Earth Science Partnership

Consulting Engineers | Geologists | Environmental Scientists

Former Pontllanfraith Comprehensive School
Proposed Sports Hall

Supplementary Geo-Environmental and Geotechnical Assessment

ESP.7977.3717

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Proposed Sports Hall

Supplementary Geo-Environmental and Geotechnical Assessment

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Executive Summary

Caerphilly County Borough Council is considering the purchase of the subject site for redevelopment as a proposed Sports Hall and associated external areas. ESP have undertaken a geo-environmental and geotechnical assessment, comprising a desk study, intrusive investigation, laboratory testing and assessment of data. This report includes the Preliminary Risk Assessment and Generic Quantitative Risk Assessment (for human health and controlled waters) elements of CLR11. The key potential land quality issues identified by the assessment are summarised below:

	Potential Hazard	Anticipated Risk	Discussion
Site Setting	*Current Site Status*	-	*The site is currently occupied by the playground of the former Pontllanfraith Comprehensive School. A building is present in the southern corner, and a fence surrounds the playground prohibiting access the north and eastern parts of the site.*
	Identified Ground Conditions.	-	*The investigation has indicated shallow bedrock in the southern corner of the site with the general site model comprising Made Ground over Glacial Deposits and the Coal Measures bedrock. The presence of cut and fill slopes indicates the site have been constructed on a plateau.*
	Groundwater Conditions.	-	*The site is underlain by a Secondary A aquifer in the form of both the Coal Measures bedrock and Glacial Deposits.*
	Historical Land Use.	-	*The site remained unused until the 1960's when it was used as the playing fields for Pontllanfraith Comprehensive School. We anticipate the site has been hard surfaced since the 1970s.*
Geo-environmental	*Potential Contamination Sources*	*Low/Moderate*	*General low levels of contaminants identified, however, some supplementary works required.*
	Chronic Risks to Human Health	*Low*	*Generally low levels encountered. One elevated level of vanadium encountered but not anticpaed to pose a significant risk. Asbestos has been encountered during the 2022 investigation (see below).*
	Risks to Controlled Waters	*Low*	*Generally low risk anticipated based on historical land use, contamination encountered and development proposals.*
	Hazardous Ground Gas	*Moderate/High*	*Potential for ground gas generation from Made Ground and shallow coal mine workings. Ground gas monitrogin regime is ongoing.*
	Other Hazards	*Moderate/High*	*Given the age of the building present in the southern corner of the site, asbestos could be present. An asbestos survey is required before demolition of the building.* *Asbestos has been encountered in 2no. samples of the near surface soils and the advice of an asbestos specialist should be sought.*
Geotechnical	*Abandoned Mine Workings and/or Old Mine Entries*	*Low*	*Available investigation evidence indicates a general low risk to the site.*
	Use of non-traditional foundations	*Low/Moderate*	*Use of more conventional foundations likely to be acceptable, subject to finalisation of design and confirmation of proposed loadings.*
	Sulphate Attack on Buried Concrete	*Low*	*Laboratory testing has indicated the site is classed as AC-2z in terms of sulphate attack on buried concrete.*
	Soakaway Feasibility	-	*Soakaways are likely to be feasible in shallow bedrock but variable/non suitable in Glacial Deposits – see Section 8.0.*
Other	*UXO*	*Low*	*Low risk identified in the Preliminary UXO assessment.*
	Invasive Plants	-	*None identified.*
	Further Investigation Required?	*Yes*	*Additional works recommended.*

1 Introduction

1.1 Background

Caerphilly County Borough Council (hereafter known as the Client) are proposing to redevelop the subject site as part of the wider regeneration of the former Pontllanfraith Comprehensive School. The Earth Science Partnership Ltd (ESP), Consulting Engineers, Geologists and Environmental Scientists, were instructed by the Client, to undertake a supplementary geotechnical and geo-environmental investigation and assessment to identify and evaluate potential ground hazards which could impact on the proposed development. The site location is shown on Insert 2.

The proposed development will comprise the construction of a sports hall building, with areas of MUGA pitches, hard standing and ladnscaping. The proposed development as we understand it, is presented as Insert 1 below. Based on the above, we understand that the proposed structures would be classified as Geotechnical Category 2 (BS5930:2015).

ESP have previously undertaken an Exploratory Assessment of the site during 2018 (Ref: 6839b.3014) and whilst the proposed end use now varies from that initial investigation, the investigation information, findings and recommendations all remain pertinent. This full report (digital only) is presented as Appendix H.

Insert 1: Proposed Site Layout (Provided By Client)

1.2 Objective and Scope of Works

The objective of the investigation was to obtain information on the geotechnical character and properties of the ground beneath the site, potential risks posed by contamination and ground gas, and to allow an assessment of these ground conditions with particular reference to the potential impact on the proposed development. In addition to this, the earlier investigation idenitfed the potential presence of a historic stream in the central portion. This has also been considered throughout this assessment.

We are not aware of any ground hazard related planning conditions relating to the development.

The scope of works for the investigation was designed by mutually developed with the Client by ESP within an agreed budget, and comprised a review of all previous report information (ESP Ref: 6839b.3014), a field reconnaissance visit, trial pits, soakaway infiltration testing, rotary boreholes, geotechnical and geo-environmental laboratory testing, assessment of foundation options, risks to human health and reporting.

The contract was awarded on the basis of a competitive tender quotation. The terms of reference for the assessment are as laid down in the Earth Science Partnership proposal of 2nd September 2021 (ref: db/7977.lt.1).

This supplementary assessment focuses on the geotechnical and geoenvironmental aspects outlined in the Proposal only and does not constitute an assessment of any other conditions.

1.3 Report Format

This report includes a summary of pertinent Desk Study field reconnaissance and investgiation reports (Section 2), and details of the supplementary investigation undertaken of Eurocode EC7 and BS5930:2015 (Section 4), along with the Preliminary Risk Assessment stage (Section 3) and Generic Quantitative Risk Assessment (Section 5) of CLR11.

The assessment of the potential for hazardous substances (contamination) or conditions to exist on, at or near the site at levels or in a situation likely to warrant mitigation or consideration appropriate to the proposed end use has been undertaken using the guidance published by CIRIA (2001). This is discussed in more detail in Section 3.2.1 and in Appendix A.

1.4 Limitations of Report

This report represents the findings of the brief relating to the proposed end use and geotechnical category of structure(s) as detailed in Section 1.1. The brief did not require an assessment of the implications for any other end use or structures, nor is the report a comprehensive site characterisation and should not be construed as such. Should an alternative end use or structure be considered, the findings of the assessment should be re-examined relating to the new proposals.

Where preventative, ameliorative or remediation works are required, professional judgement will be used to make recommendations that satisfy the site specific requirements in accordance with good practice guidance.

Consultation with regulatory authorities will be required with respect to proposed works as there may be overriding regional or policy requirements which demand additional work to be

undertaken. It should be noted that both regulations and their interpretation by statutory authorities are continually changing.

This report represents the findings and opinions of experienced geo-environmental and geotechnical specialists. Earth Science Partnership does not provide legal advice and the advice of lawyers may also be required.

1.5 Digital Copy of Report

This report is issued as a digital version only.

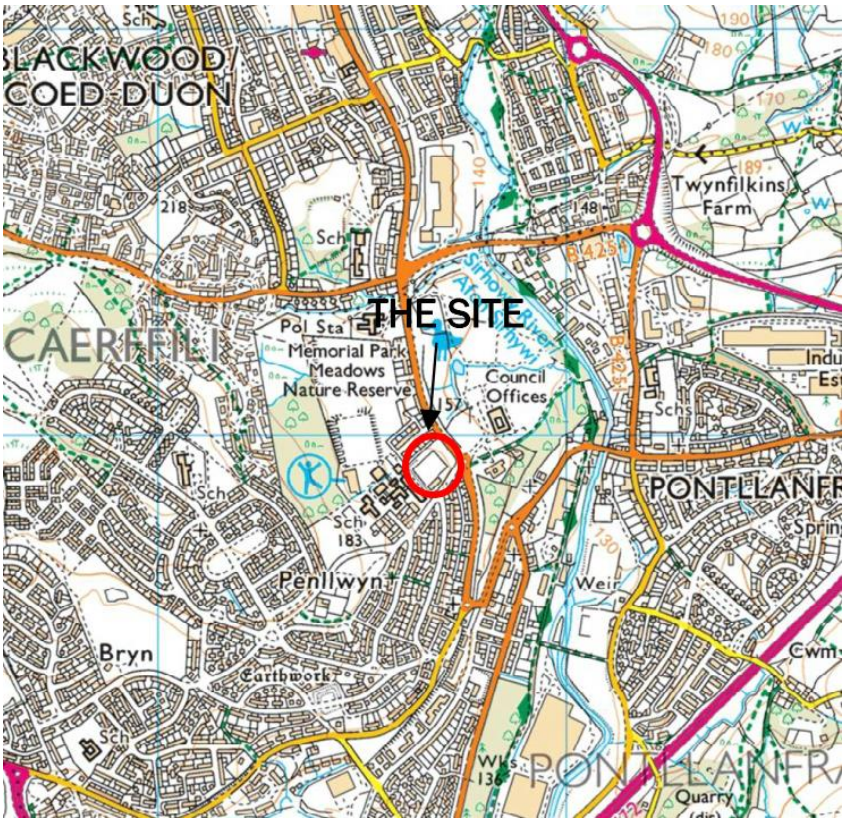
2 Desk Study Review

Full reference should be made to the previous report produced by ESP (Ref: 6839b.3014) and it included a comprehensive Desk Study. This report is presented in full in Appendix H.

Whilst it is not intended to repeat that information, pertinent data has been included below and it should be noted that only aspects associated with this current commission are included.

2.1 Site Location and Description

The site is located immediately west of Blackwood Road on the western margins of Pontllanfraith, approximately 1km south of Blackwood town centre. The National Grid Reference of the centre of the site is (ST) 317670 195930 and the postcode is NP12 2BR. A Site Location Plan is presented as Insert 2.



Insert 2 - Site Location Plan from Ordnance Survey 1:25,000 scale map.
Reproduced with permission (OS License No.: AL100015788).

The site comprises a rectangular shaped parcel of land of around 90m length (north-east to south-west) and 75m width (north-west to south-east), occupying an area of around 0.6ha. It predominantly consists of macadam hardstanding, with a fenced off grassed area in the north-east of the site, and a building associated with the former comprehensive school in the south end of the site. It is bounded by:

- To the north-east: immediately by Blackwood Road (B4251);
- To the south-east: immediately bound by residential dwellings.
- To the north-west: immediately by Penllwyn Road and further by residential dwellings.

- To the south-west: immediately by the buildings of the former Pontllanfraith Comprehensive School.

Vehicular access to the site is currently gained via a gate on the south-eastern boundary, with entry off Penllwyn Road. The boundaries generally comprise brick walls, with heavy vegetation across the south-eastern, north-eastern and north-western boundary.

2.2 Site History

2.2.1 Published Historical Maps

The site history was reviewed as part of our previous assessment (Ref: 6839b.3014) and is summarised in Table 1 below.

Table 1 - Review of Historical Maps

Date	On-Site	In Vicinity of Site
1879 – 1885	Site is unoccupied and is part of an open field.	A north- south trending railway line if present immediately to the east (Sirhowy branch of Great Western Railway). An associated slope cutting is present on the western side of the railway, along the whole of the north-eastern margin of the site. A track extends north-east – south-west immediately to the south-east. The following collieries are present in the area: • The disused Pen-llŵyn Pit (coal) is present some 300m to the south-east. • New Tir-Philkins Colliery is present some 600m to the east. • Tir-Philkins Colliery present some 1km to the north-east. • Low Plas Colliery some 900m to the north. A stream is present to the west boundary and trends approximately north east to south west past the site. The Sirhowy River extends roughly north-south some 300m to the east.
1901-1902	No significant changes identified.	Lower plas colliery and Tir-Philkins Colliery are now disused. Development of residential dwelling on Bryn Hyfryd immediately to the north-west.
1920-1922	No significant changes identified.	Blackwood Road present extending parallel to the railway way. New Tir-Philkins Pit is now disused. Old Coal Shaft present near Coed Pen-llwyn wood some 600m to the north-west.

1953-1962	Site is now the playing field of the adjacent Pontllanfraith Grammar-Technical School. Tennis court is present in the southern corner of the site. Trees are indicated on the south-eastern, north-eastern and north-western boundary.	Pontllanfraith Grammar-Technical School now present immediately to the south-west. Slope cutting indicated along the north-western boundary. Bench mark of 513.60ft (156.5m) indicated immediately to the north-east.
1971-1975	Building now indicated to be present in the place of the former tennis courts. Tennis courts are now indicated to occupy most of the site.	The railway is no longer indicated.
1980	No significant changes identified.	An embankment indicated along the north-eastern boundary. The stream to the west is no longer indicated but still identified to the north east and south west, suggesting it has been culverted.
1980-present day	No significant changes identified to the present day.	No significant changes identified to the present day, with the site now recorded as Pontllanfraith Comprehensive School.

2.2.2 Archaeological Setting

A full archaeological assessment was not included within the brief, but we have not been advised of, or identified, any obvious evidence of any significant archaeological features on the site.

2.2.3 Ecological Setting

An full ecological assessment was not included within the brief, but we have not been advised of, or identified, any obvious evidence of any significant ecological features on the site.

2.3 Hydrology

2.3.1 Surface Water Features

The nearest major surface water feature to the site is the Sirhowy River (classified as a Secondary) which flows from north to south approximately 350 m to the east. A number of streams and brooks are also present in the area, with a stream indicated to be present crossing the site. This is likely to represent the stream identified at the west boundary and indicated to be culverted from the early 1980s.

2.4 Geology

2.4.1 Published Geology

The published 1:10,560 scale geological map for the area of the site (Sheet ST15NW) indicates the site to be underlain by bedrock of the Grovesend Formation Sandstone, part of the Upper Coal Measures.

The published 1:50,000 scale geological map for the area of the site (Sheet 249), available on the website of the British Geological Survey, 2018) indicates the site to be underlain mostly by 'Boulder Clay' with some 'Glacial Sand and Gravel' encroaching the eastern margin of the site.

These superficial deposits are overlying bedrock of the overlying bedrock of the Upper Coal Measures.

Reference to the up-to-date mapping available on the website of the British Geological Survey (BGS, 2016) indicates a similar succession, but the 'Boulder Clay' has been renamed Diamicton and the Glacial Sands and Gravels have been renamed 'Glaciofluvial Deposits'.

The Glacial Diamicton superficial strata would be expected to be fine-grained in nature with some gravel, and possibly cobbles and boulders. The Glaciofluvial Deposits would be anticipated to be coarse-grained in nature, predominantly composed of sand and gravel. The Grovesend Beds bedrock is indicated to be dominated by sandstone, with coal seams and associated seat earths.

An unnamed coal seam is inferred to crop out some 300m to the south east of the site. A shaft record for the 'Penllywn Pit' is also present near this outcrop and indicates a depth of 75ft (around 22m) to the Upper Mynyddislwyn.

The geological map indicates the bedrock in the area dips between 10 and 15° to the south. The bedrock in the area is heavily faulted, with the site positioned in a fault block with two NE-SW trending faults inferred to the north-west and south-east respectively, and a further two NW – SE trending faults to the north-east and south-west respectively. The nearest of these faults is inferred to extend roughly NE-SW some 80m to the north-west.

The sequence of Upper Coal Measures in the area, comprise a series of coal seams, alternating with Mudstones and Sandstone. The vertical section presented on Sheet ST19NE indicates the Mynyddislwyn Seam to be present and approximately 5' 9" in thickness (~1.8m). The Mynyddislwyn is vertically succeeded by the "Small Rider" approximately 28m above, a number of thin coals and unnamed coals and the "Big Rider" approximately 86m above the Mynyddislwyn.

2.4.2 Available BGS Borehole Records/Previous Investigation

Reference to the website of the British Geological Survey (BGS, 2016) indicates the available records of 1no. borehole on the site, and a further 5no. boreholes across the wider school site. Copies of the available borehole records along with a plan showing their positions relative to the site are presented in Appendix E.

The borehole records indicate the following:

- ST19NE/1- Cable percussion borehole drilled in the southern corner of the site indicating topsoil from ground level to 2'6" (~0.76m), over a firm to very stiff sandy silty clay to 7'0" (~2.1m), with Sandstone to the base of the borehole at 8'9" (~2.7m).
- ST19NE/2 to 6 – Cable percussion boreholes drilled across the larger school site, indicating a similar succession to ST19NE/1, with the depth to the sandstone bedrock varying 7'6" (2.3m) and 23' (7.0m).

2.5 Hydrogeology

2.5.1 Aquifer Classification

Reference to the aquifer maps published in the environmental data report (see Appendix H) indicated that the superficial deposits beneath most of the site (Glacial Diamicton) are classed as Unproductive Strata, the Glaciofluvial Deposits which encroach on the eastern margin of the site

are classified as a Secondary A aquifer. The bedrock (Grovesend Beds Sandstone) is classed as Secondary A.

2.5.2 Anticipated Groundwater Bodies

Based on the available information, we consider that the shallowest main groundwater body is likely to be located within the Grovesend Beds strata across most of the site, with a possible groundwater body in Glaciofluvial Deposits on the eastern margin. During the previous phase of investigation works (Ref: 6839b.3014 – see Appendix H), groundwater was encountered withn these strata (see Section 4.0).

2.6 Environmental Setting

A full assessment of environmental setting was made in our previous report (Ref: 6839b.3014) as presented in Appendix H. As part of that assessment, a number of salient environmental features were identified, including potentially infilled land, past potential contaminative uses, and the presence of historical tanks, petrol filling stations and energy facilities. Historical maps indicates the following on the above salient features:

Early editions of the OS mapping show a cutting on the railway (later turned into Blackwood Road) across the length of the north-eastern boundary. Later versions don't show this feature, indicating the potential presence of a retaining wall along this boundary. Material would be placed behind the wall to a suitable level.

The 1980 historical map indicates the presence of an embankment along the north-eastern boundary. A cutting is shown on the south-western boundary. This embankment could be fill material from this cutting, but intrusive investigation is required to determine the nature of the embankment fill.

A historic stream is recorded at the west boundary until the 1980s but continues to be recorded to the north east and south west of the site, indicating it has been culverted. The Envirocheck report also identifies the presence of a stream/water body trending west to east across the site, whilst, this is not recorded on other mapping and is a disparity with other historical information, it will need to be considered further as potentially present.

2.7 Preliminary Geotechnical Risk Register

A full assessment of geotechnical hazards was made in our previous report (Ref: 6839b.3014) as presented in Appendix H. Pertinent/resultant risks are discussed further below and their likely risk updated following the previous phase of investigation.

2.7.1 Past Coal Mining

As discussed in Section 2.6, the site is underlain by bedrock of the Grovesend Beds of the Upper Coal Measures, which contains several seams of coal (and bands of ironstone).

Mine shaft details from the Penllwyn Pit presented on the geological map for the area (ST19NE) indicate the presence of the Upper Mynyddislwyn is present 75ft (22m) below the surface some 350m to the south-east. There is also the inferred presence of an unnamed coal seam at the same location.

Reference to the Coal Authority website (2018) provided the following salient information:

- The site lies within a 'Development High Risk Area'.
- The site lies within an area of 'Past Shallow Coal Mine Workings'
- A mine entry is present some 300m to the south-east, within the above mentioned area of 'Past Shallow Coal Mine Workings'.
- A outcrop of coal is shown some 300m to the south-east.

A mining report indicated that based on the available Coal Authority records:

- The property is in the likely zone of influence from workings in 1 seams of coal at shallow depth and last worked in 1825.
- The property is not within a surface area that could be affected by present underground mining.
- There are no known coal mine entries within, or within 20m of, the boundary of the property. There may however be mine entries/additional mine entries in the local area which the Coal Authority has no knowledge of.
- The property is not in an area which is earmarked/being considered for future underground working. However, reserves of coal exist which could be worked at some time in the future.
- No notice has been given, under section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.
- In view of the mining circumstances, a prudent developer would seek appropriate technical advice before any development works are undertaken.

In summary, it was concluded that there was a risk posed by shallow coal seams and/or historical mining and a coal mining investigation would be prudent.

2.7.2 Shrinkable and Swelling Soils

The Glacial Diamicton soils anticipated at shallow depth beneath the site can have a intermediate plasticity index and, hence, are often classified as of potential moderate volume change potential with changes in moisture content (shrinkage and swelling). It was determined that the risk posed by shrink/swell was **Moderate** and some further assessment as part of supplementary works would be warranted.

2.7.3 Compressible Ground

Due to the presence of Made Groud, histrocial development and fill associated with emabankments etc it was considered that the potential for compressible ground at the site was **Moderate.**

2.7.4 Pyritic Ground (include in all reports)

Glacial Diamicton anticipated beneath the site may also contain elevated levels of pyrite. Whilst generally low levels were encountered during the previous phase of investigation due to coverage across the site the risk was determined to be **Moderate** and some further assessment as part of supplementary works would be warranted.

2.8 Summary of Previous Investgiation

As part of our previous assessment (Ref: 6839b.3014 - 2018) ESP undertook a series of trial pits and soakaway tests, with these locations shown on the enclosed Figure 2.

A ground model was identified comprising Made Ground over fine and coarse Glacial Deposits, with bedrock (Grovesend Formation) identified in in the base of some trial pits. Infiltration testing identified vriable infiltration rates, with “failed” tests in some locations.

Laboraotry testing did not identify any exccedances of the then utilised guidliene values and no asbestos was detected in samples submitted to the laboratory.

Our full previous report is presented in Appendix H and pertinent ground model information and laboratory data has been assimilated into this report.

3 Current Geo-Environmental Risk Assessment

3.1 Phase One Conceptual Site Model

3.1.1 Background

The previous phase of works (Ref: 6039b.3014), see Appendix H, identified and compiled a risk assessment of source, pathway and receptors for possible contamination at the site. The following sections summrise these risks, including information obtained as part of the preliminary assessment and culminates in the presentation of resultant risks from the preliminary assessment in Table 2 below.

3.1.2 Potential Sources of Soil/Water Contamination

Although no contaminative former use has been identified for the site, it was anticipated that the site is likely to have been filled to some extent to create a level surface for use as a sports yard/court, with cut and fill slopes identified on the available historical maps. The current extent and nature of the filling is unknown.

3.1.3 Potential Sources of Hazardous Ground Gas

Depending on the source and amount of degradable organic content in the material used as fill on the site, it was determined that Made Ground could be a source of noxious and combustible ground gas, in addition to this, the potential presence of shallow coal seams can also cause a ground gas risk. To further assess this aspect, ground gas monitoring was recommended and is currently underway as part of the supplementary investigation (see Section 4.0).

3.1.4 Potential Sources of Radon

The risk from radon was identified to be low and no radon protection measures are required for development.

3.1.5 Potential Receptors

As discussed in Section 1.1, the proposed site development will comprise a sports hall, with outside MUGA pitches, landscaped areas and vehicle parking. It is our understanding that the centre will be staffed, and visited by children.

The site is located above a Secondary A Aquifer in the Coal Measures bedrock, and the Glaciofluvial Sand and Gravel which is indicated to encroach slightly on the north-eastern boundary.

Given the above, we consider that the most vulnerable receptors with regards to any contamination or hazardous ground gas present are likely to be as follows.

- Future employees and site visitors (children visiting the centre), the critical receptors being young children using the outside areas and long term employees of the centre.
- Construction and maintenance workers.
- Buried concrete (foundations, drainage etc.).

- The groundwater within the Coal Measures and Glaciofluvial Sand and Gravel strata beneath the site (classified as Secondary A aquifers).

3.1.6 Potential Migration Pathways

Based on the Conceptual Site Model discussed in the previous sections, the following are considered the most likely migration pathways with regard to any contamination or hazardous ground gas present beneath the site.

Site Users:

- Ingestion of soils and inhalation of dust in landscaping areas.
- Ingestion of edible plants and dust associated with such plants.
- Dermal contact with contaminated soils.
- Exposure to asbestos containing materials within the shallow soils.
- Potential explosive risk from flammable ground gas/vapours from on-site sources.
- Potential risk from toxic ground gas/vapours from on-site sources.

Construction and Maintenance Workers:

- Exposure to asbestos containing materials within the existing buildings.
- Exposure to asbestos containing materials within the shallow soils.
- Ingestion of soils and inhalation of dust across site.
- Dermal contact with contaminated soils.
- Potential explosive risk from flammable or toxic ground gas/vapours from on-site sources.

Groundwater:

- Leaching of mobile contaminants into the water-bearing strata within the bedrock.

Buildings:

- Sulphate attack on buried concrete (foundations, drainage etc.).
- Potential explosive risk from flammable ground gas/vapours from on-site sources.

3.2 Preliminary Risk Evaluation & Plausible Pollutant Linkages

The land use history of the site and surrounding area, as established from the desk study and previous investigation, has identified a number of potential contamination linkages due to ground conditions or former operations either on, adjacent to, or in the vicinity of the site.

3.2.1 Introduction to Risk Evaluation Methodology

The methodology set out in CIRIA C552 *Contaminated Land Risk Assessment – A Guide to Good Practice* (Rudland et al, 2001), has been used to assess whether or not risks are acceptable, and to determine the need for collating further information or remedial action.

Whilst at a later stage, this methodology may be informed by quantitative data (such as laboratory test results) the assessment is a qualitative method of interpreting findings to date and evaluating risk. The methodology requires the classification of:

- The magnitude of the potential consequence (severity) of risk occurring (Table A1 in Appendix A):
- The magnitude of the probability (likelihood) of risk occurring (Table A2 in Appendix A).

The classifications defined above are then compared to indicate the risk presented by each pollutant linkage, allowing evaluation of a risk category (Tables A3 and A4 in Appendix A). These tables have been revised slightly from those presented in CIRIA C552, to allow for the circumstances where no plausible linkage has been identified and, therefore, no risk would exist.

The following sections summrise these pertinent risks, including information obtained as part of the preliminary assessment and is presented in Table 2 below.

3.2.2 Tabulated Preliminary Risk Evaluation & Plausible Pollutant Linkages

Table 2: Preliminary Risk Evaluation & Plausible Pollutant Linkages (PPL)

Source	Pathway	Receptor	Classification of Consequence	Classification of Probability	Risk Category	Further Investigation or Remedial Action to be Taken
Potential contaminants in shallow soils	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Site Users (employees and children)	Minor – levels of contaminants below adopted GAC's[2]	Low Likelihood[1]	Low Risk (based on tested samples)	Low risk in samples tested, however sampling of inaccessible areas required to characterise the site as a whole.
	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Construction/ Maintenance Workers	Minor – standard PPE likely to be sufficient	Low Likelihood[1]		
	Leaching of soil contaminants	Impact on Groundwater (Secondary A aquifer)	Medium – site lies on Secondary A Aquifer	Low Likelihood[1]	Moderate/Low Risk	Low risk in samples tested, however sampling of inaccessible areas required to characterise the site as a whole.
	Leaching of soil contaminants	Impact on Sirhowy river	Medium – site lies adjacent to river	Unlikely[1]	Low Risk	
Asbestos in existing building	Ingestion of fibres	Demolition Workers/ Ground Workers	Medium – potential for chronic levels	Likely[2]	Moderate Risk	Asbestos survey of existing building
Asbestos in shallow soils	Ingestion of fibres	Construction/ Maintenance Workers	Medium – potential for chronic levels	Low Likelihood[1]	Moderate/Low Risk	No asbestos identified in samples tested to date – further sampling required in inaccessible areas.
Soil sulphate and pyrite	Aggressive groundwater	Buried Concrete	Mild – damage to structures	Unlikely[1]	Low/Moderate Risk	Low risk in samples tested, however sampling of inaccessible areas required to characterise the site as a whole.
Hazardous ground gas/vapours	Asphyxiation/poisoning. Injury due to explosion.	Site Users/Visitors.	Severe – acute risk.	Low Likelihood[3]	Moderate Risk	Install and monitor gas wells.
	Damage through explosion.	Building/Property	Severe – acute risk.		Moderate Risk	
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance Workers.	Severe – acute risk.		Moderate Risk	
Radon gas	Migration into Buildings	Site Users (employees and visitors)	Medium – potential for chronic levels	Unlikely	Low Risk	No protection measures required.

Notes:
1. Supplementary assessment required in areas not yet investigated.
2. Asbestos may be present in existing on site building.
3. Presence of Made Ground and potential for underground coal seams/historic workings, requires further consideration.

4 Supplementary Investigation (2022)

4.1 Investigation Points

4.1.1 Introduction

The intrusive investigation was undertaken between 7th and 14th April 2022 in accordance with BS5930:2015 and BS10175:2017, and was designed to investigate both geo-environmental and geotechnical hazards identified in the desk study and previous assessment (see ESP report Ref: 6039b.3014). It comprised trial pitting, soakaway infiltration testing and rotary boreholes, supplemented with laboratory testing, ground gas monitoring and assessment.

The exploratory holes were supervised and logged by an engineering geologist in general accordance with BS5930:2015, BS EN ISO 14688-1:2002, BS EN ISO 14688-2:2018, and BS EN ISO 14689:2018, along with published weathering schemes.

Descriptions and depths of the strata encountered are presented on the trial pit records in Appendix B, rotary boreholes records in Appendix C and infiltration records in Appendix D. The investigation point positions from this 2022 investgiation are shown on Figure 1. For completeness, the exploratory positions from 2018 are shown on the enclosed Figure 2.

The ground levels indicated on the investigation point records are approximate only and have been interpolated from online digital mapping. The coordinates shown on the investigation point records are approximate only and have been interpolated from recent Ordnance Survey maps.

4.1.2 Investigation Strategy

The investigation strategy was generally designed in accordance with BS10175:2017, in order to further investigate the hazards identified during the 2018 investigation and to explore areas previously not investigated and the potential presence of a historic stream.

Prior to this phase of works (2022), the Client provided a series of previously unavailable services records and GPR utility survey. These plans showed the potential for a historic drain trending south west to north east across the site, from the existing school building (and assumed to a wider drainage network). As it was not possible to visual identify this service, a clear stand off was implemented.

4.2 Trial Pits (2022)

10no. trial pits (TP201 to TP210) were excavated across the site between the 12th and 14th April 2022 using a wheeled, back-acting hydraulic excavator. The trial pits were excavated to depths of between of 1.2m and 3.5m. Where necessary tarmacadam and concrete surfaces were broken out prior to the excavation of the pits using a hydraulic breaker. The trial pit records are presented as Appendix B.

Disturbed samples were collected from the trial pits for laboratory testing. In situ measurements of the undrained shear strength of fine-grained soils at shallow depth were taken using a calibrated hand vane.

On completion, the trial pits were backfilled with arisings in layers compacted with the excavator bucket, the tarmacadam surface was not reinstated. Upon request from the Client, ESP returned to site and undertook further reinstatement to recompact and level off the investigation points.

4.3 Soakaway Infiltration Testing (2022)

Soakaway infiltration tests were undertaken in general accordance with BRE Digest 365 in 4no. selected trial pits across the site (TP201 to 204), with these preferred positions communicated to ESP by the Client. We understand that these positions were identified by a 3rd Party who is undertaking the drainage design for the Client. The results of the infiltration testing, and the calculated infiltration rates, are presented in Appendix D.

The infiltration rate is calculated from the time taken for the water to fall between the 75% and 25% full level. Where insufficient time is available for the water level to fall to the 25% full level, but a significant drop in water level was recorded, the infiltration rate can be estimated by extrapolating the test results. However, where the water level only dropped marginally during the available test period (e.g. not as far as the 75% full level), we consider that there is insufficient data to allow a valid extrapolation with any confidence and no infiltration rate can be estimated.

With regard to the site specific testing, in three locations, no positive infiltration was recorded over consecutive days and so were designated as "failed". Successful testing was identified in the fourth pit (TP202) with sufficient time and water available to repeat the tests.

Herras fencing was erected around the test pits during the testing as the pits were left open over night. On completion of the testing in each pit, any remaining water was removed from the test pit and it was backfilled with the excavated arisings.

4.4 Rotary Boreholes (2022)

6no. 100mm diameter rotary percussive open-hole drillholes (BH201 to BH205 including BH205a), were constructed to depths of between 5m and 40m between 7th and 11rd April 2022. BH205a was implemented only to allow the construction of a monitoring installation, as it was not possible to securely construct a monitoring installation in the primary BH205. The borehole records are presented as Appendix C and their positions are shown on Figure 1

At the commencement of each borehole, the surface tarmacadam was broken out and a service inspection pit excavated by hand to a depth of 1.2m.

The ODEX 115 system of simultaneous drilling and casing was used in the superficial deposits, and the depth of casing in each drillhole is shown on the drillhole records.

Given that the objective of the drillholes was to intercept coal seams/workings, they were constructed under license to the Coal Authority (Permit ref. 24713). In accordance with Coal Authority requirements, given the proximity to occupied properties, water was used as a flushing medium to keep the drill bits cool and return chippings to the surface, and the levels of ground gas were recorded at the drillhole during the drilling works.

The drillholes were constructed with the objective of locating the rock-head profile and the depth to coal seams or possible abandoned workings. During the drilling process, the rock chippings returned to the surface were described by the driller and the rate of progress monitored. It should be noted that, although adequate for identification purposes, the nature of the drilling method does not permit an accurate description of the strata.

On completion, the boreholes were either backfilled with bentonite below rockhead and arisings above as required by the Coal Authority or with monitoring instrumentation as detailed in Section

4.5. Below the instrumentation, the drillhole was backfilled with bentonite as required by the Coal Authority.

4.5 Monitoring Instrumentation

A 50mm diameter monitoring well was installed in selected boreholes in accordance with BS8576:2013 in order to allow monitoring of hazardous ground gases. The wells, comprising slotted plastic pipe with a gravel surround (the response zone), bentonite seals above and below the response zone, and a lockable vandal proof cover, were installed as detailed on the borehole records and summarised in the table below.

Table 3: Gas Well Installations

Well ID	Date of Installation	Response Zone depth	Response Zone Stratum
BH203	08/04/2022	1.0 – 5.0m	Made Ground/Superficial Deposits
BH204	08/04/2022	1.0 – 6.0m	Made Ground/Superficial Deposits
BH205a	11/04/2022	1.0 – 5.0	Made Ground/Superficial Deposits

Notes:
1. Details of each monitoring well are presented on the individual borehole records (Appendix C)

Monitoring of the installed gas wells is to be undertaken on 6no. occasions, fortnightly, with the results being presented as an addendum on completion.

During each visit, Gas Data LMSxi G3.18e portable monitoring equipment is used to measure levels of the following ground gases within the airspace in the wells and the flow rates from the wells:

- Methane - total and percentage of Lower Explosive limit (LEL);
- Carbon dioxide;
- Oxygen; and
- Hydrogen sulphide.

The percentage of nitrogen is also calculated by difference. The equipment uses infra-red methane (CH_4) and carbon dioxide (CO_2) detectors, coupled with pressure (barometric and well), temperature and flow sensors.

Following measurement of gas levels and flow rates, the well cap is removed, and groundwater levels were measured using a dipmeter from the site surface.

4.6 Sampling Strategy

4.6.1 Soil Sampling

Soil samples were collected from the exploratory holes as discussed in the previous sections. A non-targeted, random sampling strategy was used to obtain representative information on soil contamination across the site as a whole. However, a number of constraints were imposed on the available sampling locations by existing buildings and fenced off in the northern area of the site.

Environmental samples (denoted as ES on the exploratory holes records) were collected for possible geo-environmental laboratory testing and generally comprised a plastic tub, an amber

glass jar. The sample containers provided clean by the testing laboratory appropriate for the proposed testing to be scheduled. Immediately after collection the samples were placed in sealed cool boxes with ice packs where they remained during storage and transport to the laboratory.

Samples for logging and geotechnical laboratory testing purposes were collected at regular intervals within the exploratory holes.

4.6.2 Soil Sample Quality

Samples of soil recovered from investigations are classified as Classes 1 to 5 in terms of quality and depend on the investigation and sampling method, the particle size of the strata sampled, and the presence of groundwater. Class 1 and 2 samples are those in which there has been no or only slight disturbance of the soil structure, with moisture contents and void ratios being similar to the in-situ soil. Class 3 and 4 samples contain all the constituents of the in-situ soil in their original proportions, and the soil has retained its original moisture content, but the structure of the soil has been disturbed. In Class 5 samples, the soil structure and original layering cannot be identified and the water content may have changed from that in-situ. The category and class of samples are discussed further in BS EN ISO 22476:2006, EN 1997-2:2007 and BS5930:2015.

In general terms, disturbed samples recovered from trial pits (bulk bags and small tubs) are classed as Class 3 (if dry), Class 4 (fine soil below the water table), or Class 5 (coarse soils from beneath the water table).

4.7 Evidence of Site Hazards Found During Site Works

With regard to potential hazards identified in the desk study and Preliminary Risk Assessment, the following observations were made.

4.7.1 Site Stability

No evidence of geotechnical hazards were identified in the exploratory holes and no significant spalling/unravelling of trial pit sides was noted. However, it should be noted that due to the presence of a building on the site, certain areas were inaccessible during the time of the site works.

The environmental report obtained in 2018, identified the potential for a stream at the west boundary trending south west to north east. During both phases of work (2018 and 2022), no evidence of this stream/culvert has been identified and it may be a misrepresentation of the stream/culvert that is recorded on historical mapping at the north boundary.

4.7.2 Site Evidence of Contamination

Hardstanding tarmacadam was encountered across most of the site, with up to 1.5m of Made Ground/reworked ground in the west/north west portion of the site. No evidence of obvious extraordinary contamination was noted during this phase of works.

4.8 Geotechnical Laboratory Testing

Geotechnical laboratory testing was undertaken on samples from the suitable quality classes recovered from the exploratory holes in order to obtain information on the geotechnical properties on the soils beneath the site.

The following tests were undertaken by a UKAS accredited laboratory on samples selected by ESP in accordance with the methodologies presented in BS1377:1990. The results are presented in Appendix J.

- Natural moisture content.
- Atterberg limits.
- Particle size analysis.

Selected samples were also analysed for soil sulphate and pH value in accordance with the analytical methods specified in BRE Special Digest SD1 (BRE, 2005). The results of some sulphate testing are included with the geo-environmental test results in Appendix E.

4.9 Geo-environmental Laboratory Testing

Laboratory testing has been undertaken to identify the levels of selected contaminants within samples of shallow soil. The geo-environmental analyses were carried out by a UKAS accredited testing laboratory with detection limits being generally compatible with the relevant guideline values adopted in the assessment (see Section 4.1.1).

The general suite of geo-environmental laboratory testing undertaken comprised:

- Arsenic, barium, beryllium, boron, cadmium, total chromium, chromium VI, copper, lead, mercury, nickel, selenium, vanadium, zinc;
- US EPA 16 polyaromatic hydrocarbon (PAH) compounds;
- Total monohydric phenols;
- Total cyanide, asbestos qualitative screen (presence or absence);
- Soil organic content, pH value;

The geo-environmental soil test results are presented in Appendix F.

5 Development Of The Revised Conceptual Model

5.1 Geology

The exploratory holes undertaken over both phases of work have identified the site to be generally underlain by a tarmacadam surface with associated subbase, a fine-grained Made Ground over variable Glacial Diamicton deposits and sandstone bedrock of the Coal Measures. These strata are discussed in more detail in the following sections.

Made Ground: encountered to a maximum depth of 1.5m as a firm to stiff dark brownish grey clay with occasional man made fragments identifed. The Made Ground is spatially variable, with the layer generally thicker in the northern half of the site to the south.

Fine-grained Glacial Diamicton: encountered beneath the Made Ground (in the northern half of the site) to a maximum depth of 3.4m (TP08 - 2018) as an orange brown and grey firm to stiff slightly gravelly clay with occasional cobbles. Gravel is sub rounded to rounded sandstone. Occasional decomposed roots and rootlets.

Results of laboratory testing during the 2018 works, undertaken on the fine-grained Diamicton indicated liquid limits between 31 and 46%, plasticity indices between 15 and 18%, and natural moisture contents between 13 and 26%. The modified plasticity indices (after the coarse-grained particles have been removed) suggest that the soils are generally of intermediate to low plasticity.

Results of laboratory testing from these 2022 works, undertaken on the fine-grained Diamicton indicated liquid limits between 33 and 44%, plasticity indices between 16 and 19%, and natural moisture contents between 13 and 27%. The modified plasticity indices (after the coarse-grained particles have been removed) suggest that the soils are generally of intermediate to low plasticity.

Particle size distribution testing (2022) of the more fine grained soils (TP201 and TP204) has indicated these soils to comprise between 46 and 62% silt and clay size particles.

Coarse-grained Glacial Diamicton: encountered beneath the fine-grained Glacial Diamicton to a maximum depth of 7.5m, below the fine grained deposits, as either a:

- Probably medium dense orange brown clayey slightly sandy gravel with some cobbles. The gravel and cobbles are rounded to surrounded sandstone. Occasional pockets of firm grey clay.
- Probably medium dense dark brown clayey sandy gravel with some cobbles. Arising in this strata are wet.

Results of laboratory testing during the 2018 works, have indicated the coarse-grained glacial soils to comprise between 63% and 65% sands and gravels. Based on our observations on site, these proportions would appear representative of the in-situ soils.

Results of laboratory testing from these 2022 works, have indicated the coarse-grained glacial soils to comprise between 54% and 74% sands and gravels. Based on our observations on site, these proportions would appear representative of the in-situ soils, with the lower proportions of coarse material.

SPT testing was undertaken in three boreholes (BH203 – BH205) which were located below the proposed Sports Hall. Throughout the superficial deposits, below depths of 1.2m, SPT ‘N’ values of between 7 and 50 were recorded with most results recorded between 12 and 29. The lowest value of 7 was recorded in one location only (BH204 – 1.5m).

Grovesend Beds Bedrock (Coal Measures): encountered below the superficial deposits across the site.

In trial pits, the bedrock was excavated as tabular angular cobbles and boulders with some clayey gravel. Within the rotary boreholes, the drillers description has identified the bedrock to comprise competent alternating mudstone/sandstone with some coal seams encountered (see Table 4).

Table 4: Sumary of Borehole Investigation

BH ID	Borehole Depth (m)	Depth to Rockhead (m)	Depth to Seam 1 (m) and thickness	Depth to Seam 2 (m) and thickness	Depth to Seam 3 (m) and thickness
BH201	32.0	1.5	8.0* (0.3m)	23.0 (0.4m)	26.0* (0.2m)
BH202	24.50	2.2	-	23.7 (0.2m)	-
BH203	35.0	5.2	-	-	-
BH204	40.0	7.5	-	-	-
BH205	40.0	5.5	-	23.2 (0.3m)	32.2 (0.2m)
BH205a	5.0	Undertaken within superficials only to allow monitoring well installation.			
Notes To Table: * Coal recorded as “traces only.					

5.2 Hydrogeology

5.2.1 Groundwater Bodies

During the 2018 works, some occurrence of groundwater was recorded as identified on Table 5 below. During the 2022 investigation, no evidence of groundwater was recorded.

Table 2 - Summary of Groundwater Ingress in the Investigation

Hole ID	Stratum	Comment on groundwater encountered
TP01	Grovesend Beds – Sandstone	Seepage at the base of the pit (1.5m)
TP02	Grovesend Beds – Sandstone	Seepage at the base of the pit (2.8m)
TP03	Coarse -grained Glacial Diamicton	Moderate inflow at 2.7m
TP05	Coarse -grained Glacial Diamicton	Seepage at 2.6m

5.2.2 Hydraulic Gradient

Monitoring of long-term groundwater levels is being undertaken as part of the ground gas assessment and will be reported on completion. However, based on the site setting and available information, we consider that the hydraulic gradient beneath the site is likely to be towards the north.

5.3 Site Instability

5.3.1 Global Site Stability

The Preliminary Geotechnical Risk Register (Table 3) identified the possible presence of unstable ground. However, no evidence of any global instability was identified during the areas investigated as part of this work.

It should be noted, that the existing buildings on-site, and fence around the playground prohibited access to some areas. These areas would require investigation when available.

In addition to this, the environmental report obtained in 2018, identified the potential for a stream at the west boundary trending south west to north east. During both phases of work (2018 and 2022), no evidence of this stream/culvert has been identified and it may be a misrepresentation of the stream/culvert that is recorded on histrocial mapping at the north boundary. Notwithstanding the absence of physical proof, a careful watch will need to be kept for this feature during development.

5.3.2 Excavation Stability

No side wall instability was experienced during the excavation of the trial pits.

5.4 Chronic Risks to Human Health – Generic Assessment of Risks

5.4.1 Assessment Methodology

The long term risks to health have been assessed using methodologies and frameworks determined by the Environment Agency within documents SR2, SR3, SR4 and the CLEA Technical Review published to support the Contaminated Land Exposure Assessment Model (CLEA). Where applicable, reference has been made to the supporting toxicological reports (TOX Series) and the Soil Guideline Value reports (SGV Series). It is assumed that the reader is familiar with the above documents and it is not intended to repeat these described methodologies in detail, for further information, please refer directly to the specific documents. In order to provide an initial 'screen' to identify elevated levels of contaminants, a Generic Quantitative Risk Assessment (GQRA) has been undertaken using the most appropriate Generic Assessment Criteria (GAC) determined by assessment of exposure frequency/duration relevant to the critical receptor.

5.4.2 Assessment Criteria

In 2014, DEFRA published the Category 4 Screening Levels (C4SL) for use in Part 2A determinations. The C4SL are designed to be more pragmatic, but still strongly precautionary, assessment criteria compared to the previous assessment criteria (SGV – see below) used to assess chronic human health risks. They are designed for use in deciding whether land is suitable for use and definitely not contaminated, and DEFRA and the Welsh Government have recommended that they be used in assessing human health risks during the planning regime (i.e. as part of standard development investigations). However, the C4SL have been calculated for a limited number of contaminants at this stage, and range of land uses including residential, commercial and public open space, but are based on a 'low level' of risk rather than the 'minimal level' of risk adopted by the Environment Agency in preparing their Soil Guideline Values (SGV). At

the time of writing, the use of the C4SL in planning has not yet been accepted by many parties, including some regulators. The C4SL have also only been published for a limited number of contaminants. The C4SL have not been generally adopted in this assessment.

In this assessment, where available, the Soil Guideline Values (SGV) published by the Environment Agency have been adopted as the Generic Assessment Criteria (GAC) in the first instance. However, the SGV are only available for a limited number of contaminants for three proposed land uses (residential, commercial and allotments - not public open space). Where no SGV is available, the Suitable For Use Levels (S4ULs) published in January 2015 by the Chartered Institute of Environmental Health (CIEH) and Land Quality Management (LQM) have been adopted (Nathanail et al, 2015). These assessment criteria adopt updated toxicological data and exposure models, but the same 'minimal level' of risk as the SGV (i.e. unlike the C4SL). The S4ULs have been published for a large number of contaminants typically found on brownfield sites in the UK, and for the same range of land uses as the C4SL, i.e. including public open space scenarios.

For more exotic, predominantly organic, compounds no SGV, S4UL or C4SL assessment criteria have been published. In this instance, GAC published by CL:AIRE and the Environmental Industries Commission (CL:AIRE/EIC, 2010) have been adopted. These GAC have also been developed using the CLEA UK software based on a 'minimal level' of risk and for the same land use scenarios as the SGVs (i.e. not public open space).

At the time of writing there is no published SGV, S4UL or CL:AIRE/EIC assessment criteria for lead. For the purposes of this assessment, and in the absence of any other current authoritative guidance, the Category 4 Screening Level (C4SL) value published by DEFRA has been adopted. Details of the source of the GAC adopted for each contaminant are presented on the assessment table below.

The proposed development comprises the construction of a sports hall with associated areas of hardstanding and landscaping. There are currently no GAC published for such an end use. The critical receptors are considered to be the staff and users. Given this, we consider that the exposure scenarios adopted in the generation of the published GAC for public open space to be suitable to assess the risks to the more at risk group (visiting children). However, as the exposure frequency/durations are different for this use, using these GAC is considered a conservative approach and an exceedance does not necessarily indicate an unacceptable risk.

The GAC for most organic compounds are dependent on the organic content of the soil. Analysis has shown that the soil organic content in the soils analysed (2018 & 2022) ranged from 1.1 to 6.7%. Therefore, for the purposes of this assessment, GAC for a soil organic content of 1% has been adopted. This again is considered a conservative approach for the majority of the soils at the site.

5.4.3 Generic Quantitative Risk Assessment

At this time, the results from both the 2018 and 2022 works have been considered as one sample population. The results of the Generic Quantitative Risk Assessment are presented in Tables below.

Table 3 - Summary of Geo-environmental Soil Results with reference to Public Open Space Assessment Criteria

Determinand	Range Recorded	GAC	Source of GAC	Exceedances
Metals and Semi-metals				
Arsenic	2.5 - 13 mg/kg	37mg/kg	C4SL[2]	None
Barium[6]	45 – 360 mg/kg	1,300mg/kg	CL:AIRE/EIC[5]	None (2022 only)
Beryllium	0.5 – 4.0 mg/kg	1.7mg/kg	S4UL[4]	None
Boron	<0.2 – 4.0 mg/kg	290mg/kg	S4UL[4]	None (2022 only)
Cadmium	< 0.1 - 0.3 mg/kg	26mg/kg	C4SL[2]	None
Chromium (total)[7]	13 - 110 mg/kg	910mg/kg	S4UL[4]	None
Chromium (hexavalent)	< 1 mg/kg	21mg/kg	C4SL[2]	None
Copper	7.4 - 23 mg/kg	2,400mg/kg	S4UL[4]	None
Lead	3.8 - 25 mg/kg	200mg/kg	C4SL[2]	None
Mercury[8]	< 0.05 - 0.52 mg/kg	40mg/kg	S4UL[4]	None
Nickel	4.8 - 30 mg/kg	130mg/kg	S4UL[4]	None
Selenium	< 0.5 – 3.8 mg/kg	250mg/kg	S4UL[4]	None
Vanadium	16 – 500mg/kg	410mg/kg	S4UL[4]	1 of 6 (2022 only)
Zinc	16 - 81 mg/kg	3,700mg/kg	S4UL[4]	None
Polyaromatic Hydrocarbons (PAH)				
Acenaphthene	< 0.03 mg/kg	210mg/kg	S4UL[4,9]	None
Acenaphthylene	< 0.03 - 0.18 mg/kg	170mg/kg	S4UL[4,9]	None
Anthracene	< 0.03 mg/kg	2,400mg/kg	S4UL[4,9]	None
Benzo(a)anthracene	< 0.03 - 0.08 mg/kg	7.2mg/kg	S4UL[4,9]	None
Benzo(a)pyrene	< 0.03 - 0.11 mg/kg	5mg/kg	C4SL[2,9]	None
Benzo(b)fluoranthene	< 0.03 - 0.25 mg/kg	2.6mg/kg	S4UL[4,9]	None
Benzo(ghi)perylene	< 0.03 - 0.18 mg/kg	320mg/kg	S4UL[4,9]	None
Benzo(k)fluoranthene	< 0.03 – 0.08 mg/kg	77mg/kg	S4UL[4,9]	None
Chrysene	< 0.03 - 0.10 mg/kg	15mg/kg	S4UL[4,9]	None
Dibenzo(a,h)anthracene	< 0.03 – 0.04 mg/kg	0.24mg/kg	S4UL[4,9]	None
Fluoranthene	< 0.03 - 0.21 mg/kg	280mg/kg	S4UL[4,9]	None
Fluorene	< 0.03 mg/kg	170mg/kg	S4UL[4,9]	None
Indeno(123-cd)pyrene	< 0.03 - 0.08 mg/kg	27mg/kg	S4UL[4,9]	None
Naphthalene	< 0.03 – 0.04 mg/kg	2.3mg/kg	S4UL[4,9]	None
Phenanthrene	< 0.03 - 0.10 mg/kg	95mg/kg	S4UL[4,9]	None
Pyrene	< 0.03 - 0.25 mg/kg	620mg/kg	S4UL[4,9]	None
Other Organic Compounds				
Phenol	<0.03mg/kg	280mg/kg	S4UL[4,9]	None
Asbestos	None identified in tested samples.			

Notes:

1. C4SL: Category 4 Screening Level, published by CL:AIRE.
2. SGV: Soil Guideline Value published by Environment Agency.
3. S4ULs Suitable 4 Use Levels. Copyright Land Quality Management Limited, reproduced with permission; Publication No. S4UL3156. All Rights Reserved.
4. CL:AIRE/EIC GAC published by CL:AIRE and Environment Industries Commission.
5. GAC for barium for residential use without plant uptake. No GAC published for plant uptake risk drivers.
6. In the absence of Chromium VI, all chromium present likely to be Chromium III. GAC for Chromium III adopted.
7. GAC for inorganic mercury adopted.
8. GAC for organic compounds based on 1% soil organic content.
9. GAC for xylene based on p-xylene (lowest S4UL).

Vanadium was tested for in 2022 only and one sample exceeds the guideline value. The range of samples was between 16 and 500mg/kg with an average of 118mg/kg. With the exception of the one exceedance, all other levels of vanadium were well below 85mg/kg. All the determinands analysed were below their respective GAC.

5.4.4 Asbestos

No evidence of asbestos was identified in the samples analysed during the 2018 works, however, asbestos was indetifed in two samples during the 2022 works (TP203-0.3m and TP205-0.3m).

This accounts for two positive occurrences in 13no. samples tested. In both occurrences the asbestos was identied as chrysotile (white) asbestos. Quantification has indicated the asbestos to be present as between <0.001% and 0.03% total mass.

5.5 New Planting

Soil contamination can have a deleterious impact on the health of new plants. Such 'phytotoxic' effects can include inhibited growth, nutrient deficiencies and discolouration of vegetation. However, the potential impact on planting is difficult to quantify partly due to differing abilities of various plants to tolerate different soil conditions.

Contaminants are taken up by plants in a number of ways, the principal mechanism being via root uptake, but also including adsorption to roots. The impact on contaminants on plant growth depends on a number of factors, including the plant species, the soil type, the soil pH, the availability of the contaminant, and the impact of other external stresses on the plant such as drought.

The British Standard for the provision of Topsoil (BS3882:2007) provides guidance on acceptable levels of copper, nickel and zinc within a growing medium, which vary with soil pH value. ICRCL 70/90 (1990) discussing the restoration of metalliferous mining sites also provides 'threshold trigger levels' for a number of metals and fluoride, below which there should be no impact on plant growth. Finally MAFF (1998) provides assessment criteria for the assessment of the impact of a number of metals on the growth of plants. For the purposes of this assessment, we have adopted the BS3882 guidance values in the first instance, followed by the MAFF published guidelines, and finally the ICRCL 'trigger values'.

The assessment along with the assessment criteria adopted are presented in Table below:

Table 7: Summary of Assessment Criteria for Planting

Determinand	Range Recorded	GAC	Source of GAC	Exceedances
Metals and Semi-metals				
Arsenic	2.5 - 13 mg/kg	250mg/kg	MAFF[1]	None
Cadmium	< 0.1 - 0.3 mg/kg	3mg/kg	ICRCL[2]	None
Chromium (total)[6]	13 - 110 mg/kg	400mg/kg	MAFF[1]	None
Copper	7.4 - 23 mg/kg	135mg/kg (pH 6-7)	BS3882[3]	None
Lead	3.8 - 25 mg/kg	300mg/kg	MAFF[1]	None
Mercury	< 0.05 - 0.52 mg/kg	1mg/kg	MAFF[1]	None
Nickel	4.8 - 30 mg/kg	75mg/kg (pH 6-7)	BS3882[3]	None
Zinc	7.4 - 23 mg/kg	200mg/kg (pH 6-7)	BS3882[3]	None

Notes
1. MAFF: Ministry of Agriculture, Fisheries and Food guideline for maximum permissible concentrations in agricultural soils.
2. ICRCL: ICRCL 70/90.
3. BS3882:2007 – values dependent on soil pH values.

From Table 7, it can be seen that the levels of the potentially phytotoxic contaminants recorded were all below the respective assessment criteria.

5.6 Sulphate Attack

The assessment of the concrete protection against sulphate attack has been undertaken in accordance with BRE SD1 (2005).

5.6.1 Classification of Site:

Due to the presence of Made Ground on the site, we consider that it should be considered as 'brownfield' in terms of concrete classification.

5.6.2 Groundwater Setting:

Groundwater was encountered in the exploratory holes during 2018 and installed wells have noted the presence of shallow groundwater. This is likely to be close to the depth to which buried concrete will be placed. Therefore, groundwater has been considered as mobile in this assessment.

5.6.3 Sulphate Levels:

Some ph and sulphate test data is awaited as part of geotechnical testing and the below preliminary assessment will be updated upon receipt of geotechnical test results.

Laboratory test results (2018 & 2022) indicate the levels of water soluble sulphate (as SO_4) in the Glacial Diamicton soils to be between below detection limits and 84mg/l. As levels of water soluble sulphate are less than 3,000mg/l, there is no need to consider the levels of magnesium present in the soils.

Levels of acid soluble sulphate varied between below detection limits and 0.04% and total sulphur between below detection limits and 0.03%. From these results, the calculated levels of total potential sulphate are between 0.03 and 0.09%, and oxidisable sulphides are between 0.01 and 0.06%. As the levels of oxidisable sulphide are below 0.3%, pyrite is unlikely to be present.

pH values in the Glacial Diamicton varied between 5.8 and 10.1, indicating slightly acidic to alkaline soil conditions to exist (pH levels below 6.0 were recorded in one sample only). As the pH levels all exceed 5.5, there is no need to further assess the soils for the types of acids present (e.g. hydrochloric and nitric acids).

5.6.4 Preliminary Foundation Concrete Design:

Using the above results, we consider that the following characteristic values are applicable for the shallow soils at the site (all as SO_4):

Water soluble sulphate:	84mg/l;
Total potential sulphate:	0.09%
pH value:	5.8

6 Phase Two Geo-Environmental Risk Assessment

6.1 Discussion on Occurrence of Contamination and Distribution

The site is not recorded to have a significantly developed history. A suspected culvert is present at the west boundary of the site, however, no obvious evidence for this culvert to extend into the site (as shown on the environmental report) has been encountered. The historical mapping also indicates the current site may have been constructed on a cut-fill plateau.

Made Ground has been encountered across the site. The results of laboratory testing (2018 & 2022) has identified generally low levels of contaminants with the exception of Vanadium and asbestos.

Vanadium was tested for in 2022 only and one sample exceeds the guideline value. The range of samples was between 16 and 500mg/kg with an average of 118mg/kg. With the exception of the one exceedance, all other levels of vanadium were well below 85mg/kg. All the determinands analysed were below their respective GAC.

No evidence of asbestos was identified in the samples analysed during the 2018 works, however, asbestos was indetifed in two samples during the 2022 works (TP203-0.3m and TP205-0.3m). This accounts for two positive occurrences in 13no. samples tested. In both occurrences the asbestos was identied as chrysotile (white) asbestos, which has been quantified at between <0.01% and 0.03% total mass.

6.2 Revised Risk Evaluation & Relevant Pollutant Linkages

The risks evaluated earlier in this report have been updated and revised following information learned from the exploratory works and results of monitoring and laboratory testing.

Table 8 - Revised Risk Evaluation & Relevant Pollutant Linkages (RPL)

Source	Pathway	Receptor	Classification of Consequence	Classification of Probability	Risk Category	Further Investigation or Remedial Action to be Taken
Potential contaminants in shallow soils	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Site Users (employees and children)	Minor – levels of contaminants below adopted GAC's	Low Likelihood	Low Risk	See Section 7.1.2.
	Direct contact/ inhalation/ ingestion of contaminated soil or dust	Construction/ Maintenance Workers	Minor – standard PPE likely to be sufficient	Likely[1]	Moderate	Risk from asbestos (see below)
	Leaching of soil contaminants	Impact on Groundwater (Secondary A aquifer)	Medium – site lies on Secondary A Aquifer	Low Likelihood	Moderate/Low Risk	See Section 7.12.
	Leaching of soil contaminants	Impact on Sirhowy river	Medium – site lies adjacent to river	Unlikely	Low Risk	
Asbestos in existing building	Ingestion of fibres	Demolition Workers/ Ground Workers	Medium – potential for chronic levels	Likely	Moderate Risk	Asbestos survey of existing building
Asbestos in shallow soils	Ingestion of fibres	Construction/ Maintenance Workers	Medium – potential for chronic levels	Likely[1]	Moderate Risk	See Section 7.11.
Soil sulphate and pyrite	Aggressive groundwater	Buried Concrete	Mild – damage to structures	Unlikely[2]	Low/Moderate Risk	Sligtly advanced concrete class required.
Hazardous ground gas/vapours	Asphyxiation/poisoning. Injury due to explosion.	Site Users/Visitors.	Severe – acute risk.	Likely[3]	Moderate Risk	Continue to monitor gas wells.
	Damage through explosion.	Building/Property	Severe – acute risk.		Moderate Risk	
	Asphyxiation/poisoning. Injury due to explosion.	Construction and Maintenance Workers.	Severe – acute risk.		Moderate Risk	
Radon gas	Migration into Buildings	Site Users (employees and visitors)	Medium – potential for chronic levels	Unlikely	Low Risk	No protection measures required.

Notes:
1. Asbestos identified in two samples.
2. Results of supplementary testing awaited.
3. Presence of Made Ground and potential for underground coal seams/historic workings, requires further consideration. Ground gas monitoring ongoing.

7 Remedial Strategy For Contamination Risks

The following recommendations are based on interpretations made from the relatively limited site investigation data obtained to-date, and do not form the full Options Appraisal stage of CLR11. If at any stage of the construction works, contamination or a potential for such contamination is identified that is different to that presented within this report, all of the following should be reviewed and the advice of a geo-environmental specialist sought immediately.

7.1 Risks to Health

7.1.1 Asbestos

No evidence of asbestos was identified in the samples analysed during the 2018 works, however, asbestos was indetifed in two samples during the 2022 works (TP203-0.3m and TP205-0.3m). This accounts for two positive occurrences in 13no. samples tested. In both occurrences the asbestos was identied as chrysotile (white) asbestos. Quantification has indicated the asbestos to be present as between <0.001% and 0.03% total mass.

There is no clear UK guidance on what would constitute an acceptable concentration of asbestos in soil. Therefore, we recommend that all asbestos contaminated soils be removed from site prior to development. Working with asbestos (even within soils) is governed by the Control of Asbestos Regulations (2012). This requires that the excavation and removal of the asbestos contaminated soils musty be undertaken by a licensed contractor. Alternatively, an asbestos specialist may be employed to undertake further assessment of the risk from the asbestos present in the soils beneath the site with a view to investigating whether there would be an alternative risk mitigation method to prevent the expensive and non-sustainable removal and disposal of soils.

Prior to the demolition of the existing school building on site, an asbestos survey should be undertaken and any asbestos materials found removed by a licensed contractor.

The following sections presume that any risks from asbestos materials at the site are mitigated.

7.1.2 Site End Users

Vanadium was tested for in 2022 only and one sample exceeds the guideline value. The range of samples was between 16 and 500mg/kg with an average of 118mg/kg. With the exception of the one exceedance, all other levels of vanadium were well below 85mg/kg. All other determinands analysed were below their respective GAC.

Assuming an end use of as a Sports Hall with associated external areas and limited areas of landscaping, the identified levels of soil contamination at the site are not considered to pose a risk to future site users. Therefore, no specific remedial measures are considered necessary for the development.

However, it should be appreciated that due to the presence of a building on the site, and a fence line, certain areas were inaccessible during the time of the site works. Further evidence of contamination on site could be present in these areas and further work should be undertaken in these area to fully determine the risk to end users present from contamination at the site.

The Envirocheck has identified the potential for an infilled stream to trend west to east across the site. No evidence of this has been observed and this information does not agree with other

mapping, however, the potential for an infilled channel in the centre of the site should be considered.

Review of contamination information should be undertaken, if any type of growing green schemes are to be considered, or the proposed end use amended.

7.1.3 New Service Connections

The current water industry guidance for the suitability of pipe materials on potentially contaminated sites (Blackmore et al, 2010) has onerous requirements and it is likely/possible, based on this guidance, that the levels of contaminants on site may prevent the use of plastic pipework. We recommend that enquiries are made to the local water authority to confirm their requirements for underground service materials for this development.

7.1.4 Risk to Construction and Maintenance Workers

Short term (acute) risks to construction and maintenance workers are generally poorly understood within the industry, certainly when compared to the volume of research undertaken on long term risks. However, we anticipate that the levels of contamination at the site are not likely to pose a severe acute risk to construction workers or future maintenance workers. Ground workers would need to undertake their own assessment of the risks to their workers. This will be of particular importance with regard to the presence of asbestos.

7.1.5 General Public/Neighbouring Properties

We do not anticipate any significant risks to the general public from the development of the site. However, careful dust control measures should be adopted during construction to minimise the risk (and nuisance) to the general public and neighbouring residents.

7.2 Risks to Controlled Waters

No specific assessment of the risks to controlled waters has been undertaken to date. However, the following points are considered salient.

- No past contaminative use has been identified at the site.
- Made Ground has been identified on the site.
- The levels of soil contaminants are low.
- The proposed development comprises a sports hall and will include areas of landscaping and also car parking which are anticipated to be hard surfaced.
- The site is underlain by fine- and coarse grained glacial soils, and weathered bedrock which contains a high fine-grained fraction in its upper layers
- The bedrock beneath the site is classified as a Secondary A aquifer. The glacial diamicton are defined as Unproductive Strata, the geological map for the site indicates that Glaciofluvial sands and gravels encroach on the north-eastern edge of the site. Groundwater is anticipated in the coarse-grained Glacial soils.
- The Sirhowy River lies some 300m to the east at its closest point,

Given the above, we consider that the overall risk to controlled waters from the development of the site is likely to be low and no further assessment is warranted. As some areas of the site

have yet to be investigated, the above conclusions should be reviewed once examination of the currently inaccessible areas is possible.

7.3 Risks from Ground Gas

7.3.1 Risk to the Development – Degradation of Organic Material

Potential sources of hazardous ground gas have been identified across part of the site in the form of Made Ground, a culvert at the west boundary and the potential for shallow underground mine workings.

Ground gas monitoring wells were installed within the rotary boreholes and a monitoring regime is underway. The risk from hazardous ground gas will be reviewed in an addendum report following completion of the monitoring, but in the interim, the monitoring to date has identified levels of Carbon Dioxide up to 8.9% and no recorded Methane. Due to the site setting and history, it would at present to consider that some ground gas protection may be required for permanent structures and this will be confirmed via an addendum report on completion of all monitoring,

In addition to the above the Envirocheck has identified the potential for an infilled stream to trend west to east across the site. No evidence of this has been observed and this information does not agree with other mapping, however, the potential for an infilled channel in the centre of the site should be considered as it may pose a ground gas source if present.

7.3.2 Risk to the Development – Radon

As discussed in Section 3.1.4, the Preliminary Risk Assessment has indicated that no radon protection is required.

7.3.3 Risk to Construction and Maintenance Workers

We recommend good site practice and all excavations should be considered potentially confined spaces. Carbon dioxide is a particular risk in Made Ground materials as it is commonly present and as it is heavier than air, it can displace it at the base of excavations, which can then lead to workers being at risk from asphyxiation. If during construction any organic materials are encountered they should be excavated and replaced.

This will be further updated upon completion of the ground gas monitoring regime.

7.4 Risks to Property

7.4.1 Spontaneous Combustion

No evidence of combustible materials has been identified in the shallow soils. Therefore, the risk from spontaneous combustion is considered to be low.

7.4.2 Sulphate Attack on Buried Concrete

The following characteristic values are applicable for the shallow soils at the site (all as SO_4):

Water soluble sulphate:	84mg/l;
Total potential sulphate:	0.09%
pH value:	5.8

Based on these characteristic values, we consider that the site would be classified as Design Sulphate Class DS-1 and Aggressive Chemical Environment for Concrete Class AC-2z, allowing for mobile groundwater.

7.5 Risks to New Planting

Analysis of the shallow soils has indicated no levels of contaminants above the respective assessment criteria for general new planting. However, some species of plant have particular requirements and limitations and a landscaping specialist should be consulted with regards to future planting.

Whilst the levels of contaminants satisfy the guideline values for landscaping around commercial end uses and public open spaces, they are unlikely to be suitable for growing green projects such as vegetable or interactive gardens. If these are proposed, the concentrations of potential contaminants should be reviewed as alternatives may be required.

In addition to the above, the near surface Made Ground may not be suitable in terms of material quality for landscaping and should be reviewed as part of detailed design.

8 Geotechnical Comments

8.1 Site Preparation and Earthworks

8.1.1 Invasive Plants

No evidence of invasive plants such as Japanese Knotweed/Himalayan Balsam etc. was identified on the site during the site works. Notwithstanding the above, a careful watch should be kept during the works and the absence of invasive species confirmed by a specialist prior to the onset of development.

8.1.2 Existing Foundations and Services

No evidence of old foundations and underground structures have been identified in the investigation and are not anticipated beneath the site. However, if any are discovered then they should be grubbed up as part of the site preparation works. The foundation of the existing building on—site should be removed with the demolition works.

Service plans indicate the presence of a gas main servicing the main building of the former comprehensive school is indicated to run parallel along the north-western boundary of the site.

A signal was detected with the CAT scanner along the north-western boundary, indicating the possible presence of a electricity cable along this area.

Prior to this phase of works (2022), the Client provided a series of previously unavailable services records and GPR utility survey. These plans showed the potential for a historic drain trending south west to north east across the site, from the existing school building (and assumed to a wider drainage network). As it was not possible to visual identify this service, a clear stand off was implemented.

The environmental report obtained in 2018, identified the potential for a stream at the west boundary trending south west to north east. During both phases of work (2018 and 2022), no evidence of this stream/culvert has been identified and it may be a misrepresentation of the stream/culvert that is recorded on histrocial mapping at the north boundary. Notwithstanding the absence of physical proof, a careful watch will need to be kept for this feature during development.

8.1.3 New Services

For new services, flexible pipework and connections should be provided as a safeguard against potential settlements. Consideration could be given to increasing the gradients on sewage connections to mitigate against possible settlements.

8.2 Geotechnical Risk Register

8.2.1 Updated Geotechnical Risk Register

The following potential geotechnical hazards were determined to potentially be present at the site, prior to this phase of works:

- Coal mining;
- Compressible ground;

- Shrinkable/swelling soils; and
- Sulphate/pyrite.

This has been updated in Table with additional information on these and other potential geotechnical/construction risks identified by the intrusive investigation.

Table 9 - Updated Geotechnical Risk Register

Hazard	Risk	Comments
Shrinkage and Swelling	Low/Moderate	Soils of low to intermediate plasticity identified.
Coal Mining	Low	Available evidence suggests that whilst coal is present there is suitable protection afforded the site development (see Section 8.2.2).
Compressible Ground/ Settlement of Foundations	Moderate	Settlement of shallow footings could be excessive depending on final design and loadings proposed – see Section 8.3
Sulphate Attack	Low	Testing indicates DS-1 and AC-2z are sufficient for concrete in the Glacial Soils at the site.
Notes 1. Further discussion is presented in the following sections.		

8.2.2 Risks Associated with Shallow Coal Seams

Information available during the 2018 investgiation (Ref: 6839b.3014) identified that there was a risk associated with potential shallow coal seams, including the Mynyddislwn seam. As such a series of 6no. boreholes have been drilled, with 5no. targeted at proving rock head, the depth to any coal seams, and associated seam condition.

As repeated on Table 9 below, boreholes have been extended to depths of between 24.5m and 40m into the rock with only minor/thin seams encountered and in a number of cases, these where identified as “traces” only. Review of the borehole information suggests that the thin, minor seams identified, pose a low risk to the site and should any thicker, deeper coal seams be present immediately below maximum borehole depth (40m), a suitable cover of rock is present to provide adequate protection.

Table 10: Summary of Borehole Investigation

BH ID	Borehole Depth (m)	Depth to Rockhead (m)	Depth to Seam 1 (m) and thickness	Depth to Seam 2 (m) and thickness	Depth to Seam 3 (m) and thickness
BH201	32.0	1.5	8.0* (0.3m)	23.0 (0.4m)	26.0* (0.2m)
BH202	24.50	2.2	-	23.7 (0.2m)	-
BH203	35.0	5.2	-	-	-
BH204	40.0	7.5	-	-	-
BH205	40.0	5.5	-	23.2 (0.3m)	32.2 (0.2m)
Notes To Table: * Coal recorded as “traces only.					

Based on the available investigation information and proposed end use, the risk posed by shallow coal seams is considered low, however, it should be appreciated that in any area of past mining activity the possibility of the existence of unrecorded mine entries cannot be discounted. During site clearance operations and all excavation, a careful watch should be maintained for any

isolated pockets of loose fill, brickwork or other anomalous features which may be indicative of past mining operations. Any such features should be subject to further investigation.

8.3 Preliminary Foundation Design and Construction

The following foundation recommendations are preliminary and should be reviewed dependant on the finalised development plan and proposed loadings (when available).

We understand that the site is being considered for potential development as a sports hall with a MUGA pitch, external areas of hardstanding, access and landscaping. The comments and recommendations in this report assume that the development will involve the construction of typical two-storey structures of conventional load-bearing brickwork construction.

On the basis of the available investigation information, we consider that mass concrete spread foundations could be used at the site, constructed in the coarse Glacial Diamicton encountered from depths of 1.5m beneath ground level. We consider that for foundations placed in this stratum, a presumed bearing value of around 75kPa should maintain settlements to within acceptable limits. Where the coarse deposits are encountered deeper, an allowance should be made to extend the depth of building foundations. The proposed founding stratum is coarse-grained in composition across much of the site and, therefore, should not be affected by seasonal changes in moisture content. We recommend that the minimum foundation depth should be 1.5m below ground level.

Where the sports hall construction encroaches on the site boundaries, a suitable assessment of slope stability should be undertaken to determine if the proposed structure and excavation for foundations will cause any instability.

For all spread foundation options, the formations should be cleaned, and subsequently inspected by a suitably qualified engineer prior to placing concrete. Should any soft, compressible or otherwise unsuitable materials be encountered they should be removed and replaced by lean mix concrete or suitable compacted granular material. We recommend that a blinding layer of concrete be placed on the formation after excavation and inspection in order to protect the formation against softening and disturbance.

8.4 Floor Slab Foundations

Due to the presence of Made Ground and fine Glacial Deposits in some areas of the site, the use of cast in-situ ground bearing floor slabs is not considered suitable and slabs should be suspended. Dependant on the final design proposed, this may be a difficult undertaking for a sports hall with anticipated large spans etc. and we can review/discuss further once the design in finalised.

8.5 Excavation and Dewatering

It is anticipated that excavation throughout most of the site will be within the capabilities of conventional mechanical excavators. Old foundations will require higher capacity machines for their removal.

A specialist assessment has identified a low risk from buried ordnance at the site. Notwithstanding this, on any development site, we cannot totally discount the risk from buried ordnance as records are not complete. Therefore, although no special precautions are considered necessary, a careful watch should be maintained during all excavation and any suspected ordnance identified should be investigated further by specialists. Ordnance awareness may be prudent during site inductions.

For shallow excavations where there is no danger to life, support of excavation sides is unlikely to be necessary. Should any indication of excavation instability be noted at any depth, support should be provided as appropriate. Where water ingress occurs it is likely that pumping from screened sumps within shallow excavations will be adequate.

The environmental report obtained in 2018, identified the potential for a stream at the west boundary trending south west to north east. During both phases of work (2018 and 2022), no evidence of this stream/culvert has been identified and it may be a misrepresentation of the stream/culvert that is recorded on histrocial mapping at the north boundary. Notwithstanding the absence of physical proof, a careful watch will need to be kept for this feature during development.

Prior to this phase of works (2022), the Client provided a series of previously unavailable services records and GPR utility survey. These plans showed the potential for a historic drain trending south west to north east across the site, from the existing school building (and assumed to a wider drainage network). As it was not possible to visual identify this service, a clear stand off was implemented.

8.6 Soakaway Drainage

8.6.1 Soakaway Design

During the 2018 works a series of infiltration tests were undertaken, which were then supplemented during the recent 2022 works. The combined results are presented on the table below.

Variable infiltration has been observed and the design of any sustaible drainage should be undertaken with care and not solely be based on the lowest rate observed. We understand a 3rd party is advising the Client on sustainable drainage options.

Table 11 - Summary of soakaway infiltration test results

Test Pit	Fill Number	Test depth (m)	Measured Infiltration Rate[1] (m/sec)	Estimated Infiltration Rate[2]	Infiltration Soils
TP01	1	2.1	$3.02x10^{-6}$	-	Grovesend Beds – Sandstone
TP01	2	2.1	-	$4.4x10^{-6}$	
TP02	1	2.8	$2.83x10^{-6}$	-	
TP02	2	2.8	-	$1x10^{-5}$	
TP03	1	3.0	*test failed*		Glacial Diamicton
TP07	1	4.2	*test failed*		
TP08	1	3.9	*test failed*		
TP09	1	2.4	$1.61x10^{-4}$	-	Grovesend Beds – Sandstone
TP09	2	2.4	$1.29x10^{-4}$	-	
TP09	3	2.35	$8.08x10^{-5}$	-	
TP201	1	2.30	*test failed*		Glacial Diamicton
TP202	1	1.70	$3.82x10^{-6}$		Glacial Diamicton
TP202	2	1.70	$3.61x10^{-6}$		
TP202	3	1.70	-	$\sim3.0x10^{-6}$	
TP203	1	1.55	*test failed*		Glacial Diamicton
TP204	1	2.10	*test failed*		Glacial Diamicton

Notes:
1. Testing undertaken in accordance with BRE 365. Water level fell to 25% of fill depth.
2. Water level did not fall to 25% fill depth, but did fall beyond 75% fill depth, allowing extrapolation of data to 25% fill depth to provide an estimate of infiltration rate. Results should be treated with caution.

8.6.2 Soakaway Location

Care should be taken in the siting of the soakaways, with in particular, soakaways should be constructed a minimum of 10m away from the crest of slopes and 5m from buildings and party boundaries.

8.6.3 Soakaway Discharge

As the soakaway is located a significant distance from the nearest surface water course, a discharge consent will not be required. However, prior to construction, this should be confirmed with Natural Resources Wales/the Environment Agency.

The infiltration stratum at the site would be the Grovesend Beds sandstone bedrock, which is classed as a Secondary A aquifer and the groundwater within is vulnerable to pollution. The Environment Agency has a general policy that no direct discharge of surface run-off would be accepted in vulnerable groundwater aquifers. Given the shallow depth of the bedrock at the site, any soakaways would result in the direct discharge of surface water run-off into the aquifer. We recommend that enquiries are made to Natural Resources Wales (who have taken over the role of the Environment Agency) to identify whether they would allow such discharge at the site. As a minimum, risk mitigation measures such as oil interceptors are likely to be required.

The Environment Agency indicates that the main aquifer beneath the site is within the Coal Measures bedrock, and is classed as a Secondary A aquifer with a groundwater vulnerability of 'minor aquifer high' (Environmental Data Report, Appendix C). The investigation has identified the main groundwater body beneath the site to be within the lower parts of the Glacial Sand and Gravels, however, this is likely to be in direct hydraulic connection with the groundwater within the bedrock and, hence, should also be considered potentially vulnerable to pollution. Secondary A aquifers comprise permeable layers capable of supporting water at a local rather than strategic scale and in some cases form an important base flow to rivers. The site is not located within a Source Protection Zone.

The discharge of clean roof water to ground is acceptable both within and outside SPZ1 (Source Protection Zone 1) provided that all roof water down-pipes are sealed against pollutants entering the system from surface run-off, effluent disposal or other forms of discharge. The method of discharge must not create new pathways for pollutants to groundwater or mobilise contaminants already in the ground.

9 Recommendations

We consider that the following further investigation and assessment would be required or prudent prior to development:

Required Further Actions:

- Continuation of ground gas monitoring and production of ground gas risk assessment.
- Engaging of an asbestos specialist to determine risks posed by soils to workers and disposal routes.
- Asbestos survey of existing building before demolition.
- Confirmation of ground conditions below existing (to be demolished) building.
- Careful watch for anomalous conditions or any evidence of historic mine workings, possible culvert and historic stream during development.
- Location/protection of drainage line shown on Client provided plans.
- Review and assessment as to whether the proposed development has the potential to affect slope stability, once design is finalised.

Recommended Further Actions:

- Verification testing of any soils/stone imported to site.
- WM3 assessment of soils to be disposed of off-site.
- Materials management plan for re-use of soils on site and WM3 assessment of soils to be disposed of/re-used off-site, followed by WAC testing if disposal to landfill.

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