sandy GRAVEL with ash, clinker and coal fragments.
					1.00	119.80		MADE GROUND. Soft to firm very silty slightly sandy CLAY.
				HVP=79				Firm (becoming stiff) orange/brown sandy gravelly CLAY with grey mottling and fine to medium subrounded sandstone GRAVEL.
				HVP=89				
				HVP=99				
		1.50 - 1.70	ES					
		1.60 - 1.80	D					
				HVP=101				
				HVP=105				
				HVP=167				
				HVP=156				
				HVP=148				
		2.50 - 2.60	D					
				HVP=138				
				HVP=131				
		3.00	D					
					3.90	116.90		Dark grey/black stiff/hard CLAY/fissile MUDSTONE with iron staining between laminations.
		4.00	D					
		4.00		N=36 (5,5/7,8,9,12)				
		4.00 - 4.20	ES					
		5.00		50 (9,15/50 for 190mm)	5.00	115.80		End of borehole at 5.00 m

Remarks

Refusal at approximately 5m in mudstone. No groundwater strike recorded by driller. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **WS03**

Sheet 1 of 1

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords:	-199589.17 - 7103531.18	Hole Type WS
Location:	Greenhead College. Huddersfield, HD1 4ES		Level:	124.60	Scale 1:27
Client:	Mace Group		Dates:	20/10/2020 - 20/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.10	124.50		BITUMINOUS HARDSTANDING.
					0.30	124.30		MADE GROUND/SUBBASE. Coarse dark grey/ black silty sandy GRAVEL.
		0.50 - 0.60	ES					MADE GROUND. Soft dark brown/grey silty sandy gravelly CLAY with brick, ash/clinker and fine brick fragments.
					1.40	123.20		
		1.50 - 1.60	ES	HVP=153				Firm to orange/brown slightly silty sandy gravelly CLAY. Gravels are medium to coarse subangular to subrounded sandstone.
		1.60 - 1.70	D	HVP=131	1.70	122.90		
		1.70		N=45 (7,10/12,12,10,11) HVP=125				Orange/brown clayey gravelly SAND with medium coarse sandstone gravel. Weathered sandstone.
		2.00	D					
		2.50		50 (25 for 80mm/50 for 0mm)				
		2.50 - 2.60	ES		2.60	122.00		End of borehole at 2.60 m

Remarks

Refusal on sandstone. No groundwater strike recorded by driller. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **WS04**

Sheet 1 of 1

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords:	-199563.56 - 7103645.74	Hole Type WS
Location:	Greenhead College. Huddersfield, HD1 4ES		Level:	122.47	Scale 1:27
Client:	Mace Group		Dates:	20/10/2020 - 20/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.10	122.37		BITUMINOUS HARDSTANDING.
					0.30	122.17		MADE GROUND. Dark grey/black medium/ coarse sandy GRAVEL with sandstone and brick fragments.
		0.40 - 0.50	ES	HVP=117				Firm to stiff orange/brown slightly silty, slightly sandy gravelly CLAY with grey mottling.
				HVP=130				
				HVP=120				
		0.80 - 1.00	D	HVP=122				
				HVP=115				
				HVP=104				
				HVP=138				
				HVP=128				
				HVP=133				
				HVP=122				
		1.70 - 1.80	ES	HVP=121				
		1.80 - 2.00	D	HVP=140				
		2.30		50 (25 for 20mm/50 for 85mm)	2.30	120.17		End of borehole at 2.30 m

1 2 3 4 5

Remarks

Refusal on sandstone. No groundwater strike recorded by driller.Elevations inferred from topographical survey.

Borehole Log

Borehole No. **WS05**

Sheet 1 of 1

Project Name: Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords: -199573.58 - 7103698.32	Hole Type WS
Location: Greenhead College. Huddersfield, HD1 4ES		Level: 122.65	Scale 1:27
Client: Mace Group		Dates: 20/10/2020 - 20/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.10 - 0.25	ES		0.10	122.55		BITUMINOUS HARDSTANDING.
					0.25	122.40		MADE GROUND/SUBBASE. Pale yellow sandstone GRAVEL.
					0.45	122.20		MADE GROUND. Coarse dark brown/grey silty sandy GRAVEL with coal/clinker and brick.
		0.70 - 0.80	D	HVP=111	0.70	121.95		MADE GROUND. Soft to firm dark dark grey silty sandy CLAY with subtle organic odour.
		0.80 - 1.00	ES	HVP=115				Firm becoming stiff orange/brown silty sandy CLAY with some grey mottling and medium coarse sandstone gravel.
				HVP=118				
				HVP=125				
				HVP=148				
				HVP=166				
				HVP=159				
		1.70 - 1.80	D	HVP=144				
				HVP=163				
				HVP=156				
				HVP=160				
				HVP=153				
				HVP=166				
					3.00	119.65		Weathered SANDSTONE recovered as light brown/orange very sandy gravelly CLAY.
					3.90	118.75		Dark brown/grey firm to stiff slightly silty gravelly CLAY (weathered mudstone).
		4.20 - 4.40	D					
		4.40		50 (25 for 5mm/50 for 5mm) HVP=141	4.60	118.05		End of borehole at 4.60 m

Remarks

Refusal on sandstone. No groundwater strike recorded by driller. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **WS06**

Sheet 1 of 1

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords:	-199805.13 - 7103471.09	Hole Type WS
Location:	Greenhead College. Huddersfield, HD1 4ES		Level:	130.70	Scale 1:27
Client:	Mace Group		Dates:	20/10/2020 - 20/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.10 - 0.20	ES		0.20	130.50		TOPSOIL. Soft dark brown silty sandy CLAY.
					0.40	130.30		MADE GROUND. Soft grey/orange silty sandy gravelly CLAY.
				HVP=98 HVP=104				Firm very sandy gravelly CLAY. Gravels comprise medium/coarse sandstone.
		0.80 - 0.90	ES		0.80	129.90		Weathered SANDSTONE recovered as orange grey very clayey gravelly SAND.
		1.50		50 (25 for 10mm/50 for 5mm)	1.50 1.51	129.20 129.19		Grey SANDSTONE End of borehole at 1.50 m

Remarks

Refusal on sandstone. No groundwater strike recorded by driller. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **WS07**

Sheet 1 of 1

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords: -199837.41 - 7103501.14
Location:	Greenhead College. Huddersfield, HD1 4ES		Level: 130.80
Client:	Mace Group		Dates: 20/10/2020 - 20/10/2020

Hole Type: WS | Scale: 1:27 | Logged By: LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.20 - 0.40	ES					TOPSOIL. Soft dark brown silty sandy slightly gravelly CLAY with rare brick fragments and sandstone.
					0.40	130.40		
		0.50		50 (10,12/50 for 155mm)	0.50	130.30		Yellow/grey SANDSTONE.
								End of borehole at 0.50 m

Remarks

Refusal on sandstone. No groundwater strike recorded by driller. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **WS08**

Sheet 1 of 1

Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords:	-199691.58 - 7103687.06	Hole Type WS
Location:	Greenhead College. Huddersfield, HD1 4ES		Level:	126.80	Scale 1:27
Client:	Mace Group		Dates:	21/10/2020 - 21/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.10	126.70		BITUMINOUS HARDSTANDING.
								MADE GROUND. Grey black silty sandy very clayey GRAVEL. Brick and ash/clinker observed.
		0.40 - 0.70	ES		0.40	126.40		MADE GROUND. Black/grey silty sandy GRAVEL with frequent ash/clinker.
					0.70	126.10		MADE GROUND. Soft dark grey very silty sandy gravelly CLAY with fragments of brick and ceramic recorded.
					1.00	125.80		Soft to firm brown silty CLAY with fine dark intrusions.
				HVP=101				
				HVP=86				
		1.20 - 1.40	D					
				HVP=88				
		1.40 - 1.70	ES					
					1.70	125.10		Light grey to brown sandstone COBBLES.
					2.10	124.70		Firm brown/orange slightly silty sandy gravelly CLAY.
		2.40 - 2.70	ES					
				HVP=157				
				HVP=140				
		2.80 - 3.00	D					
				HVP=182				
				HVP=171				
					3.30	123.50		Stiff/hard dark grey fissile CLAY/weathered MUDSTONE.
				HVP=143				
		4.00	D					
		4.00		N=23 (3,4/5,5,6,7)				
		5.00	D		5.00	121.80		End of borehole at 5.00 m
		5.00		N=19 (6,4/4,4,5,6)				

Remarks

No groundwater strike recorded by driller. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **WS09**

Sheet 1 of 1

Project Name: Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords: -199647.05 - 7103698.32	Hole Type WS
Location: Greenhead College. Huddersfield, HD1 4ES		Level: 124.45	Scale 1:27
Client: Mace Group		Dates: 21/10/2020 - 21/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.00 - 0.10	ES		0.10	124.35		TOPSOIL. Soft dark brown slightly gravelly CLAY.
		0.30 - 0.70	B	HVP=89 HVP=95 HVP=128				Firm light brown slightly silty slightly gravelly CLAY with grey mottling
		0.80 - 1.00	ES					
					1.20	123.25		Stiff brown brown (becoming darker with depth) silty sandy gravelly CLAY. Gravel is coarse sandstone.
		1.50 - 1.60	D					
					4.80	119.65		Siff/hard dark grey fissile CLAY/MUDSTONE.
		5.00		N=50 (25 for 115mm/50 for 225mm)				
		5.20	D		5.20	119.25		End of borehole at 5.20 m

Remarks

Refusal on sandstone. No groundwater strike recorded by driller. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **WS10**

Sheet 1 of 1

Project Name: Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords: -199732.77 - 7103570.62	Hole Type WS
Location: Greenhead College. Huddersfield, HD1 4ES		Level: 130.70	Scale 1:27
Client: Mace Group		Dates: 21/10/2020 - 21/10/2020	Logged By LA

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.15	130.55		BITUMINOUS HARDSTANDING.
					0.25	130.45		MADE GROUND/SUBBASE. Grey/brown sandy medium coarse subangular GRAVEL.
					0.40	130.30		MADE GROUND. Soft dark grey silty sandy slightly gravelly CLAY. Fine fragments of brick and coal/clinker.
		0.50 - 0.70	ES					MADE GROUND. Black silty gravelly sand with brick, clinker and coal fragments.
					1.10	129.60		
		1.20 - 1.40	ES					MADE GROUND. Soft to firm dark brown/grey silty sandy gravelly CLAY. Gravels mainly fine brick, coal and medium/coarse sandstone.
					2.00	128.70		
				HVP=48				Soft to firm brown silty sandy CLAY.
				HVP=81				
		2.30 - 2.50	D		2.30	128.40		
				HVP=55				Soft becoming firm to stiff light brown/orange silty sandy gravelly CLAY. Gravels medium coarse sandstone.
				HVP=75				
				HVP=118				
				HVP=154				
				HVP=156				
				HVP=161				
		3.20 - 3.50	D					
		3.60	D		3.60	127.10		
		3.60		50 (25 for 65mm/50 for 150mm)	3.61	127.09		SANDSTONE.
								End of borehole at 3.60 m

Remarks

Refusal on sandstone. No groundwater strike recorded by driller. Elevations inferred from topographical survey.

Borehole Log

Borehole No. **WS11**

Sheet 1 of 1

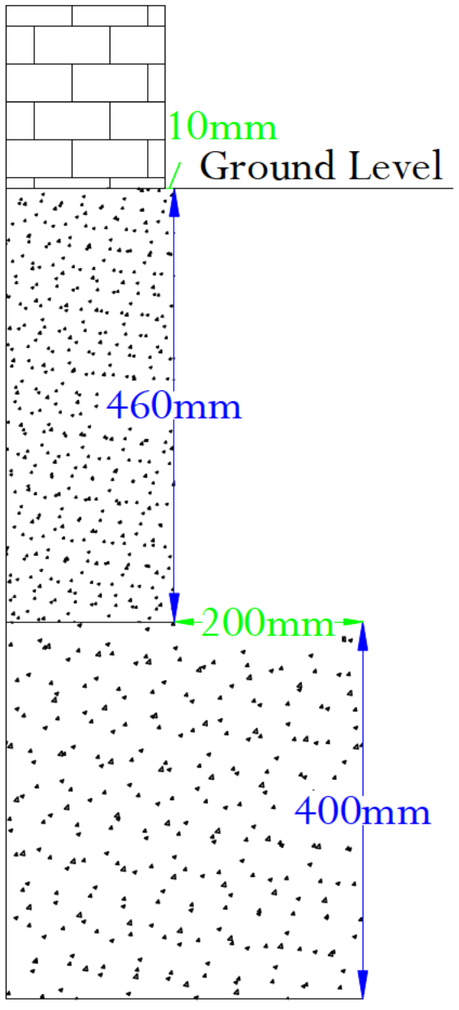
Project Name:	Greenhead College, Huddersfield	Project No. UK20.5113b	Co-ords:	-199777.30 - 7103608.18	Hole Type WS
Location:	Greenhead College. Huddersfield, HD1 4ES		Level:	131.05	Scale 1:27
Client:	Mace Group		Dates:	21/10/2020 - 21/10/2020	Logged By LA

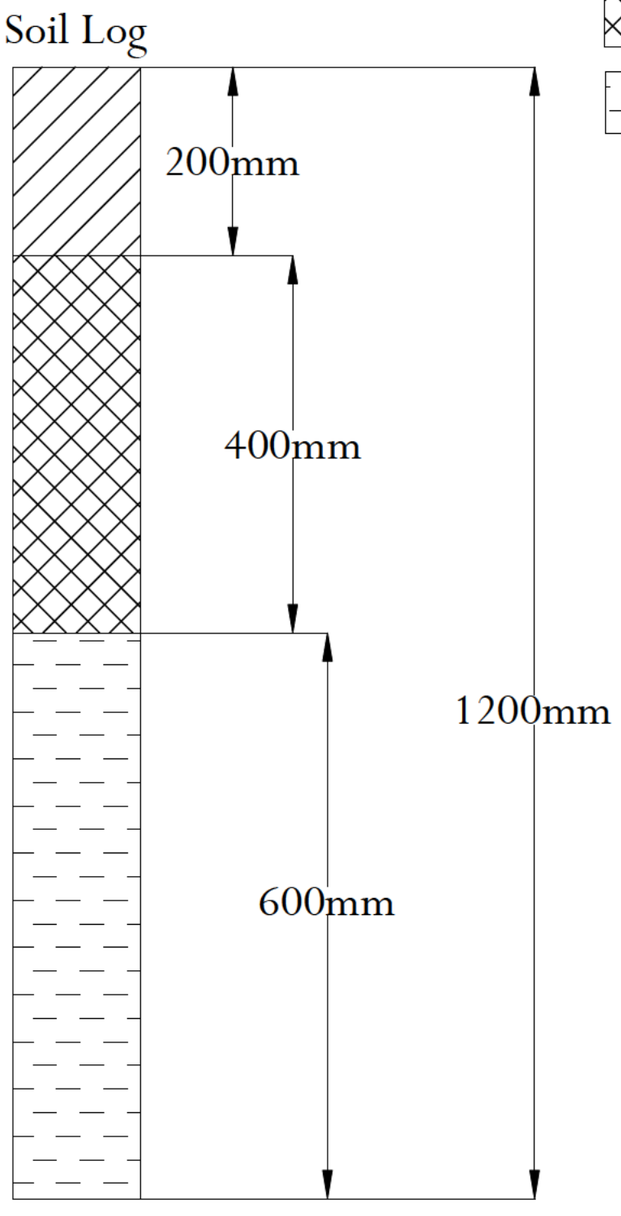
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.15	130.90		BITUMINOUS HARDSTANDING.
					0.30	130.75		MADE GROUND/SUBBASE. Light grey/brown medium coarse subangular to angular GRAVEL. Geotextile at base.
		0.50 - 0.80	ES					MADE GROUND. Soft dark brown silty sandy gravelly CLAY. Gravels mainly comprise brick, sandstone and clinker.
					1.00	130.05		MADE GROUND. Soft dark brown silty sandy gravelly CLAY.
		1.50 - 1.80	ES					
					1.90	129.15		Firm to stiff brown/orange silty sandy gravelly CLAY with grey mottling. Gravels are medium to coarse sandstone.
		3.00		50 (25 for 5mm/50 for 75mm)	3.00 3.01	128.05 128.04		SANDSTONE. End of borehole at 3.00 m

Remarks

Refusal on sandstone. No groundwater strike recorded by driller. Elevations inferred from topographical survey.

Foundation Exposure 1 (FE01)





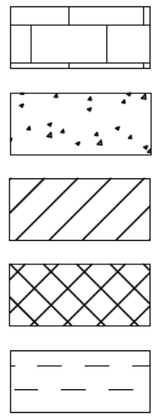


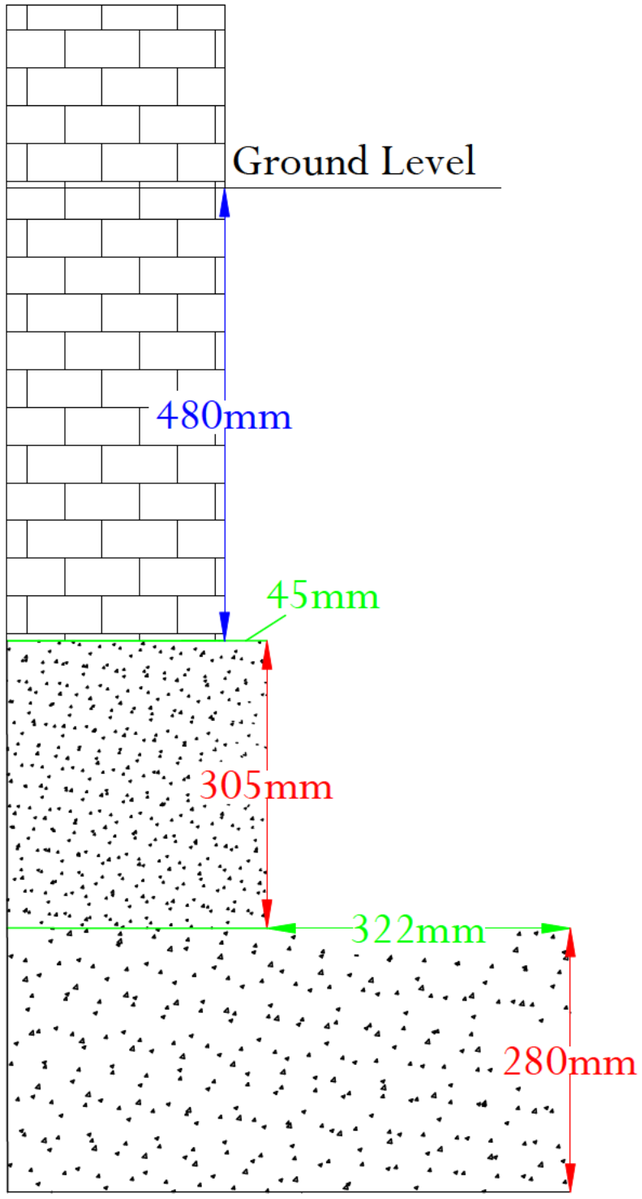
Fig No: X

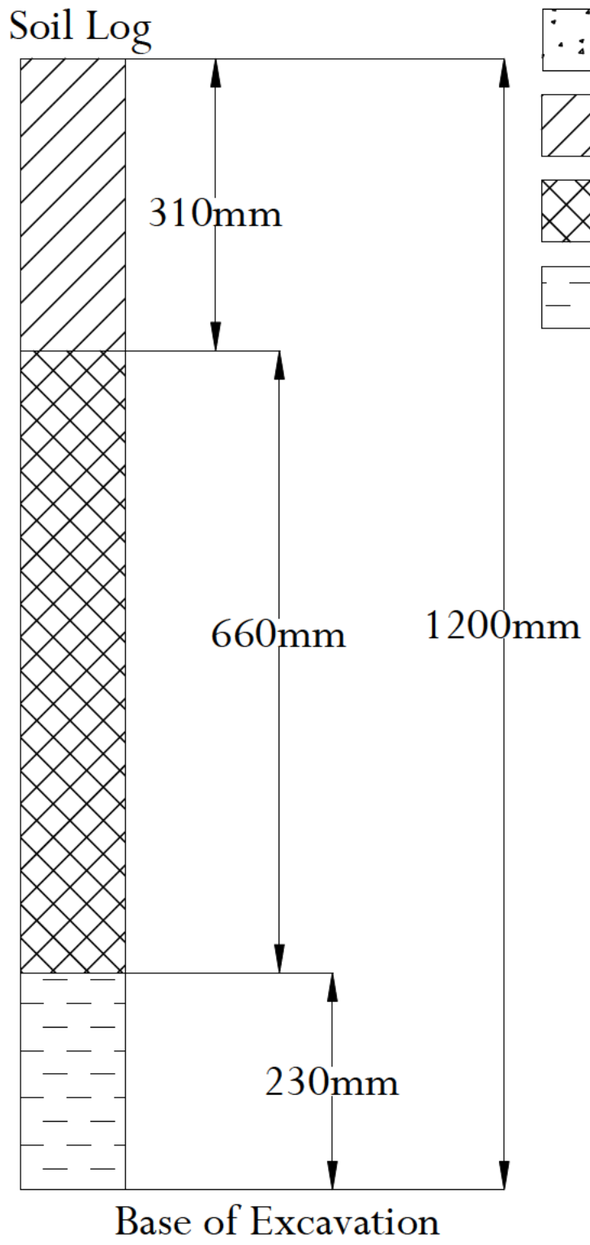
Title: Foundation Exposure

Project: Greenhead College

Scale	NTS - For Illustration purposes only
Drawn By	LA
Job No	UK20 5113b
Dwg No	Greenhead/1120/****
Date	November 2020

Foundation Exposure 2 (FE02)





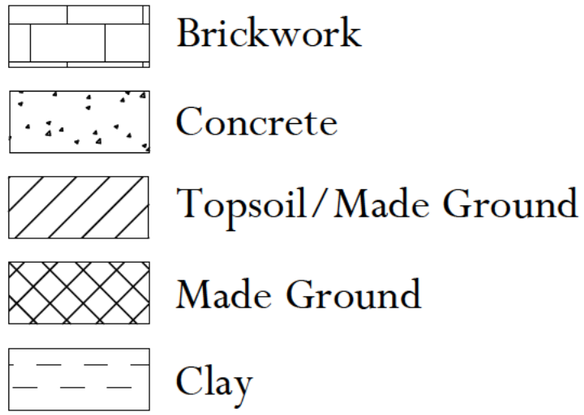


Fig No: X

Title: Foundation Exposure

Project: Greenhead College

Scale	NTS - For Illustration purposes only
Drawn By	LA
Job No	UK20 5113b
Dwg No	Greenhead/1120/****
Date	November 2020

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Attention :	Lee Anderson
Date :	26th November, 2020
Your reference :	UK20.5113B
Our reference :	Test Report 20/14666 Batch 1
Location :	Greenhead College
Date samples received :	24th October, 2020
Status :	Final report
Issue :	2

Thirty six samples were received for analysis on 24th October, 2020 of which twenty were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:

Phil Sommerton BSc
Senior Project Manager

Client Name: EPS Ltd
Reference: UK20.5113B
Location: Greenhead College
Contact: Lee Anderson
EMT Job No: 20/14666

Report : Solid

Solids V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	4-6	10-12	13-15	25-27	28-29	30-32	33-35	42-44	45-46	47-48	LOD/LOR	Units	Method No.
Sample ID	R01-ES2	R01-ES4	WS01-ES1	WS02-ES2	WS02-ES3	WS03-ES1	WS03-ES2	WS04-ES2	WS05-ES1	WS05-ES2			
Depth	0.3-0.9	1.8-2.0	0.1-0 25	1.5-1.7	4.0-4.2	0.5-0.6	1.5-1.6	1.7-1.8	0.1-0 25	0.8-1.0			
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J	V J T	V J T	V J T	V J	V J			
Sample Date	19/10/2020	19/10/2020	20/10/2020	20/10/2020	20/10/2020	20/10/2020	20/10/2020	20/10/2020	20/10/2020	20/10/2020			
Sample Type	Clayey Sand	Clay	Loamy Sand	Clay	Clay	Clay	Clay	Clay	Clay	Clay			
Batch Number	1	1	1	1	1	1	1	1	1	1			
Date of Receipt	24/10/2020	24/10/2020	24/10/2020	24/10/2020	24/10/2020	24/10/2020	24/10/2020	24/10/2020	24/10/2020	24/10/2020			
Arsenic #M	96.7	-	3.5	-	6.5	26 0	5.8	-	<0.5	-	<0.5	mg/kg	TM30/PM15
Cadmium #M	<0.1	-	0.1	-	<0.1	<0.1	<0.1	-	0.1	-	<0.1	mg/kg	TM30/PM15
Chromium #M	51 5	-	347.2AB	-	31.4	50 9	33 2	-	3.0	-	<0.5	mg/kg	TM30/PM15
Copper #M	6113AE	-	41	-	47	94	20	-	4	-	<1	mg/kg	TM30/PM15
Lead #M	199	-	22	-	29	423	14	-	<5	-	<5	mg/kg	TM30/PM15
Mercury #M	<0.1	-	<0.1	-	<0.1	0.2	<0.1	-	<0.1	-	<0.1	mg/kg	TM30/PM15
Nickel #M	91.7	-	25.1	-	59 3	34 3	12 2	-	1.0	-	<0.7	mg/kg	TM30/PM15
Selenium #M	2	-	2	-	2	<1	1	-	<1	-	<1	mg/kg	TM30/PM15
Sulphur as S	-	0 01	-	-	-	-	-	-	-	-	<0.01	%	TM30/PM15
Total Sulphate as SO4 #M	-	144	614	-	149	-	140	-	-	-	<50	mg/kg	TM50/PM29
Zinc #M	114	-	64	-	123	80	40	-	29	-	<5	mg/kg	TM30/PM15
PAH MS													
Naphthalene #M	85 90AD	-	0.51AB	-	<0.04	0 37	<0.04	-	<0.04	-	<0.04	mg/kg	TM4/PM8
Acenaphthylene	1.29AD	-	0.97AB	-	<0.03	0 28	<0.03	-	<0.03	-	<0.03	mg/kg	TM4/PM8
Acenaphthene #M	63.71AD	-	1.66AB	-	<0.05	0 29	<0.05	-	<0.05	-	<0.05	mg/kg	TM4/PM8
Fluorene #M	47 85AD	-	1.34AB	-	<0.04	0 24	<0.04	-	<0.04	-	<0.04	mg/kg	TM4/PM8
Phenanthrene #M	360 85AD	-	14.08AB	-	0 07	2 29	<0.03	-	<0.03	-	<0.03	mg/kg	TM4/PM8
Anthracene #	88 03AD	-	5.30AB	-	<0.04	0 65	<0.04	-	<0.04	-	<0.04	mg/kg	TM4/PM8
Fluoranthene #M	332 26AD	-	28.21AB	-	0 08	3 92	<0.03	-	<0.03	-	<0.03	mg/kg	TM4/PM8
Pyrene #	280 32AD	-	24.94AB	-	0 08	3.40	<0.03	-	<0.03	-	<0.03	mg/kg	TM4/PM8
Benzo(a)anthracene #	124 87AD	-	10.95AB	-	0 09	1.73	<0.06	-	<0.06	-	<0.06	mg/kg	TM4/PM8
Chrysene #M	137.46AD	-	12.32AB	-	0.10	1 85	<0.02	-	<0.02	-	<0.02	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #M	212 36AD	-	25.46AB	-	0.12	3 37	<0.07	-	<0.07	-	<0.07	mg/kg	TM4/PM8
Benzo(a)pyrene #	123 34AD	-	15.70AB	-	0 06	1 97	<0.04	-	<0.04	-	<0.04	mg/kg	TM4/PM8
Indeno(123cd)pyrene	73 50AD	-	10.72AB	-	<0.04	1 35	<0.04	-	<0.04	-	<0.04	mg/kg	TM4/PM8
Dibenzo(ah)anthracene #	15 32AD	-	2.61AB	-	<0.04	0 23	<0.04	-	<0.04	-	<0.04	mg/kg	TM4/PM8
Benzo(ghi)perylene #	79 04AD	-	11.73AB	-	<0.04	1 36	<0.04	-	<0.04	-	<0.04	mg/kg	TM4/PM8
Coronene	12 03AD	-	-	-	-	0 23	-	-	<0.04	-	<0.04	mg/kg	TM4/PM8
PAH 16 Total	2026.1AD	-	166.5AB	-	0.6	23 3	<0.6	-	<0.6	-	<0.6	mg/kg	TM4/PM8
PAH 17 Total	2038.13AD	-	-	-	-	23.53	-	-	<0.64	-	<0.64	mg/kg	TM4/PM8
Benzo(b)fluoranthene	152 90AD	-	18.33AB	-	0 09	2.43	<0.05	-	<0.05	-	<0.05	mg/kg	TM4/PM8
Benzo(k)fluoranthene	59.46AD	-	7.13AB	-	0 03	0 94	<0.02	-	<0.02	-	<0.02	mg/kg	TM4/PM8
PAH Surrogate % Recovery	89AD	-	90AB	-	86	84	76	-	97	-	<0	%	TM4/PM8
Naphthalene	-	-	-	-	-	-	-	-	-	-	<0.04	mg/kg	TM4/PM6
Acenaphthylene	-	-	-	-	-	-	-	-	-	-	<0.03	mg/kg	TM4/PM6
Acenaphthene	-	-	-	-	-	-	-	-	-	-	<0.05	mg/kg	TM4/PM6
Fluorene	-	-	-	-	-	-	-	-	-	-	<0.04	mg/kg	TM4/PM6
Phenanthrene	-	-	-	-	-	-	-	-	-	-	<0.03	mg/kg	TM4/PM6
Anthracene	-	-	-	-	-	-	-	-	-	-	<0.04	mg/kg	TM4/PM6
Fluoranthene	-	-	-	-	-	-	-	-	-	-	<0.03	mg/kg	TM4/PM6
Pyrene	-	-	-	-	-	-	-	-	-	-	<0.03	mg/kg	TM4/PM6
Benzo(a)anthracene	-	-	-	-	-	-	-	-	-	-	<0.06	mg/kg	TM4/PM6

Please see attached notes for all abbreviations and acronyms

Client Name: EPS Ltd
Reference: UK20.5113B
Location: Greenhead College
Contact: Lee Anderson
EMT Job No: 20/14666

Report : Solid

Solids V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	4-6	10-12	13-15	25-27	28-29	30-32	33-35	42-44	45-46	47-48	LOD/LOR	Units	Method No.
Sample ID	R01-ES2	R01-ES4	WS01-ES1	WS02-ES2	WS02-ES3	WS03-ES1	WS03-ES2	WS04-ES2	WS05-ES1	WS05-ES2			
Depth	0.3-0.9	1.8-2.0	0.1-0 25	1.5-1.7	4.0-4.2	0.5-0.6	1.5-1.6	1.7-1.8	0.1-0 25	0.8-1.0			
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J	V J T	V J T	V J T	V J	V J			
Sample Date	19/10/2020	19/10/2020	20/10/2020	20/10/2020	20/10/2020	20/10/2020	20/10/2020	20/10/2020	20/10/2020	20/10/2020			
Sample Type	Clayey Sand	Clay	Loamy Sand	Clay	Clay	Clay	Clay	Clay	Clay	Clay			
Batch Number	1	1	1	1	1	1	1	1	1	1			
Date of Receipt	24/10/2020	24/10/2020	24/10/2020	24/10/2020	24/10/2020	24/10/2020	24/10/2020	24/10/2020	24/10/2020	24/10/2020			
PAH MS Continued													
Chrysene	-	-	-	-	-	-	-	-	-	-	<0.02	mg/kg	TM4/PM6
Benzo(bk)fluoranthene	-	-	-	-	-	-	-	-	-	-	<0.07	mg/kg	TM4/PM6
Benzo(a)pyrene	-	-	-	-	-	-	-	-	-	-	<0.04	mg/kg	TM4/PM6
Indeno(123cd)pyrene	-	-	-	-	-	-	-	-	-	-	<0.04	mg/kg	TM4/PM6
Dibenzo(ah)anthracene	-	-	-	-	-	-	-	-	-	-	<0.04	mg/kg	TM4/PM6
Benzo(ghi)perylene	-	-	-	-	-	-	-	-	-	-	<0.04	mg/kg	TM4/PM6
PAH 16 Total	-	-	-	-	-	-	-	-	-	-	<0.6	mg/kg	TM4/PM6
Benzo(b)fluoranthene	-	-	-	-	-	-	-	-	-	-	<0.05	mg/kg	TM4/PM6
Benzo(k)fluoranthene	-	-	-	-	-	-	-	-	-	-	<0.02	mg/kg	TM4/PM6
Methyl Tertiary Butyl Ether #	<2 SV	-	<2	-	<2	<2 SV	<2	-	<2	-	<2	ug/kg	TM15/PM10
Benzene #	5 SV	-	<3	-	<3	<3 SV	<3	-	<3	-	<3	ug/kg	TM15/PM10
Toluene #	17 SV	-	<3	-	<3	6 SV	<3	-	<3	-	<3	ug/kg	TM15/PM10
Ethylbenzene #	38 SV	-	<3	-	<3	<3 SV	<3	-	<3	-	<3	ug/kg	TM15/PM10
m/p-Xylene #	83 SV	-	<5	-	<5	7 SV	<5	-	<5	-	<5	ug/kg	TM15/PM10
o-Xylene #	71 SV	-	<3	-	<3	<3 SV	<3	-	<3	-	<3	ug/kg	TM15/PM10
Surrogate Recovery Toluene D8	41 SV	-	53	-	89	63 SV	107	-	105	-	<0	%	TM15/PM10
Surrogate Recovery 4-Bromofluorobenzene	44 SV	-	54	-	56	47 SV	97	-	95	-	<0	%	TM15/PM10
Mineral Oil (C10-C40) (EH_CU_1D_Tota)	697	-	-	-	-	<30	-	-	<30	-	<30	mg/kg	TM5/PM8/PM16
TPH CWG													
Aliphatics													
>C5-C6 (HS_1D_AL) #M	<0.1 SV	-	<0.1 SV	-	<0.1	<0.1 SV	<0.1	-	<0.1	-	<0.1	mg/kg	TM36/PM12
>C6-C8 (HS_1D_AL) #M	<0.1 SV	-	<0.1 SV	-	<0.1	<0.1 SV	<0.1	-	<0.1	-	<0.1	mg/kg	TM36/PM12
>C8-C10 (HS_1D_AL)	0.1 SV	-	<0.1 SV	-	<0.1	<0.1 SV	<0.1	-	<0.1	-	<0.1	mg/kg	TM36/PM12
>C10-C12 (EH_1D_AL) #M	8.2	-	<0 6 AA	-	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	mg/kg	TM5/PM8/PM16
>C12-C16 (EH_1D_AL) #M	21	-	<12 AA	-	15	<4	<4	-	<4	-	<4	mg/kg	TM5/PM8/PM16
>C16-C21 (EH_1D_AL) #M	25	-	<21 AA	-	23	<7	<7	-	<7	-	<7	mg/kg	TM5/PM8/PM16
>C21-C35 (EH_1D_AL) #M	492	-	706 AA	-	42	<7	<7	-	<7	-	<7	mg/kg	TM5/PM8/PM16
Total aliphatics C5-35 (EH+HS_1D_AL)	546	-	706 AA	-	80	<19	<19	-	<19	-	<19	mg/kg	M5 M36 M8 M 2 M 6
Aromatics													
>C5-EC7 (HS_1D_AR) #	<0.1 SV	-	<0.1 SV	-	<0.1	<0.1 SV	<0.1	-	<0.1	-	<0.1	mg/kg	TM36/PM12
>EC7-EC8 (HS_1D_AR) #	<0.1 SV	-	<0.1 SV	-	<0.1	<0.1 SV	<0.1	-	<0.1	-	<0.1	mg/kg	TM36/PM12
>EC8-EC10 (HS_1D_AR) #M	<0.1 SV	-	<0.1 SV	-	<0.1	<0.1 SV	<0.1	-	<0.1	-	<0.1	mg/kg	TM36/PM12
>EC10-EC12 (EH_1D_AR) #	104 8	-	<0 6 AA	-	<0.2	<0.2	<0.2	-	<0.2	-	<0.2	mg/kg	TM5/PM8/PM16
>EC12-EC16 (EH_1D_AR) #	375	-	<12 AA	-	<4	10	<4	-	<4	-	<4	mg/kg	TM5/PM8/PM16
>EC16-EC21 (EH_1D_AR) #	2002	-	176 AA	-	<7	42	<7	-	<7	-	<7	mg/kg	TM5/PM8/PM16
>EC21-EC35 (EH_1D_AR) #	4651	-	2178 AA	-	<7	149	<7	-	<7	-	<7	mg/kg	TM5/PM8/PM16
Total aromatics C5-35 (EH+HS_1D_AR) #	7133	-	2354 AA	-	<19	201	<19	-	<19	-	<19	mg/kg	M5 M36 M8 M 2 M 6
Total aliphat cs and aromat cs(C5-35) (EH HS_CU_1D_Total)	7679	-	3060 AA	-	80	201	<38	-	<38	-	<38	mg/kg	M5 M36 M8 M 2 M 6
MTBE #	-	-	-	-	-	-	-	-	-	-	<5	ug/kg	TM36/PM12

Please see attached notes for all abbreviations and acronyms

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.