



e3p

Phase I Geoenvironmental Site Assessment
Land to the West of New Street, Littleborough

Reference: 15-075-R1-2

Date: July 2022



PHASE I GEOENVIRONMENTAL SITE ASSESSMENT

Land to the West of New Street
Littleborough
OL15 8HW

Prepared for:



Report Ref: 15-075-R1-2
Date Issued: July 2022

New Street, Littleborough

Phase I Geoenvironmental Site Assessment

July 2022

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EXECUTIVE SUMMARY

Site Address	Land off New Street, Littleborough, OL15 8HW
Grid Reference	E 392610, N 415790
Site Area	~3.39 Ha
Proposed Development	Russell Homes intend to construct a low-rise residential development comprising 62 dwellings with associated access, gardens, public open space, attenuation basin, estate roads and ancillary infrastructure. The site is located west of the current Russell Homes development accessed off New Road.
Current Site Use	The Site comprises an undeveloped parcel of land located west of New Street in Littleborough. The Site is variable in topography with undulating land. Generally, the Site topographically falls from 150 m AOD in the north to 140 m AOD in the south. A steep slope is present in the northwest. The central-southern sector has been subject to overland flooding attributed to the accumulation of surface water in recent years. It is understood this occurred due to blockages within failing surface water drainage. A narrow drainage channel runs from the area of surface water to the manholes identified in the southwest. The route of a stream/ditch is present from the northwest to the southeast, however, this was noted to be dry during the site walkover. An area of orange staining was noted in the stagnant water at the north end of the stream/ditch. A Spring is also located at the western site boundary. An area of dense woodland is present in the far north of the Site, and sporadic semi-mature and mature trees are present in the location of the overland flooding and along the southern site boundaries. Reeds and rushes are present at the edge of the flooded area.
Site History	Historical mapping suggests that the southeast sector of the Site was developed circa 1910 as part of Lower Mill Cottage to the east. The structures are no longer recorded on-site by 1960. An area of surface water flooding is located in the central sector of the Site, this appears to have gradually increased in size since circa 2000 when two small ponds were recorded, with it now indicated to encompass a notable portion of the development site area. A watercourse flows from northwest to southeast from the earliest available mapping dated 1851. Wells were recorded in the west of the Site from 1851; however, these are no longer shown by 1893. A spring is recorded at the western boundary from circa 1930. A sandpit and clay pit is recorded in the far north of the Site from circa 1930, these features were subsequently backfilled. Between circa 1930 and 1960, allotment gardens were located in the east of the Site.



Environmental Setting	Drift Geology	Glacial Till – CLAY, SAND, GRAVEL Alluvium (South, Centre) – CLAY, SILT, SAND, GRAVEL
	Bedrock Geology	Pennine Lower Coal Measures Formation – MUDSTONE, SILTSTONE AND SANDSTONE.
	Faults	There are no faults recorded within 250 m.
	Hydrogeology	The Glacial Till deposits are classified as secondary undifferentiated, and the Alluvium is a secondary A aquifer. The solid geology is classified as a Secondary A aquifer.
	Hydrology	A spring is recorded in the west of the Site. The historical stream that flowed through the Site leading to a culvert has become blocked in recent years. This has resulted in some localised overland flooding in the central/southern sector. The River Roch (main river) is located 52 m south.
Utility Locations	Overhead BT cables are present in the east of the Site. Combined public sewers are present in the west and east. Manholes were noted in the west of the Site during the site walkover.	
Landfill Sites and Ground Gases	A historic landfill and registered landfill are recorded in the south of the Site. Inert waste was deposited between March 1988 and December 1990. The Site has undergone some historic ground working; the Made Ground may produce hazardous ground gases such as methane and carbon dioxide.	
Radon	The Site is unaffected.	
Coal Mining/Land Stability	The Site is located in a high-risk development area. Coal seams are recorded to sub-crop across the Site, with areas of recorded underground workings underlying the western side of the Site. Mine workings are recorded in the Upper Mountain and Lower Mountain seams between 7.0 – 22.0 m. The Coal Authority also indicate probable shallow mine workings across the majority of the Site. Mine shafts are recorded circa 120 – 140 m to the west/northwest, indicating access to workings in the immediate vicinity. The desk-based Coal Mining Risk Assessment (CMRA) confirms the high probability with respect to extensive shallow workings beneath the area of the proposed development. These workings will likely pose a surface stability risk associated with the unquantifiable future collapse and subsequent consolidation of workings inducing subsidence at the surface. The CA, as a statutory consultee, will require a series of rotary open holes across the Site to determine the location of coal sub-crops on-site and to understand the nature of any coal workings. These investigation works will assist in defining the requirements for mine stabilisation works that are highly likely to be required across significant areas of the Site.	



Hazardous Installations & Former Land Use	No hazardous installations that could potentially prejudice the proposed construction of highly sensitive residential dwellings have been identified within influencing distance of the subject site. The south-central sector is a licensed historical landfill site, the material deposited in this sector is legally defined as waste material. To ensure safe and lawfully compliant recovery and reuse of this material, a suitable Environmental Permit will be required for the land remediation works.
Initial Conceptual Site Model	Contaminant Sources Made Ground associated with localised construction and demolition activities, the on-site landfill and infilled features is a potential source of heavy metals PAHs, hydrocarbon compounds and ACM. There is the potential for localised small fuel leaks or spillages from the former tanks at the northwest boundary which are a potential source of VOCs, SVOCs, PAHs, hydrocarbon compounds, acids and metalloids. The former mill at the northern boundary associated with bleaching and dyeing is a potential source of semi-volatile and volatile organic compounds including chlorinated solvents. Made Ground, the on-site landfill, peat, alluvium and coal measures underlying the Site are potential sources of hazardous ground gas which can accumulate within deep excavations or migrate through permeable strata, foundation structures, and/or service ducting and pose a potential risk to construction workers and future site users. Off-site sources of hazardous ground gas include landfills, former reservoirs and sewage works. Pathways The main pathways based on the identified potential contaminants are direct contact and ingestion, volatilisation and indoor explosion, vapour inhalation, dust inhalation and lateral migration. Receptors The presence of potentially impacted Made Ground and landfill on site poses a risk to both construction workers and future site users. Mobile contaminants may be present associated with Made Ground, infilled features and the on-site landfill, leaks from the historic tanks at the northwest boundary and the historic mill to the north. The underlying alluvium is recorded as a secondary A aquifer and the bedrock is recorded as a secondary A aquifer. However, the absence of any groundwater abstraction points within proximity to the site reduces the sensitivity of the aquifers. Lateral migration of potential mobile contaminants may impact surface water features identified on-site. The River Roch located 52 m south is also a potential receptor.



Preliminary Geotechnical Considerations	The initial Desk Study has identified several pertinent geotechnical hazards that will require detailed consideration as part of the proposed development design. ❗ Inert landfill located in the south-central sector, variable and deep Made Ground is anticipated. Remediation and enabling earthworks will be required to render this sector suitable for future development. Waste materials will need to be processed and recovered using an appropriate Environmental Permit. ❗ The central sector has been subject to overland flooding attributed to blocked culverts and drainage infrastructure. The retention of water for prolonged periods in this sector will have resulted in the deposition of organic material and saturation of the natural soils resulting in a reduction in soil strengths. ❗ The Site topography varies significantly. Therefore, cut / fill enabling earthworks are required. ❗ The natural deposition of alluvial soils represents an area of geotechnical risk. ❗ Extensive shallow mine workings underlie the Site. Consequently, much of the Site will probably require stabilisation by drilling and pressure grouting to mitigate the risk of subsidence at the surface. ❗ The presence of shallow mine workings will limit the application of piled foundations and ground improvement by Vibro Stone Columns.
Recommendations	A detailed Phase II intrusive Geoenvironmental Site Assessment should be undertaken to confirm the findings of the initial conceptual site model and value engineer a development solution. The Phase 2 Site Investigation will need to incorporate extensive works to investigate abandoned shallow mine workings, the former landfill and geotechnical hazards.



Table of Contents

EXECUTIVE SUMMARY	1
1. INTRODUCTION	7
1.1. Background	7
1.2. Proposed Development.....	7
1.3. Objectives	8
1.4. Sources of Information	8
1.5. Limitations	8
1.6. Confidentiality	8
1.7. Risk Classification	9
2. SITE SETTING	10
2.1. Site Details	10
2.2. Current Site Use	10
2.3. Surrounding Area	11
3. SITE HISTORY	12
3.1. On-Site Historical Development.....	12
3.2. Off-Site Historical Development	17
3.3. Planning History	17
3.4. Previous Reports	18
4. ENVIRONMENTAL SETTING.....	20
4.1. Geology and Hydrogeology	20
4.2. Natural Landform and Geomorphology	21
4.3. Geotechnical Data	22
4.4. Coal Mining	22
4.5. Coal Mining Information	23
4.5.1. Coal Authority Plan	26
4.5.2. Coal Mining Geology.....	26
4.6. Preliminary Mine Gas Assessment	27
4.7. Coal Mining Risk Assessment	28
4.8. Brine Workings.....	29
4.9. Radon Risk Potential	29
4.10. Preliminary Geotechnical Assessment	29
4.11. Hydrology	30
4.12. Industrial Land Uses.....	31
4.13. Sensitive Land Uses	31
4.14. Site Sensitivity Assessment.....	31
5. REGULATORY DATA	33
5.1. Landfill Sites and Waste Treatment Sites	33
5.2. Regulatory Database	33
5.1. Unexploded Ordnance	34
6. INITIAL CONCEPTUAL SITE MODEL.....	35
6.1. Initial Conceptual Site Model	36
7. CONCLUSIONS AND RECOMMENDATIONS.....	39
7.1. Site Summary.....	39
7.2. Contaminated Land Assessment	40
7.3. Coal Mining	41
7.4. Geotechnical Assessment	41



APPENDIX I LIMITATIONS.....	42
APPENDIX II GLOSSARY	44
APPENDIX III DRAWINGS	47
APPENDIX IV PHOTOGRAPHS	49
APPENDIX V HISTORICAL MAPS	54
APPENDIX VI COAL AUTHORITY REPORT	55

DRAWING LIST

15-075-R1-001 - Site Location Plan
15-075-R1-002 - Proposed Development Plan
15-075-R1-003 - Historical Features Plan
15-075-R1-004 - Site Features Plan



1. INTRODUCTION

1.1. BACKGROUND

E3P Ltd has been commissioned by Russell Homes (the client) to undertake a Phase I Geoenvironmental Site Assessment at land to the west of New Street in Littleborough. The site is located west of the current Russell Homes development accessed off New Road.

This report is required to determine potential contaminated land liabilities and geotechnical constraints as part of the proposed site redevelopment.

1.2. PROPOSED DEVELOPMENT

Russell Homes intend to construct a low-rise residential development comprising 62 residential dwellings with associated access, gardens, public open space, attenuation basin, estate roads and infrastructure. Drawing 15-075-002 (Appendix III) identifies the proposed development layout.

A snapshot of the proposed development layout is indicated in Figure 1.1.

FIGURE 1.1 SNAPSHOT OF PROPOSED DEVELOPMENT



1.3. OBJECTIVES

- ✿ The objectives of the geoenvironmental investigation are as follows:
- ✿ Review historical plans, geology, hydrogeology, site sensitivity, floodplain issues, mining records and any local authority information available in order to complete a desk study in line with Environment Agency (EA) document Land Contamination: Risk Management (LC:RM) (2019)
- ✿ Assess the implications of any potential environmental risks, liabilities and development constraints associated with the Site in relation to the future use of the Site and in relation to off-site receptors.
- ✿ Assess the desk-study information and, where possible, provide preliminary recommendations in relation to foundations, pavement construction and floor slabs.
- ✿ Provide recommendations regarding future works required and undertake a preliminary pre-construction cost appraisal.

1.4. SOURCES OF INFORMATION

Background information was sought from the following sources:

- ✿ Envirocheck Search;
- ✿ Historical mapping dated 1851 to 2022. A selection of historical maps are reproduced in Appendix V;
- ✿ Online planning records held by Rochdale Borough Council;
- ✿ Magic Map Groundwater Vulnerability Map;
- ✿ Radon: Guidance on protective measures for new buildings (BRE Document BR 211, 2007);
- ✿ British Geological Survey Map;
- ✿ Groundsure IO database;
- ✿ <https://zeticauxo.com/downloads-and-resources/risk-maps/>; and,
- ✿ <https://flood-map-for-planning.service.gov.uk>.

1.5. LIMITATIONS

The limitations of this report are presented in Appendix I.

1.6. CONFIDENTIALITY

E3P has prepared this report solely for the use of the client and those parties with whom a warranty agreement has been executed or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from E3P; a charge may be levied against such approval.



1.7. RISK CLASSIFICATION

E3P has utilised the available data to classify the Site on the basis of its potential contaminated land liability and potential for geotechnical constraints in relation to the site development. The risk classification definitions are summarised in Table 1.1.

TABLE 1.1 RISK CLASSIFICATION

RISK	DEFINITION
Low	There are unlikely to be significant contaminated land liabilities/geotechnical constraints associated with the property.
Low Moderate	There are unlikely to be significant contaminated land liabilities/geotechnical constraints associated with the property with regard to the proposed use. However, minor issues may require further consideration in the event of future redevelopment of the Site.
Moderate	Some potential contaminated land liabilities/geotechnical constraints are likely to affect the property as a result of historical and/or current activities. The risks identified are unlikely to pose an immediate significant issue but the purchaser/developer may wish to make further enquiries of the vendor or undertake further environmental improvements. Redevelopment of the Site will likely require further site investigation.
Moderate High	Some potentially significant contaminated land liabilities/geotechnical constraints have been identified at the property that requires further assessment, including intrusive ground investigations.
High	Significant potential contaminated land liabilities/geotechnical constraints have been identified at the property. Further assessment including intrusive ground investigation will be required to determine the level of risk and associated liability.



2. SITE SETTING

2.1. SITE DETAILS

Site Address	Land off New Street, Littleborough, OL15 8HW
National Grid Reference	E 392610, N 415790
Site Area	~3.39 Ha

All acronyms used within this report are defined in the Glossary presented in Appendix II.

A site location map is presented in Appendix III as Drawing 15-075-001.

2.2. CURRENT SITE USE

E3P has undertaken a site walkover of the entire Site, and a description of the key findings is summarised in Table 2.1.

TABLE 2.1 SITE DESCRIPTION

Occupancy/Use	The Site comprises an undeveloped parcel of land located to the west of New Street in Littleborough. The central-southern sector has been subject to overland flooding attributed to the accumulation of surface water in recent years. It is understood this occurred due to blockages within failing surface water drainage. A narrow drainage channel runs from the area of surface water to the manholes identified in the southwest. The route of a stream/ditch is present from the northwest to the southeast, however, this was noted to be dry during the site walkover. An area of orange staining was noted in the stagnant water at the north end of the stream/ditch. A Spring is also located at the western site boundary.	
Surface Cover (%)	Buildings	0 %
	Hardstand	0 %
	Soft Cover	100 %
Structures	No structures have been identified within the site boundary.	
Access	A metal access gate is present in the southeast corner of the Site. Gaps were also noted in the post and wire fencing and Heras fencing along the eastern site boundary.	
Slope	The Site is variable in topography with undulating land. Generally, the Site topographically falls from 150 m AOD in the north to 140 m AOD in the south. A steep slope is present in the northwest.	
Retaining Structures	None present.	
Vegetation/Ecology	Rough scrub vegetation is present across the Site with areas of overgrown grasses, although most of the grass is short. An area of dense woodland is present in the far north of the Site, and sporadic semi-mature and mature trees are present in the location of the overland flooding and along the southern site boundaries. Reeds and rushes are present at the edge of the flooded area. A habitat survey will be required to support the planning application.	



Hazardous Material Storage	No above-ground storage tanks (ASTs) or underground storage tanks (USTs) were observed at the Site during the preliminary site walkover. Due to the previously undeveloped nature of the Site, it is unlikely that hazardous materials storage will have occurred on the Site. Tanks were present at the northwest boundary associated with the adjacent mill. Mapping suggests that the tank structures may still be present.
Asbestos-Containing Material (ACM)	No evidence of ACM was noted across the Site during the site walkover. The presence of ACM in any Made Ground associated with the demolition of former structures cannot be discounted.
Polychlorinated Biphenyls (PCBs)	There is no equipment identified that may contain PCBs within the site boundary.
Waste Storage	Potentially hazardous waste streams are unlikely to be generated at the Site, and none were observed during the preliminary site inspection. Orange staining was noted in the stagnant water at the north end of the stream/ditch. This may indicate a high concentration of iron within the deposited Made Ground which has been transferred to the surface water feature as acid mine drainage.
Drainage	A formal drainage survey has not been completed; however, a review of online records held by United Utilities indicates combined public sewers are present in the west and east of the Site. Manholes were noted in the west of the Site during the site walkover.

2.3. SURROUNDING AREA

The surrounding area land uses are summarised in Table 2.2.

TABLE 2.2 SURROUNDING LAND USES

DIRECTION	LAND USE
North	Commercial units, New Road, residential units
East	Russell Homes residential development
South	Agricultural land, River Roch
West	Residential units



3. SITE HISTORY

3.1. ON-SITE HISTORICAL DEVELOPMENT

A review of historical mapping and historical aerial imagery pertinent to the Site is summarised in Table 3.1. In addition, historical site features are presented in Drawing No 15-075-003 in Appendix III.

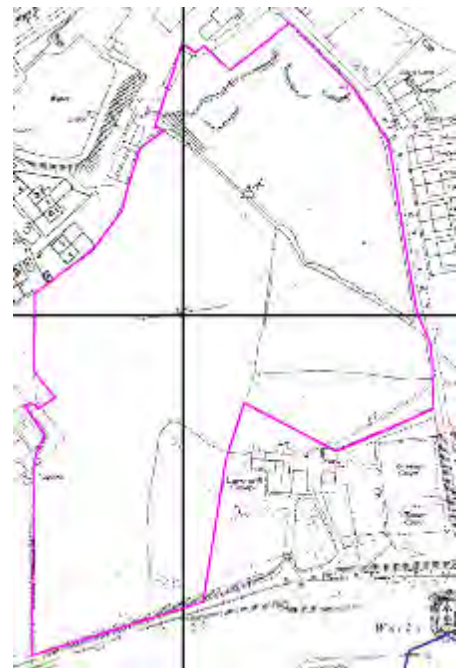
TABLE 3.1 HISTORICAL DEVELOPMENT

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1851 1:10,560	The Site is undeveloped agricultural land. Wells are recorded in the west of the Site. A watercourse flows from northwest to southeast in the north of the Site. Field boundaries are present in the south and east of the Site.	
1893 1:2,500	The wells are no longer recorded. Tanks are located off-site at the northwest boundary.	



MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1910 1:2,500	Additional field boundaries are present in the centre and north of the Site. Small structures are present in the south of the Site associated with Lower Mill Cottage to the east.	
1930 1:2,500	Two springs are present at the western boundary. A sand pit is present in the northwest corner and an additional excavation (possible clay pit) is present in the northeast. The field boundary in the north is no longer present. Allotment Gardens are recorded in the east and a possible track is present leading to the Allotments. A footpath is present in the southeast corner. A cutting is shown along Stubley Mill Road to the south.	

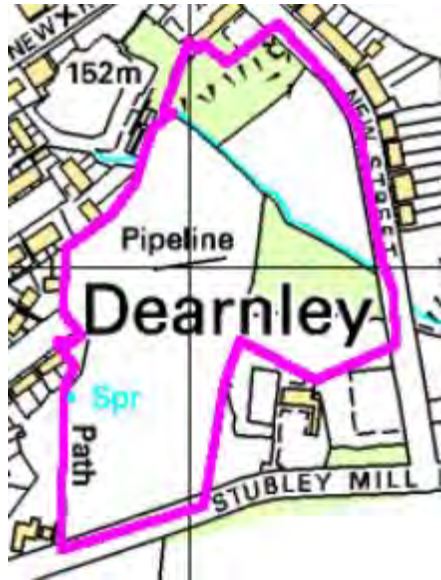
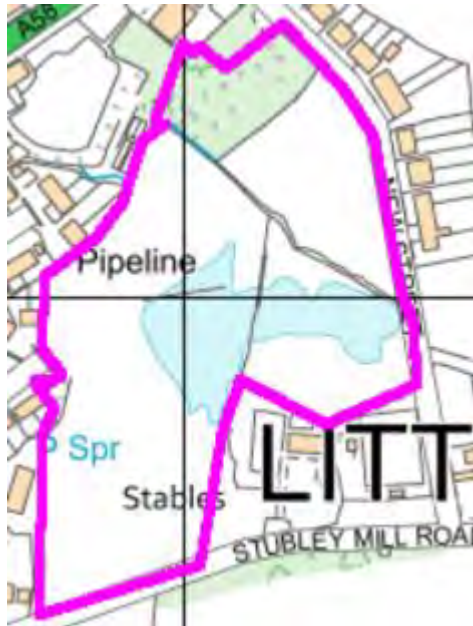


MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1960 1:1,250	A pipeline is recorded in the centre of Site. Arisings from possible excavations are shown in the north of the Site. No structures are shown in the south. The Allotment Gardens are no longer recorded. One spring is shown at the western boundary.	
1976 1:1,250	There are no significant changes.	



MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1992 1:1,250	A field boundary has been added in the north of the Site.	 This is a black and white historical map excerpt. A pink line outlines a large, irregular field area. To the north of this field, a new boundary line has been added, separating it from an adjacent area. The map shows surrounding streets and buildings.
2000 Google Earth Aerial Imagery	Two ponds appear to be present in central eastern sector.	 This is an aerial photograph from 2000. A pink line outlines the same field area as in the 1992 map. Two distinct ponds are visible in the central eastern sector of the field. The surrounding area includes residential streets and buildings.



MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
2006 1:10,000	There are no significant changes.	
2021 1:10,000	A large area of surface water flooding is shown across the centre of the Site.	



3.2. OFF-SITE HISTORICAL DEVELOPMENT

A review of potentially contaminative uses identified on historical Ordnance Survey maps within a 250 m radius of the Site is summarised in Table 3.2.

TABLE 3.2 SURROUNDING HISTORICAL DEVELOPMENT

SURROUNDING FEATURE	DISTANCE	DATES	DIRECTION
Dearnley Mill (Woollen) <i>Then: marked as Dearnley Mill Bleaching & Dyeing</i> <i>Then: marked as Hotel</i>	0 m	Pre 1851–Pre 1910 Pre 1910–Pre 1984 Pre 1984–Present	North
Tanks	0 m	Pre 1893–Present	Northwest
Reservoir	20 m	Pre 1851–Present	Northwest
Reservoir <i>Then: no longer recorded</i>	10 - 20 m	Pre 1893–Pre 1984 Pre 1984–Present	South
Electricity Substation <i>Then: no longer recorded</i>	60 m	Pre 1984–Pre 2021	North
Tanks <i>Then: no longer recorded</i>	80 m	Pre 1893–Pre 1910 Pre 1910–Present	South
Lower Mill (Woollen) <i>Then Calliards Mill (Woollen)</i> <i>Then Ruins</i> <i>Then: no longer recorded</i>	80 m	Pre 1851–Pre 1910 Pre 1910–Pre 1960 Pre 1960–Pre 1988 Pre 1988–Present	South
Tanks	110 m	Pre 1910–Pre 2022	South
Sewage Works <i>Then: no longer present</i>	60 - 140 m	Pre 1893–Pre 1984 Pre 1984–Present	Southeast
Saw Mills <i>Then: Timber Works</i> <i>Then: no longer recorded</i>	130 m	Pre 1910–Pre 1971 Pre 1971–Pre 1988 Pre 1988–Present	North
Dry Dock Mills (Woollen)	140 m	Pre 1893–Pre 2022	North
Reservoirs <i>Then: no longer present</i>	200 m	Pre 1893 –Pre 2021 Pre 2021–Present	North

3.3. PLANNING HISTORY

E3P has undertaken a review of online planning records held by Rochdale Borough Council.

Planning permission was granted for the adjacent Russell Homes development site to the east of the subject site on 27th January 2021 (Ref: 20/00607/FUL). The proposed development includes a residential development of 100 dwellings together with associated access, earthworks, landscaping, public open space, and on-site infrastructure (including the capping of artesian well).

No pertinent information was obtained for the subject site area.



3.4. PREVIOUS REPORTS

E3P completed a Phase I and II Geoenvironmental Assessment Report (Ref: 10-423-r1-rev 4, May 2020) for the adjacent Russell Homes development site to the east. A number of exploratory holes were located in the northern area of the subject site.

E3P has also been provided with the following site investigation report which includes investigation in the north of the subject site area:

- ✿ URS – Phase II Environmental Investigation (Ref: 44320062, February 2007).

The key findings of the reports are summarised below:

E3P - Phase I & II Geoenvironmental Site Assessment

- ✿ E3P completed three mechanically excavated trial pits, two deep rotary boreholes and four dynamic cone penetrometer tests in the north of the subject site.
- ✿ TP116 identified PEAT between 0.30 m and 1.80 m bgl.
- ✿ Ground conditions generally comprised TOPSOIL overlying grey sandy GRAVEL of sandstone and firm to stiff grey sandy gravelly CLAY.
- ✿ RB106 identified light grey to brown SAND with boulders to 30.00 m bgl. RB104 further north recorded a complete loss of flush at 10.50 m with minimal recovery to 30.00 m. Drilling was recorded as consistent with voids not suspected.
- ✿ The solid bedrock geology was not encountered despite the drilling of boreholes to a depth of 30.00 m bgl.
- ✿ A groundwater strike was recorded in TP116 at 2.70 m bgl.
- ✿ No exceedances of the GAC were noted in the topsoil sample from TP115.
- ✿ No evidence of visual or olfactory evidence of hydrocarbon impact was noted.
- ✿ A cast driven piled solution was recommended for the proposed development.

URS - Phase II Environmental Investigation

- ✿ URS completed one mechanically excavated trial pit and two boreholes within the north of the subject site.
- ✿ BH103 identified Made Ground to 0.80 m bgl overlying dark brown to black silty SAND and GRAVEL and soft sandy SILT to 3.40 m bgl. The silt was underlain by sandy GRAVEL of sandstone to 3.95 m bgl.
- ✿ BH104 identified Made Ground to 3.60 m bgl which was underlain by soft slightly gravelly CLAY. Soft dark brown PEAT/black organic rich SILT was noted between 4.70 to 5.00 m bgl.



-  TP103 identified Topsoil to 0.20 m bgl underlain by soft orange brown silty SAND with lenses of firm orange brown SILT. Dark grey GRAVEL of sandstone was noted between 3.20 – 4.00 m bgl.
-  Elevated concentrations of heavy metals (arsenic and lead) and non-volatile PAHs were recorded in soil samples from BH103 and BH104.
-  Exceedances were noted for copper and lead in the groundwater sample from BH103.



4. ENVIRONMENTAL SETTING

4.1. GEOLOGY AND HYDROGEOLOGY

The British Geological Survey (BGS) map (Sheet 76) for the Site, (1:50,000, Solid and Drift editions) and online records indicate the Site is underlain by the geological sequence presented in Table 4.1.

TABLE 4.1 SUMMARY OF UNDERLYING GEOLOGY

GEOLOGICAL UNIT	CLASSIFICATION	DESCRIPTION	AQUIFER CLASSIFICATION
Drift	Glacial Till	SAND, CLAY and GRAVEL	Secondary undifferentiated
	Alluvium (South, Centre)	CLAY, SILT, SAND, GRAVEL	Secondary A
Solid	Pennine Lower Coal Measures Formation	MUDSTONE, SILTSTONE, SANDSTONE	Secondary A

FIGURE 4.1 EXTRACT FROM BGS SHOWING SUPERFICIAL DRIFT DEPOSITS



TABLE 4.2 SUMMARY OF BGS BOREHOLE RECORDS

LOCATION	DEPTH	MADE GROUND	DRIFT	SOLID
60 m S SD91NW4	84.43 m	-	SAND & GRAVEL 1.00 - 46.00 m	Black SHALE 46.00 - 56.00 m Cavity 56.00 - 57.00 m GRITSTONE/SLATE 57.00 – 84.43 m
70 m NE SD91NW5	83.52 m	1.0 m	SAND, CLAY and GRAVEL 1.00 - 37.00 m	Dark SHALE 37.00 m SANDSTONE 48.00 m Black SHALE/MUDSTONE 82.00 m

No faults are recorded within 250 m.

The Envirocheck report indicates that the Site is not located within a groundwater source protection zone. The closest groundwater abstraction point is located 818 m northeast for public water supply; however, this is listed as revoked.

A review of the historical and present-day mapping has identified springs and wells in the west of the Site. The location of the on-site features is shown on drawing 15-075-003 (Appendix III).

Based on the local topography, the location of surface watercourses and the presence of drainage ditches within the site boundary, it is considered likely that shallow groundwater, if present, will flow in a southerly direction, following the topographical gradient towards the River Roch.

4.2. NATURAL LANDFORM AND GEOMORPHOLOGY

Based on the initial geological assessment, a review of available topographic data and pertinent mapping, E3P has undertaken a preliminary geomorphological assessment of the landform and its possible mechanism for formation.

The Site has not been subject to significant anthropogenic changes, with the current site topography broadly representing natural landform. Ground workings have occurred in the far north of the Site.

It is likely that the infilling in the south has resulted in a greater thickness of Made Ground overlying the natural Glacial Till/Alluvium.

An extract showing the surface Lidar data is included in Figure 4.2.



FIGURE 4.2 SURFACE LIDAR DATA (GROUNDSURE IO)



4.3. GEOTECHNICAL DATA

Geotechnical data presented within a commercially available environmental database is summarised in Table 4.3.

TABLE 4.3 SUMMARY OF GEOTECHNICAL DATA

HAZARD	DESIGNATION
Shrink-Swell Clay	Very low risk
Landslides	Very low to low risk
Ground Dissolution	No hazard
Compressible Ground	Moderate risk
Collapseable Deposits	Very low risk
Running Sand	Very low risk

4.4. COAL MINING

The Envirocheck report states the Site is in an area that may be affected by coal mining.

A CA mining report was obtained (Ref: 51003006852001) dated 7th April 2022.

The CA operates a risk-based approach to the assessment of potential instability issues associated with future development of land located within the predefined CA consultation areas. This risk-based approach subdivides the potential risk into “low” and “high” risk categories.

The risk categories can be defined as:



Low-Risk Sites – Deemed to be land where coal mining has taken place, however, it was at such depth not to pose a risk to new development and it, therefore, contains no known recorded risks and as such no further assessment is required.

For low-risk sites, the CA categorically states:

If your proposed development is within the Development Low Risk Area there is no need for you to submit any coal mining information with your planning application and The Coal Authority will not be consulted by the LPA. The LPA will include our Standing Advice as an informative note within the decision notice.

High-Risk Sites – Deemed to be landholdings located within an area known to contain legacy risks that include:

- ☛ Mine entries (shaft or adit);
- ☛ Shallow coal workings (recorded and probable);
- ☛ Workable coal seam outcrops;
- ☛ Mine gas sites and areas;
- ☛ Recorded coal-mining-related hazards;
- ☛ Geological features (fissures and break lines); and
- ☛ Former surface mining sites (sometimes using historic opencast extraction methods).

4.5. COAL MINING INFORMATION

Prior to the enactment of the Coal Mines Regulation Act (1872), which came into force on the 1st January 1883, there was no statutory requirement to record the extent of abandoned mine workings and as such the CA has no knowledge of extensive workings throughout the UK Coal Fields where shallow workings are present at a depth that could result in a subsidence event in the future (through successive cavitation) associated with failure of support mechanism.

To determine if a site may have unrecorded or recorded coal mine workings requires the consideration of a wide range of information and E3P has completed a review of relevant information in relation to potential coal mining activities.

In the first instance, E3P has reviewed the Coal Authority Online Viewer and an excerpt of this is presented as Figure 4.3. This map shows that the Site lies within a development high risk area. There are six outcrops shown on Site and an area of underground workings is shown across the western side of the Site. Probable workings are also shown across the majority of the Site.



FIGURE 4.3 EXCERPT OF THE COAL AUTHORITY ONLINE VIEWER



As the Site is within an area affected by Coal Mining E3P have consulted with the Coal Authority who have provided a Consultant Coal Mining Report for the Site (Ref: 51003006852001).

Table 4.4 provides a summary of pertinent coal mining information with this report.

TABLE 4.4 COAL MINING INFORMATION

SOURCES OF INFORMATION	SUMMARY									
Known Past Underground Mining	Colliery	Seam	Mineral	Coal Authority reference	Depth (m)	Direction to working	Dipping rate of seam worked (degrees)	Dipped direction of seam worked	Extraction thickness (cm)	Year last mined
	unmined	UPPER MOUNTAIN	Coal	3365	7	Beneath Property	8.1	South	30	1867
	unmined	UPPER MOUNTAIN	Coal	3366	18	Beneath Property	8.1	South	30	1867
	unmined	LOWER MOUNTAIN	Coal	3368	22	Beneath Property	8.1	South	50	1868
Probable Unrecorded workings	Yes.									
Spine Roadways at Shallow Depth	None.									
Mine Entries within 100m of the Site	None within 100 m.									



SOURCES OF INFORMATION	SUMMARY					
Mine Abandonment plans	Yes.					
Known outcrops	Seam name	Mineral	Seam workable	Distance to outcrop (m)	Direction to outcrop	Bearing of outcrop
	BASSEY	Coal	Yes	Within	N/A	184
	BASSEY	Coal	Yes	23.2	North-East	153
	NCH	Coal	Yes	Within	N/A	113
	LOWER FOOT	Coal	Yes	Within	N/A	174
	LOWER FOOT	Coal	Yes	Within	N/A	180
	LOWER MOUNTAIN	Coal	Yes	Within	N/A	9
	LOWER MOUNTAIN	Coal	Yes	Within	N/A	152
	UPPER FOOT	Coal	Yes	Within	N/A	105
	UPPER MOUNTAIN	Coal	Yes	Within	N/A	126
Faults / Fissures	None recorded.					
Opencast mines	None within 500 m.					
Coal Authority Managed Tips	None within 500 m.					
Remediated Sites	None recorded within 50 m.					
Coal Mining Subsidence	The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres of the enquiry boundary, since 31 October 1994.					
	There is no current Stop Notice delaying the start of remedial works or repairs to the property.					
	The Coal Authority is not aware of any request having been made to carry out preventive works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991					
Mine Gas	None within 500 m.					
Mine Water	None within 500 m.					
Future Underground Mining	None recorded.					
Coal Authority Development Advice	The Site is within an area of historical coal mining activity.					
British Geological Survey Mapping	The 10,000 plan for the Site shows the Lower Foot Coal and the Lower Mountain Coal outcropping on Site. The Upper Foot Coal outcrop is shown at the western boundary. The closest dip direction shows the strata to dip to the south at 4 degrees.					

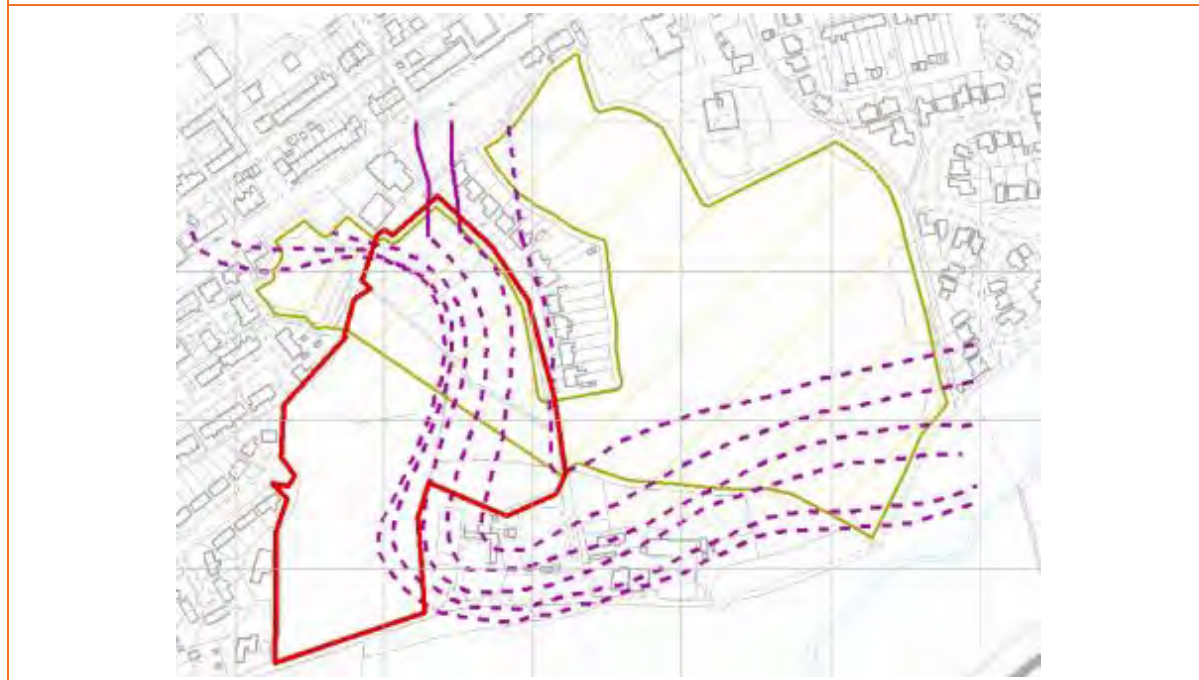


SOURCES OF INFORMATION	SUMMARY
Historical Ordnance Survey Mapping	A review of the 1:10,000 Ordnance Survey mapping from circa 1850, which has records of mine workings that predate the Mining & Regulation Act of 1872, identified the following features indicative of historical mine workings in proximity to the application site: ☛ Coal Pits – 180 m W ☛ Old Coal Shaft – 600 m NW ☛ Middle Wood Colliery – 850 m N In consideration of the historical mining features in proximity to the Site and potential for coal close to the surface it is considered possible that coal extraction has occurred, underlying the Site at relatively shallow depths; further extensive investigation would be required to determine the extent and depth of any worked seams.
Historical Site Investigations	E3P drilled 5 No. deep rotary boreholes for the adjacent Russell Homes development (detailed within report 10-423-R1-rev 4, May 2020). Two of the boreholes (RB104 and RB106) were located within the subject site boundary.

4.5.1. COAL AUTHORITY PLAN

The Coal Authority plan referenced: MR-LARGE-PLOT-51003006852001-1649344698727 shows six conjectured outcrops on Site. Two of the outcrops are recorded as proven at the northern boundary.

FIGURE 4.4 COAL AUTHORITY PLAN FOR THE SITE



4.5.2. COAL MINING GEOLOGY

Figure 4.5 is a photograph of the 1:10,000 plan for the Site which shows the Lower Foot Coal and the Lower Mountain Coal outcropping on Site. The Upper Foot Coal outcrop is shown at the western boundary.



FIGURE 4.5 PHOTOGRAPH OF THE 1:10,000 PLAN FOR THE SITE



4.6. PRELIMINARY MINE GAS ASSESSMENT

If coal mining is present below the Site, then this may be a potential source of ground gas that could pose a risk to site end users. A preliminary mine gas assessment is provided within Table 4.5.

TABLE 4.5 PRELIMINARY MINE GAS ASSESSMENT

SCENARIO	DISCUSSION	RATING
Are there known coal seams beneath the Site?	Yes – numerous coal seams are present below the Site.	Moderate
Are there coal seams within 150m of the top of bedrock?	Yes	High
Are there any known workings below the Site?	Yes – there are known workings between 7.0 m and 22.0 m bgl.	High
Are the underlying drift deposits impermeable?	The Site is underlain by Glacial Till and Alluvium comprising CLAY, SILT, SAND and GRAVEL.	Moderate
Are there any mine entrances within the site boundary or within 50m of the Site?	There are no recorded mine shafts within 100 m.	Low
Are there any faults below the Site or in close proximity?	There are no faults within 250 m.	Low



SCENARIO	DISCUSSION	RATING
Is there any records of mine gas emission on or within 50m of the Site	No	Low
Is there any record of historical mine stabilisation works?	No	Low
Evidence of rising groundwater in flooded mine workings?	Not known	Moderate
OVERALL MINE GAS RISK (IF MODERATE/ HIGH THEN FURTHER ASSESSMENT IS REQUIRED)		Moderate
Conclusions:		
Source: The Site is underlain by known coal workings at shallow depth, which are a potential source of ground gas.		
Pathway: Granular drift deposits may provide a pathway for mine gas migration. However, there are no known mine shafts or faults which could create a preferential pathway for mine gasses to reach the ground surface.		
Recommendations: Further assessment is required to assess the potential for mine gas to be migrating to the ground surface.		

4.7. COAL MINING RISK ASSESSMENT

This risk assessment comprises a desk-based review of all available information on coal mining issues that are relevant to the application site deemed to be located within a high-risk area. This includes:

-  Interpretation of information to identify and assess the risks to the proposed development from coal mining legacy, including the cumulative impact of issues;
-  Setting out appropriate mitigation measures to address the coal mining legacy issues affecting the Site, including any necessary remedial works and/or demonstrate how coal mining issues have influenced the proposed development; and
-  Demonstrating to the local planning authority that the application site is, or can be made, safe and stable to meet the requirements of national planning policy with regard to development on unstable land.

The coal mining risk assessment is summarised in Table 4.6.



TABLE 4.6 SUMMARY OF COAL MINING RISK ASSESSMENT

COAL MINING RISK ASSESSMENT	YES/NO	RISK ASSESSMENT
Recorded Underground Coal Mining at Shallow Depth (< 30 m)	Yes	High
Recorded Underground Coal Mining at Shallow Depth (> 30 m)	No	Low
Evidence of Unrecorded Surface Extraction of Coal Outcrop	No	Low
Unrecorded Underground Coal Mining at Shallow Depth (< 30 m)	Yes	High
Mine Entries (Shaft/Adits)	No	Low
Coal Mining Geology – Fractures/Fissures	No	Low
Recorded Gas Emissions	No	Low
Recorded Mining Surface Hazard	No	Low
Surface Mining (Opencast)	No	Very Low/Low

The desk-based Coal Mining Risk Assessment (CMRA) confirms the high probability with respect to extensive shallow workings beneath the area of the proposed development. These workings will likely pose a surface stability risk associated with the unquantifiable future collapse and subsequent consolidation of workings inducing subsidence at the surface.

The CA, as a statutory consultee, will require a series of rotary open holes across the Site to determine the location of coal sub-crops on-site and to understand the nature of any coal workings. These investigation works will assist in defining the requirements for mine stabilisation works that are highly likely to be required across significant areas of the Site.

4.8. BRINE WORKINGS

The Site is not situated within the Cheshire Salt Field and is not within an area deemed to be at risk from historic brine workings or rock salt extraction.

4.9. RADON RISK POTENTIAL

The Envirocheck report indicates the Site is situated in an area where less than 1% of homes are above the “Action Level” and that the BGS reports that radon protective measures are not necessary in the construction of new dwellings or extensions.

4.10. PRELIMINARY GEOTECHNICAL ASSESSMENT

Based on the desk-study information, the following geotechnical assessment has been made:

-  Inert landfill located in the south-central sector, variable and deep Made Ground is anticipated. Remediation and enabling earthworks will be required to render this sector suitable for future development. Waste materials will need to be processed and recovered using an appropriate Environmental Permit.



- ✿ The central sector has been subject to overland flooding attributed to blocked culverts and drainage infrastructure. The retention of water for prolonged periods in this sector will have resulted in the deposition of organic material and saturation of the natural soils resulting in a reduction in soil strengths.
- ✿ The Site topography varies significantly. Therefore, cut / fill enabling earthworks are required.
- ✿ The natural deposition of alluvial soils represents an area of geotechnical risk.
- ✿ Extensive shallow mine workings underlie the Site. Consequently, much of the Site will probably require stabilisation by drilling and pressure grouting to mitigate the risk of subsidence at the surface.
- ✿ The presence of shallow mine workings will limit the application of piled foundations and ground improvement by Vibro Stone Columns

4.11. HYDROLOGY

Surface water features within 250 m of the subject site are summarised in Table 4.7.

TABLE 4.7 SURFACE WATER FEATURES

SURFACE WATER FEATURE	QUALITY	DISTANCE (m)	DIRECTION
Surface water body/Stream	N/A	0 m	On-site
River Roch	B - Good	52 m	South
Pond	N/A	180 m	North

The Site is predominantly located within a currently defined “Flood Risk Zone 1”; defined as land assessed as having less than 1 in 1,000 annual probability of river or sea flooding (< 0.1%), and as such is considered to be unaffected by river flooding. The Environment Agency (EA) Flood Risk Map for the Site is presented in Figure 4.6.

The Envirocheck report states that there is potential for groundwater flooding to occur at the surface.



FIGURE 4.6 EA FLOOD RISK MAP



Source - <https://flood-map-for-planning.service.gov.uk/>

4.12. INDUSTRIAL LAND USES

The Site is located within a predominantly residential area.

The closest active industrial land use within the trade directory is Brookfield Engineering Co located 148 m north. There are no other active industrial land uses within 250 m.

4.13. SENSITIVE LAND USES

The closest residential properties are located adjacent to western site boundary. A spring is located in the west of the Site. No other environmentally sensitive land uses have been identified within close proximity to the Site.

4.14. SITE SENSITIVITY ASSESSMENT

The Site is assessed to be located within a “Moderate” sensitivity setting as discussed within Table 4.8.



TABLE 4.8 SITE SENSITIVITY ASSESSMENT

SENSITIVITY PROFILE	DISCUSSION	RATING
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	The Site is not affected.	Low
Distance to the Closest Groundwater Abstraction Point	818 m northeast for public water supply, however this is listed as revoked. 906 m northeast for general cooling.	Low
Aquifer Classification in Superficial Drift Deposits	Secondary undifferentiated/secondary A	Low/Moderate
Aquifer Classification in Bedrock	Secondary A	Moderate
Is the Site Underlain by Low-Permeability Drift to Depths in Excess of 10 m?	The underlying superficial deposits are likely to comprise gravelly sands interbedded with low-permeability clay soils to depths in excess of 10 m. Previous boreholes in the north of the Site identified predominantly granular drift deposits in excess of 30.00 m bgl.	Moderate
Is the Site Located Within 50 m of a Surface Watercourse?	The historical stream that flowed through the Site leading to a culvert has become blocked in recent years. This has resulted in some localised overland flooding in the central/southern sector. The River Roch is located 52 m south.	High
Sensitive Land Uses	Residential properties are located adjacent to the west. A spring is located in the west of the Site.	High
OVERALL SITE ENVIRONMENTAL SENSITIVITY		MODERATE



5. REGULATORY DATA

5.1. LANDFILL SITES AND WASTE TREATMENT SITES

A historic landfill and registered landfill are recorded in the south of the Site. Inert waste was deposited between March 1988 and December 1990. The location of the landfill is shown in Figure 5.1. Remediation and enabling earthworks will be required to render this sector suitable for future development. Waste materials will need to be processed and recovered using an appropriate Environmental Permit.

A historic landfill, BGS recorded landfill and registered landfill known as Paragon Industrial Works is located 297 – 332 m southeast. Inert and industrial waste was deposited between May 1984 and December 1984.

Clough Field Works historic landfill and BGS recorded landfill is located 470 m east. No information is available on the type of waste deposited; however, the first input date is listed as December 1835.

FIGURE 5.1 LOCATION OF ON-SITE LANDFILL



5.2. REGULATORY DATABASE

The information summarised in Table 5.1 has been obtained from a commercially available environmental database. The summary table only includes records from within 250 m of the subject site and not otherwise detailed in the report.



TABLE 5.1 SUMMARY OF ENVIRONMENTAL DATA

RECORD	ENTRIES WITHIN 250 m	DETAILS
Contaminated Land Register Entries and Notices	0	None Identified
Authorised Industrial Processes (IPC/IPPC/LAPPC)	0	None Identified
Fuel Stations Entries	0	None Identified
Licensed Radioactive Substances	0	None Identified
Enforcements, Prohibitions or Prosecutions	0	None Identified
Discharge Consents	3	United Utilities (181 m SE) – Public Sewage to the River Roch Mr N.P. Jones (249 m W) – Sewage Discharges to the River Roch
Pollution Incidents	0	None Identified
Consents Issued Under the Planning (Hazardous Substances) Act 1990	0	None Identified
Control of Major Accident Hazard (COMAH) Sites	0	None Identified

5.1. UNEXPLODED ORDNANCE

The regional unexploded bomb risk map from Zetica (2014) indicates that the Site is in an area at low risk from possible unexploded ordnance (UXO) resulting from the Second World War. The Zetica UXO Risk Map is presented as Figure 5.2.

FIGURE 5.2 ZETICA UXO RISK MAP



Source - <https://zeticauxo.com/downloads-and-resources/risk-maps/>



6. INITIAL CONCEPTUAL SITE MODEL

In accordance with EA LCRM (2019) and BSI 10175 (Code of Practice for Investigation of Potentially Contaminated Land), E3P has developed an initial conceptual site model (CSM) to identify potential contamination sources, migration pathways and receptors within the study area. This is summarised within Table 6.1.

ON-SITE SOURCES OF CONTAMINATION

The following potential on-site sources of contamination have been identified:

- ✿ Infilled Field Boundaries (Made Ground) – PAHs, heavy metals, hydrocarbon compounds, asbestos, hazardous ground gas.
- ✿ Inert landfill (1988-1990) – PAHs, heavy metals, hydrocarbon compounds, asbestos, hazardous ground gas.
- ✿ Former Structures (Made Ground) – PAHs, heavy metals, hydrocarbon compounds, asbestos, hazardous ground gas.
- ✿ Allotment Gardens – PAHs, heavy metals, hydrocarbon compounds, pesticides, herbicides.
- ✿ Sand Pit/Clay Pit (Made Ground) – PAHs, heavy metals, hydrocarbon compounds, asbestos, hazardous ground gas.
- ✿ Coal Measures – Hazardous ground gas.
- ✿ Alluvium, Peat – Hazardous ground gas.

OFF-SITE SOURCES OF CONTAMINATION

The following potential off-site source of contamination have been identified:

- ✿ Tanks – VOCs, SVOCs, PAHs, hydrocarbon compounds, acids, metalloids.
- ✿ Landfill sites – Hazardous ground gas.
- ✿ Mills (including bleaching and dyeing works) – VOCs, SVOCs, PAHs, heavy metals, hydrocarbon compounds, asbestos, hazardous ground gas.
- ✿ Former Reservoirs – Hazardous ground gas.
- ✿ Sewage Works – Heavy metals, organic compounds, hazardous ground gas.



6.1. INITIAL CONCEPTUAL SITE MODEL

Following the completion of the desk-based site assessment, the initial conceptual model shown in Table 6.1 has been prepared for the Site.

SOURCE	PATHWAY	RECEPTOR
Human Health		
Heavy Metals and non-volatile PAHs associated with Made Ground, Landfill, Infilled Field Boundaries, Pits, Former Mills (off-site)	Dermal Contact and Ingestion Consumption of Homegrown Produce	Construction Workers End Users
Assessment: Made Ground associated with localised construction and demolition activities, the on-site landfill and infilled field boundaries/pits is a potential source of heavy metals and non-volatile PAHs, albeit likely low-level. Recommendation: Further investigation is required to confirm if the Made Ground across the Site is impacted by heavy metals and non-volatile PAHs. If identified, a suitable clean cover system for areas of landscaping will prevent exposure to future site users. Construction works should be completed with PPE and the provision of welfare.		
Volatile Hydrocarbon Compounds associated with Made Ground, Landfill, Historic Tanks (Northwest Boundary), Former Mills (off-site)	Volatilisation/Accumulation Vapour Inhalation	Construction Workers End Users
Assessment: Although deemed to be unlikely, there is a potential for low-level volatile hydrocarbon impact in localised areas of Made Ground. There is the potential for localised small fuel leaks or spillages from the former tanks at the northwest boundary. The former mill at the northern boundary associated with bleaching and dyeing is a potential source of semi-volatile and volatile organic compounds including chlorinated solvents. Future site users may be exposed to volatile contaminants via inhalation and accumulation of vapours in indoor space, representing a long-term risk. Volatile contamination may pose a short-term risk to construction workers, particularly in confined spaces. Recommendation: Further investigation is required to confirm if the Made Ground soils are impacted by volatile contaminants. Should potentially volatile contamination be identified during the intrusive phase of works, appropriate mitigation measures will be required.		



SOURCE	PATHWAY	RECEPTOR
Asbestos-Containing Materials (ACMs) within Made Ground, Landfill, Infilled Field Boundaries, Pits	Fibre/Dust Inhalation	Construction Workers End Users Third-Party Property
Assessment: The presence of landfill, infilled historic field boundaries and pits and former structures are a potential source of asbestos within soils. Recommendation: The risks associated with potential asbestos and ACM within Made Ground can be mitigated through the development of a detailed enabling works strategy following guidance and protocol specified within the <i>Control of Asbestos Regulations (2012)</i> and industry best practice as detailed in <i>CIRIA733 (Asbestos in Soil and Made Ground: A guide to understanding risk)</i>. Construction works completed with PPE and provision of suitable welfare.		
Organic Contaminants such as Hydrocarbons associated with Made Ground	Ingestion of Tainted Water Supply	End Users
Assessment: Made Ground associated with infilled features and the on-site landfill may contain organic contaminants such as hydrocarbons which pose a risk to future site users through the ingestion of tainted water supply. Recommendation: An intrusive investigation is required to confirm requirements for the proposed water supply.		
Hazardous Ground Gases		
Methane and Carbon Dioxide associated with Made Ground, Landfill, Coal Measures, Alluvium, Peat and Infilled Features within 250 m	Inhalation Accumulation	Construction Workers End Users
Assessment: Made Ground underlying the Site, the on-site landfill, peat and alluvium are potential sources of hazardous ground gas which can accumulate within deep excavations or migrate through permeable strata, foundation structures, and/or service ducting and pose a potential risk to construction workers and future site users. The underlying drift deposits may provide a preferential pathway for any hazardous ground gases to migrate to the proposed development. Carbon dioxide and methane have asphyxiation and explosive risks, respectively, and should the underlying Made Ground soils be actively gasping the risk to construction workers can be mitigated through appropriate management of confined space entry, whereas the risk to future end users can be mitigated through the adoption of appropriate gas protection measures in accordance with BS8485 (Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings (2015+A1:2019)). Recommendation: A phase of ground gas monitoring should be completed to determine the level of risk.		



SOURCE	PATHWAY	RECEPTOR
Controlled Waters		
Mobile Contaminants associated with Made Ground, Landfill, Former Mills and Tanks (off-site)	Vertical/Lateral Migration	Secondary A Aquifer, Secondary undifferentiated (drift) Secondary A Aquifer (bedrock) Ditch/stream Surface water body River Roch
Discussion: Mobile contaminants may be present associated with Made Ground, infilled features and the on-site landfill, leaks from the historic tanks at the northwest boundary and the historic mill to the north. The presence of sand and gravel drift deposits will likely facilitate downward migration to the underlying aquifers and lateral migration to the identified surface water features. The sensitivity of the aquifers is reduced given there are no active potable groundwater abstractions within 800 m. Orange staining was noted in the stagnant water at the north end of the stream/ditch. This may indicate a high concentration of iron within the deposited Made Ground which has been transferred to the surface water feature as acid mine drainage. Recommendation: Sampling of surface water and groundwater is required.		
Buildings and Infrastructure		
pH and Sulphate	Corrosion of Concrete	Foundations/Concrete
Discussion: Made Ground across the Site may contain ash deposits and elevated pH and sulphate which may result in corrosion of buried concrete within any proposed subsurface structures. Assessment must be undertaken to confirm the levels of pH and sulphate within the underlying strata. Recommendation: An intrusive investigation is required.		
Ecology		
Phytotoxic contaminants (Made Ground)	Plant Uptake	Flora
Discussion: Contamination may be present within shallow Made Ground which may be taken up by flora in soft landscaping. Recommendation: Intrusive investigation to determine risk on a site wide basis. If identified, a cover system may be required within any future proposed landscaped areas.		



7. CONCLUSIONS AND RECOMMENDATIONS

7.1. SITE SUMMARY

Current Site Use	The Site comprises an undeveloped parcel of land located west of New Street in Littleborough. The Site is variable in topography with undulating land. Generally, the Site topographically falls from 150 m AOD in the north to 140 m AOD in the south. A steep slope is present in the northwest. The central-southern sector has been subject to overland flooding attributed to the accumulation of surface water in recent years. It is understood this occurred due to blockages within failing surface water drainage. A narrow drainage channel runs from the area of surface water flooding to the manholes identified in the southwest. The route of a stream/ditch is present from the northwest to the southeast, however, this was noted to be dry during the site walkover. An area of orange staining was noted in the stagnant water at the north end of the stream/ditch. A Spring is also located at the western site boundary. An area of dense woodland is present in the far north of the Site, and sporadic semi-mature and mature trees are present in the location of the overland flooding and along the southern site boundaries. Reeds and rushes are present at the edge of the flooded area.
Historical Site Use	Historical mapping suggests that the southeast sector of the Site was developed by circa 1910 as part of Lower Mill Cottage to the east. The structures are no longer recorded on-site by 1960. An area of surface water flooding is located in the central sector of the Site, this appears to have gradually increased in size since circa 2000 when two small ponds were recorded, with it now indicated to encompass a notable portion of the development site area. A watercourse flows from northwest to southeast from the earliest available mapping dated 1851. Wells were recorded in the west of the Site from 1851, however these are no longer shown by 1893. A spring is recorded at the western boundary from circa 1930. A sand pit and clay pit are recorded in the far north of the Site from circa 1930. Between circa 1930 and 1960 allotment gardens were located in the east of the Site.
Site Sensitivity	The Site is assessed to be located within a “moderate” sensitivity setting. This is due to the presence of the on-site surface water features, spring and secondary A aquifer in the bedrock. The sensitivity of the aquifers is reduced considering there are no potable groundwater abstractions within 800 m. Residential properties are located adjacent to the Site.



7.2. CONTAMINATED LAND ASSESSMENT

Human Health	Made Ground associated with localised construction and demolition activities, the on-site landfill and infilled features is a potential source of heavy metals PAHs, hydrocarbon compounds and ACM. There is the potential for localised small fuel leaks or spillages from the former tanks at the northwest boundary which are a potential source of VOCs, SVOCs, PAHs, hydrocarbon compounds, acids and metalloids. The former mill at the northern boundary associated with bleaching and dyeing is a potential source of semi-volatile and volatile organic compounds including chlorinated solvents.
Controlled Waters	Mobile contaminants may be present associated with Made Ground, infilled features and the on-site landfill, leaks from the historic tanks at the northwest boundary and the historic mill to the north. Granular drift deposits may facilitate the migration of mobile contamination, if present, to the underlying secondary A aquifer in the bedrock and to the on-site surface water features. The risk of downward migration is reduced considering there are no potable groundwater abstractions within 800 m. Intrusive investigation with chemical analysis of soil, surface water and groundwater samples is recommended to assess the presence of mobile contaminants and facilitate further risk assessment. Orange staining was noted in the stagnant water in the north end of the stream/ditch. This may indicate a high concentration of iron within the deposited Made Ground which has been transferred to the surface water feature as acid mine drainage.
Ground Gas	Made Ground, the on-site landfill, peat, alluvium and coal measures underlying the Site are potential sources of hazardous ground gas. Off-site sources of hazardous ground gas include landfills, former reservoirs and sewage works. Carbon dioxide and methane have associated asphyxiation and explosive risks, respectively. If present, the risks can be appropriately mitigated through the careful design of building structures. A programme of ground gas monitoring is required to confirm the ground gas regime for the Site.
Potable Water	No significant sources of contamination have been identified that would pose a significant risk to the proposed potable water supply, however, this will need to be confirmed following intrusive investigation.



7.3. COAL MINING

Coal Mining	The Site is located in a development high-risk area. Coal outcrops are recorded on Site and an area of underground workings is recorded across the western side of the Site (workings are recorded in the Upper Mountain and Lower Mountain seams between 7.0 – 22.0 m). The Coal Authority also show probable workings across the majority of the Site. Mine shafts are recorded circa 120 – 140 m to the west/ northwest. A high risk of unrecorded coal mining at shallow depth has been identified. The CA, as a statutory consultee, will require a series of rotary open holes across the Site to determine the presence of any coal on-site and to understand the nature of any coal workings. E3P drilled 5 No. deep rotary boreholes for the adjacent Russell Homes development (detailed within report 10-423-R1-rev 4, May 2020). Two of the boreholes (RB104 and RB106) were located within the northern sector of the subject site boundary.
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7.4. GEOTECHNICAL ASSESSMENT

Geological	A moderate risk is identified for compressible ground. Peat has been identified in the north of the Site during the previous E3P ground investigation. Alluvium is recorded in the south and centre of the Site. Clay strata may underly the Site and therefore a volume change potential assessment will be required and given that the Site is lined by mature and semimature trees and hedges, consideration of the potential water demand of trees effecting foundations should be considered. Localised organic deposits may be present in infilled field boundaries.
Civil and Structural	All existing underground foundations and obstructions beneath the proposed development will require grubbing out in their entirety and backfilling with a suitably engineered fill to create a suitable development platform. Where peat will remain beneath areas of roadway, drainage and service infrastructure, private driveways and hardstanding, the highly compressible material will require excavation to the base (circa 2.50m bgl) due to the potential for differential settlement within the proposed development platform.
Abnormal Foundations	Foundation solutions will be largely dependent on the proposed development levels and the requirement to cut and fill to achieve the development platform levels. An abnormal engineering solution may be required where there is significant thickness of Made Ground, tree influence, loose granular soils or soft cohesive and organic deposits.

END OF REPORT

