West Yorkshire Combined Authority

DEWSBURY BUS STATION

Desk Study and Coal Mining Risk Assessment

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CONFIDENTIAL

West Yorkshire Combined Authority

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Desk Study and Coal Mining Risk Assessment

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EXECUTIVE SUMMARY

Aspect	Summary
Authorisation	West Yorkshire Combined Authority appointed WSP to prepare a '*Desk Study and Coal Mining Risk Assessment*' for proposed improvement works at Dewsbury Bus Station (the site).
Proposed Works	The proposed improvement works include a new canopy at the western entrance of the bus station, general roof improvements and refurbishments to the interior.
Environmental/ Geological Setting	Geology: The recorded geology comprises a variable thickness of Made Ground underlain by Alluvium and bedrock of the Pennine Lower Coal Measures Formation. Two coal seams are shown to subcrop within the site. Hydrogeology: The superficial and bedrock deposits are classified as Secondary A Aquifers. Hydrology: The west to east flowing River Calder is the closest surface water course, located approximately 50m south of the site.
Land Quality	Potential sources of contamination have been identified associated with the current and historical site uses. However, given the limited amount of works being undertaken within the ground, the site is considered to represent a low risk assuming that appropriate risk assessments and method statements are completed and implemented for the proposed works.
Preliminary Geotechnical Appraisal	Depending on loadings and serviceability requirements, shallow spread foundations bearing within the underlying Made Ground or Alluvium may be suitable to support the canopy. However, in the absence of site-specific information, the requirement for deeper piled foundations cannot be ruled out. A shallow coal mining risk has been identified and ground investigation is considered necessary to assess whether any mitigation measures are required.

1 INTRODUCTION

1.1 TERMS OF REFERENCE

The West Yorkshire Combined Authority appointed WSP to prepare a '*Desk Study and Coal Mining Risk Assessment*' to inform proposed improvement works to Dewsbury Bus Station **(Appendix A)**.

The Desk Study and Coal Mining Risk Assessment has been completed in accordance with our proposal dated 25.10.2021.

1.2 DEVELOPMENT PROPOSALS

The proposals are not yet fixed and three differing designs have been suggested, which are included in **Appendix A.** These show a range of potential options, including: a new feature glass roof canopy over the west entrance; modifications of the existing roof structure to accommodate new rooflights; a new profiled metal sheet roof; a new glass roof at the eastern end of the station; new parapets and a new glazed roof and feature entrances at the East Concourse.

1.3 PROJECT SCOPE

The scope of works for this report includes the following items:

- Presentation of relevant desk based factual information regarding the site;
- Undertaking a preliminary geotechnical engineering assessment of the presented information;
- Undertaking a preliminary geo-environmental assessment of the presented information, including development of a preliminary conceptual site model;
- Undertaking a coal mining risk assessment; and,
- Compilation of a preliminary ground risk register and recommendations for further works to be undertaken.

1.4 SOURCES OF INFORMATION

The following relevant sources of information were used in the production of this report.

- Envirocheck Report, dated 28 September 2021 (**Appendix B**);
- The Coal Authority, Consultants Coal Mining Report, 285532477_2, dated 28 September 2021(**Appendix C**);
- Coal Authority Interactive Map accessed on 29 September 2021 (available at: http://mapapps2.bgs.ac.uk/ coalauthority/home.html).
- DEFRA MagicMap website accessed on 29 September 2021 (available via: https://magic.defra.gov.uk/MagicMap.aspx);
- British Geological Survey (BGS) 'Geology of Britain' online viewer accessed on 29 September 2021 (available via: https://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html);
- BGS 'GeoIndex Onshore' online viewer accessed 29 September 2021 (available via: http://mapapps2.bgs.ac.uk/geoindex/home.html);
- BGS Geological maps: Sheet number 77, 1:50,000 Huddersfield Solid and Drift (2003);
- BGS Geological maps: 1:10,000 Heckmondwike Sold and Drift SE33SW (1999);
- Aitkenhead, N, Barclay, W J, Brandon, A, Chadwick, R A, Chisholm, J I, Cooper, A H, And Johnson, E W. 2002. British regional geology: the Pennines and adjacent areas (Fourth edition). (London: HMSO for the British Geological Survey); and,

- Zetica 'Regional unexploded bomb risk map' website accessed 29 September 2021 (available via: https://zeticauxo.com/downloads-and-resources/risk-maps/) **(Appendix D).**

No previous reports for the site were provided by the Client.

1.5 LIMITATIONS

This report is presented to West Yorkshire Combined Authority in respect of Dewsbury Bus Station, and may not be used or relied on by any other person or by the client in relation to any other matters not covered specifically by the scope of this Report.

Notwithstanding anything to the contrary contained in the report, WSP UK Limited is obliged to exercise reasonable skill, care and diligence in the performance of the services required by West Yorkshire Combined Authority and WSP UK Limited shall not be liable except to the extent that it has failed to exercise reasonable skill, care and diligence, and this report shall be read and construed accordingly.

This report has been prepared by WSP UK Limited. No individual is personally liable in connection with the preparation of this report. By receiving this report and acting on it, the client or any other person accepts that no individual is personally liable whether in contract, tort, for breach of statutory duty or otherwise.

WSP has used reasonable skill, care and diligence in the design and interpretation of the ground investigation. However, the inherent variability of ground conditions allows only definition of the actual conditions at the location and depths of exploratory holes and samples/tests therefrom, while at intermediate locations conditions can only be inferred.

New information, changed practices or new legislation may necessitate revised interpretation of the report after the date of its submission.

1.6 RELIANCE

This report is addressed to and may be relied upon by the following:

West Yorkshire Combined Authority

This assessment has been prepared for the sole use of the above-named party. This report shall not be relied upon or transferred to any other parties without the express written authorisation of WSP. No responsibility will be accepted where this report is used in its entirety or in part, by any other party. Information provided by others is taken in good faith as being accurate. WSP cannot and will not accept liability for any deficiencies in third party information.

2 SITE DESCRIPTION

2.1 SITE DESCRIPTION AND CURRENT USE

Site location and site boundary plans are presented in **Appendix A**.

Table 2-1 – Summary of Site Details

Details	Comments
Site Address	Dewsbury Bus Station, Dewsbury, WF12 8AR.
National Grid reference	424445, 4215560 (Approximate site centre).
Site Description and Current Use	The site is a single-storey public bus station, with the main concourse being a steel portal frame with a standard/duo pitched roof and brick and glass infill. External areas are predominantly hardstanding used for bus parking, pedestrian walkways and an access road for buses.
Area	Approximately 10,000 m^2.
Site Setting and Surrounding Area	The site is located in Dewsbury city centre. The surrounding land use is predominantly commercial. The site is accessible via Aldams Road and South Street.
Topography and Ground Cover	The site slopes very gradually from north to the south. The area is covered almost entirely by the bus station building and hardstanding material, including paving, brick, concrete and bituminous surfacing. There is some soft landscaping along the western boundary of the site.
Boundaries	The site is bound to the north by South St and to the south by Aldams Rd. To the west of the site is Dewsbury Police Station, and to the east are commercial properties.
Embankments & Slopes	No notable slopes or embankments are present within or adjacent to the site.

3 HISTORICAL LAND USES

A review of historical maps has been undertaken to identify potential sources of historical contamination, former land uses and potential sensitive receptors.

Table 3-1 presents a summary of relevant historical information on the site presented within the Envirocheck Report. Historical maps are included in **Appendix B**.

Table 3-1 – Summary of Historical Site Use

Details	Comments
1852	A large rectangular pond is situated centrally on site. The land surrounding the pond to the east and south is undeveloped with the exception of one building occupying the easternmost point of the area. The land surrounding the pond to the north and west is divided into small unlabelled rectangles, with defined paths circumnavigating each rectangle.
1894	The pond is labelled as 'Mill Pond'. A mixture of terraced houses and commercial buildings are recorded in the east of the site. Large warehouses occupy an area to the southeast of site. Multiple roads throughout the site, such as Wilton Road and Back Wilton Street. Aldams Mill is recorded immediately west of the site boundary. A small 'tank' is mapped along the western boundary of the site.
1922	Mill pond is now a reservoir.
1933	The eastern most part of the warehouse buildings and some residential properties have been demolished.
1955 - 1956	The eastern side of Mill Pond has been infilled, along with the construction of a drain on the southern bank. Terrace houses to the north-east have become a warehouse.
1966-1975	The buildings on site are all demolished, replaced by a car park. Immediately east of site the area is shown to support a police station. The 'tank' is no longer shown.
1972 - 1974	The pond is no longer present, and the area is labelled as a car park. The streets accessing the car park are the same as the present day.
1982 - 1983	Dewsbury Bus Station is now recorded onsite, similar to the existing structure.
2000	Minor changes in the shape of the main concourse are recorded in mapping. The bus station is now the same size as the current structure.

3.1 HISTORY OF THE SURROUNDING AREA

Throughout the mapped period the site has been located within an urban area. The area has experienced multiple phases of development and demolition, predominantly of warehouses and residential and commercial buildings.

Land uses likely to be associated with significant ground or groundwater contamination have been identified from the Envirocheck Report. One tank is observed in the 1955 – 1956 ordnance survey map.

Within the 'Historic Land Use maps' section of the Envirocheck Report the following are identified within 250 m of the site:

- *'Tanks'*, *'potential tanks'* and *'potential fuel related tanks'*.
- An *'underground fuel tank'*.
- Four areas where asbestos has been identified.

3.2 REGULATORY DATABASE

Reference was made to the Envirocheck Report (**Appendix B**) for regulatory information relevant to this assessment. This includes information and data collated from several organisations, including but not limited to, the Environment Agency (EA), the Local Authority, the BGS, Department for Environment Food & Rural Affairs (DEFRA), Health & Safety Executive (HSE), the National Radiological Protection Board (NRPB) and the CA. This information is summarised in **Table 3-2**

Table 3-2 – Summary of Regulatory Information

Aspect	On Site	0 – 250 m	Details
Contaminated land register entries and notices	0	0	
Fuel Station Entries	0	2	Mixture of open, closed and obsolete fuel stations.
Discharge Consents	0	0	
Control of Major Accident Hazard Sites (COMAH)	0	0	
Radon Potential	0	n/a	

3.3 UNEXPLODED ORDNANCE

The Zetica UXO risk map notes the site lies within an area with a low risk of unexploded ordnance (UXO). A copy of the Zetica risk map for the site is included in **Appendix D**.

The pre-desk study assessment indicates that there are no significant risks from UXO at the site and a detailed UXO desk study is not considered necessary.

3.4 LANDFILL AND WASTE MANAGEMENT ACTIVITY

There are no records of active or historical landfill sites or licensed waste sites on or within 250 m of the site in the Envirocheck Report.

4 ENVIRONMENTAL SETTING

4.1 GEOLOGY

The ground conditions on site have been established from the following sources:

- BGS 1:10,000 and 1:50,00 scale maps;
- BGS GeoIndex Onshore interactive map viewer;
- Coal Authority interactive map viewer;
- Coal Authority Consultants Report;
- Envirocheck Analysis Report (**Appendix B**).

4.2 GEOLOGICAL MAPS

4.2.1 SUPERFICIAL

The BGS maps show the site to predominately underlain by Alluvium, except for the north-western most corner of the site, where no superficial deposits are recorded. This is described as typically comprising clay, sand and gravel.

4.2.2 BEDROCK

The north-west of the site shown to be underlain by the Emley Rock of the Pennine Lower Coal Measures Formation. This lithology is described as '*a fine-grained flaggy sandstone with mudstone partings'*. Its thickness is not recorded.

The remainder of the site is underlain by undifferentiated strata of the Pennine Lower Coal Measures, described as often being '*Interbedded grey mudstone, siltstone and pale grey sandstone, commonly with mudstones containing marine fossils in the lower part, and more numerous and thicker coal seams in the upper part''.*

Two coal seams, named as the Flockton Thick Coal and Flockton Thin Coal subcrop in a south-west to north-east direction through the site. These seams are inferred and not proven. The seams are recorded as being 0.3 – 1.5 m thick and 0.4 – 1.4 m thick respectively on the BGS 1:10'000 maps. The BGS 1:10,000 map highlights that stratigraphically the Flockton Thick coal overlies the Flockton Thin coal by approximately 11 m. The strata dip in a north westerly direction.

A south-east to north-west trending fault, dipping to the north-east, is shown on the BGS 1:10,00 map approximately 40 m to the south-west of the site. Beyond this fault lies the Birstall Rock, which is described as '*a fine-grained, thickly bedded, cross bedded sandstone with common pebbles of ironstone, coal sandstone and mudstone, and common streaks of shaly coal'*.

A second geological fault is located approximately 50 m north of the site. This fault trends in a south-west to north-east direction. The fault dips to the south-east. The throw on the fault is not stated.

4.3 BOREHOLE DATA

The British Geological Survey has records of ten historical boreholes within the site boundary. The boreholes predate the construction of the bus station, and were conducted as part of the ground investigation prior to its construction (Appendix F**). A summary of the findings of these boreholes is shown in**

Table 4-1.

Table 4-1 – Summary of historical borehole data

Geological Unit	Top of strata (m BGL)	Base of strata (m BGL)	Proven thickness (m)	Comments
Made Ground	Ground level	1.07 – 3.89	1.07 – 3.89	Recorded in all boreholes within the site boundary. Includes: broken brick, ash, burnt shale, coal fragments, medium gravel sized angular sandstone fragments, lumps of tar, weathered ironstone siltstone fragments, loose topsoil, slag, lumps of bitumen, clay and sand.
Alluvium	1.07 – 3.89	8.23 – 13.6	6.35 – 11.8	Recorded in all boreholes within the site boundary. The Alluvium recorded as predominantly granular, although does contain cohesive elements. Alluvium to the east and west of the site is predominantly gravel. Whilst alluvial deposits recorded in central boreholes is recorded to be predominantly clay and sand. The Alluvium across site is described as: ▪ Medium dense, SAND; ▪ Medium dense, SAND & GRAVEL; ▪ SAND & BOULDERS ▪ Soft SILT; ▪ Soft to very soft CLAY; ▪ Medium dense COBBLES & GRAVEL.
Pennine Lower Coal Measures	8.23 - 13.6	Base not proven.	Thickness not proven.	Boreholes within the north of the site record bedrock as being a '*medium grained, grey, hard sandstone'* The lithologies within the south of the site are described as: ▪ Seatearth – mudstone; ▪ Shale – *'hard, black, fissile'*; ▪ Mudstone – *'soft, becoming harder with depth'*; ▪ Siltstone – '*hard, grey, mudstone striping'.*

				Bands of coal are found in some boreholes within the PLCM – the depths and thickness of these are described in Table 4-2.

Boreholes formed within the footprint of the historical Mill Pond do not record significantly greater depths of Made Ground relative to the rest of the site.

Coal seams are recorded within three of the historical boreholes and these are summarised in **Table 4.2**. The remaining boreholes do not significantly penetrate deeper than rockhead.

Table 4-2 – Summary of the depths and thickness of coal encountered in on-site boreholes.

Borehole reference	British National Grid reference	Depth (m BGL)	Thickness (m)
SE22SW14	424380,421510 (Overlying subcrops)	21.79	0.15
		22.86	0.30
SE22SW15	424370,421540 (north of subcrops)	20.42	0.15
		21.79	0.30
SE22SW16	424430,421550 (north of subcrops)	11.58	0.30
		13.18	0.30
		24.69	0.3

4.4 GEOHAZARD SUMMARY INFORMATION

The Envirocheck Report determines the area to have '*potentially infilled land (water)*' in the west of the site, and '*potentially contaminated land use (Past Land Use)*'across its entire footprint. The potentially infilled land mentioned is assumed to be associated with the former mill pond in the west of the site.

Geohazards included in the Envirocheck Analysis report are summarised below:

- Collapsible ground – Very low risk across the site.
- Compressible ground – Moderate risk, with the exception of the north-western corner of site, which has negligible risk.
- Ground dissolution – Negligible risk.
- Landslides – Very low risk across the site.
- Running sands – Low risk, with the exception of the north-western corner of site, which has negligible risk.
- Shrinking or swelling clay – Very low risk across the site, with the exception of the north-western corner of site, which has negligible risk.

4.5 HYDROGEOLOGY

4.5.1 HYDROGEOLOGICAL CLASSIFICATION

Table 4-3 summarises the relevant hydrogeological features within 500 m of the site, as highlighted within the Envirocheck Report and DEFRA Magic Map.

Table 4-3 - Hydrogeological Features Within 500 m of the Site

Hydrogeological Aspect	Details
Geology Aquifer Designation	Superficial and bedrock geologies are classified as Secondary A Aquifers.
Groundwater Source Protection Zones (SPZ)	The site does not lie within or within close proximity to a SPZ.
Groundwater Vulnerability	The bedrock aquifer is defined as a '*High Vulnerability, Secondary Aquifer*'.
BGS Flood GFS Data	The site is shown as having the potential for groundwater flooding to occur at surface.
Groundwater Classification	The Pennine Lower Coal Measures Formation is defined as a '*moderately productive aquifer'*. The aquifer is described as *'a regional, cyclic multi-layered aquifer with moderate yields from sandstones and many springs.'*

4.5.2 GROUNDWATER LEVELS

Table 4-4 summarises the groundwater data recorded on the historical borehole logs.

Table 4-4 – Table summarising borehole groundwater readings

Borehole Reference	Borehole Location within site	Standing Water Depth (m BGL)	Depth when Groundwater Struck (m BGL)
SE22SW638	East	5.4 – 5.7	Not specified
SE22SW636	East	4.0 – 5.0	6.2
SE22SW632	West	4.2 – 5.4	5.1
SE22SW633	West/Centre	4.6 – 7.85	5.8

All the boreholes record the groundwater strikes or standing groundwater levels within the Alluvium.

4.6 HYDROLOGY

Table 4-5 summarises the notable hydrological features within 500 m of the site.

Table 4-5 – Notable Hydrological Features Within 500 m of the Site

Surface Water Feature	Approx. Distance from Site (m)	Details
River Calder	50 m south of the site.	The River Calder meanders through Dewsbury, trending approximately east to west.
Batley Beck	The beck flows in a north to south direction, at its closest it is approximately 165 m to the east of site.	The route the beck takes is mapped on the OS Water Network Map. It is culverted underground, entering approximately 1 km north of the site and emerging where it meets the River Calder approximately 300 m south-east of site.
Surface Water Abstractions	There are five recorded surface water abstractions within 500 m of the site. All of these relate to surface abstractions from the River Calder for use in textile and leather, mineral products, boiler feed and other general industrial uses. The end dates for these water abstractions are not provided in the Envirocheck Report.	

4.7 SENSITIVE LAND USES

The site does not lie within 1 km of a National Nature Reserve, Marine Conservation Zone Ramsar Site, Site of Special Scientific Interest, Special Area of Conservation, Special Protection Area or World Heritage Site.

All Saints Churchyard situated approximately 100 m to the east of the site is defined as a '*Priority Habitat Inventory – Deciduous Woodland*'. Furthermore, the site is an area for '*Priority Species for CS Targeting – Lapwing'* meaning it is a *'Priority area for countryside Stewardship measures addressing Lapwing habitat issues'*.

5 PRELIMINARY COAL MINING RISK ASSESSMENT

5.1 SCOPE OF COAL MINING RISK ASSESSMENT

The site does not lie within a Coal Authority (CA) defined '*Development High Risk Area'.* However, two named coal seams are shown to subcrop within the boundary of the site and, as such, a Coal Mining Risk Assessment (CMRA) has been completed.

The preliminary CMRA:

- Presents a desk-based review of information relating to the coal mining issues that are relevant to the proposed development site.
- Uses that information to identify and assess the risk to the proposed development from coal mining legacy, including the cumulative impact of issues.
- Outlines appropriate mitigation measures (if any) to address the coal mining legacy issues affecting the site, including any necessary remedial works and/or demonstrate how these issues have affected the proposed development.

5.2 SOURCES OF INFORMATION USED TO INFORM THIS ASSESSMENT

The following sources have been used to assist in the assessment of the potential mining risk of the proposed development area:

- Coal Authority interactive viewer;
- Coal Authority Consultants Coal Mining Report and Map **(Appendix C)**;
- BGS geological viewer;
- BGS 1:10,000 and 1:50,000 geological maps;
- Historical BGS Borehole Logs; and,
- Envirocheck Analysis Report.

5.3 MINING ACTIVITY AND GEOLOGY

5.3.1 RECORDED SHALLOW UNDERGROUND COAL MINING

The Coal Authority Consultants Report states there are no historical shallow workings recorded in the area.

5.3.2 PROBABLE UNRECORDED SHALLOW WORKINGS

The Coal Authority Consultants Report does not identify any probable unrecorded shallow workings in the site or immediate surrounding area, nor does it record the two coal seam subcrops (the Flockton Thick and Flockton Thin seams) that are shown on the geological maps. The reason for this discrepancy is unknown.

The historical BGS borehole logs reviewed for the site do not record any evidence of shallow coal mine workings.

Three historical BGS boreholes record coal seams, as summarised in Table 4-2. These may be associated with the Flockton Thick and Flockton Thin coal seams that are shown to subcrop on the site. The recorded spatial separation between the coal seams is similar to that stated in the stratigraphic column on the 1:10,000 BGS map (11 m in the stratigraphic column and 11.2 m in borehole SE22SW16).

Given that the two seams are shown to subcrop on the site there would be areas where the rock cover above the coal seams would be insufficient to mitigate the risk of surface movement should unrecorded workings (if present) collapse.

The CA report states that past investigations on the site by Ove Arup & Partners (Arup) stated that the evidence for mining instability on site was inconclusive. However, this report is not available.

5.3.3 MINE ENTRIES (SHAFTS AND ADITS)

The Coal Authority Consultants Report states that there are no recorded mine entries within 500 m of the site boundary.

5.3.4 COAL MINING GEOLOGY (FAULTS AND FISSURES)

The Coal Authority Consultants Report and the BGS mapping do not show any faults or fissures within the site boundary.

5.3.5 SURFACE MINING (OPENCAST WORKINGS)

The Coal Authority Consultants Report does not identify any surface mining within influencing distance of the site.

5.4 COAL MINING RISK SUMMARY

Table 5-1 provides a summary of the identified coal mining risks to the site.

Table 5-1 - Coal Mining Risk Summary

Coal Mining Hazard	Recorded		Risk Assessment	
	Yes	No	Rating	Comment
Past underground mining		X	Low Risk	None recorded within the site boundary.
Probable underground shallow workings		X	Medium Risk	The CA Consultants Report does not identify the presence of potential unrecorded workings. However, it is considered that the presence of two coal seam subcrops within the site means that the potential for unrecorded workings cannot be discounted, albeit no evidence of workings are recorded within the histporical BGS boreholes.
Mine entries (shafts and adits)		X	Low Risk	None recorded within 500 m of the site boundary.
Coal mining geology (faults, fissures)		X	Low Risk	No faults or fissures are recorded within the site's boundary.
Record of past mining gas emissions (mine gas)		X	Low Risk	No records of mining gas emissions have been identified.

Coal Mining Hazard	Recorded		Risk Assessment	
	Yes	No	Rating	Comment
Surface mining (Opencast workings)		X	Low Risk	No surface mining is shown within influencing distance of the site.

Based on all the information reviewed for the site (as summarised above), the evidence for or against the potential presence of unrecorded shallow workings beneath the site is considered to be inconclusive. As such, it is considered that the risk of shallow unrecorded workings cannot be discounted and further investigation is considered warranted.

6 PRELIMINARY CONCEPTUAL SITE MODEL

6.1 INTRODUCTION

Plausible source-pathway-receptor contaminant linkages have been defined in line with industry good practice, principally the Environment Agency's guidance on Contaminated Land Risk Management (LCRM, October 2020, updated April 2021).

The potential risks from contamination within soil and groundwater are assessed according to the environmental setting / ground model, likely presence of potential sources of contamination and the proposed use of the site.

The source-pathway-receptor model forms the basis of the risk assessment. Potential risks are only considered to exist if there is a credible source (e.g. a chemical substance capable of causing harm); a pathway for migration of the source to a receptor; and a sensitive receptor that could be affected (e.g. nearby river or site user). A source-pathway-receptor contaminant linkage assessment is termed a conceptual site model (CSM). A preliminary CSM is produced prior to intrusive ground investigation and is refined following collection of site-specific data (if appropriate).

The CSM described in this section provides an understanding of the site based on the findings of the desk study.

6.2 PRELIMINARY GROUND MODEL

Made Ground is likely to be present across the site associated with the former and current site uses. Superficial deposits comprising Alluvium are mapped as being present underlying the majority of the site (beneath the Made Ground if present) but may be absent in the north.

The superficial deposits (Alluvium) and the underlying bedrock of the Pennine Lower Coal Measures Formation / Emley Rock are classified as Secondary A Aquifers.

6.3 POTENTIAL SOURCES OF CONTAMINATION

Table 6-1 summarises the identified potential on-site sources of contamination:

Table 6-1 – Potential On-Site Source of Contamination

Source	Potential Contaminants in Soil and/or Groundwater
General Made Ground (from current and previous on-site and nearby developments)	Asbestos, heavy metals, polyaromatic hydrocarbons (PAHs), oil / fuel hydrocarbons. Hazardous ground gases.
Historical tank present along western site boundary (1890-1967)	Oil / fuel hydrocarbons, volatile and semi-volatile organic compounds (VOCs / SVOCs)
Infilled pond / reservoir (1890-1967)	Asbestos, heavy metals, polyaromatic hydrocarbons (PAHs), oil / fuel hydrocarbons. Hazardous ground gases.
Potential historical coal mining activities beneath the site	Hazardous ground gases.

Alluvium (potentially organic)	Hazardous ground gases.

6.4 POTENTIAL RECEPTORS

The following sensitive receptors are those which have been identified to be at risk of contamination.

6.4.1 HUMAN HEALTH

- Site users, such as people using the bus station or working at the bus station or in one of the attached shops.
- Construction and maintenance workers involved with below ground excavations / works.

6.4.2 CONTROLLED WATERS

- Secondary A Aquifers (both the superficial and bedrock geologies).
- Batley Beck - flows approximately 165m to the east of the site in a culvert in a north to south direction.
- River Calder (approximately 50m south of site), flowing in an easterly direction.

Due to the fact that Batley Beck is approximately 165m east of the site at its closest point and is culverted (assumed stone / concrete walled or similar) it is not considered as a potential receptor to contamination.

6.4.3 OTHER RECEPTORS

- Below ground building structures and services.

6.5 POTENTIAL PATHWAYS

The following potential pathways may be present:

- Exposure to contaminated soil and groundwater via ingestion / dermal contact / inhalation.
- Gas / vapour inhalation indoors and outdoors.
- Migration of contaminants into underlying and adjacent groundwater, and into adjacent watercourse (River Calder).
- Migration of ground gas into buildings.
- Direct contact of foundations and services with contamination.

6.6 PRELIMINARY CONCEPTUAL SITE MODEL

Table 6-2 summarises the possible source-pathway-receptor linkages. The CIRIA risk definitions (**Appendix E**) were used to determine the level of risk.

Table 6-2 – Preliminary Conceptual Site Model

Source	Exposure Pathway	Potential Receptor	Probability of Exposure	Consequence of Exposure	Discussion of Pollutant Linkage	Risk
Made Ground associated with previous development, historical tank, infilled pond / reservoir (heavy metals, PAHs, asbestos, fuel / oil hydrocarbons and hazardous ground gases)	Inhalation, Ingestion and Dermal Contact	Humans – future users of site infrastructure (public)	Unlikely	Medium (dependent on the types of contaminants someone is exposed to).	The likelihood of general site users being exposed to contaminants at this site is unlikely, even in the long term. The presence of hardstanding across the vast majority of the site severs the potential pathway mechanism of the contaminant to the human receptor.	Low Risk
Hazardous ground gases from Alluvium, infilled pond / reservoir and historical coal mining (if present).		Humans – construction & maintenance workers	Low (with appropriate use of PPE / RPE)	Medium (dependent on the types of contaminants someone is exposed to).	Potential for construction and maintenance workers to encounter contaminated soil / asbestos fibres. Exposure times likely to be limited and risks should be reduced by wearing	Low to Moderate Risk

Source	Exposure Pathway	Potential Receptor	Probability of Exposure	Consequence of Exposure	Discussion of Pollutant Linkage	Risk
					appropriate personnel protective equipment (PPE/RPE).	
	Leaching and Migration	Groundwater – underlying Secondary A Aquifer (superficial).	Low Likelihood	Medium	Potential for mobile contaminants on site. Hardstanding surfacing should act as a low permeability surface, thus infiltration to superficial geology should be limited.	Low to Moderate Risk
		Groundwater - underlying Secondary A aquifer (bedrock).	Low Likelihood	Medium	Hardstanding surfacing acts as a low permeability surface limiting infiltration. The cohesive areas of alluvium deposits may also act as a buffer between surface and bedrock aquifer; however, the alluvium is predominantly granular.	Low to Moderate Risk

Source	Exposure Pathway	Potential Receptor	Probability of Exposure	Consequence of Exposure	Discussion of Pollutant Linkage	Risk
		Surface water – Calder River	Low Likelihood	Medium	The Calder River is located in close proximity to the site (50 m to the south), Infiltration and migration is predicted to be limited and the migration potential is assessed as low.	Low to Moderate Risk
	Direct contact	Foundations	Likely	Mild	Potential for contaminants posing risk to new foundations and underground structures to be present.	Low to Moderate Risk
	Migration towards surface hazardous ground gas from historical mine workings, Alluvium and infilled pond.	Humans – construction & maintenance workers	Unlikely	Severe	Although potential sources of hazardous ground gases are present beneath the site, the proposed improvement works	Low to Moderate Risk

Source	Exposure Pathway	Potential Receptor	Probability of Exposure	Consequence of Exposure	Discussion of Pollutant Linkage	Risk
		Risk of explosion with future buildings and infrastructure	Unlikely	Severe	are unlikely to increase the risk of ground gas exposure. No new buildings are proposed.	

7 PRELIMINARY GROUND ENGINEERING ASSESSMENT

7.1 PROPOSED REDEVELOPMENT

At this stage, three differing options for the redevelopment of the bus station have been put forward; a 'Do min' option, a 'Do something' option and a 'Do max' option (**Appendix A**), all of which will require differing engineering approaches.

The only option which is assumed to require new foundations to be constructed is the 'Do max', which involves changes to the roof and the addition of a new feature glass roof canopy extension at the western most point of the building. No details of the foundation loads or serviceability requirements for the canopy structure are known at this stage.

7.2 GROUND CONDITIONS SUMMARY

Based on the relevant published data and the site's history, the anticipated ground conditions beneath the site can be summarised as follows:

- Made ground associated with the construction and demolition of various industrial, commercial and residential buildings and roads, with a thickness varying between 1 and 4 m; overlying,
- Alluvium (thickness between 6 and 12 m); and,
- Bedrock of the Pennine Lower Coal Measures (thickness not proven).

Groundwater is recorded between the depths of 4.0 – 7.85 m BGL (standing water depth).

7.3 FOUNDATIONS

The following assessment is made assuming that the site levels will remain similar to those at present. If this is not the case, then the following will require review.

In the absence of foundation loads and serviceability criteria it is difficult to assess the most likely form of foundation for the structure. If foundations loads are low and the structure can tolerate a certain amount of settlement, shallow spread foundations formed within the predominantly granular Made Ground may be feasible following suitable preparation of the formation (e.g. local dig out and replacement with a suitably compacted engineered fill).

However, if foundation loads are high or settlement tolerances are low, foundations may need to be deepened to found on the more competent Alluvium or bedrock. If the depth to a competent strata is excessive, a mini-pile solution is likely to be appropriate to minimise disturbance to the operation of the bus station and to the existing structure.

Standing groundwater levels encountered within the historical works were recorded between 4.20 and 7.85 m BGL. If these depths are representative of current levels, groundwater is considered unlikely to be encountered within the typical depth range for spread foundations or pile caps. However, it is noted that the Envirocheck Report identifies that the site lies in an area at risk of groundwater flooding, and the risk of shallow groundwater being present should not be discounted.

In order to confirm foundation design, intrusive ground investigation should be undertaken within the footprint of the proposed canopy extension, including the installation of a groundwater monitoring installation. This should enable ground conditions to be confirmed and allow geotechnical parameters to be assessed for the use in detailed geotechnical design.

7.4 EARTHWORKS

No significant earthworks are anticipated.

7.5 OBSTRUCTIONS

Historical maps record several structures being constructed and demolished within the site boundary and the presence of below ground obstructions cannot be ruled out at this stage. The potential for obstructions within the Made Ground should be considered when assessing suitable ground investigation techniques, as well as construction methods.

Historical borehole logs record boulders within the Alluvium, which may present an obstruction to intrusive works.

7.6 SHALLOW COAL MINING

The risk of unrecorded shallow workings below site is deemed to be inconclusive. The Coal Authority define all coal mining risks and hazards to be low risk, but do not identify the two Flockton coal seams subcropping below site, thus a definite conclusion on the level of risk cannot be made at this point.

If present, they may pose a potential risk to the new foundations and remedial measures could be required. This would most likely take the form of drilling and grouting beneath the foundations and an appropriate easement around them.

8 CONCLUSIONS

8.1 GROUND CONDITIONS

Ground conditions are anticipated to comprise Made Ground associated with the historical activity on site overlying Alluvium and bedrock of the Pennine Lower Coal Measures. The mapped superficial deposits and bedrock are both noted as Secondary A aquifers.

8.2 ENVIRONMENTAL SETTING

The environmental setting of the site in terms of potential risk from contamination is considered to be low for human health due to the continued use as a bus station and low to moderate for controlled waters due to the presence of a Secondary A aquifer underlying the site.

8.3 LAND QUALITY

Potential sources of contamination have been identified associated with the current and historical site uses. The site has been occupied by mills, warehouses, former residential properties (now demolished), a pond / reservoir (later infilled), a car park and a bus station.

Risk ratings assigned to the key identified receptors are summarised below:

- **Risks to future site users**: Given the surface cover across the majority of the site comprises buildings or hardstanding there is considered to be a low risk posed to future site users in the context of the continued use as a bus station.
- **Risks to construction and maintenance workers**: To support the proposed redevelopment of the site, preparation and enabling works could result in the excavation and movement of small quantities of Made Ground and fill materials which may contain asbestos, heavy metals, PAHs and oil / fuel hydrocarbons. It is considered there is a low to moderate risk to construction and maintenance workers, based on the assumption that excavation will be limited in extent, exposure durations will be limited, that appropriate PPE / RPE will be worn, and clean hygiene practices (e.g. handwashing, housekeeping) will be adopted.
- **Risks to controlled waters**: Risks to controlled waters (underlying Secondary A Aquifers and River Calder) are considered to be low to moderate. Although potential sources of contamination are present on site, the improvement works are unlikely to impact controlled waters receptors. The presence of hardstanding across the site should inhibit the migration of potential contaminants to the underlying aquifers or River Calder.

The site lies within an area defined to be at low risk from UXOs.

8.4 GROUND ENGINEERING

It may be feasible to support the canopies on shallow spread foundations bearing within the Made Ground and / or Alluvium. However, if the foundation loads are high, the settlement tolerances low or the geotechnical properties of the shallow soils are unsuitable, a piled foundation may be required to transfer loads to more competent soils or rock at greater depth.

The potential for buried obstructions should be specifically considered during the intrusive ground investigation and taken into account when positioning the foundations during the detailed design phase of the scheme.

Based on the findings of the Coal Mining Risk Assessment the information relating to the risk of the site being affected by shallow unrecorded mine workings is considered inconclusive and further assessment is considered appropriate.

8.5 RECOMMENDATIONS

Given the absence of site specific data and the potential for contamination and shallow mine workings to be present, it is considered that an intrusive ground investigation should be undertaken to support the design of foundations and support the discharge of planning conditions. The investigation scope should aim to obtain the following information:

- The nature of the shallow ground and groundwater conditions beneath the site;
- The geotechnical properties of the shallow soils;
- The nature of the underlying bedrock and the potential for historical shallow mine working beneath the site; and,
- The potential presence of contaminants associated with identified potential sources of contamination such as Made Ground.

Based on the above, it is likely the proposed investigation will comprise two boreholes (one each side of the canopy), down to rockhead to a minimum of 20 m of intact rock to discount unrecorded shallow coal mining.

9 GEOTECHNICAL RISK REGISTER

A review of the geotechnical risks has been undertaken and a Risk Register produced. Risks have been evaluated using the risk evaluation matrices shown below.

Table 9-1 – Geotechnical Risk Register

Probability (P)	
Very Likely	5
Probable	4
Likely	3
Unlikely	2
Negligible	1

Impact/Consequence (I)	
Very High	5
High	4
Medium	3
Low	2
Very Low	1

Risk P X I = R		Impact/Consequence				
		1	2	3	4	5
Probability	1	1	2	3	4	5
	2	2	4	6	8	10
	3	3	6	9	12	15
	4	4	8	12	16	20
	5	5	10	15	20	25

Risk Rating (R) =
Probability (P) x Impact *(I)*

Hazard	Before			Risk Control Measures	After Control		
	P	I	R		P	I	R
Site Specific Geotechnical Risks							
Buried obstructions in the Made Ground and Alluvium impacting foundation installation.	4	3	12	Undertake site specific ground investigation.	2	3	6
Unknown Ground Conditions	3	4	12	Undertake site specific ground investigation	1	4	4
Surface and Groundwater Flooding - The site is deemed to be at risk of groundwater flooding.	3	3	9	Appropriate surface and groundwater control measures should considered for construction.	2	3	6
Shallow/unknown groundwater levels	3	3	9	Undertake site specific ground investigation and assess requirements for temporary groundwater control during design and construction.	2	3	6
Shallow unidentified historical coal workings.	2	5	10	Conduct further site-specific ground investigation to assess shallow mining risk. If risk is identified, then appropriate mitigation measures should be conducted (e.g. drill and grout).	1	5	5
General Geotechnical Risks							
Bearing capacity failure or excessive total or differential settlements of foundations	4	4	16	Foundation design should be based on the findings of the ground investigation	1	4	4
Aggressive ground conditions – sulphate and sulphide attacks on concrete footings.	2	4	8	Undertake specific ground investigations to assess aggressive ground conditions risk. The design should be conducted in accordance with BRE - Special Digest 1.	1	4	4
Running sands risk – defined as a low risk area. The risk may be exacerbated by leaking drains or mains water supply pipes in the area.	2	3	6	Special care should be taken to support excavations such as trial pits that go below the water table.	1	3	3