

Phase II Site Investigation Report

Barton Peveril Sixth Form College, Chestnut Avenue, Eastleigh SO50 5ZA

On behalf of Barton Peveril Sixth Form College c/o Bidwells

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EXECUTIVE SUMMARY	
PROPOSED DEVELOPMENT	At the time of reporting, April 2023, the proposed development was understood to comprise the construction of a new two storey Arts and Design Building at the Barton Peveril Sixth Form College. The surrounding area around the building is to comprise hard landscaping areas.
GEOLOGY AND HYDROGEOLOGY	The British Geological Survey Solid and Drift Geology Map for the Eastleigh area (Southampton Sheet No. 315) revealed that the western portion of the site was underlain by superficial River Terrace Deposits 1 (Sand and Gravels) whereas the eastern portion of the site was underlain by superficial River Terrace Deposits comprising mainly loamy Clay. The entire site was underlain by bedrock deposits of the London Clay Formation. No areas of Made Ground or Reworked Ground were noted within a 250m radius. A study of the aquifer maps on the DEFRA website revealed the western and central areas of the site was underlain by a Secondary A Aquifer whilst the eastern portion of the site was underlain by a Secondary (Undifferentiated) Aquifer comprising the superficial River Terrace Deposits, underlain by Unproductive Strata comprising bedrock deposits of the London Clay Formation. Examination of the Environment Agency records showed that the site did not fall within a Groundwater Source Protection Zone (SPZ) as classified in the Policy and Practice for the Protection of Groundwater. No surface water features were present within a 250m radius of the site. The nearest surface water feature was the Monks Brook located 260m west of the site flowing in a north to south direction. A lake associated with the Lakeside country park was noted approximately 370m south of the site.

	From analysis of hydrogeological and topographical maps it was anticipated that groundwater was, present within the seasonal aquifer of the superficial River Terrace Deposits. Water may be perched within Made Ground at shallower depths. It was considered that groundwater was flowing in a westerly direction toward the Monks Brook in line with local topography.
VOLUME CHANGE POTENTIAL	Foundations should be designed in accordance with soils of medium volume change potential.
FOUNDATION DESIGN	Foundations should be taken through any Topsoil/Made Ground/soft spots and extend 300mm below root penetrated soils, before founding onto competent, moisture stable soils of the River Terrace Deposits at 1.80 - 2.00m bgl. Foundations constructed at 1.80 - 2.00m bgl can be designed based on an allowable bearing capacity of 150 – 175kN/m² if granular soils are recorded at foundation locations. The majority of the trial pits have shown that cohesive soils may extend deeper than 1.80/2.00m bgl and have not proven the granular soils horizon, with the exception of TP2, where gravel was recorded at 1.50m bgl. Therefore, care must be taken when founding on those soils and a lower bearing capacity should be adopted. The only N SPT result within shallow cohesive soils is the soft spot within BH1, which should be bypassed, therefore a deeper depth (like 1.80/ 2.00m bgl) across the proposed buildings should be considered. A bearing pressure of 100 kPa might be achievable within cohesive soils at these depths, if granular soils are not recorded yet.
SUB-SURFACE CONCRETE	The water-soluble sulphates in the Topsoil was noted to be 4mg/l, with a pH of 7.96, from chemical laboratory testing. According to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the Topsoil. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1. The water-soluble sulphates in the Made Ground was noted to be 4mg/l, with a pH of 8.46, from chemical laboratory testing. According to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the Made Ground. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1. The water-soluble sulphates in the River Terrace Deposits was noted to be between <4-260mg/l, with a pH of 6.81-8.29, from chemical laboratory testing. The total potential sulphate (3x total sulphur) was <0.06-0.0912%, from chemical laboratory testing. According to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the River Terrace Deposits. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1.

CONTAMINATION	Chemical laboratory testing of the Topsoil, Made Ground and River Terrace Deposits did not reveal any elevated levels of determinands above the guideline levels for a 'Commercial' land-use scenario. In addition, the intrusive investigation did not reveal any visual or olfactory evidence to suggest any hydrocarbon-type contamination in the trial holes excavated on the site. The chemical laboratory results have verified that no elevated concentrations of aliphatic/aromatic hydrocarbons (C5-C35) or BTEX compounds are present in the soils underlying the site. Given the low levels of determinands noted during the chemical laboratory testing, it was considered that no remediation was required within the soils for the end users of the site. No asbestos has been identified during the testing, however, an Asbestos Management Strategy should be put in place so that any potentially asbestos containing materials are identified and removed from site in a suitable manner to prevent cross-contamination.
REMEDIATION	Given the low levels of determinands noted during the chemical laboratory testing, it was considered that no remediation was required within the soils for the end users of the site. The Water Supply pipe risk assessment indicated that the use of PE pipes is appropriate at the site and no further measures are required. Comparison between the soil laboratory analysis and the derived Level 1 (soils) target concentrations indicate that Cadmium, nickel, and zinc were elevated and have the potential to pose a risk to Controlled Waters. It should be noted that a number of determinands at laboratory limit of detection exceed the target concentration for a Level 1 (soils) risk assessment, most notably PAHs. Where a determinand is identified at the laboratory limit of detection, no further assessment is considered necessary. Given the Level 1 risk assessment does not consider dilution, dispersion or attenuation, and the conceptual site model shows the nearest receptor to be the Monks Brook, ~260m west of the site, it is not expected that the soils on-site represent an unacceptable risk to controlled water receptors. No further action is considered necessary. Based on risk assessment undertaken, the site warrants classification as Characteristic Situation CS1. The risk from vapours was considered to be low due to the very low concentrations of BTEX compounds (Benzene, Toluene, Ethylbenzene, Xylene) and MTBE, which are used as marker compounds for Volatile Organic Compounds (VOCs) and the low anticipated risk level. Basic radon protective measures are required for the report area.

1. INTRODUCTION

1.1. General

Ground and Water Limited were instructed by Bidwells on behalf of Barton Peveril Sixth Form College on the 28th February 2023 to conduct a Phase 2 Site Investigation Report on the site at Barton Peveril Sixth Form College, Chestnut Avenue, Eastleigh SO50 5ZA. The scope of the investigation was detailed within the fee proposal GW-1716, dated the 21st February 2023.

1.2. Aims of the Investigation

The aim of this report was to supply the client and their designers with information regarding the ground conditions underlying the site to assist them in preparing an appropriate scheme for development.

A contamination assessment was to be undertaken following chemical laboratory testing on soil samples recovered from the site to enable recommendations for the safe redevelopment of the site and the protection of site workers, end-users and the public from any potential contamination identified.

This Site Investigation Report must be read in conjunction with the Desk Study Report referenced GWPR5268/DS/April 2023.

The techniques adopted for the investigation were chosen considering the requirements of the client, anticipated ground conditions, and bearing in mind the nature of the site, limitations to site access and other logistical limitations.

1.3. Conditions and Limitations

This report has been prepared based on the terms, conditions and limitations outlined within Appendix A.

1.4. Technical Glossary

Generic technical terms and their description can be viewed within the glossary provided within Appendix B.

2. SITE SETTING

2.1. Site Location

The site comprised a ~50,000m² rectangular-shaped plot of land, orientated in a north-west to south-east direction, along the northern side of Chestnut Avenue. The site was located in the southern portion of town of Eastleigh in the county of Hampshire.

The national grid reference for the centre of the site was approximately SU 44653 18273. A site location plan is given within Figure 1. A site development area plan is shown in figure 2 and an aerial photograph of the site shown in figure 3.

2.2. Site Description

A Site Walkover was undertaken on the 4th April 2023. A description of the site, as noted during the Site Walkover, is tabulated below.

Site Description Sheet	
Use of site	At the time of the site walkover visit, 4 th April 2023. The site is a car parking area used at Barton Peveril college
Site topography	The majority of the site is reasonably flat.
Area topography	Area is reasonably flat in the surrounding area.
Structures onsite	The site development area comprised Temporary units currently used as educational Classrooms, and tennis court. The central and western portion of the site comprised permeant college buildings.
Structures off-site	Residential houses were noted to the north and west of the site. Another school was noted to the east of the site.
Use of surrounding ground	Land to the south, west and north of the site comprised residential houses. Another school and college were noted to the east of the site.
Boundary features	Northern Boundary: Residential Houses. Eastern Boundary: An open boundary comprising a school playing field. Southern Boundary: Residential Houses. Western Boundary: Residential Houses.
Site covering	The majority of the central and western areas of the site was covered with tarmac hardstanding with small soft landscaped areas. The eastern portion of the site comprised a grass playing field.
Contamination sources onsite	None noted
Contamination sources off-site	None noted
Vegetation onsite	Large playing field on the eastern side of the site. Small vegetation area that looks like an old allotment on the northern portion of the site.
Vegetation off-site	Large playing field on the eastern side of the site.
Services	A few drains around the development area, along with lighting too.

2.3. Proposed Development

At the time of reporting, April 2023, the proposed development was understood to comprise the construction of a new two storey Arts and Design Building at the Barton Peveril Sixth Form College. The surrounding area around the building is to comprise hard landscaping areas.

The proposed development plan can be seen within Figure 4.

2.4. Geology

The British Geological Survey Solid and Drift Geology Map for the Eastleigh area (Southampton Sheet No. 315) revealed that the western portion of the site was underlain by superficial River Terrace Deposits 1 (Sand and Gravels) whereas the eastern portion of the site was underlain by superficial River Terrace Deposits comprising mainly loamy Clay. The entire site was underlain by bedrock deposits of the London Clay Formation. No areas of Made Ground or Reworked Ground were noted within a 250m radius.

Superficial deposits (Drift) are the youngest geological deposits formed during the most recent period of geological time. They rest on older deposits or rocks referred to as bedrock (Solid), which are the main mass forming the Earth. Bedrock is present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

River Terrace Deposits (Southampton area)

Extensive spreads of River Terrace Deposits occur along the Rivers Test and Itchen. Eleven terraces have been provisionally recognised in the area. The deposits are variable in thickness, ranging from 1 to 5m, and generally consist of gravels, predominantly sub-angular to sub-rounded flints, with a considerable sand content. Poorly sorted clayey and sandy silts and silty clays overlie some of the terraces.

London Clay Formation

In the Hampshire Basin area, the London Clay Formation comprises blue, brown and grey clay with yellow and grey sands and silts interspersed with pebble beds. Localised developments of sandstone also occur. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. Crystals of Gypsum (Selenite) are often found within the weathered part of the London Clay Formation, and precautions against sulphate attack to concrete are sometimes required. The basement beds of the London Clay Formation are sandy with rounded flints.

A BGS borehole (SU41NW/706) located ~270m west of the site revealed a 1.00m capping of Topsoil comprising a soil with gravel and tarmac over a soft grey silty clay with some fine to coarse gravel to 1.90m bgl followed by a loose fine to coarse sandy Gravel to 2.60m bgl. From 2.60 to 7.00m (base of the borehole) a stiff heavily fissured grey silty Clay was recorded. Groundwater was noted at 1.60m bgl rising to 0.80m bgl in 15 minutes.

2.5. Hydrogeology and Hydrology

A study of the aquifer maps on the DEFRA website revealed the western and central areas of the site was underlain by a **Secondary A Aquifer** whilst the eastern portion of the site was underlain by a **Secondary (Undifferentiated) Aquifer** comprising the superficial River Terrace Deposits, underlain by **Unproductive Strata** comprising bedrock deposits of the London Clay Formation.

Examination of the Environment Agency records showed that the site **did not** fall within a Groundwater Source Protection Zone (SPZ) as classified in the Policy and Practice for the Protection of Groundwater.

No surface water features were present within a 250m radius of the site. The nearest surface water feature was the Monks Brook located 260m west of the site flowing in a north to south direction. A lake associated with the Lakeside country park was noted approximately 370m south of the site.

From analysis of hydrogeological and topographical maps it was anticipated that groundwater was, present within the seasonal aquifer of the superficial River Terrace Deposits. Water may be perched within Made Ground at shallower depths. It was considered that groundwater was flowing in a westerly direction toward the Monks Brook in line with local topography.

Examination of the Environment Agency records showed that the site was located within a Flood Zone 1, i.e. an area with a low probability of flooding.

The Groundsure Datasheets revealed the site was at a very low risk of flooding from rivers and the sea. The datasheets also revealed the central portion of the site was at risk of a high risk of groundwater flooding, while the western portion had a moderate risk and the eastern portion a moderate to high risk. The central area of the site had a 1 in 30 year 0.30-1.00m risk of surface water flooding.

2.6. Radon

BRE 211 (2015) Map 4 of the Hampshire, Berkshire and South Oxfordshire area indicated that the site **was not** located within an area where mandatory protection measures against the ingress of radon were likely to be required.

A review of the freely available UK Health Security Agency radon database, UK Radon, indicated that the site was located within a 1km grid square, where the maximum radon potential of 3 – 5% was recorded. Basic radon protection measures are required in areas where more than 3% of houses are at or above the Action Level. **Basic radon protection measures might be required.**

The site is in an area where a risk assessment is required.

This risk assessment will be taken further and a BGS report will be obtained for the site.

The UKHSA advises that radon gas should be measured in all properties within radon Affected Areas and that homes with radon levels at or above the Action Level (200 Bq m⁻³) should be remediated. Householders with levels between the Target Level (100 Bq m⁻³) and Action Level should seriously consider reducing their radon level, especially if they are at greater risk, such as if they are current or ex smokers. Whether or not a home is in fact above or below the Action Level or Target Level can only be established by having the building tested.

Is the property in a radon Affected Area as defined by the UK Health Security Agency (UKHSA) and if so what percentage of homes are estimated to be at or above the Action Level:

Yes-the property is in a radon affected area where 3 to 5% of homes are estimated to be at or above the action level.

Basic radon protective measures are required for the report area.

The BGS Radon report can be viewed in Appendix I.

2.7. Internet Search (Site Setting)

2.7.1. Available Unexploded Ordnance (UXO) Map Review

A review of the data available on www.zeticauxo.com/ revealed the site was located within a moderate-risk area associated with unexploded ordnance (UXO), as indicated by having 15 – 49 bombs dropped per 1000 acres. 1No. known UXO find was recorded 420m north-west of the site as well as an Industrial Strategic target located 100m north of the site.

2.7.2. Historical Landfill Tool Review

A review of the data available on www.groundsure.io/ revealed an area of Historical Landfilling approximately 315m south of the site. This historical landfill was refenced Land at the West of Wilde Lane and was active from 19/01/1983 with no last input date provided. No information regarding the type of waste that was stored has been provided.

2.8. Preliminary Risk Assessment

The tabulated Conceptual Site Model developed as part of the Ground and Water Ltd Desk Study (GWPR5268/DS/April 2023) is outlined overleaf. For ease of reference and understanding, the risks have been classified within this risk assessment against four possible levels / categories, summarised in the table below. Any risk deemed to be negligible within the Preliminary Risk Assessment have been excluded from this report.

Risk Categories used in the Tabulated CSM	
Low Risk	Regarding this potential SPR linkage, the site is considered suitable for the proposed end-use and there is not considered to be an unacceptable risk to receptors. However, it is considered that further investigation to confirm this is recommended.
Moderate Risk	Regarding this potential SPR linkage, the site may not be suitable for the proposed end-use in its current condition and there may be an unacceptable risk to receptors. Further investigation is required to confirm this.
High Risk	Regarding this potential SPR linkage, the site is probably or certainly not suitable for proposed end-use and there is likely to be an unacceptable risk to receptors. Contaminants probably or certainly present and urgent action required in the short term.

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(On-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Made Ground from construction/ demolition activities: - Asbestos, - PAHs, - TPHs, - VOCs, - Sulphates, and - Metals.	- Direct ingestion of soil and soil derived dust - Dermal contact of soil and soil derived dust - Inhalation of dust (indoors and outdoors) with elevated concentration of determinands - Ingestion of home-grown produce, and soils attached - Direct ingestion of groundwater - Inhalation of volatile vapour (indoors and outdoors)	Human Health - End Users (Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public	Low
	- Direct uptake of groundwater - Direct uptake of determinands in the soil	Flora and Fauna Vegetation within soft landscaped areas	Low
	- Anthropogenic (man-made) pathways - Vertical and lateral migration in permeable strata - Surface water runoff	Controlled Waters - Secondary A Aquifer and Secondary Undifferentiated Aquifer (River Terrace Deposits) - Monks Brook	Low
Gas Governor - Metals and semi metals - Phenols - Ammonia - PAHS's	Migration through anthropogenic & natural pathways	Human Health - End Users (Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public	Low – negligible
Electricity Sub-Station PCB oils and other cable/transformer oils	Migration through anthropogenic & natural pathways	Human Health End Users (Residents/Future site visitors)	Negligible
Aggressive ground conditions with Made Ground and natural ground, including groundwater: - Sulphates, - PAH/TPH.	Direct contact with aggressive ground conditions	Building Materials and Services - Buried Concrete - Underground services (water pipes)	Low - Moderate
Ground gases generated by Made Ground: Methane,	- Migration through anthropogenic & natural pathways - Inhalation of Asphyxiating gases - Explosion (methane only)	Human Health - End Users (Future site visitors) - Construction workers during development (especially in confined spaces)	Low

- Carbon Dioxide, - Hydrogen Sulphide, and - Carbon Monoxide.		- Site operatives during maintenance works in confined spaces - Neighbours and public	
	- Migration through anthropogenic & natural pathways - Explosion (methane only)	Building Materials and Services - Buildings - Confined spaces - Underground services	Low
Radon	- Migration	Human Health End Users (Residents/Future site visitors)	Moderate – see relevant sections for protection needed

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(Off-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Made Ground from sewage works, surface ground workings and allotment gardens: - Asbestos, - PAHs, - TPHs, - VOCs, - Sulphates, and - Metals. - Herbicides and pesticides	- Direct ingestion of soil and soil derived dust - Dermal contact of soil and soil derived dust - Inhalation of dust (indoors and outdoors) with elevated concentration of determinands - Direct ingestion of groundwater - Inhalation of volatile vapour (indoors and outdoors)	Human Health - End Users (Future site visitors) - Construction workers during development - Site operatives during maintenance works	Negligible
	Direct uptake of groundwater	Flora and Fauna Vegetation within soft landscaped areas	Negligible
Made Ground from Tank - Asbestos, - PAHs, - TPHs, - VOCs, - Sulphates, and - Metals.	- Direct ingestion of soil and soil derived dust - Dermal contact of soil and soil derived dust - Inhalation of dust (indoors and outdoors) with elevated concentration of determinands - Direct ingestion of groundwater - Inhalation of volatile vapour (indoors and outdoors)	Human Health - End Users (Future site visitors) - Construction workers during development - Site operatives during maintenance works	Negligible
Electricity Sub-Station PCB oils and other cable/transformer oils	Migration through anthropogenic & natural pathways	Human Health End Users (Residents/Future site visitors)	Negligible
Gas Governor - Metals and semi metals - Phenols - Ammonia PAHS's	Migration through anthropogenic & natural pathways	Human Health - End Users (Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public	Negligible
Aggressive ground conditions associated with impacted groundwater; Sulphates,	Direct contact with aggressive ground conditions	Building Materials and Services - Buried Concrete - Underground services (water pipes)	Low

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(Off-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
PAH/TPH.			
Ground gases generated by Made Ground: - Methane, - Carbon Dioxide, - Hydrogen Sulphide, and - Carbon Monoxide.	- Migration through anthropogenic & natural pathways - Inhalation of Asphyxiating gases - Explosion (methane only)	Human Health - End Users (Future site visitors) - Construction workers during development (especially in confined spaces) - Site operatives during maintenance works in confined spaces	Negligible
	- Migration through anthropogenic & natural pathways - Explosion (methane only)	Building Materials and Services - Buildings - Confined spaces	Negligible

3. SITE WORKS

3.1. Scope of Works

Site works were undertaken on two separate occasions. The first set of site works comprised 5No. Trial Pits to depths of 1.00-2.00m bgl on the 4th April 2023. Soakaway tests in accordance with BRE 365 were undertaken in TP1 and TP2.

On the 11th and 12th April 2023 additional site works were carried out comprising the drilling of 1No. Cable Percussion Borehole (BH1) to a depth of 20.00m bgl with Standard Penetration Tests at 1.00m intervals to 5.00m and at 1.50m intervals from 5.00-20.00m bgl.

A trial hole location plan has been provided within Figure 5.

Prior to commencing the ground investigation, a walkover survey was carried out to identify the presence of underground services and drainage. Where underground services/drainage were suspected and/or positively identified, the exploratory position was relocated away from these areas.

As a further precautionary measure, the borehole was hand excavated to 1.20m below the local ground level (bgl) and scanned with a Cable Avoidance Tool (CAT scanner) to minimise the risk to services.

Upon completion of the drilling works, the trial holes were backfilled and made good, in relation to the surrounding area.

3.2. Sampling Procedures

Small disturbed samples and environmental samples were recovered from the trial holes at the depths shown on the trial hole records. Soil samples were generally retrieved from each change of strata and/or at specific areas of concern. Samples were also taken at approximately 0.5m intervals during broad homogenous soil horizons.

A selection of samples were despatched to a laboratory for both geotechnical and chemical testing purposes.

4. ENCOUNTERED GROUND CONDITIONS

4.1. Soil Conditions

The trial holes were logged by a Ground and Water Limited representative, generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

The ground conditions encountered within the trial holes constructed on the site did generally conform to that anticipated from examination of the geology map. A capping of Made Ground/Topsoil was noted to overlie the superficial River Terrace Deposits and the bedrock London Clay Formation.

The succession of conditions and description of soils encountered in the trial holes in descending order is tabulated below.

Summary of Strata Encountered (TP1 – TP5)			
Strata	Top Depth (m bgl)	Base Depth (m bgl)	Thickness (m)
TOPSOIL (TP1-TP2): Dark brown, slightly gravelly sandy SILT. Sand is fine to medium. Gravel is fine to medium subangular of flint.	GL	0.30	0.30
MADE GROUND (TP3 Only): Brown, grey, orange, gravelly sandy CLAY. Sand is fine to medium. Gravel is fine to medium sub-angular of flint, brick bituminous material and concrete.	GL	>1.00	>1.00
UNDIFFERENTIATED RIVER TERRACE DEPOSITS: Brown, orange, gravelly sandy CLAY. Sand is fine to medium. Gravel is fine to coarse sub-angular to sub-rounded of flint.	0.30	>1.00 – 1.50	>1.00 – >1.70
UNDIFFERENTIATED RIVER TERRACE DEPOSITS (TP2): Orange, brown, grey, sandy silty GRAVEL/ gravelly SAND. Sand is fine to coarse. Gravel is fine to coarse sub-angular to sub-rounded of flint.	1.50	>2.00	>0.50

Summary of Strata Encountered (BH1)			
Strata	Top Depth (m bgl)	Base Depth (m bgl)	Thickness (m)
TOPSOIL: Orange, brown slightly gravelly CLAY. Gravel is fine sub-angular of flint.	GL	0.20	0.20
UNDIFFERENTIATED RIVER TERRACE DEPOSITS: Grey, orange, brown, gravelly sandy CLAY. Sand is fine. Gravel is fine to medium sub-angular of flint.	0.20, 1.20, 4.70	0.80, 1.80, 5.80	0.60-1.10
UNDIFFERENTIATED RIVER TERRACE DEPOSITS: Brown, grey orange, white, sandy GRAVEL/ gravelly SAND. Sand is fine to coarse. Gravel is fine to coarse subangular to sub-rounded of flint.	0.80, 1.80, 5.80	1.20, 4.70, 14.10	0.40, 2.90, 8.30
LONDON CLAY FORMATION: Blue, grey silty CLAY/ clayey SILT with rare fine selenite crystals.	14.10	>20.00	>5.90

For details of the composition of the soils encountered at particular points, reference must be made to the individual trial hole logs within Appendix D of this report. A trial hole location plan can also be viewed within Figure 5.

4.2. Roots Encountered

The depths of root penetration can be seen tabulated below.

Summary of Root Penetration	
Trial Hole	Fresh Root Depth (m bgl)
TP1	1.00
TP2	1.00
TP3	1.00
TP4	1.00
TP5	1.00
BH1	1.20

It should be noted that the accuracy of determining the depth of root penetration within narrow diameter boreholes is considered low. It should be noted that roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.

4.3. Groundwater Conditions

No Groundwater was encountered in any of the trial holes.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was undertaken in April 2023 when groundwater levels are likely to be at their annual maximum (highest elevation). Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site.

4.4. Obstructions

A possible obstruction was noted in TP3 at 1.00m bgl where the trial pit encountered some concrete. Ground and water were advised that a rainwater store was located in this area and therefore the trial pit was terminated early.

No other artificial or natural sub-surface obstructions were noted during construction of the trial holes.

5. IN-SITU AND LABORATORY TESTING

5.1. In-situ Strength Testing

Standard Penetration Tests (SPTs) were undertaken as part of the site investigation. The results of the SPT's have not been amended to consider hammer efficiency, rod lengths and overburden pressure in accordance with Eurocode 7. The test results are presented on the borehole logs within Appendix D. An interpretation of the in-situ geotechnical testing results is given in the table below.

Interpretation of In-situ Geotechnical Testing Results					
Strata	SPT "N" Blow Counts/Equivalent SPT "N" Value from DP	Equivalent Undrained Shear Strength (Cu) (kPa)	Soil Type		Trial Hole/s
			Granular (Density)	Cohesive (Cu)	
Soft spots within River Terrace Deposits (Cohesive)	5	25	-	Low	BH1/1.20 – 1.45m bgl
River Terrace Deposits (Granular)	33-47	-	Dense to Very Dense	-	BH1/2.20 – 4.65m bgl BH1/6.50- 12.95m bgl
River Terrace Deposits (cohesive)	12	60	-	Medium	BH1/5.20- 5.65m bgl
London Clay Formation (Cohesive)	26-39	130 – 195	-	High to Very High	BH1/14.10 – >20.00m bgl

It must be noted that field measurements of undrained shear strength (Cu) are dependent on a number of variables including disturbance of sample, method of investigation and also the size of specimen or test zone.

5.2. Geotechnical Laboratory Testing

A programme of geotechnical laboratory testing, scheduled by Ground and Water Limited and carried out by an accredited geotechnical testing laboratory was undertaken on samples recovered. Details of the specific tests used in each case are given below.

Standard Methodology for Laboratory Geotechnical Testing		
Test	Standard	Number of Tests
Atterberg Limit Tests	BS1377:2016:Part 2:Clauses 3.2, 4.3 & 5	4
Particle Size Distribution Tests	BS1377:2016:Part 2:Clause 9	1
Water Soluble Sulphate and pH Test	BS1377:2018:Part 3:Clause 5	1
BRE Special Digest 1 Tests	BRE Special Digest 1 "Concrete in Aggressive Ground (BRE, 2005).	2

5.2.1. Atterberg Limit Testing

A précis of Atterberg limit testing undertaken can be seen tabulated below. The test results are presented within Appendix E.

Atterberg Limit Tests Results Summary							
Stratum	Moisture Content (%)	Passing 425 µm sieve (%)	Modified PI (%)	Soil Class	Consistency Index (Ic)	Volume Change Potential	
						BRE	NHBC
River Terrace Deposits	21-31	89-100	24.03-27.26	MH-CI	Stiff to Very Stiff	Medium	Medium
River Terrace Deposits (TP2/1.50m)	9.1	17	N/A	N/A	N/A	NP	NP
- NP – Non-plastic - BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results) - Soil Classification based on British Soil Classification System. - Consistency Index (Ic) based on BS EN ISO 14688-2:2018.							

5.2.2. Moisture Deficit Assessment

The results of the Atterberg Limit tests were analysed to determine the Liquidity Index of the samples, to give an indication as to whether the samples recovered showed a moisture deficit as well assessing their degree of consolidation. Liquid Limit analyses was undertaken to assess whether there were any potentially significant moisture deficits within the samples tested.

No potential moisture deficits were recorded in the samples tested.

5.2.3. Particle Size Distribution Testing

The results of particle size distribution (PSD) testing undertaken show that the sample tested from BH1/2.70m bgl had no volume change potential in accordance with BRE240 and NHBC Standards Chapter 4.2. The results of the PSD testing can be viewed within Appendix E, and summarised below.

Particle Size Distribution Results Summary			
Stratum	Range Passing 63µm Sieve (%)	Volume Change Potential	
		BRE	NHBC
River Terrace Deposits (BH1/2.70m bgl)	0	No	No
- Volume Change Potential refers to BRE Digest 240 (based on Grading test results). - Shrinkability refers to NHBC Standards Chapter 4.2 (based on Grading test results). - BRE 240 states that a soil has a volume change potential when the clay fraction exceeds 15%. Only the silt and clay combined fraction are determined by sieving therefore the volume change potential is estimated from the percentage passing the 63µm sieve. - NHBC Standards Chapter 4.2 states that a soil is shrinkable if the percentage of silt and clay passing the 63µm sieve is greater than 35% and the Plasticity Index is greater than 10%.			

6. ENGINEERING CONSIDERATIONS

6.1. Soil Characteristics and Foundation Considerations

A summary of the soil characteristics following the intrusive site investigation and laboratory testing and the relevant foundation considerations has been provided below. The following information from the ground investigation was considered pertinent to the design of foundations.

- Foundations should be taken through any Made Ground/Topsoil and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.
- Foundations should be designed in accordance with soils of medium volume change potential.
- Given the presence of cohesive soils at shallow depth, special foundation precautions may be required to prevent possible future shrinkage/swelling of the soils affecting the integrity of the faces of foundations (underfloor void diameter/compressible material/void formers etc.).
- The loads of proposed foundations should not exceed the allowable bearing capacity of the soils they are founding upon.
- If soft spots are encountered, they should be bypassed.
- Care should be taken not to overdig foundations as this may stress underlying soft spots, should they be present.
- Foundations must not be placed within fresh root penetrated and/or desiccated soils with volume change potential. It is recommended that foundations are taken at least 300mm into non-fresh root penetrated strata if the soils have volume change potential, or into soils of no volume change potential.
- The influence of trees on or surrounding the site will need to be taken into account in final design.
- Any water ingress must be prevented from entering foundation trenches and excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate within the excavation for even a short period of time, an increase in heave occur. The shear strength will also be reduced, resulting in lower bearing capacities, resulting in increased settlements. Instability issues may arise within the foundation trenches, in case of perched water being present.

6.2. Shallow Foundations

Foundations should be taken through any Topsoil/Made Ground/soft spots and extend 300mm below root penetrated soils, before founding onto competent, moisture stable soils of the River Terrace Deposits at 1.80 - 2.00m bgl. Foundations constructed at 1.80 - 2.00m bgl can be designed based on an allowable bearing capacity of 150 – 175kN/m² **if granular soils are recorded at foundation locations.**

The majority of the trial pits have shown that cohesive soils may extend deeper than 1.80/2.00m bgl and have not proven the granular soils horizon, with the exception of TP2, where gravel was recorded at 1.50m bgl. Therefore, care must be taken when founding on those soils and a lower bearing capacity should be adopted. The only N SPT result within shallow cohesive soils is the soft spot within BH1, which should be bypassed, therefore a deeper depth (like 1.80/ 2.00m bgl) across the proposed

buildings should be considered. A bearing pressure of 100 kPa might be achievable within cohesive soils at these depths, if granular soils are not recorded yet.

This is based on trial hole records, the results of in-situ testing, inspection of samples recovered, and referral to BS 8004:2015, Code of Practice for Foundations, and based on a 5m long by 1m wide foundation and a maximum settlement of 25mm.

Stability issues may be experienced within foundation trenches, especially in the presence of granular soils and potential perched water.

Carbon Footprint

A basic carbon footprint calculation was carried out for potential nominal / anticipated footing arrangements. A typical strip footing with a typical width of 0.75m, along a 5m nominal length, can be considered leaving a footprint of ~2.41 Total tCO₂e/t. For a 2.00m depth, this value becomes 2.68 Total tCO₂e/t. A width of 0.60m will lower this value to 1.93 and 2.14 tCO₂e/t respectively.

Additional Comments

A number of comments and recommendations has been provided below.

- It is prudent to avoid having a foundation spanning across materials of different consistency, like clay and gravel, in order to avoid potential differential settlements. If unavoidable, foundations must be reinforced to allow for such potential differential movement. It should be noted that differential settlement may also occur between strip and isolated pad foundations.
- Foundation excavations must be carefully bottomed out and any loose soil or soft spots removed prior to the foundation concrete or blinding being placed. Failure to ensure that foundation excavations are suitably bottomed out could result in additional settlements.
- Inspection of foundation excavations, prior to concreting, must be made by a competent and suitably qualified person to check for soft spots and to check for the presence of roots.
- Foundations must not be cast over foundations of former structures and/or other hard spots.
- Given soils of volume change potential were encountered and Topsoil/Made Ground was noted to be deeper than 0.60m bgl, a suspended slab is required.
- Isolated Pad Foundations must be at least 1.5 times the width of the widest pad apart to keep to the anticipated settlements.
- Final designs for the foundations should be carried out by a suitably qualified Engineer based on the findings of this investigation and with reference to the anticipated loadings, serviceability requirements for the structure and the developments proximity to former, present, and proposed trees. Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping.

6.3. Piled Foundation

Based on the results of the intrusive investigation, a piled foundation scheme was unlikely to be required.

6.4. Excavations and Stability

Shallow excavations in the Made Ground and River Terrace Deposits are likely to be marginally stable at best. Long, deep excavations, through these strata and into the underlying London Clay Formation are likely to become unstable.

Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported before excavations are entered by personnel.

6.5. Sub-Surface Concrete Design

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1, 2005, '*Concrete in Aggressive Ground*' considering the pH of the soils. For the classification given below, the "mobile" and "brownfield" case was adopted given the geology encountered and the land use of the site.

Topsoil

The water-soluble sulphates in the Topsoil was noted to be 4mg/l, with a pH of 7.96, from chemical laboratory testing.

According to BRE Special Digest 1, 2005, '*Concrete in Aggressive Ground*' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the Topsoil. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1.

Made Ground

The water-soluble sulphates in the Made Ground was noted to be 4mg/l, with a pH of 8.46, from chemical laboratory testing.

According to BRE Special Digest 1, 2005, '*Concrete in Aggressive Ground*' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the Made Ground. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1.

River Terrace Deposits

The water-soluble sulphates in the River Terrace Deposits was noted to be between <4-260mg/l, with a pH of 6.81-8.29, from chemical laboratory testing. The total potential sulphate (3x total sulphur) was <0.06-0.0912%, from chemical laboratory testing.

According to BRE Special Digest 1, 2005, '*Concrete in Aggressive Ground*' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the River Terrace Deposits. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1.

6.6. Roads and Hardstanding Design

This section provides information relating to the construction of roads and hardstanding, for each strata encountered.

6.6.1. Anticipated CBR Values and Frost Susceptibility

Topsoil

Roads and hardstanding should bypass Topsoil given the likely low strength, high compressibility and general variability.

Made Ground

Where roads and hardstanding are to be founded on Made Ground, a CBR value of 1% should be adopted, as a result of the variable nature of Made Ground in terms of consistency, strength and compressibility.

River Terrace Deposits -Granular

Roads and hardstanding constructed on the granular River Terrace Deposits, should be designed based on a CBR value of 15%. This is based on reference to Table C1 of TRL1132 and average construction conditions. Based on wet conditions a CBR of 10% should be adopted, with dry conditions a CBR of 20% being applicable. Given these deposits were a mixture of gravelly sandy soils, it would be prudent to treat them as frost susceptible.

River Terrace Deposits -Cohesive

Roads and hardstanding constructed on the cohesive **River Terrace Deposits** should be designed based on a CBR value of 4.0%. This is based on reference to Table C1 of TRL1132 and average construction conditions. Based on wet conditions a CBR of 2.5% should be adopted, with dry conditions a CBR of 4.5% being applicable. The River Terrace Deposits samples that were tested had high plasticity index values and were cohesive and therefore they were probably not frost susceptible, however due to the granular content it is prudent for them to be treated as frost susceptible.

6.7. Surface Water Disposal

Soakaway testing in accordance with BRE365 was undertaken within TP1 and TP2 with the results tabulated below.

Soakaway Testing Results						
Trial Hole	Test Number	Depth (m bgl)	Start Depth (m bgl)	Finish Depth (m bgl)	Time Taken (mins)	Infiltration Rate (m/sec)
TP1	1	2.00	1.00	1.81	20	1.42x10 ⁻⁴
TP1	2	2.00	1.00	1.78	30	8.01x10 ⁻⁵
TP1	3	2.00	1.00	1.81	40	6.87x10 ⁻⁵
TP2	1	2.00	1.03	1.77	40	5.87x10 ⁻⁵
TP2	2	2.00	0.96	1.75	40	5.53x10 ⁻⁵
TP2	3	2.00	1.00	1.79	50	5.11x10 ⁻⁵

Any soakaways should be located sufficiently away from buildings and infrastructure, in order to prevent undermining of foundations.

The submission of a Sustainable Urban Drainage Scheme (SUDS) is likely to be required for this site due to the proposed development increasing the amounts of hardstanding.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources, abstractions and surface water features/watercourses.

7. CONTAMINATION RISK ASSESSMENT

7.1. Results of the Preliminary Risk Assessment

The tabulated Conceptual Site Model (CSM) developed by the Ground and Water Desk Study (ref. GWPR5268/DS/April 2023) is reproduced in section 2.8. For the complete information please see the Desk Study report.

No additional source of contamination, pathway or receptor was identified between the desk study and the ground investigation and as such, it was not necessary to modify the CSM.

In the UK, the assessment of risk from contamination follows the source-pathway-receptor (SPR) approach. For a risk to be present there must be a source of contamination, a receptor or receptors, and a pathway for contaminants to migrate or be absorbed. If there is a linkage between any given source and receptor, then a quantitative risk assessment is used to assess the significance or impact of the pollutant linkage.

7.2. Sampling Locations

The synopsis for the trial hole locations and their final depth can be seen tabulated below. A trial hole location plan is provided within Figure 5. The table also indicates whether any locations targeted a source of contamination as well as the proposed end-use. The proposed development can be seen in Figure 4.

Trial Hole Location Synopsis		
Trial Hole/Final Depth	Sampling Strategy	Proposed End-Use
BH1/20.00m	Random	Soft Landscaping
TP1/2.00m	Random	Hard Landscaping
TP2/2.00m	Random	Soft Landscaping
TP3/1.00m	Targeted – North of Rainwater storage Tank	Soft Landscaping
TP4/1.50m	Random	Hard Landscaping
TP5/1.00m	Random	Hard Landscaping

The investigation area totals approximately 50,000m² and with six sampling locations, given an unknown hotspot shape, the sampling density means that a hotspot with an area of approximately 12,500m² and a radius of approximately 35.58m would be encountered (CLR 4).

7.3. Soil Risk Assessment

Sampling depths were chosen to reflect the receptor of concern (e.g. human health, controlled waters and vegetation). Samples where olfactory or visual evidence of contamination was present underwent targeted scheduling. The remaining samples were scheduled under a random strategy. The receptors relevant to the sampling depths are tabulated below.

Summary of Receptors per Sample Depth	
Depth	Receptors
Shallow Samples (< 0.75m bgl)	- End Users (Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public - Vegetation within soft landscaped areas (shallow rooted)

	• Secondary A and Secondary Undifferentiated Aquifer (River Terrace Deposits) • Buried Concrete • Receiving landfill
Moderate Samples (0.75 – 1.50m bgl)	• Construction workers during development • Site operatives during maintenance works • Vegetation within soft landscaped areas (deep rooted) • Secondary A and Secondary Undifferentiated Aquifer (River Terrace Deposits) • Buried Concrete • Receiving landfill • Underground services (water pipes)
Deep Samples (> 1.50m bgl)	• Construction workers during development • Secondary A and Secondary Undifferentiated Aquifer (River Terrace Deposits) • Buried Concrete • Receiving landfill

Chemical laboratory testing, scheduled by Ground and Water Limited, and carried out by ALS Laboratories UK Limited, was undertaken on one sample of made Ground, One sample of topsoil and one sample of the River Terrace Deposits. The samples were subjected to a combination of analysis that comprised:

- Asbestos screen;
- Semi-metals and heavy metals incl. Arsenic, Cadmium, Chromium (incl. Hexavalent Chromium), Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc;
- Polycyclic Aromatic Hydrocarbons (PAH's) incl. Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, Benzo(ghi)perylene;
- Speciated TPH including full aliphatic/aromatic split;
- BTEX compounds (Benzene, Toluene, Ethylbenzene, Xylene) and MTBE – used as marker compounds for Volatile Organic Compounds (VOCs);

A breakdown of the number of tests undertaken for each determinand is discussed in further sections. The chemical laboratory results are presented in Appendix F.

7.3.1. Soil Assessment Criteria and Results

At the time of reporting, April 2023, the proposed development was understood to comprise the construction of a new two storey Arts and Design Building at the Barton Peveril Sixth Form College. The surrounding area around the building is to comprise hard landscaping areas. Proposed site plans are provided as Figure 4.

Based on the proposed development, the results of the chemical laboratory testing were compared to the Generic Assessment Criteria (GAC) for a '**Commercial**' land-use scenario, as this was considered the most appropriate land-use scenario.

Where a contaminant of concern's GAC varies according to the Soil's Organic Matter (SOM), the SOM recorded for each uncontaminated soil type was used to derive the appropriate GAC for each soil type. A SOM value of 1%, the most conservative value, was utilised.

A summary of the analytical results and the comparison to the determinands adopted screening value are presented in the table below and overleaf.

Soil Contamination Test Results and Screening Values					
Determinand	Number of Samples	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Adopted Screening Value (mg/kg)	Was the adopted screening value exceeded for relevant land-use scenario?
INORGANICS					
Asbestos	3	ND	ND	ND	No
Cyanide (total)	3	<1	<1	24	No
Phenols	3	<0.035	<0.035	280	No
METALS					
Arsenic	3	3.45	8.26	640	No
Boron	3	<1	<1	240000	No
Cadmium	3	<0.02	0.372	190	No
Chromium (III)	3	5.37	9.6	8600	No
Chromium (Hexavalent)	3	<0.6	<0.6	33	No
Copper	3	13.4	16.1	68000	No
Lead	3	16.8	32	2300	No
Mercury	3	<0.1	<0.1	58	No
Nickel	3	4.32	23.1	980	No
Selenium	3	<1	<1	12000	No
Vanadium	3	12.9	45.2	9000	No
Zinc	3	39.7	53.6	730000	No
TOTAL PETROLEUM HYDROCARBONS (TPHs)					
Aliphatic >C5 - C6	2	<0.01	<0.01	3200	No
Aliphatic >C6 - C8	2	<0.01	<0.01	7800	No
Aliphatic >C8 - C10	2	<0.01	<0.01	2000	No
Aliphatic >C10 - C12	2	<1	<1	9700	No
Aliphatic >C12 - C16	2	<1	<1	59000	No
Aliphatic >C16 - C21	2	<1	<1	1600000	No
Aliphatic >C21 - C35	2	<1	1.2		No
Aliphatic >C35 - C44	2	<1	<1	1600000	
Aromatic >C5 - C7	2	<0.01	<0.01	26000	No
Aromatic >C7 - C8	2	<0.01	<0.01	56000	No
Aromatic >C8 - C10	2	<0.01	<0.01	3500	No
Aromatic >C10 - C12	2	<1	<1	16000	No
Aromatic >C12 - C16	2	<1	<1	36000	No
Aromatic >C16 - C21	2	<1	<1	28000	No
Aromatic >C21 - C35	2	1.43	5.34	28000	No
Benzene	2	<0.009	<0.009	27	No
Toluene	2	<0.007	<0.007	56000	No
Ethylbenzene	2	<0.004	<0.004	5700	No
m,p-Xylene	2	<0.01	<0.01	5900	No

o-Xylene	2	<0.01	<0.01	6600	No
POLYCYCLIC-AROMATIC HYDROCARBONS					
Acenaphthene	3	<0.008	<0.008	84000	No
Acenaphthylene	3	<0.012	<0.012	83000	No
Anthracene	3	<0.016	<0.016	520000	No
Benzo(a)anthracene	3	<0.07	0.02	170	No
Benzo(a)pyrene	3	<0.075	0.026	35	No
Benzo(b)fluoranthene	3	<0.015	0.116	44	No
Benzo(ghi)perylene	3	<0.024	<0.024	3900	No
Benzo(k)fluoranthene	3	<0.014	<0.014	1200	No
Chrysene	3	<0.01	0.0817	350	No
Dibenzo(a,h)anthracene	3	<0.023	<0.023	3.5	No
Fluoranthene	3	<0.017	0.106	23000	No
Fluorene	3	<0.01	<0.01	63000	No
Indeno(1,2,3-cd)pyrene	3	<0.09	0.021	500	No
Naphthalene	3	<0.009	<0.009	190	No
Phenanthrene	3	<0.015	<0.015	22000	No
Pyrene	3	<0.015	0.0988	54000	No
MARKER FOR VOLATILE ORGANIC COMPOUND					
Methyl tert-butyl ether (MTBE)	2	< 0.01	< 0.01	7900	No
The derivation of the Soil Assessment Criteria used within this report can be seen within Appendix G. The soil concentrations were typically compared to the LQM/CIEH Suitable for Use Levels (S4UL) (2014), based upon the assumption of 1% soil organic matter. A screening value for Lead is based on the Category 4 Screening Levels (C4SLs). Where no S4UL or C4SL is available for Cyanide, a SoBRA acute GAC is assigned. Where no S4UL or C4SL is available for MTBE, a CL:AIRE 2010 GAC is assigned. Where exceedances are noted, the trial hole and depth of sample is recorded.					

The proposed development includes areas of soft-landscaping, where shallow rooted vegetation may be exposed to aggressive ground conditions. The previous table compares the results of the laboratory analysis to GAC that is protective of Human Health and therefore different GAC is required for vegetation.

Soil Contamination Test Results and Screening Value					
Determinand	Number of Samples	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Adopted Screening Value (mg/kg)	Was the adopted screening value exceeded for relevant land-use scenario?
Copper	3	13.4	16.1	100	No
Nickel	3	4.32	23.1	60	No
Zinc	3	39.7	53.6	200	No
The derivation of the Soil Assessment Criteria used within this report can be seen within Appendix G. The soil concentrations were compared to BS3882:2015 <i>Specification for Topsoil</i> and based on differing pH. For the purpose of conservatism, the pH of the soils have been assumed to be below 6 within this table. Where exceedances are noted, the trial hole and depth of sample is recorded.					

7.3.2. Soil Assessment

Chemical laboratory testing of the Topsoil, Made Ground and River Terrace Deposits did not reveal any elevated levels of determinands above the guideline levels for a 'Commercial' land-use scenario.

In addition, the intrusive investigation did not reveal any visual or olfactory evidence to suggest any hydrocarbon-type contamination in the trial holes excavated on the site. The chemical laboratory results have verified that no elevated concentrations of aliphatic/aromatic hydrocarbons (C5-C35) or BTEX compounds are present in the soils underlying the site.

Given the low levels of determinands noted during the chemical laboratory testing, it was considered that no remediation was required within the soils for the end users of the site.

Asbestos

No asbestos has been identified during the testing, however, an **Asbestos Management Strategy** should be put in place so that any potentially asbestos containing materials are identified and removed from site in a suitable manner to prevent cross-contamination.

7.3.3. Water Supply Pipe Risk Assessment

As part of the proposed development it is expected that new water supply pipes will be installed at the site. Water supply pipes have the potential to be exposed to contaminants in the ground that can lead to unacceptable concentrations within the drinking water. If a risk is identified, specialist pipes that are protective of the drinking water are required.

A pipe selection risk assessment should be submitted to the water supply company as part of the development based on the supplier's assessment criteria. An indication of whether there is likely to be a risk can be seen tabulated below, where the PE pipe thresholds are based on *UKWIR Contaminated Land Assessment Guidance, 2014*.

Pipe Selection Risk Assessment			
Determinand	PE Pipe Threshold (mg/kg)	Laboratory Analysis Range (mg/kg)	Was the Threshold Exceeded?
Total BTEX and MTBE	0.1	< 0.04	No
Total VOCs	0.5	N/A	No
Total SVOCs	2	N/A	No
Phenols	2	<0.01	No
TPH EC5 – EC10 (aliphatics and aromatics)	2	< 0.01	No
TPH EC10 – EC16 (aliphatics and aromatics)	10	<1	No
TPH EC16 – EC40 (aliphatics and aromatics)	500	6.77	No
Naphthalene	5	< 0.045	No

The results indicate that no determinands were above the threshold for the use of a PE pipe at the site.

7.4. Groundwater Risk Assessment

In the UK, the water environment is protected under a number of regulatory regimes, mainly governed by the Environment Agency. The Environment Agency is consulted when there may be a risk to Controlled Waters, or where a pollution incident has occurred historically. The Water Framework Directive is implemented in various guises covering groundwater, surface water and drinking water supply.

The soil samples analysed as part of the risk assessments in section 7.3 have been used to undertake a Level 1 (soils) Controlled Waters risk assessment. At Level 1 (soils), the conceptual site model and

the determinand concentrations of the soils are used to indicate whether the concentrations are sufficient to impact the receptor. At this stage, dilution, dispersion and attenuation along the pathway are not considered.

A study of the aquifer maps on the DEFRA website revealed the western and central areas of the site was underlain by a **Secondary A Aquifer** whilst the eastern portion of the site was underlain by a **Secondary (Undifferentiated) Aquifer** comprising the superficial River Terrace Deposits, underlain by **Unproductive Strata** comprising bedrock deposits of the London Clay Formation.

Examination of the Environment Agency records showed that the site **did not** fall within a Groundwater Source Protection Zone (SPZ) as classified in the Policy and Practice for the Protection of Groundwater.

No surface water features were present within a 250m radius of the site. The nearest surface water feature was the Monks Brook located 260m west of the site flowing in a north to south direction. A lake associated with the Lakeside country park was noted approximately 370m south of the site.

From analysis of hydrogeological and topographical maps it was anticipated that groundwater was, present within the seasonal aquifer of the superficial River Terrace Deposits. Water may be perched within Made Ground at shallower depths. It was considered that groundwater was flowing in a westerly direction toward the Monks Brook in line with local topography.

During the site investigation, Made Ground was encountered to >1.00m bgl in TP3 only. Generally, the rest of the site was comprised a topsoil overlying both cohesive and granular soils of the River Terrace Deposits overlying the London Clay Formation to the base of the borehole (20.00m bgl).

Comparison between the soil laboratory analysis and the derived Level 1 (soils) target concentrations indicate that Cadmium, nickel, and zinc were elevated and have the potential to pose a risk to Controlled Waters. It should be noted that a number of determinands at laboratory limit of detection exceed the target concentration for a Level 1 (soils) risk assessment, most notably PAHs. Where a determinand is identified at the laboratory limit of detection, no further assessment is considered necessary.

Given the Level 1 risk assessment does not consider dilution, dispersion or attenuation, the low levels of contamination noted and the conceptual site model shows the nearest surface water receptor to be the Monks Brook, ~260m west of the site, it is not expected that the soils on-site represent an unacceptable risk to controlled water receptors. No further action is considered necessary.

The findings of this risk assessment should be agreed with the Environment Agency.

7.5. Ground Gas Risk Assessment

A review of freely available information prior to site works, including historical mapping and Phase I desk study, did not identify any source of ground gas on-site or within influencing distance of the site that warranted investigation through ground gas monitoring. The only source of ground gases was anticipated to be limited Made Ground and therefore classified as 'Low risk', where the pragmatic approach to ground gas risk assessment presented within the CL:AIRE research bulletin RB17 and included within Annex D of BS8485:2015+A1:2019 can be considered.

7.5.1. Pragmatic Approach

The alternative approach to ground gas risk assessment considers the uncertainty from the measurement of ground gas concentrations and flow rates in monitoring wells for low-risk sites and removes the need for monitoring. Low risk sites typically comprise:

- Natural soils with high carbonate content (e.g. chalk);
- Natural soils that can produce gases (e.g. alluvium, peat etc.);
- Made Ground between 1.00m to 5.00m, with low organic content; and
- Areas of flooded mine workings, unless a building is to be within 20m of shaft or adit.

The method considers the gas generation potential of the soils from data that is not subject to external influences, for example atmospheric pressure can change the recorded flow and concentrations of ground gas during spot monitoring, or a rising groundwater level can displace ground gases in pore spaces. Determination of the characteristic situation is based on the total organic carbon (TOC) of the soils, coupled with any organic-rich material identified within the borehole logs, such as wood gravels. TOC is easily analysed by the laboratory and can also be calculated by the equation outlined below.

$$\text{Total Organic Carbon (TOC)} = 0.58 \times \text{Soil Organic Matter (SOM)} = 1.33 \times \text{Degradable Organic Carbon (DOC)}$$

As part of the ground investigation works, three samples, (one Topsoil, one Made Ground and one river terrace deposits) were submitted to the laboratory for analysis, which identified TOC to vary between 0.7% in the Topsoil, 0.777% in the Made Ground and 0.324% in the River Terrace Deposits. The trial hole logs identified the gravels within the Made Ground to comprise; flint, brick, bituminous material and concrete. Topsoil was generally recorded in trial holes. Made Ground was identified in one trial hole, however the depth could not be confirmed. It was >1.00m bgl.

7.5.2. Data Quality

A review was made of the quality of the available data for the site, which can be viewed in the table below. CIRIA Report C665 (2007), BS 8485:2015+A1:2019 and BS 8576:2013 stress the need for risk assessments to be based on good quality data and give guidance as to best practice in this respect.

Review of Data Quality			
Data Type	Current Understanding	UK Practice	Recommendation
Geological and hydro-geological conditions	The CSM identified the site to be located generally on limited Made Ground overlying both permeable and impermeable strata of the River Terrace Deposits. No Groundwater was encountered during the drilling/excavation process.	CIRA C665 & C659, Wilson and Card (1999) and BS 8485 recommend that geology and hydrogeology be fully understood.	The geological and hydrogeological model is understood to a standard that will not compromise the findings of the risk assessment. No further action required.
Soil Laboratory Analysis	A dataset of soil analysis from 3No. samples have identified a range of TOC concentrations between 0.324% and 0.777%. The Made Ground strata had the highest TOC concentrations.	CL:AIRE RB17 outlines an approach to ground gas risk assessment away from the influences that directly affect ground gas monitoring. It should typically be used on sites with limited sources identified in the CSM and Made	The TOC concentrations are below the limit of 6% in order to use the soil derived approach for the risk assessment. No further action required.

		Ground with average thickness <3m and maximum thickness <5m. TOC should be < 4/6%.	
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7.5.3. Risk Assessment

The intrusive investigation has revealed a maximum thickness of Made Ground of >1.00m overlying River Terrace Deposits comprising cohesive and granular soils. Site has undergone a previous phase of construction and limited degradable material has been identified. The introduction of oxygen to the Made Ground through redevelopment may lead to an initial increase of ground gas generation as degradable material within the soils present on-site may act as source of ground gas. The soils at the site are considered to be of variable permeability (low to high) in nature and pathways for ground gas migration will be present.

Using the soil derived method, it is considered that a TOC value of <1% within soil is unlikely to pose an unacceptable risk from ground gases and the site can be characterised as Characteristic Situation CS1. Any value between 1.5 and 4% warrants classification as a Characteristic Situation CS3. Any value over 4% requires investigation through ground gas monitoring. Any site with Made Ground <1.00m bgl will have a limited gas generation potential from the organic carbon present and consideration should be given to this thickness within the risk assessment.

An alternative approach for ground gas risk assessment (CL:AIRE RB17) can be considered utilising measured concentrations from soil parameters that are independent of influencing factors such as atmospheric pressure and groundwater level. Total Organic Carbon (TOC) was tested on 3No. samples with the analytical results ranging between 0.324 and 0.777%.

Based on the soil derived method outlined and the maximum TOC concentration encountered and the general risk from the CSM, the soils from site would warrant classification as **Characteristic Situation CS1**. It should be noted that this only represents the assessment from an on-site source.

7.6. Vapour Risk Assessment

The CSM did not identified a significant source of contamination that may pose an unacceptable risk to receptors through vapours.

7.6.1. Soil Assessment

The risk from vapours was considered to be low due to the very low concentrations of BTEX compounds (Benzene, Toluene, Ethylbenzene, Xylene) and MTBE, which are used as marker compounds for Volatile Organic Compounds (VOC's) and the low anticipated risk level.

7.7. Updated Conceptual Site Model

Following completion of the Phase 2 Site Investigation, the CSM, inclusive of associated risk, within Section 2.8 of this report was re-evaluated.

For ease of reference and understanding, the risks have been re-assigned within this risk assessment against three possible levels / categories, summarised in the table below.

Risk Categories used in the Tabulated CSM	
Low Risk	Regarding this potential SPR linkage, the site is considered suitable for the proposed end-use and there is not considered to be an unacceptable risk to receptors.
Moderate Risk	Regarding this potential SPR linkage, the site is suitable for the proposed end-use however remediation and/or further investigation is required.
High Risk	Regarding this potential SPR linkage, the site is not suitable for proposed end-use and there is an unacceptable risk to receptors. Urgent action required in the short term.

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(On-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Made Ground from construction/ demolition activities: - Asbestos, - PAHs, - TPHs, - VOCs, - Sulphates, and - Metals.	- Direct ingestion of soil and soil derived dust - Dermal contact of soil and soil derived dust - Inhalation of dust (indoors and outdoors) with elevated concentration of determinands - Ingestion of home-grown produce, and soils attached - Direct ingestion of groundwater - Inhalation of volatile vapour (indoors and outdoors)	Human Health - End Users (Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public	Low
	- Direct uptake of groundwater - Direct uptake of determinands in the soil	Flora and Fauna Vegetation within soft landscaped areas	Low
	- Anthropogenic (man-made) pathways - Vertical and lateral migration in permeable strata - Surface water runoff	Controlled Waters - Secondary A Aquifer and Secondary Undifferentiated Aquifer (River Terrace Deposits) - Monks Brook	Low
Gas Governor - Metals and semi metals - Phenols - Ammonia - PAHS's	Migration through anthropogenic & natural pathways	Human Health - End Users (Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public	Low – negligible
Aggressive ground conditions with Made Ground and natural ground, including groundwater: - Sulphates, - PAH/TPH.	Direct contact with aggressive ground conditions	Building Materials and Services - Buried Concrete - Underground services (water pipes)	Low
Ground gases generated by Made Ground: - Methane, - Carbon Dioxide, - Hydrogen Sulphide, and - Carbon Monoxide.	- Migration through anthropogenic & natural pathways - Inhalation of Asphyxiating gases - Explosion (methane only)	Human Health - End Users (Future site visitors) - Construction workers during development (especially in confined spaces) - Site operatives during maintenance works in confined spaces - Neighbours and public	Low
	Migration through anthropogenic & natural pathways	Building Materials and Services	Low

	Explosion (methane only)	- Buildings - Confined spaces - Underground services	
Radon	Migration	Human Health End Users (Future site visitors)	High Risk – see relevant sections for protection needed

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(Off-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Aggressive ground conditions associated with impacted groundwater; - Sulphates, - PAH/TPH.	Direct contact with aggressive ground conditions	Building Materials and Services - Buried Concrete - Underground services (water pipes)	Low

8. CONTAMINATION RECOMMENDATIONS AND REMEDIATION STRATEGY

8.1. Soils

Given the low levels of determinands noted during the chemical laboratory testing, it was considered that no remediation was required within the soils for the end users of the site.

An Asbestos Management Strategy should be put in place so that any potentially asbestos containing materials are identified and removed from site in a suitable manner to prevent cross-contamination. An asbestos survey of existing temporary classroom structures is required prior to any demolitions / site works.

8.1.1. Water Supply Pipes

The Water Supply pipe risk assessment indicated that the use of PE pipes is appropriate at the site and no further measures are required.

8.2. Groundwater

Comparison between the soil laboratory analysis and the derived Level 1 (soils) target concentrations indicate that Cadmium, nickel, and zinc were elevated and have the potential to pose a risk to Controlled Waters. It should be noted that a number of determinands at laboratory limit of detection exceed the target concentration for a Level 1 (soils) risk assessment, most notably PAHs. Where a determinand is identified at the laboratory limit of detection, no further assessment is considered necessary.

Given the Level 1 risk assessment does not consider dilution, dispersion or attenuation, and the conceptual site model shows the nearest receptor to be the Monks Brook, ~260m west of the site, it is not expected that the soils on-site represent an unacceptable risk to controlled water receptors. No further action is considered necessary.

8.3. Ground Gas and Vapours, Radon

Based on risk assessment undertaken, the site warrants classification as **Characteristic Situation CS1**. The risk from vapours was considered to be low due to the very low concentrations of BTEX compounds (Benzene, Toluene, Ethylbenzene, Xylene) and MTBE, which are used as marker compounds for Volatile Organic Compounds (VOCs) and the low anticipated risk level.

Basic radon protective measures are required for the report area.

The BGS Radon report can be viewed in Appendix I.

8.4. Discovery Strategy

There may be areas of contamination that have not been identified during the course of the intrusive investigation (e.g. underground storage tanks). Such occurrences may be discovered during the construction phases for the redevelopment of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination; this may comprise visual indicators, such as fibrous materials within the soil,

discolouration, or odours and emission. Upon discovery advice must be taken from a suitably qualified person and then the Local Authority will need to be informed.

8.5. Imported Material

Any soil which is to be imported onto the site must undergo chemical analysis to prove that it is suitable for the purpose for which it is intended.

The soil must be fit for purpose and must either be supplied with traceable chemical laboratory test certificates or be tested, prior to placing (ideally) and after placing, to ensure that the future receptors (human health and vegetation) cannot come into contact with compounds that could be detrimental to their health. The compounds that are to be tested for are those given in the Generic Assessment Criteria, which can be viewed in Appendix G of this report.

8.6. Waste Disposal

The excavation of foundations and other soils is likely to produce waste which will require classification and then recycling or removal from site.

Under the Landfill (England and Wales) Regulations 2002 (as amended), prior to disposal, all waste must be classified as either: Inert; Non-hazardous; or Hazardous.

The Environment Agency's Hazardous Waste Technical Guidance (WM3) document outlines the methodology for classifying wastes. Once classified the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

Following the investigation, 3No. samples (1No. Topsoil, 1No. Made Ground, 1No River Terrace Deposits), were submitted to the analytical laboratory to undergo a suite of testing for contamination testing, as discussed in the previous sections. Sampling depths were chosen to reflect the receptor of concern, human health, and typically comprised a surface or near surface sample and periodically to 1.00m bgl. Any horizon where olfactory or visual evidence of contamination was present was also sampled.

Based on a risk phase analysis of the chemical laboratory test results, in accordance with EC Hazardous Waste Directive and undertaken by Ground and Water Limited, all soil samples tested (Made Ground, Topsoil and River Terrace Deposits) encountered on-site were NON-HAZARDOUS. The results of the assessment are given within Appendix H.

It is important to note that whilst we consider our in-house assessment tool to be an accurate interpretation of the requirements of WM3, therefore producing an initial classification in accordance with the guidance, this method classifies soils as either non-hazardous or hazardous and landfill operators have their own assessment tools and can often come to different conclusions. As a result, some landfill operators could refuse to take apparently suitable waste. It is recommended that the receiving landfill views the results of this assessment and the chemical laboratory results to determine their own classification.

In addition to the samples described above, 1No. sample of the Made Ground was scheduled to undergo Waste Acceptance Criteria (WAC) testing with single batch leachate from samples with a range of depths. The results indicate that the sample conformed to the Inert Waste Classification.

Where contaminated soils are to be removed, they should be placed on an impermeable membrane (visqueen or similar) to ensure that no cross-contamination of soils occurs.

8.7. Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust would be generated as a result of construction activities.

The site should be securely fenced at all times to prevent unauthorised access. Washing facilities should be provided and eating restricted to mess huts.

FIGURES



Site Location



Barton Peveril Sixth Form College, Chestnut Avenue, Eastleigh SO50 5ZA

Barton Peveril Sixth Form College c/o Bidwells

April 2023

Figure 1 – Site Location Plan

GWPR5268





◇ Site Boundary

Barton Peveril Sixth Form College, Chestnut Avenue, Eastleigh SO50 5ZA

Barton Peveril Sixth Form College c/o Bidwells

April 2023

Figure 2 – Site Development Area

GWPR5268





NTS

Barton Peveril Sixth Form College, Chestnut Avenue, Eastleigh SO50 5ZA

Barton Peveril Sixth Form College c/o Bidwells

April 2023

Figure 3 – Aerial Photograph

GWPR5268





-  Site boundary
-  Trial Pit
-  Cable Percussion borehole

Barton Peveril Sixth Form College, Chestnut Avenue, Eastleigh SO50 5ZA

Barton Peveril Sixth Form College c/o Bidwells

April 2023

Figure 5– Trial Hole Location Plan

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