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Phase 1 Geo-Environmental Investigation Report

For: Redwaters Developments Ltd



Job Number:		4548
Report Reference:		4548-01
Issue Status / Revision:	1st issue	
Date:	February 2026	
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1.0 INTRODUCTION

This Phase 1 Geo-Environmental Investigation report has been prepared at the request of Redwaters Developments Limited. Instructions to proceed were received in January 2026. Phase 1 desk study work was undertaken in February 2026.

1.1 Site Location and Description

This report pertains to a c. 0.61 Ha site located to the west of York Lane, Langho, c. 6.5km northeast of Blackburn Town Centre, at the approximate post code BB6 8DT. The National Ordnance Survey Grid Reference for the centre of the site is 370773E, 433621N.

The site currently comprises a residential garden with associated landscaping. A driveway is present in the northern site section running from east to west. The site is bound by York Lane to the east and residential buildings, Snodworth Drive and The Nook residential building to the west, a sheer rock face slope, open land and woodland to the south and a residential building to the north. Access to the site is off Snodworth Road to the west or off York Lane to the east, via the driveway running through the northern site section. An aerial photo of the site is included below and a site location plan is contained in Appendix 2.



Figure 1: Aerial image dated April 2023.

Proposed Development

This Phase 1 Geo-Environmental Investigation is to be used for submission to the Local Authority as part of a planning application. It is the client's intention to develop the site into a low-rise residential development comprising 6 No. detached dwellings with associated private gardens, soft landscaping and access roads.

A proposed development plan is contained in Appendix 2 with an extract below as Figure 2.



Figure 2: An extract of the proposed development plan.

1.2 Brief

The brief was to carry out a Phase 1 Geo-Environmental Investigation for the site based upon the proposed development outlined in Section 1.0. The site area is shown on the site location plan contained in Appendix 2.

The investigation was to include the following:

- a) Assess the probable ground conditions and contaminated land conditions on and below the site based on existing and historical site uses and relevant off-site activities, including a site walkover.
- b) Identify sources of contamination that may be present at the site using current contaminated land guidance and develop a conceptual site model for potential human health, ground gas and controlled waters receptors.

- c) Undertake a Preliminary Risk Assessment which will determine the requirement for further environmental (contaminated land) investigation and assessment.
- d) Design, on the basis of the anticipated ground conditions, appropriate ground investigation works and discuss potential development issues (i.e. sub-surface features – obstructions, infilling, compressible ground, faulting, mineral extraction, mining and land instability).

A report was to be provided to summarise findings and to provide recommendations.

The limitations of this investigation work and report are included in Appendix 1.

2.0 SCOPE OF INVESTIGATION WORKS

2.1 Walkover Survey

The site was visited on 3rd February 2026 in overcast weather conditions. Photographs were taken of the site during the walkover survey and these photographs, together with a plan indicating their location and direction, are contained in Appendix 3.

2.2 Documentation

A combined Enviro + Geo Insight report (Ref GS-OWX-Z1X-UTQ-NFS) was obtained from Groundsure, an environmental database company, which provides a list of recorded past and present activities at or adjacent to the site which could have an impact on the levels of contamination in the soils and groundwater at the site. As part of the desk study works, the below documents were obtained and examined. Unless otherwise stated, the documents are contained within the Groundsure Enviro + Geo Insight Report in Appendix 5:

a) Groundsure maps, all dated 2026 as follows:

- Historical Land Use map;
- Environmental Permits, Incidents and Registers map;
- Landfill and other Waste Sites map;
- Current Land Use map;
- Hydrogeology and Hydrology maps;
- Environment Agency / Natural Resources Wales flood maps;
- Designated Environmentally Sensitive Sites map;
- Geological maps and Ground Working map;
- Mining, Extraction & Natural Cavities map;
- Natural Ground Subsidence maps;
- Borehole Records map; and

- Railways and Tunnels map.
- b) Aerial photographs of the site dated April 2023, April 2020 and May 2001.
- c) Historical Ordnance Survey maps dated between 1844 and 2025, at scales of 1:1,250, 1:2,500, 1:10,000 and 1:10,560.
- d) The following sources were obtained and examined from the British Geological Survey (BGS). All items were copied under licence: [C18/01] British Geological Survey ©UKRI. All rights reserved:
- The BGS 1:50,000 drift geological map (Sheet ref 68 dated 1990); and
 - The BGS 1:63,360 solid geological map (Sheet ref 68 dated 1971).
- e) A Zetica UXO Risk Map was obtained and is included in Appendix 6.
- f) The Ribble Valley Borough Council planning portal was accessed on 6th February 2026. Trial pit logs from planning application reference 3/2023/0457 are contained within Appendix 7.
- g) Britain From Above was accessed on 5th February 2026 however, no relevant information was obtained.

3.0 FINDINGS

3.1 Walkover Survey

The walkover survey was carried out on 3rd February 2026 during overcast weather conditions. During the walkover survey the following features were noted.

The site currently comprises a residential garden with associated landscaping with a driveway which runs from east to west in the northern site section. The garden area was also noted to be terraced due to the site topography, which generally falls to the north. The ground underfoot was noted to be grass across the majority of the site with the presence of gravel and asphalt along the driveway.



Figure 3: Photographs of the northern (left) and central (right) site sections illustrating the presence of terracing.

The topography of the site generally slopes from c. 170.00m AOD in the south to c. 161.00m AOD in the north, a rate of 1:10. However, steeper areas are present in the central site section where a gradient of 1:2 is present, as well as in areas that are terraced, falling at gradients of between 1:5 and 1:6. Beyond the southern site boundary a sheer rock face was identified, rising to a height of c. 174.00m AOD. A LiDAR contour plan is included below showing the topography of the site.

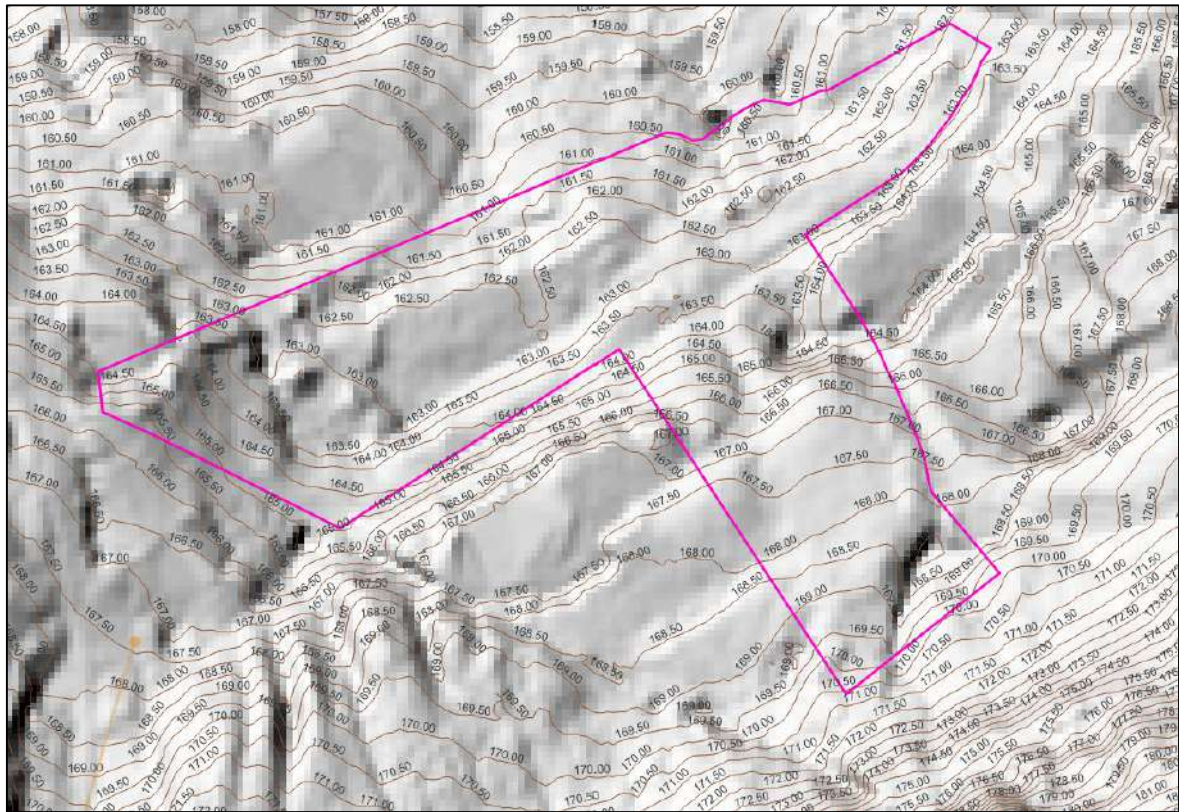


Figure 4: Extract of the LIDAR 0.50m contour plan.

A pond feature was noted in the southern site section, with 2 No. culverted watercourses feeding into it from the south. An outlet was recorded to the north of the pond into an off-site culverted watercourse. A second pond feature was identified in the central site section.



Figure 5: Pond features identified in the northwestern site section (left) and in the central site section (right).

Established trees and dense vegetation are present along site boundaries and in the southern site section. Tree felling was noted to have been recently undertaken across the site by the presence of tree stumps.

Contamination

No evidence of significant contamination (i.e. spillages or leakages) or contaminative sources were identified. Evidence of fly tipping was noted in the northeastern site section, however, this is not considered a contaminative source as the material was primarily inert materials such as metal and timber. Some evidence of burning of unknown materials was identified in the northeastern site section with the presence of ash and charcoal, this may lead to a potential contaminative hotspot.



Figure 6: Evidence of fly tipping in the northeastern site section (left) and burning (right).

3.2 Site History

The site development history has been researched by reference to historical maps, street plans and aerial photographs. The historical maps are included in Appendix 4 to this report and the principal observations, which are divided into on-site history and off-site history, are summarised below:

On-Site History

Date	Site Feature
1848 – 1892	On the earliest historical map, the site is recorded as an open field with a footpath in the northern site section running east to west until c. 1912. The path is recorded again in c. 1969 and remains present today.
1892 – 1912	A spring is recorded in the northeastern site section from c. 1892 until c. 1912.
1912 – 1931	In the 1912 historical map, an unnamed watercourse is identified in the northwestern site section travelling south to north. It is anticipated that this is the currently present culverted watercourse. An unnamed track is recorded in the northern site section running east to west in c. 1912, anticipated to be associated with the adjacent property 'The Nook'.

1931 - 1969	In the 1931 historical map, 2 No. buildings are recorded on site, in the northwestern and southeastern site section. The southeastern building is noted to encroach onto the site from the southeast. Both buildings are no longer recorded by 1969. A second unnamed watercourse was recorded in c.1931 in the northeastern site section, and was no longer recorded by c. 1978
1969 - 2026	In the 1969 historical map, the unnamed track in the northern site section extends southwards to connect to the adjacent property, where it remains unchanged at present. A third building is recorded on site in the central site section in c. 1969 and is no longer recorded by 2003. However, it is anticipated that this building is still present on site as a garage was identified in this area during the site walkover.

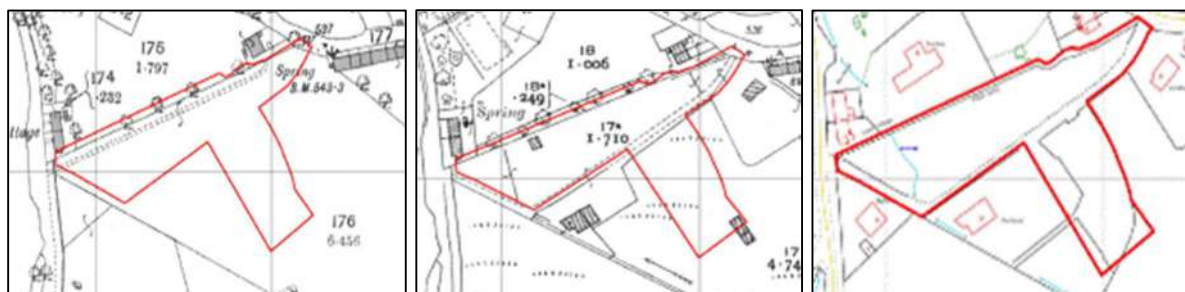


Figure 7: Extracts of the OS historical maps dated 1892, 1931 and 2003 from left to right.

Off-Site History

Date	Feature	Distance (m)	Direction
1909 - 2026	A quarry is present c. 50m southeast of the site from 1909. It is shown to expand in c. 1931 where it has remained until present day. The quarry is not shown to be infilled and a residential building was present in this area from c. 2010.	50	SE
1912 - 1969	A tank was identified within the 1912 historic map c. 60m southeast of the site and remained present until 1969.	60	SE
1909 - 1978	Residential development has occurred to a minor extent within 100m of the site from c. 1909. In 1909 the adjacent The Nook property was identified which remains present. Residential development along York Lane c. 100m east is recorded in 1929. Development along Snodworth Road c. 50 – 100m west of the site is recorded in 1969 and 1978 historical maps.	50 – 100m	E-W

Given the residential and agricultural nature of the surrounding area, no significant off site contaminative sources have been identified.

3.3 Geology

3.3.1 BGS Geological Map

The BGS 1:63,360 Solid and 1:50,000 Drift Geological Maps of the area (Sheet No: 68, dated 1971 and 1990 respectively) indicate that only the north of the site is underlain by superficial deposits of **Glacial Till** which typically comprises a heterogenous mixture of clays, sands and gravels. No superficial deposits are recorded across the remainder of the site. The site is underlain by bedrock of the **Pendle Grit Member**, comprising sandstone.

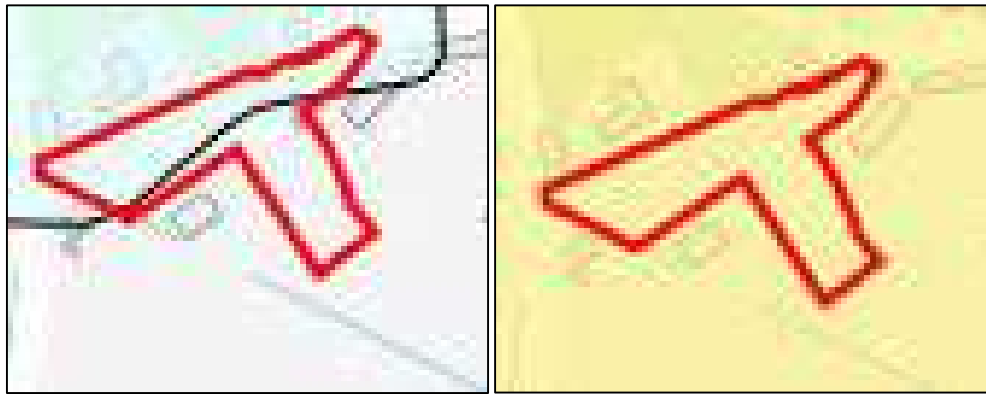


Figure 8: Extracts of the BGS 1:50,000 Drift (left) and Solid (right) Geological Maps. Light blue = Glacial Till, Yellow = Pendle Grit Member.

The BGS geological maps do not record **Made Ground** across the site, however, Made Ground is anticipated in localised areas associated with the presence of development platforms associated with the adjacent The Nook residential building, as well as the on-site driveway and garden terraces.

3.3.2 BGS Borehole Logs

There were no available BGS boreholes on site or within 500m of the site.

3.3.3 Previous Ground Investigation

There is a previous planning application (ref: 3/2023/0457) pertaining to the redevelopment of a dwelling at Overdale, Langho c. 50m northeast of the site. An intrusive ground investigation was undertaken by Hutchinson Whitlam Associates Ltd in September 2023 which comprised 3 No. mechanically excavated trial pits. The ground investigation is included in Appendix 7 and the following ground conditions were recorded:

- **Topsoil** comprising brown slightly gravelly clayey SAND with frequent rootlets to a depth of between 0.20m bgl, underlain by:
- **Glacial Till** comprising firm to stiff becoming stiffer with depth light brown slightly gravelly slightly sandy CLAY with occasional cobbles to a depth of 1.20m bgl, where the trial pits were terminated.

3.3.4 BGS Geohazards

Data Type	Details
Ground Stability Data	- The Potential for Shrinking or Swelling Clay Ground Stability Hazards is regarded as negligible to very low. - The Potential for Running Sand Ground Stability Hazards is regarded as negligible to very low. - The Potential for Compressible Ground Stability Hazards is regarded as negligible. - The Potential for Collapsible Ground Stability Hazards is regarded as very low. - The Potential for Landslide Ground Stability Hazards is regarded as low to very low. - The Potential for Dissolution Ground Stability Hazards is regarded as negligible.

3.3.5 BGS Estimated Soil Chemistry

The BGS have estimated that the superficial deposits across the site to naturally comprise the following determinands:

- Arsenic: 15mg/kg – 25mg/kg
- Cadmium: 2.2mg/kg – 3.0mg/kg
- Chromium: 60mg/kg – 90mg/kg
- Nickel: 15mg/kg – 30mg/kg
- Lead: 100mg/kg
- Bioaccessible Lead: 60mg/kg

3.4 Mining

3.4.1 Coal Mining

The site does not lie within a Mining Remediation Authority Coal Mining Reporting Area. Furthermore, there are no development high risk areas, coal outcrops, probable or recorded workings or mine entries on site or in close proximity to the site.

3.4.2 Non-Coal Mining

The Groundsure Enviro + Geo Insight report indicates that underground mine workings of a vein mineral have been recorded on site, however are uncommon, although the geology is similar to that worked elsewhere. Groundsure states that *‘Potential for difficult ground conditions are unlikely and localised and are at a level where they need not be considered’*.

3.4.3 Salt Mining / Brine Extraction

The site lies outside of the Cheshire Brine Subsidence Compensation Board Compensation District.

3.4.4 Historical Surface Excavations

There are no historical surface excavations recorded on site. However, 2 No. quarries are present 36m east and 209m south west of the site. It is unlikely that these quarries are infilled due to their current presence as a topographical low points. An unspecified pit has also been recorded c. 65m northwest of the site between 1909 and 1938 which is likely to have been infilled with an unknown material. Furthermore, the presence of development platforms indicates that surface excavations may have been undertaken on site therefore, unrecorded surface excavations cannot be discounted.

3.4.5 Mineral Safeguarding

Where mineral resources are present the mineral planning authority may designate areas as Mineral Safeguarding Areas (MSA) and Mineral Consultation Areas (MCA). These are aimed to safeguard mineral resource areas from unnecessary sterilization by non-mineral development. The BGS Mineral Resources maps designate the areas of potential mineral resources and where active / lapsed planning permission was granted for mineral extraction.

The BGS Mineral Resources Map for Lancashire indicates that the southern site section lies within an area of sandstone resources. The extract below shows the locations of the MSA with regard to the site boundary.

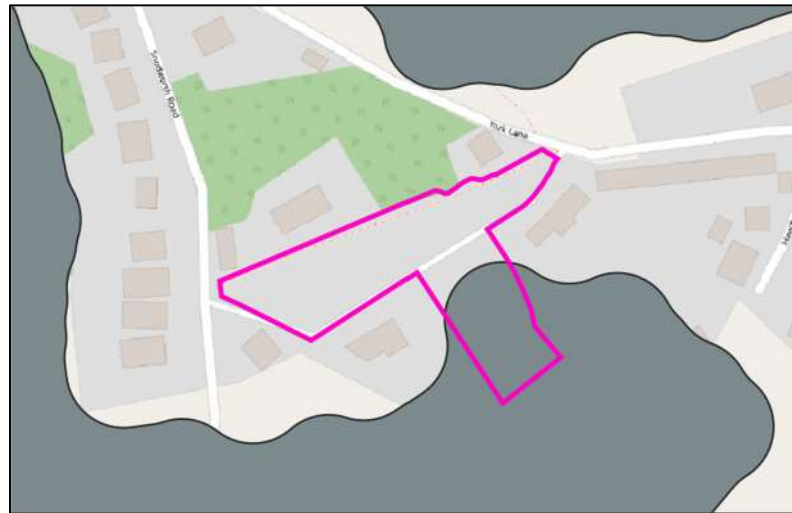


Figure 9: Extract of the BGS Mineral Resources Map for Lancashire with the sandstone MSA (grey) and the site boundary (magenta).

The Lancashire County Council Minerals and Waste Local Plan indicates that the south of the site lies within a Mineral Safeguarding Area for sandstone.

The sandstone underlying the site is anticipated to be present at a significant thickness of c. 457m. Furthermore, the southern site section is located in an area where there are no superficial deposits recorded by BGS geological mapping to underlie the site.

However, even though the mineral is extractable, given the size of the site, the capacity for mineral extraction in large quantities is considered economically unfeasible. Given the shallow presence of the sandstone, it is expected to be highly weathered, but will still require breaking out with large machinery, therefore an opencast extraction method would need to be utilised – supported by the presence of 2 No. opencast quarries within close proximity to the site. This method would require borders around the open extraction site and terraces for stability. Therefore, given the size of the site, the extraction area is very limited.

The NPPF (2025) states that sites for associated processes including transport, handling and distribution of the mineral should also be considered. As the site is located adjacent to a residential area with limited access roads that are a single vehicle wide, these roads are unlikely to be suitable to large vehicles associated with large scale mineral extraction. If any processing or storage of the extracted minerals

is required, associated facilities may need to be accommodated on site, further reducing the overall yield of the mineral.

Although the NPPF recognises that unacceptable noise limits for the short-term are unavoidable, given the site is adjacent to residential properties, especially the close proximity to the adjacent property The Nook, these distances and the effects of noise on neighbours should be carefully considered.

Finally, for the reasons stated above, it is not considered feasible for the prior extraction of minerals to have taken place given the low potential yields of the mineral.

3.5 Hydrology and Hydrogeology

Environmental data relevant to the site and its immediately surrounding area has been obtained from sources available in the public domain. In addition, an environmental report was obtained from Groundsure. The Enviro + Geo Insight report and associated maps that have been inspected are presented in Appendix 5 and the principal observations in relation to waters and flooding can be summarised as follows:

Data Type	Details
Flooding	- With respect to rivers and seas, the site lies within Flood Zone 1. - The risk of surface water flooding is deemed to be negligible. - A BGS groundwater flooding susceptibility area has also been identified on site, however, the risk is deemed to be negligible to low.
Surface Water Features	An unnamed surface watercourse and a culverted watercourse are recorded in the northern site section. A pond is also present in the northwestern site section.
Surface Water Abstractions	- There are no licensed surface water abstractions located on site. - There are 2 No. licensed surface water abstractions located within 2km of the site, 1 No. is historical and 1 No. is active. The active license is located 890m southeast and pertains to the direct potable water supply from the upper and lower Dean Reservoirs.
Superficial Aquifer	The north of the site is underlain by superficial deposits classified as a Secondary Undifferentiated Aquifer - <i>Assigned where it is not possible to attribute either category A or B to a rock type. In general these layers have previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.</i>
Bedrock Aquifer	The underlying bedrock is classified as a Secondary A Aquifer - <i>Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.</i>
Groundwater Abstractions	There are no recorded groundwater abstraction licenses located on site or within 2km of the site.

Source Protection Zones	There are no recorded Source Protection Zones recorded on site or within 500m of the site.
Nitrate Vulnerable Zones	There are no Nitrate Vulnerable Zones recorded on site or within 500m of the site.
Licensed Discharge Consents	There are no recorded licensed discharge consents to controlled waters on site or within 500m of the site.
Pollution Incidents to Controlled Waters	- There are no recorded pollution incidents to controlled waters located on site. - There is 1 No. pollution incidents recorded within 500m of the site and is located 22m east of the site. It concerns an incident in April 2020 involving oils and fuels. The incident was recorded as a Category 2 (Significant) incident to controlled waters.

3.6 Hazardous Installations, Landfill and Waste

The following information relating to hazardous installations, landfill and waste obtained from the Groundsure Enviro + Geo Insight report, published information and the walkover survey can be summarised as follows:

Data Type	Details
Environment Agency Recorded Active Landfill Sites	There are no Environment Agency recorded landfill sites located on site or within 500m of the site.
Environment Agency Recorded Historical Landfill Sites	There are no Environment Agency recorded historical landfill sites located on site or within 500m.
BGS Recorded Historical Landfill Sites	There are no BGS recorded landfill sites located on site or within 500m of the site.
Local Authority Recorded Landfill Sites	There are no Local Authority recorded landfill site located on site or within 500m.
Local Authority Pollution Prevention and Control (Part A(2) and Part B Activities and Enforcements)	There are no Local Authority Part A2 or Part B Activities or Enforcements located on site or within 500m of the site.
Registered Radioactive Substances	There are no Registered Radioactive Substances recorded on site or within 500m of the site.
Registered Waste Treatment, Transfer or Disposal Sites	- There no waste exemptions recorded on site. - There are 6 No. waste exemptions recorded within 500m of the site, the nearest is located 48m northwest and pertains to the use of waste for construction. - There are no historical or licensed waste sites on site or within 500m of the site.
Industrial Land Use	- There are no current industrial land uses recorded on site. - There are 2 No. recent industrial uses recorded within 500m of the site, the nearest is located 186m east and relates to electrical features. - There are no petrol / fuel station recorded within 500m of the site. - There are no historical industrial site uses recorded on site. - There are 24 No. historical industrial land uses recorded within 500m of the site, concerning unspecified quarries, unspecified tanks, unspecified pits, a sandstone quarry and an electricity substation.

Dangerous Substances	There are no recorded discharges of dangerous substances on site or within 500m of the site.
Hazardous Building Materials	No hazardous building materials are anticipated on site.

3.7 Radon

A site-specific radon map is included in the Groundsure Enviro + Geo Insight report which finds that the site lies within an area where less than 1% of homes are above the Action Level and consequently, no protection measures are required.

3.8 Unexploded Ordnance (UXO)

The Zetica UXO risk map, contained in Appendix 6, indicates that the site lies within an area of low risk.

3.9 Animal Burial Sites

The Animal Health and Veterinary Laboratories Agency (AHVLA) no longer routinely respond to consultations relating to records of animal burial sites. Based upon a review of the site history it is considered unlikely that the site has been subject to recorded animal burials.

3.10 Archaeology

We do not anticipate that the site will be affected by archaeological issues, however consultation with the county archaeologist is recommended.

4.0 CONCLUSIONS

4.1 General

The site is a residential garden associated with an adjacent property. The site generally slopes gently down to the north falling from c.170.00m AOD in the south to c. 161.00m AOD in the north, with steeper slopes of 1:2 identified in the central section. Steep areas were also noted associated with terracing within the garden at gradients between 1:5 and 1:6. 2 No. historical building were recorded in the southern and northwestern site sections between 1931 and 1969. A third building was identified in the central site section in c. 1969 and is anticipated to still be present. An unnamed track has been identified to cross the northern site section from east to west.

4.2 Ground Conditions and Geotechnical Hazard Identification

The anticipated typical ground conditions across the site are as follows:

- **Topsoil** to a depth of c. 0.20m bgl, and:
- Possible localised **Made Ground** associated with development platforms to an unknown depth, underlain by:
- (Northern site section only) **Glacial Till** comprising firm to stiff, becoming stiffer with depth, brown, slightly gravelly, slightly sandy CLAY with a low cobble content to a depth of between 3.00m bgl and 11.00m bgl, underlain by:
- **Pendle Grit Member** comprising SANDSTONE.

4.2.1 Geotechnical Hazard Identification

Potential geotechnical hazards based on the expected ground conditions that may require further consideration at the site are outlined below:

Factors	Remarks	Considerations	Hazard
Possible Localised Made Ground	Although not anticipated to be widespread or deep, Made Ground may be present associated with development platforms.	Made Ground may settle variably, have highly inconsistent bearing capacity and may suffer significant movements that may be problematic for foundations, externals and infrastructure elements without treatment. The presence of Made Ground may be problematic for foundations as there may be loose / soft spots within the Made Ground and it may not be suitable to utilise traditional foundations.	Low
Aggressive Ground and Groundwater	While the risk posed from the natural strata is anticipated to be very low, given the possible presence of localised Made Ground there is potential for aggressive ground conditions to be present on-site, however, the risk remains low.	Acidic ground / groundwater and sulfate may attack the concrete and steel used in foundations and react with aggregates. The oxidation of pyrite and other sulfides can also occur due to geotechnical activities. This can lead to the generation of high concentrations of sulfate and low pH that attacks construction materials and may lead to the precipitation of gypsum resulting in the heave of foundations and floor slabs. Pyrite oxidation can also be triggered by mixing susceptible materials with lime or cement resulting in high pH that can lead to the expansion of some sulfates that cause heave of stabilised soils.	Low
Shrink and Swell Clays	Established trees are present along the northern site boundary. Glacial Till deposits are anticipated at shallow depth in this area. However, the plasticity and volume change potential of these deposits are not confirmed. Where present, Glacial Till may exhibit moderate to high plasticity and low to moderate volume change potential.	Some types of ground (e.g., clay soils) can change volume due to changes in moisture content that may be induced by weather variations (e.g., drought), vegetation (e.g., growth or removal of trees) or man-made activities (e.g., changes to local drainage). This shrink / swell behaviour typically causes ground movement to a depth of approx. 3m potentially damaging building foundations, externals, pipes or services by differential movements.	Low to Moderate (Northern Area Only)
Compressible Deposits and Soft Spots	A pond and an unnamed surface water course are recorded in the northern site section; compressible deposits may be present associated with these. Soft spots may be present in the northern site section associated with the presence of a pond feature.	May cause differential settlement of foundations therefore there will be a requirement for localised deepening of foundations where soft spots and compressible deposits are present.	Low to Moderate (Northern Area Only)
Slope Stability	The site is noted to generally slope gently, falling from south to north at c. 1:10, and therefore presents no significant risk. Localised areas of steeper gradients are present, including within the central site section at a gradient of 1:2, with terraced areas exhibiting a gradient of between 1:5 and 1:6, which carry an increased yet still limited risk. Furthermore, given the presence of shallow bedrock across the site, the overall risk is reduced to low.	A relatively rapid outward and downward movement of a mass of rock or soil on a slope due to the force of gravity. Typically slope instability is caused by either a decrease in soil strength or an increase in shear stress. Numerous factors are involved but usually loading on or at the crest of the slope, increasing the amount of water entering the slope or cutting at the toe of the slope cause failure. Damage by landslide can occur through the removal of supporting ground from under structures, externals or services or by the movement of material onto property.	Low

4.3 Sources of Contamination and Probable Contaminants

Based on the desk study information the following potentially contaminative sources have been identified:

Potentially Contaminative Source	Associated Determinands	Remarks
On-Site Possible Made Ground	Unknown, anticipated to be metals, semi-metals, PAHs, TPH, asbestos. Ground Gas – carbon dioxide, methane, hydrogen sulfide, VOCs	Localised areas of Made Ground may be present across the site associated with the presence of development platforms. 2 No. historical buildings have been identified in the northwestern and southern site sections. These historical buildings have been demolished therefore Made Ground is anticipated in the areas associated with the historical buildings.
Off-Site Historical Tank (1912-1969)	Unknown, anticipated to be metals, semi-metals, PAHs, TPH	A historical tank was present c. 62m southeast of the site. The contents of the tank are unknown.

It should be noted that potentially contaminative unrecorded historical activities may have occurred (e.g. the use or deposition of Made Ground from off site during historical on-site developments) and in this event, further contaminative sources may be present.

4.3.1 Unknowns

Following the desk study, the areas of uncertainty are summarised as follows:

- Presence, depth and extent of Glacial Till in the northern site section; and
- Presence and extent of Made Ground associated with development platforms.

4.4 Identified Pathways of Contamination

Human Health		Ground Gas		Controlled Waters	
A	Ingestion of dust and soil	A	Migration through fractures and fissures in bedrock	A	Vertical migration through coarse Made Ground and coarse soils
B	Dermal contact with dust and soil	B	Preferential migration along foundations & service ducts	B	Lateral migration along low permeability natural soils & pooling at relative low points
C	Inhalation (dust)	C	Migration within groundwater	C	Vertical migration along future foundations and pooling at base
D	Inhalation (vapours)	D	Ingress through cavity walls & floors	D	Migration through porous bedrock
E	Consumption of homegrown produce	E	Inhalation	E	Overland flow
F	Inhalation and oral backgrounds				

4.5 Identified Receptors of Contamination

Human health receptors include the following:

- End users (residential land use scenario);
- Construction workers; and
- The general public and adjacent site users.

Controlled waters receptors include the following:

- Groundwater contained within the underlying Secondary Undifferentiated Aquifer and Secondary A Aquifer in bedrock; and
- Surface water – on-site culverted stream and on-site surface water course.

Other receptors include the following:

- Subsurface plastic (e.g. potable plastic water pipe); and
- Building fabric (e.g. concrete foundations, etc)

4.6 Conceptual Site Model

4.6.1 Conceptual Model for Human Health Risk Assessment

A site conceptual model in the form of a linkage table for the purposes of a preliminary risk assessment for the human health of site occupants has been produced as a result of the probable contaminants, pathways and receptors identified above. A diagram of the site conceptual model is included as Appendix 2.

Conceptual Model for Human Health Assessment					
Sources of Contamination	Pathway	Receptor	Hazard (severity)	Likelihood	Risk
On-Site Possible Made Ground Off-Site Historical Tank (1912-1969)	A B C D E F	End users	Effect on human health (Medium)	Unlikely: The site is currently part of a residential garden associated with an adjacent property. During the site walkover, development platforms were noted as well as an access road/ track. Therefore, the presence of Made Ground cannot be discounted at this stage and localised, potentially deep pockets may exist across the site. However, the Made Ground is anticipated to be localised and not deep and is not expected to contain significantly elevated concentrations of contaminants given the site history and limited potentially contaminative sources identified.	Low
		General public		The off-site historical tank may be a source of fuels including TPH, PAH and VOCs however, its contents are unknown. However, due to the presence of shallow bedrock in the southern site section, and the increased elevation of the historical tank from the site, no viable contaminate linkages exist. Therefore, the risk is considered to be low. Ingestion, dermal and inhalation pathways will be reduced across the majority of the site given the presence of hardstanding i.e. roads and buildings. Private gardens and areas of soft landscaping will be at increased risk, however, the risk remains low given the lack of significant contaminative sources.	
		Construction workers		Unlikely: Construction workers will be at increased risk due to their acute interaction with soils, however, given the lack of identified potentially contaminative sources the risk is reduced to low. The appropriate use of PPE, Good Practice and Health and Safety Measures will also significantly reduce the risk.	
		End users and general public		Unlikely: No potential sources of VOCs have been identified on site. If localised contaminative hotspots of VOCs are present (i.e. from possible spillages), given their relative mobility and volatility VOCs are unlikely to remain at significant concentrations.	
	D	Construction workers		Unlikely: Construction workers at increased risk if any disturbance of soil occurs as this may generate a temporary increase in the release of soil vapours, however risk remains low given the lack of a source of VOCs.	Low

4.6.2 Conceptual Model for Ground Gas Risk Assessment

A conceptual model in the form of a linkage table for the purposes of a preliminary risk assessment for ground gas has been produced as a result of the probable contaminants, pathways and targets identified above as follows:

Conceptual Model for Ground Gas Risk Assessment					
Source	Pathway	Receptor	Hazard (severity)	Likelihood	Risk
On-Site Possible Made Ground	A	Human occupants	Effect on human health (Mild to Severe*)	Unlikely: Significant Made Ground deposits are not anticipated on site. Possible localised pockets may be present but are likely to be less than 1m in depth. The Made Ground is also unlikely to contain significant organic rich or putrescible material. Consequently, the Made Ground is anticipated to be a very low ground gas generation source.	Low
	B	Site Workers			
	C	Building and Structures	Damage to building (Mild)		
	D				
	E				

*Due to the risk of explosion.

4.6.3 Conceptual Model for Controlled Waters Risk Assessment

A site conceptual model in the form of a linkage table for the purposes of a preliminary risk assessment for pollution of waters has been produced as a result of the probable contaminants, pathways and targets identified above as follows:

Conceptual Model for Controlled Waters Risk Assessment					
Source	Pathway	Receptor	Hazard (severity)	Likelihood of Occurrence	Risk
On-Site Possible Made Ground	A C D	Groundwater within the Secondary Undifferentiated and Secondary B Aquifers	Effects to controlled waters (Mild)	Pre-Development Site Low-Likelihood: No significant potential sources of contamination have been identified on site. Localised Made Ground may be present in association with development platforms, but it is unlikely to contain determinands at elevated concentrations. BGS mapping indicates that the northern parts of the site include areas of Glacial Till, which would act to reduce vertical migration. In contrast, the southern site section comprises shallow bedrock with no overlying Glacial Till. If fractures or fissures are present within the bedrock, there may be an elevated risk to the Secondary B Aquifer.	Low
				Post Development Site Unlikely: Following development there will be a significant increase in hardstanding (i.e. buildings and roads) across the site therefore vertical migration will be significantly reduced. Furthermore, if any contamination is encountered, then remedial measures may be undertaken for human health purposes (i.e. possible removal of source) further reducing the risk to controlled waters. However, no significant contamination is anticipated so the likelihood of requiring remedial action is low.	Very Low
	B	Surface water courses (On-site culverted watercourse, on-site surface watercourse and on-site pond)	Effects to controlled waters: (Mild)	Pre-Development Site: Low-Likelihood: Lateral migration of contaminants is considered unlikely given the lack of potentially contaminative sources despite the presence of a surface water course on site. In general, the site lacks the presence of cohesive Glacial Till, with the exception of the northern site section, which generally reduces the likelihood of lateral migration. Therefore, the risk to the on-site surface water course is considered low.	Low
				Post Development Site: Unlikely: The potential for lateral migration of contaminants will be further reduced following development given the increased presence of hardstanding and drainage infrastructure significantly reducing infiltration of water into the underlying ground.	Very Low
	E	Surface water courses (On-site culverted watercourse, on-site surface watercourse)	Effects to controlled waters: (Mild)	Pre-Development Site Low-Likelihood: A surface water feature is located on site, and overland flow is considered likely as hardstanding is currently present in areas of the site. However, the existing topsoil will facilitate vertical migration rather than lateral migration to the surface water receptors. Furthermore, a lack of potentially contaminative sources further reduces the risk.	Low

		and on-site pond)		Post Development Site: Unlikely: Although the presence of hardstanding is likely to increase significantly following development, the risk remains very low as any contamination is likely to be beneath hardstanding or beneath areas of soft landscaping / private gardens which will facilitate vertical migration rather than lateral migration to the surface water receptors.	Very Low
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4.7 Preliminary Risk Assessment Summary

Human Health

Based on the human health conceptual model, the risk to human health is deemed low to end users and construction workers. Made Ground is likely to be encountered in localised areas associated with the presence of development platforms, however no significant contamination is anticipated. Although the risk to construction workers is increased due to their acute interaction with site soils, it is envisaged that with appropriate PPE and site management, risks to construction workers can be mitigated, reducing the risk to low.

Ground Gas

Potential ground gas sources have been identified on site with the possible presence of Made Ground associated with development on site. However, due to the likely localised and thin nature of Made Ground and anticipated lack of organic matter, the risk is considered very low. Ground gas monitoring is not deemed necessary for this site, considering the anticipated shallow nature of Made Ground and the presence of shallow bedrock. A qualitative assessment utilising total organic carbon in line with CLAIRE RB17 (2013) is recommended.

If any organic rich Made Ground deposits are identified or if previously unrecorded potential ground gas sources are recorded during the ground investigation works, then ground gas monitoring may be required. The length and frequency of the ground gas monitoring regime and the sampling method, initial results and alterations to the conceptual model are subject to the findings of the ground investigation works and development constraints (i.e. development timescales and liaison with the local authority).

Controlled Waters

Although sensitive receptors have been identified on site (Secondary Undifferentiated and Secondary B Aquifers and the on-site unnamed water course) no significant contaminative linkages exist, therefore the risk to controlled waters is deemed low to very low.

If unrecorded contaminative sources are noted, the above conceptual models may require re-assessment.

4.8 Scope of Phase 2 Intrusive Geo-Environmental Ground Investigation

As a result of the preliminary risk assessment, a Phase 2 intrusive geo-environmental ground investigation should be carried out to quantify the identified risks. This intrusive ground investigation works should include the collection of appropriate samples across the site for appropriate chemical testing as detailed above.

Furthermore, to determine the geotechnical and geological properties of the underlying ground conditions, appropriate intrusive works and associated testing should be undertaken. The rationale and aims for these Phase 2 environmental, geotechnical and geological investigative works are detailed below.

In order to provide adequate assessment in terms of both environmental and geotechnical site parameters, ground investigation works will be required on a spatial basis and targeting the historical buildings.

The proposed initial ground investigation works should comprise a programme of dynamic sampling boreholes and mechanically excavated trial pits. The trial pits should be undertaken with the aim of delineating the extent of Glacial Till deposits in the north and rock break requirements in relation to the shallow bedrock.

The rationale for the exploratory holes is discussed below:

- To allow the collection of samples from the Made Ground and natural deposits for chemical laboratory testing (solid samples) for an appropriate suite of determinands and to determine the suitable concrete classification in associated with relevant guidance e.g. BRE Special Digest 1;
- To determine the extent, composition and depth of any Made Ground deposits;
- To determine the nature, thickness and extent of superficial deposits;

- Enable geotechnical testing, including density testing (SPTs), hand shear vane (HSV) testing and undrained shear strengths of the underlying Made Ground and natural deposits for the purposes of sub-structure design;
- To understand the extent and thickness of Glacial Till deposits in the northern site section; and
- To understand the presence of extent of shallow bedrock in the southern site section to identify if rock break will be required.

Based on the findings of the initial ground investigation works, further works may be required for detailed design including California Bearing Ratio determinations, testing for earthworks information and deep ground investigation to inform pile design where shallow bedrock is present.

5.0 RECOMMENDATIONS

- As a result of the information gathered and the risks identified in this report, there is a low risk to human health on the basis that no feasible contaminative linkages have been identified for end users and construction workers. The risk to controlled waters is deemed very low to low given the lack of significant contaminative linkages.
- A very low ground gas risk has been identified based on the presence of shallow bedrock. Ground gas monitoring is not recommended for this site due to the lack of significant contaminative sources and ground conditions present. It is therefore recommended that a qualitative assessment is undertaken in line with CLAIRE RB17 (2013) . On the basis that the site lies within an area where between less than 1% of homes are above the action level no radon protection measures are necessary.
- Due to geotechnical requirements, ground investigation works should be undertaken in order to determine the ground conditions with a greater degree of certainty and allow design of the proposed development, drainage, services and immediate external areas to be undertaken. It is therefore recommended that exploratory holes are constructed where access is permitted across the site. The use of soakaways is unlikely to be suitable given the presence of low-permeability shallow Glacial Till in the northern site section and the presence of shallow bedrock across the rest of the site.
- From the results of the Phase 2 ground investigation work – if this report identifies a potential risk and / or a requirement for further detailed site-specific assessment, a Phase 3 environmental investigation report and / or a Remedial Strategy (informing on potential remediation solutions) may be required.
- The nature and extent of the proposed targeted chemical and environmental testing should be confirmed, if time / commercial constraints allow, with the relevant Local Authority Environmental Health Officer and the Environment Agency prior to

undertaking works on-site. Proceeding without agreement between regulatory authorities may result in further assessment being required.

- It should be noted that if any visual or olfactory evidence of contamination is encountered during remediation or construction work, the Local Authority Environmental Health Officer and Environment Agency should be contacted immediately in order to agree any necessary remediation measures.
- Given the possibility of services on site, full service plans should be obtained prior to any intrusive ground investigation works.
- Due to the presence of established trees on-site and the presence of cohesive deposits, an arboricultural survey is recommended.