

4.0 Geology, Hydrogeology and Hydrology

4.1 Geology and Hydrogeology

A study of the Envirocheck (Ref. 1) Report and the British Geological Survey (BGS) 1:50,000 mapping records (Bedrock and Superficial Editions) for Manchester (Sheet 085) dated 2011 (Ref. 2) indicates the following geological and hydrogeological succession underlying the site:

Table 4.1 – Geological/Hydrogeological Succession

Geology	Associated Hydrogeological Classification
Glacial Till – Devensian, Diamicton ¹	Secondary Aquifer, Undifferentiated ²
Pennine Lower Coal Measures Formation ³ - majority of site	Secondary A Aquifer ⁴
Pennine Middle Coal Measures Formation ⁵ – southern corner	Secondary A Aquifer ⁴

- Notes:
- 1. A heterogenous mixture of clay, sand, gravel, and boulders varying widely in size and shape.
 - 2. These layers have not been assigned an attribute either category A or B rock type due to not being possible. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.
 - 3. 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.
 - 4. Layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.
 - 5. Interbedded grey mudstone, siltstone and pale grey sandstone and commonly coal seams, with a bed of mudstone containing marine fossils at the base, and several marine-bearing mudstones in the upper half of the unit.

BGS Records do not indicate the presence of Made Ground on site, however the site’s historic land use, construction and demolition of the Whitemoss care home, suggests that made ground soils may be present beneath the site.

There are five available BGS borehole scans within 100m of the site, three of which were all recorded as the same location (Ref. 3). Due to ease of reporting only one of these three borehole scans have been recorded below. The BGS borehole scans are summarised in *Table 4.2* below:

Table 4.2 – BGS Borehole Records

Record Reference	Location (NGR)	Details (bottom to top of strata/details/thickness of strata)	
SD80SE1001	34m northwest (386580, 403560)	0.00m to 0.91m bgl	TOPSOIL (0.91m)
		0.91m to 1.22m bgl	Soft grey CLAY (0.31m)
		1.22m to 2.13m bgl	Dark brown sandy PEAT (0.91m)
		2.13m to 3.65m bgl	Very soft grey sandy CLAY (1.52m)
		3.65m to 4.42m bgl	Soft brown CLAY (0.77m)
		4.42m to 8.50m bgl	Fine silty SAND with bands of laminated clay (4.08m)
		8.50m to 13.25m bgl	Firm brown CLAY (4.75m)
		13.25m to 15.39m bgl	Fine brown SAND (2.14m)
		15.39m to 15.70m bgl	GRAVEL and COBBLES (0.31m)
		15.70m to 22.86m bgl	Fine brown SAND (7.16m)
		22.86m to 30.17m bgl	Fine brown SAND with bands of clayey silt (7.31m)

Record Reference	Location (NGR)	Details (bottom to top of strata/details/thickness of strata)	
		30.17m bgl	Borehole terminated
SD80SE1000	73m north (386690, 403640)	0.00m to 0.46m bgl	TOPSOIL (0.46m)
		0.46m to 0.76m bgl	MADE GROUND: Fill (0.30m)
		0.76m to 2.60m bgl	Soft light brown sandy CLAY (0.84m)
		2.60m to 5.33m bgl	Soft clayey SILT with bands of sand (2.73m)
		5.33m to 6.70m bgl	Firm brown silty CLAY (1.37m)
		6.70m to 9.60m bgl	Firm brown CLAY with bands of sand (2.90m)
		9.60m to 14.33m bgl	Firm brown laminated silty CLAY with thin bands of clayey sand (4.73m)
		14.33m to 16.15m bgl	Soft silty CLAY (1.82m)
		16.15m to 17.07m bgl	Stiff brown CLAY (0.92m)
		17.07m to 17.67m bgl	Fine brown SAND (0.60m)
SD80SE1159	83m southeast (386710, 403410)	17.67m to 18.60m bgl	GRAVEL and COBBLES (0.93m)
		18.60m to 21.18m bgl	Firm brown CLAY (3.21m)
		21.18m to 21.95m bgl	Very fine brown SAND (0.77m)
		21.95m to 29.87m bgl	Brown slightly clayey fine SAND (7.92m)
		29.87m bgl	Borehole terminated
		0.00m to 0.20m bgl	TOPSOIL
		0.20m to 0.40m bgl	Firm sandy CLAY (0.20m)
		0.40m to 1.40m bgl	Firm becoming stiff mottled CLAY (1.00m)
		1.40m to 1.60m bgl	Firm sandy silty CLAY (0.20m)
		1.60m to 2.00m bgl	Firm sandy CLAY (0.40m)
		2.00m to 5.20m bgl	Stiff CLAY with sand lenses (3.20m)
		5.20m to 5.60m bgl	Loose very silty SAND (0.40m)
		5.60m to 6.00m bgl	Dense SAND (0.40m)
		6.00m bgl	Borehole terminated

There are three BGS recorded fault lines within 1km of the site. The nearest is located on the western boundary of the site, orientated approximately north to south. The fault identifies the boundary between the Pennine Lower and Middle Coal Measures Formation and the Manchester Marls Formation. Six coal outcrops are noted to be present to the east of the fault. The other two faults are located approximately 425m east of the site and 570m southwest, intersected by the fault on the site’s boundary.

The site is not situated within a Source Protection Zone (SPZ). There are no groundwater abstraction points within 1km of the site.

4.1.1 Mining

A review of the Coal Authority interactive mapping (Ref. 4) for the area indicates that the site is located within a Coal Mining Reporting Area, however it is not located within a Development High-Risk Area. The nearest Development High-Risk Areas are associated with coal outcrops to the east of the site.

There are no recorded mine entries within 500m of the site. The closest is approximately 740m north of the site.

There are no recorded coal workings and no probable coal workings within 250m of the site. The closest are 340m northeast of the site.

Consequently, the risk to development from historic coal mining is considered to be **Low**. No further actions are required to further assess the risk to development from historic coal mining.

The closest recorded BGS mineral sites is located 438m northeast of the site, an opencast site known as Crossby's Gravel Pit which extracted sand and gravel from superficial soils (Till). The site has since ceased operation.

4.1.2 Other Ground Stability Issues

The Envirocheck Report (Ref. 1) confirms that there is a no hazard to very low risk from the following ground stability hazards on the site; collapsible ground, compressible ground, ground dissolution, landslide ground, running sands and shrinking or swelling clay.

4.1.3 Ground Gas

Given historic development on site, the construction and demolition of a care center, it is possible that made ground soils may be present on site. These soils may act as a source of ground gas generation.

There are is one historical landfill located within 500m, located 130m west of the site. No further information regarding type of waste deposited or input dates is supplied.

There are two areas of infilled land (non-water) located within 500m of the site. The nearest is located 346m northeast, which is an infilled pit, quarry etc. dated 1990.

There is one infilled water feature (Pond, marsh, river, stream etc.) on site to the east, dated 1910.

The Envirocheck Report (Ref. 1) and BGS Radon Mapping (Ref. 5) confirms the site is situated in an area where 1-3% of homes are above the radon action level. Radon protection measures are therefore not considered necessary within the proposed development. However, where the new development incorporates a basement the advice of a specialist Radon assessor must be obtained.

4.2 Hydrology

The nearest surface water feature is an issue located 158m south which flows southwards.

No recorded pollution incidents to controlled waters have occurred within 500m of the site.

There are no surface water abstractions within 1km.

There is one discharge consent in the last 20 years located within 500m of the site. It is located 432m north of the site for the discharge of public sewage during storm overflows into freshwater.

5.0 Unexploded Ordnance Risk Assessment

Military activities including those conducted as part of both the First and Second World Wars have resulted in a legacy of unexploded ordnance (UXO) being present within the shallow soils of the UK.

UXO result from various sources including both allied (military training) and German (bombing raids) with a guide figure of approximately 10% of all munitions failing to function as designed.

The likelihood of UXO being encountered on a development site is influenced by several factors including; the proximity to strategic targets, the nature of the development works being undertaken and evidence of local damage in the post-war periods amongst others. To determine the likelihood of UXO being present on a site, a step-wise risk assessment process is followed. This process is outlined within CIRIA C681 Unexploded Ordnance: A Guide for the Construction Industry (Ref. 6) with the following commentary considered to represent a Preliminary Risk Assessment intended to guide if and where there is a requirement for a Detailed Risk Assessment.

5.1 Preliminary UXO Assessment

Risk mapping (Ref. 7) for UXO's has placed the site in a **Moderate** risk area. Moderate-risk regions are those with a bombing density between 11 and 50 bombs per 1000 acres. These areas are considered to have a significant but low UXB risk. In general, further action to mitigate the risk is considered prudent, although not essential. Care is required when assessing the risk for specific sites where the risk may be higher because of local wartime activity.

A review of the available historic mapping did not identify any evidence of bomb damage onsite or within close proximity of the site boundary. No ruins were recorded in the immediate vicinity of the development site, and no buildings appear to have been demolished following WWII on or surrounding the site. Detailed bomb strike mapping does not record any strikes or damage on the site (Ref. 4).

Considering the above, the risk of encountering potential UXO as part of future intrusive investigation works is considered **Low**.

If unexploded ordnance is discovered during any works, stop immediately, prevent access to the area, and inform the police. If the site boundary or location changes then the UXO risk should be reassessed.

6.0 Conceptual Site Model & Qualitative Risk Assessment

The conceptual site model (CSM) and Qualitative Risk Assessment (QRA) are presented in the table within this section.

The CSM details the source-pathway-receptor linkages or potential pollutant linkages (PPL) that have been identified for the site. The QRA details the associated level of risk relating to these potential pollutant linkages.

The CSM and QRA concern risk to human health and water environment with additional, more specific risk assessment protocols contained within the main body of this reporting, as detailed in *Section 6.1* below.

The QRA follows the framework outlined within CIRIA C552 (Ref. 8) which is summarised within *Appendix C*.

The 'risk rating' within the QRA refers to the risk that the source, pathway, receptor linkage or PPL is complete. Unless specifically stated it does not necessarily refer to an immediate risk and is intended to be used as a tool to assess the necessity for further assessment/investigation.

6.1 Additional Risk Assessments

The following risk assessments, listed below, are not included within the main CSM and QRA but nonetheless can be of critical importance to the onward development of the site:

- The risk presented by Mining is discussed and assessed in *Section 4.1.1*.
- The risk presented by Radon is discussed and assessed in *Section 4.1.3*.
- The risk presented by Unexploded Ordnance is discussed and assessed in *Section 5.0*.

Under current health and safety legislation, employers are required to carry out their own appropriate risk assessments and mitigation to protect themselves and their employees, other human receptors and the environment from potential contamination. Such risks must be adequately mitigated by law, specifically the Construction Design Management (CDM) Regulations, 2015 (Ref. 9) which require that potential risks to human health and the environment from construction activities are appropriately identified and all necessary steps taken to eliminate / manage that risk. It has been assumed that any future construction works on site will be undertaken in compliance with these requirements.



- The table below represents the first stage in the land quality risk assessment process: The Qualitative Risk Assessment.
- For a development site to be deemed 'suitable for use', the level of risk needs to be brought down to acceptable levels, i.e. low to very low risk. The purpose of each stage of risk assessment is ultimately to establish, if there is a requirement for additional levels of assessment to be made to have sufficient confidence to support a risk characterisation or management decision, e.g. remedial action.
- In the absence of specific site data, a Generic Quantitative Risk Assessment is invariably recommended.

Conceptual Site Model				Qualitative Risk Assessment		Recommended Actions
Source	Pathway(s)	Receptor(s)	Consequence	Likelihood of Occurrence	Risk Rating	
Significant sources of on-site contamination: • Made Ground of unknown composition from uncontrolled deposition of materials onsite during the demolition and construction of the care centre.	Direct contact, ingestion, inhalation (dust and vapours)	End-user of site (Residents) & Construction Workers	Medium Chronic health risk	Low Likelihood Based on the site's limited development history and lack of historical industrial use, the likelihood of encountering significant contamination within the Made Ground is considered to be Low. There is potential for localised contamination related to ACM-containing structures considering structures onsite before 2000s. Likelihood of construction workers coming into contact with contamination on site can reduced by appropriate PPE.	Moderate / Low	Generic Quantitative Risk Assessment Recommended as part of the ground investigation.
	Vertical migration through the superficial deposits (soils) May occur due to existing service corridors and physical processes including; capillary action and downwards into the natural deposits through infiltration.	Controlled Waters (Groundwater) Secondary A Aquifer (Bedrock), overlain by Glacial Till Deposits (Secondary Aquifer – Undifferentiated). There are no potable groundwater abstraction points within 1km. The site is not within a designated Source Protection Zone.	Medium Pollution of sensitive water resources	Unlikely While there is the potential for localised contamination to migrate vertically through the superficial deposits to the bedrock Secondary A Aquifer, there is a low likelihood of significant contamination being present in the Made Ground due to lack of historical industrial land use and taking into account the lack of an SPZ or abstraction points within 1km.	Low	No further action required
Significant sources of off-site contamination: • Uncontrolled deposition of Made Ground during the construction of roads and structures and demolition near and adjacent to the site's boundaries. • Deposition of made ground associated with infilled ground from the ponds on site.	Horizontal migration over and through the superficial deposits (soils)	Controlled Waters (Surface Water) Nearest surface water feature is an issue 158m south. No surface water abstraction points within 1km.	Mild Pollution of sensitive water resources	Unlikely Considering the distance from the site to the nearest surface water receptor and the expected low levels of contamination within the Made Ground, this pathway is considered unlikely.	Very Low	No further action required
	Vertical and horizontal migration through existing service corridors and the underlying superficial deposits	End-user of site (Residents)	Medium Human health risk	Likely There is potential for gas generation from any localised organically rich deposits present in the Made Ground or superficial soils and reflecting.	Moderate	Generic Quantitative Risk Assessment Recommended as part of the ground investigation.
Significant sources of ground gas: • Localised organically rich deposits present within infilled land, made ground and within natural soils. • Site within a Coal mining area. • Infilled water feature on site.						

7.0 Conclusion and Recommendations

The qualitative risk assessment (QRA) determined a varied level of level of risk associated with the proposed development.

The QRA concluded by recommending that generic quantitative risk assessments (GQRA) were conducted to confirm the assessment of risk ascribed to each of the respective potential pollutant linkages (PPLs). It is recommended that the GQRA is conducted as part of a ground investigation in support of the engineering design of the proposed development.

In summary, the following recommendations are made:

- Undertake a GQRA as part of the ground investigation; and
- Undertake ground gas monitoring over a period of two-three months for potential hazardous gases.

It is further recommended that the site investigation works are completed in advance of any development works taking place.

7.1 Contaminants of Concern

Potential contaminants of concern associated with the sources identified within the Conceptual Site Model in *Section 6.0* of this reporting include but are not limited to: broad range aliphatic and aromatic hydrocarbons present within any fuel oils; polycyclic aromatic hydrocarbons (PAHs); inorganic compounds including heavy metals; and asbestos present in discarded building materials.

Potential contaminants associated with the airborne dust/particulates include but are not limited to: polycyclic aromatic hydrocarbons and inorganic compounds including toxic metals that are also accounted for by potential onsite contaminants of concern.

7.2 Other Considerations

The requirement for additional surveys, e.g. arboricultural and ecological surveys, should be confirmed through advice from a suitably qualified and experienced professional.

8.0 References

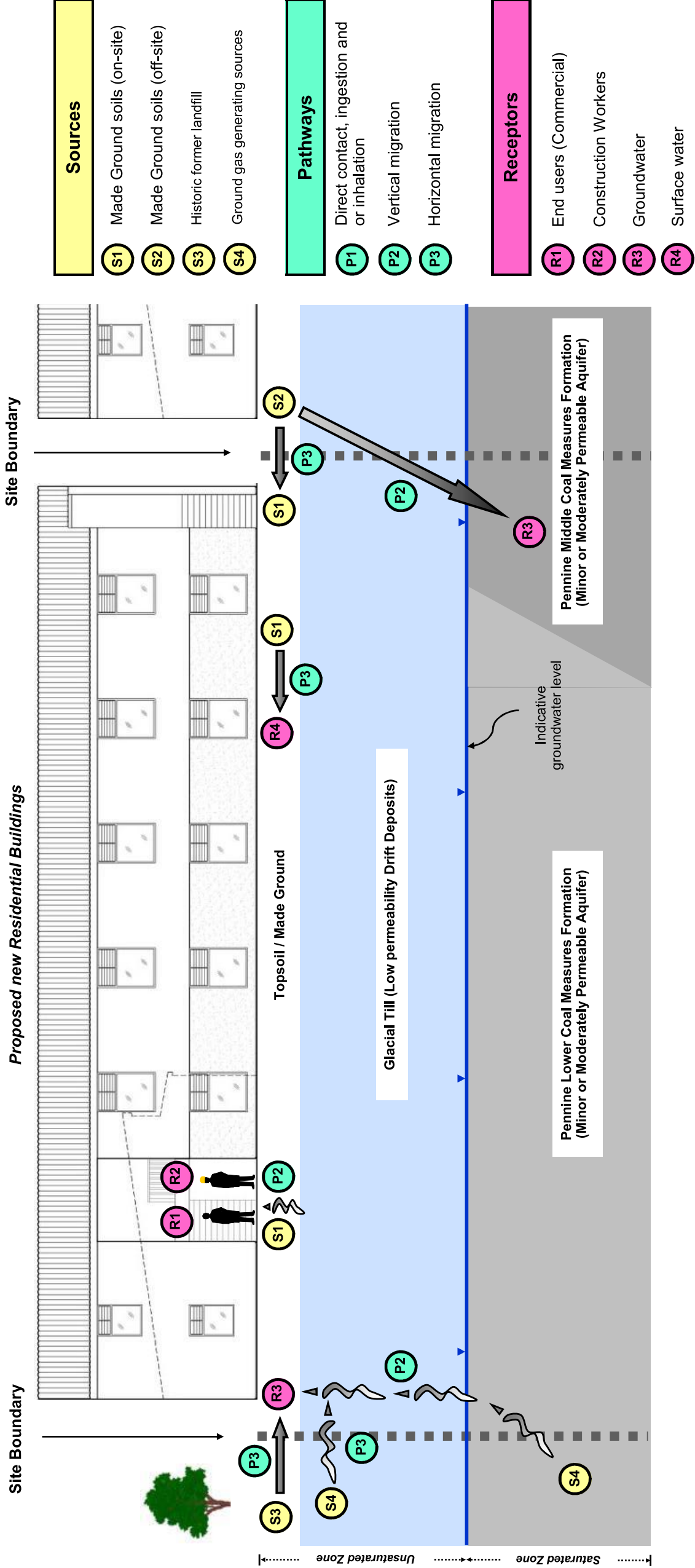
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2. British Geological Survey (BGS) Solid and Drift Editions (2011) 1:50,000 mapping, Sheet No. 085 (Manchester).
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4. Coal Authority Interactive Map Viewer [online], <http://mapapps2.bgs.ac.uk/coalauthority/home.html> (accessed April 2021).
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6. CIRIA (2009) Unexploded Ordnance: A Guide for the Construction Industry (report no. C681).
7. Zetica Regional Unexploded Bomb Risk map [online], <https://zeticauxo.com/downloads-and-resources/risk-maps/> (accessed April 2021).
8. CIRIA (2001) Contaminated Land Risk Assessment. A guide to good practice (report no. C552).
9. Health and Safety Executive (2015) Construction (Design and Management) Regulations.

Appendix A Drawings

- Curtins, Conceptual Site Model, 078016-CUR-00-XX-DR-GE-008-V01_Diagrammatic_CSM, 08/04/21

Former Whitemoss Community Resource Centre

077873-CUR-00-XX-DR-GE-07-V01



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Project

Former Whitemoss Centre, Manchester

Drawing Title

Diagrammatic Conceptual Model

Job Reference

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Author

ZH

Client

One Manchester

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08/04/2021

Checked

SH

Scale

Not to scale