



Phase 1 Desk Study Site Investigation Report

LOCATION	Hough End Leisure Centre, 480 Princess Road, Manchester M20 1NA
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FOR	Ameresco c/o Rik Aindow
CLIENT REF.	
OUR REF.	G21424

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Table of Contents

EXECUTIVE SUMMARY	3
1. INTRODUCTION.....	3
2. SCOPE OF WORKS	4
3. FINDINGS OF PHASE 1 INVESTIGATION	4
3.1 ANTICIPATED GEOLOGY	4
3.2 HISTORICAL OS MAPS AND HISTORICAL LAND USE	4
3.3 GROUNDSURE ENVIRO + GEO INSIGHT REPORT	5
3.3.2 Groundsure GeoInsight Report	7
3.5 PREVIOUS GROUND INVESTIGATION CONCLUSION	8
3.6 WALKOVER SURVEY OBSERVATIONS	9
4. QUALITATIVE RISK ASSESSMENT	11
4.1 METHOD	11
4.2 RISK ASSESSMENT.....	11
5. CONCLUSIONS.....	15
6. RECOMMENDATIONS.....	16



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Executive Summary

The major conclusions of this desk-based Phase one study are summarised in the table below:

Site Suitability	Desk Study Finding	Preliminary Assessment
Normal Foundations	Bedrock expected to be present at shallow depth with drift deposits of sand and gravel underlain by boulder clay anticipated, based upon the previous ground investigation.	Not required for the development planned
Soakaways	Sand/gravel soils likely to be present which might offer good permeability, underlain by Clay soils unlikely to offer sufficient permeability.	Not required for the development planned
Radon Gas	Less than 1% of properties effected	Negligible

Potential Risks	Desk Study Finding	Preliminary Risk Assessment
Chemical Contamination	Historical nearby and on-site land uses potentially giving rise to a range of inorganic and organic contaminants including asbestos, metals/metalloids, PAHs and petroleum hydrocarbons.	Low
Hazardous Gas	Possible chance for significant potential source of hazardous gas. Development will not involve any enclosed spaces/buildings.	Very low
Ground Instability/ subsidence	Potential for vegetation influence on shrink-swell clays which may be present, including risk of soil heave.	Low
	Potential for significant deposits of compressible made/infilled ground.	Low

NB. Arbitrary potential hazard assessment: High (Red), Moderate (Amber), Low (Yellow), Very Low (Green), Negligible (uncoloured)

1. Introduction

In accordance with your instruction, Geoinvestigate Ltd. has carried out a Phase 1 Desk Study Investigation of Hough End Leisure Centre, 480 Princess Road, Manchester M20 1NA. The location of the site is shown on the Groundsure Enviro+Geo Insight report presented in Appendix 2.

The site currently comprises an area of land some 0.93ha in size with access from A5103 from the southeast and Framley Road to the north. Recent satellite imagery shows that the study area forms part of a larger site occupied by the leisure centre, car park and the soft landscaping/playing field to the north-western and southwestern parts of the site. The site itself bounded by playing fields to the west and residential dwellings to the east. Given that the study site is part of the wider leisure centre site there are no clear site boundaries, save from the A5103 and the large trees/wooded area to the north of the site.

It is understood that it is proposed to install a closed loop ground source heat pump (GSHP) system as part of building works at Hough End Leisure Centre.

The purpose of the Phase 1 Desk Study investigation was to review the historical land use and geological information for the site in order to provide an assessment of the potential geotechnical/foundation problems together with a qualitative contamination and ground gas risk assessment.

The client has also provided a previous site investigation report which was carried out by Coffey Geotechnics Ltd (2013) within the existing site area. This ground investigation was carried out prior to the construction of the leisure centre currently present at the site, and comprised of a desk study, intrusive ground investigation and remediation strategy. These have been provided in appendix 3.

2. Scope of Works

The investigation comprised a review of the following information:

- An extract from the 1:50,000 BGS geological mapping (Sheet 98 – Stockport).
- Historical OS maps of various scales dating back to 1876 (presented in Appendix 1).
- Observations from a walkover study carried out by Tristan Campbell-Reynolds of Geoinvestigate
- A GroundSure Enviro+Geo Insight Report. This is included in Appendix 2.
- Coffey Geotechnics Ltd previous ground investigation reports are provided in Appendix 3.

3. Findings of Phase 1 Investigation

3.1 Anticipated Geology

The extract of the 1: 50,000 BGS geological map (Sheet 98 – Stockport) indicates the site is expected to be underlain by superficial deposits comprising Glaciofluvial Sheet Deposits (Devensian) with underlying bedrock geology of the Wilmslow Sandstone Formation (Sandstone). The map also states that the Shridley Hill Sand Formation lies close to the northeast of the site, possibly encroaching onto the site.

BGS borehole records some 600m to the southwest, generally show topsoil to 0.60m depth followed by natural fluvioglacial gravel to 3.97m, underlain by boulder clay to 12.19m. No bedrock is recorded within the boreholes.

The previous ground investigation carried out by Coffey Geotechnics at the site, encountered topsoil to between 0.10m and 0.40m, followed by made ground to 0.40m to 1.00m depth, underlain by natural drift of loose and medium, dense sandy gravel (glaciofluvial sheet deposits) to between 1.10m to 2.40m, firm to stiff sandy gravelly clay (glacial till) to 1.30m to 2.70m, then natural bedrock of the Wilmslow Sandstone Formation to borehole termination.

3.2 Historical OS Maps and Historical Land Use

Copies of historical OS maps were obtained for the site covering the period 1881 to 2021. Historical land uses and major features located within the site boundary and externally but potentially within influencing distance are summarised in Table 1. The earliest OS map of 1881 shows the site as undeveloped agricultural land. The map also shows the Red Lion Brook to the north of the site, with Old Marl Pits approximately 100m from the site.

Table 1: Summary of Historical OS Map Land Use & Potential Hazard Identification

Map Feature	Location	Appears	Absent	Notes
Leisure Centre	On site	2021	Present	Construction of building on site, potential source of made ground, source of hazardous has and contamination.
Residential development	On site	1933	Present	Construction of residential estate potential source of made ground, if substantial enough, this could be a source of hazardous gas.
Framley Road	On site	1950	2010	Construction of roadway. Potential source of made ground nearby or on site.
Car Park	On site	1992	Present	Construction of car park (Asphalt hardstanding) potential source of deep made ground, source of hazardous gas and contamination.

Table 1 continued following page

NB. Arbitrary potential hazard assessment: High (Red), Moderate (Amber), Low (Yellow), Very Low (Green), Negligible (uncoloured)

Table 1 (ctd): Summary of Historical OS Map Land Use & Potential Hazard Identification

Map Feature	Location	Appears	Absent	Notes
Princess Road	5m east	1933	Present	Construction of road. Potential source of made ground nearby or on site. Potential contamination from emissions
Red Lion Brook + Cuttings	10m northeast	1881	Present	Potential receptor and pathway for contamination.
Pavilion	70m southwest	1973-76	Present	Too distant to be considered source of contamination to the site.
Old Marl Pits	80m west	1881	1894	Pits are noted as marsh/bog and occupied by ponds. Infill of pits by 1894. Considered too distant to be source of contamination or hazardous gas.
Ponds	90m west	1881	1933	1907 – Eastern (closest) pond infilled/removed. 1933 – Southern ponds (two) infilled/removed. Considered too distant to be source of contamination or hazardous gas.

NB. Arbitrary potential hazard assessment: High (Red), Moderate (Amber), Low (Yellow), Very Low (Green), Negligible (uncoloured)

A review of the historical OS maps has highlighted the land uses most likely to present (or have presented) a hazard or source of potentially harmful contamination to the study area. The primary feature of interest is the adjacent infilled ponds (marl pits) and the multiple development that has occurred on site (Commercial and Residential). Additionally, the presence and construction of the roads on and nearby to the site, may have led to contamination from the placement of made ground and emissions, the former also possibly being a source of hazardous gas.

3.3 GroundSure Enviro + Geo Insight Report

The GroundSure Enviro+Geo Insight Report presented in Appendix 2 provides listings of potentially contaminative current and past land uses together with possible pathway and receptor information. It also covers other potential risks to the site including ground hazards associated with the area's natural geological setting and man-made hazards such as those arising from development activities. A summary of the relevant EnviroInsight Report findings (environmental issues) is presented in Table 2 below and on the following pages with GeoInsight findings discussed in the following section (geotechnical issues).

Table 2: GroundSure EnviroInsight Summary: Potential Contaminative Uses/Pathways/Receptors

Details	Feature	Location relative to site
Past land use		
Historical industrial land uses	Cuttings (15)	4m northeast (Closest)
	Nursery (2)	214m north (Closest)
	Unspecified Pit (2)	407m northwest (Closest)
	Railway Station (8)	442m northwest (Closest)
	Unspecified Ground Workings	453m northwest
	Railway Building (5)	467m northwest
Historical Tanks	No (0) records within 500m	N/A
Historical Energy Features	Electricity Substation (7)	240m southeast
Historical garages	Garage	424m northwest
Landfill and Other Waste Sites		
Historical landfill (LA/mapping records)	No (0) records within 500m	N/A
Historical landfill (EA/NRW records)	No (0) records within 500m	N/A
Table 2 is continued on the following page		

NB Arbitrary potential hazard assessment: potentially significant (yellow), or unlikely to be significant (uncoloured). Potential receptors for contamination are highlighted blue.

Table 2 (ctd.): GroundSure EnviroInsight Summary: Potential Contaminative Uses/Pathways/Receptors

Details	Feature	Location relative to site
Landfill and Other Waste Sites (continued)		
Historical waste sites	No (0) records within 500m	N/A
Licensed waste sites	No (0) records within 500m	N/A
Waste exemptions	Using waste exemption Treating waste exemption	
Current Land uses		
Recent industrial land uses	Electricity Sub Station	On site
Current or recent petrol stations	Status – Open	450m northwest
Control of Major Accident Hazards (COMAH)	No (0) records within 500m	N/A
Licensed pollutant release (Part A(2)/B)	Unloading of Petrol into Storage at Service Stations	447m northwest
Licensed Discharges to controlled waters	Sewage discharges – sewer storm overflow – water company (2)	425m northwest (Closest)
Pollution Incidents (EA/NRW)	No (0) records within 500m	N/A
Hydrogeology - Superficial aquifer		
Superficial aquifer	Secondary A	On site
Bedrock aquifer	Principal	On site
Groundwater vulnerability	Soil / surface leaching class: High Superficial geology vulnerability: High Bedrock geology vulnerability: Low	
Groundwater abstractions	Active	1895m southwest
Surface Water Abstractions	No (0) records within 2000m	N/A
Potable abstractions	No (0) records within 2000m	N/A
Hydrology		
Water Network (OS MasterMap)	Water year round (3)	12m Northeast (closest)
WFD Surface water body catchments	River WB catchment	On Site
WFD Surface water bodies	River (1)	434m north
WFD Groundwater bodies	Manchester and East Cheshire Permo-Triassic Sandstone Aquifers	Onsite
River and coastal flooding		
Risk of Flooding from Rivers and Sea (RoFRaS)	No (0) records within 50m	N/A
Historical Flood Events	No (0) records within 250m	N/A
Flood Zone 2	No (0) records within 50m	N/A
Flood Zone 3	No (0) records within 50m	N/A
Surface water flooding		
Surface water flooding	Highest risk on site Highest risk within 50m	1 in 1000 year, 0.3m - 1.0m 1 in 30 year, 0.3m - 1.0m
Groundwater flooding		
Groundwater flooding	Highest risk on site Highest risk within 50m	Moderate – High High
Environmental designations		
Local Nature Reserves (LNR)	Chorlton Water Park	1828m North
Green Belt	Merseyside and Greater Manchester	1523m south

NB Arbitrary potential hazard assessment: potentially significant (yellow), or unlikely to be significant (uncoloured). Potential receptors for contamination are highlighted blue.

The EnviroInsight report, has shown a potential source of contamination from the electricity substation, otherwise no new potentially contaminative land uses or natural risks have been listed in the EnviroInsight section beyond those already discussed in the review of the historical map record. Other identified features are considered to be too distant or historical to pose significant risk to the study site. Potential geotechnical hazards are discussed in the review of the GeoInsight section of the Groundsure Report (see Section 3.4 below). The report also identified the (bedrock) aquifer beneath the site as a Principal Aquifer.

3.3.2 Groundsure GeoInsight Report

The GroundSure Enviro+Geo Insight Report (Appendix 2) provides additional detailed information on potential geological hazards. A summary of the relevant GeoInsight Report findings (geotechnical issues) is presented in Table 3 below and on the following page:

Table 3: Groundsure GeoInsight Summary: Potential Geological Hazards

Geology 1:10,000 scale		
Artificial and made ground (10k)	Infilled Ground (2) Made Ground (Undivided) (3) Worked Ground (Undivided)	77m northwest (Closest) 234m southwest (Closest) 385m southwest
Superficial geology (10k)	Glaciofluvial Sheet Deposits, Devensian – Sand and Gravel	On Site
Bedrock geology (10k)	Wilmslow Sandstone Formation - Sandstone	On Site
Bedrock faults and other linear features (10k)	Normal fault, inferred; crossmarks on downthrow side (2)	301m northeast (Closest)
Geology 1:50,000 scale		
Artificial and made ground (50k)	No (0) records within 500m	N/A
Superficial geology (50k)	Glaciofluvial Sheet Deposits, Devensian – Sand and Gravel	On Site
Superficial permeability (50k)	Very High to High	On Site
Bedrock geology (50k)	Wilmslow Sandstone Formation - Sandstone	On Site
Bedrock permeability (50k)	High	On Site
Bedrock faults and other linear features (50k)	Fault, inferred (2)	296m northeast (Closest)
Natural ground subsidence		
Shrink swell clays	Negligible	Onsite
Running sands	Very Low Low	Onsite 16m northeast
Compressible deposits	Negligible	Onsite
Collapsible deposits	Very low	Onsite
Landslides	Very Low	Onsite
Ground dissolution of soluble rocks	Negligible	Onsite
Mining, ground workings and natural cavities		
BritPits	No (0) records within 500m	N/A
Surface ground workings	Cuttings (2) Ponds (3)	4m northeast (Closest) 130m southwest (Closest)
Underground workings	No (0) records within 1000m	N/A
Non-coal mining	No (0) records within 1000m	N/A
JPB mining areas	In addition to being located inside an area where The Coal Authority have information on coal mining activities, Johnson Poole & Bloomer (JPB) have information such as mining plans and maps held within their archive of mining activities that have occurred within 1km of this property which may supplement this information. Further details and a quote for services can be obtained by emailing this report to enquiries.gs@jpb.co.uk. Onsite	
Coal mining	No (0) records on site	N/A
Radon Risk		
Radon Risk	Less than 1% of properties effected, no protection required	Onsite
Soil chemistry		
Mostly near normal levels recorded though slightly elevated arsenic might be expected.		

NB Arbitrary potential hazard assessment: potentially significant (yellow), or unlikely to be significant (uncoloured). Potential receptors for contamination are highlighted blue.

The GeoInsight section has highlighted no additional potential risks to the site or the intended development arising due to the geological setting beyond those already discussed. As the strata beneath the leisure centre is already known, the geotechnical hazards can be considered elevated within the shrink-swell clays and compressible deposits (weak made ground).

However, as no geotechnical design will be required for the GSHP installation, any geotechnical hazards will have a reduced risk. The JPB mining areas is not considered to be of risk to the site.

3.5 Previous Ground Investigation Conclusion

As stated in section 1, a previous ground investigation has been carried out by Coffey Geotechnics, prior to the construction of the leisure centre currently on site. This investigation found:

- Ground conditions encountered during the ground investigation comprised Made Ground over (sequentially): Glaciofluvial Sheet Deposits (GSD), Glacial Till and (weathered strata of the) Wilmslow Sandstone Formation.
- Ground water was recorded at depths of between 0.70m and 5.00m during the borehole exercise. During subsequent monitoring, groundwater levels were recorded at depths of between 1.92m and 2.83m BGL (28.36 – 28.87m AOD).
- Asbestos (Chrysotile) was positively identified in one sample of Made Ground. Near-surface soils in landscaped/soft-standing parts of the development need to be devoid of asbestos.
- The results of a screen against the GQRA criteria in soils indicated concentrations of all tested determinands in samples of Made Ground to be below their respective screening values. No values exceeding the GQRA were found in natural ground in the samples tested.
- Testing of leachate prepared from several Made Ground samples indicated marginal exceedances for chromium and lead with reference to UK drinking water standards.
- A Tier 1 risk assessment based on the results of the screen against GQRA criteria indicated that the risks to site users and groundwater are very low to low, based on the information available, Coffey considered that further risk assessment is not necessary for this development.
- Specific remediation to protect controlled waters is not indicated to be necessary.
- The ground gas monitoring the site is indicated to classify as CS 2, in accordance with BS8485:2007.

As the remediation strategy for the site has also been carried out, this is thought to have satisfied the conditions which would have presented from the asbestos identified near to the pedestrian entrance on the eastern side of the site. The validation report has not been provided collected for this study.

Additionally, the asbestos (Chrysotile), which was previously identified with the ground investigation, is believed to be sourced from the previous residential estate present on the site. This could also be present with other artificial deposits on the site.

3.6 Walkover Survey Observations

A site reconnaissance visit was undertaken on the 21st October 2021 by Anthony Montgomery of Geoinvestigate.

The site was as described in Section 1 of this report comprising an area of land some 0.93 ha in size with access from A5103 from the southeast and Framley Road to the north. Recent satellite imagery shows that the study area forms part of a larger site occupied by the leisure centre, car park and the soft landscaping/playing field to the north-western and southwestern parts of the site. The study site itself bounded by playing fields to the west and residential dwellings to the east. There are no clear site boundary features to the study area, save from the boundary with A5103 and the large trees/wooded area to the north of the site.

The walkover found the site to be relative flat, with the soft landscaping and the hardstanding to both be level with one another. There are no clear site boundary features, aside from the boundary with A5103 and the large trees/wooded area to the north of the site.

The existing pavilion to the south of the site, was surrounded by asphalt hardstanding.

The electricity substation (Photograph 4) which was identified in the Groundsure report was found to be in good condition and had no damage to the outer casing. Its apparent recent age would preclude the presence of PCBs as a contamination risk.

Access to the site is via Princess Road to the southeast corner of the site.

Large trees are present within the soft landscaping around the site, and some have been left in place within and around the northern perimeter of the site. Considering the clay soils, this could indicate a potential for vegetation influence on shrink-swell clays, and potentially soil heave following any removal that may take place. However, given the upper granular strata and the nature of the proposed development, there is currently considered to be of low risk attributable to this geotechnical hazard.

The inspection of the surface of the site found no obvious evidence of physical hazards or odours, staining, or residues that might be indicative of the presence of chemical (including hydrocarbon) contamination. On the basis of the walkover inspection only, the risk of a serious contamination hazard occurring at this site would be assessed to be very low given the current condition of the site and use. The hazardous gas risk at the site, based solely on the findings of the walkover survey, would also be assessed to be very low given it is unlikely any substantial gas source exists beneath the site. The limited evidence of minor groundworks does not indicate that significant made ground might be present.

It is noted however that despite the apparent lack of evidence of any contamination encountered during the visual inspection described above, any planning application is likely to require confirmation that no contamination is likely to be present. Photographs taken during the walkover survey are presented below and on the following page:

Photograph 1: Taken in the northern car park looking towards the northern part of the site.



Photograph 2: Looking to the southwest, from the northern corner of the site.



Photograph 3: Stood to the southern end of the leisure centre, with the hard standing path.



Photograph 4: Northern side of the site, showing the electricity substation present.



4. Qualitative Risk Assessment

4.1 Method

In order to assess the potential risks to the site, information obtained on the potential sources of hazard identified in Section 3 have been reviewed and applied to a model of the site. This allows an assessment of the potential sources of contamination to be made by examining the potential pollutant linkages between these and the receptors at the site. The risk assessment presented comprises a source-pathway-receptor model developed in the context of the intended end use of the site (Commercial use).

It is noted that an alternative land use would present different pollutant linkages with more or less vulnerable receptors and differing pathways for exposure. Were the intended land use to be changed at the site, a revised risk assessment would be required.

Identified potential sources of hazard or contamination, vulnerable receptors, and possible pathways by which they may be exposed are presented in the Conceptual Ground Hazard Model (CGHM) presented in Figure 1, see Section 4.2.

In addition to risks to human health and controlled waters and aquifers posed by contamination and ground gas, the CGHM examines the potential risks to the construction of the development including its buildings from geological or geotechnical hazards.

It allows an overall assessment to be made of the potential hazards and risks to the site and the proposed development with respect to “fitness for purpose”. Superficial and bedrock geology which is recorded to be beneath the site by the Groundsure report and confirmed by the previous groundworks, is shown to have very high to high and high permeability, respectively.

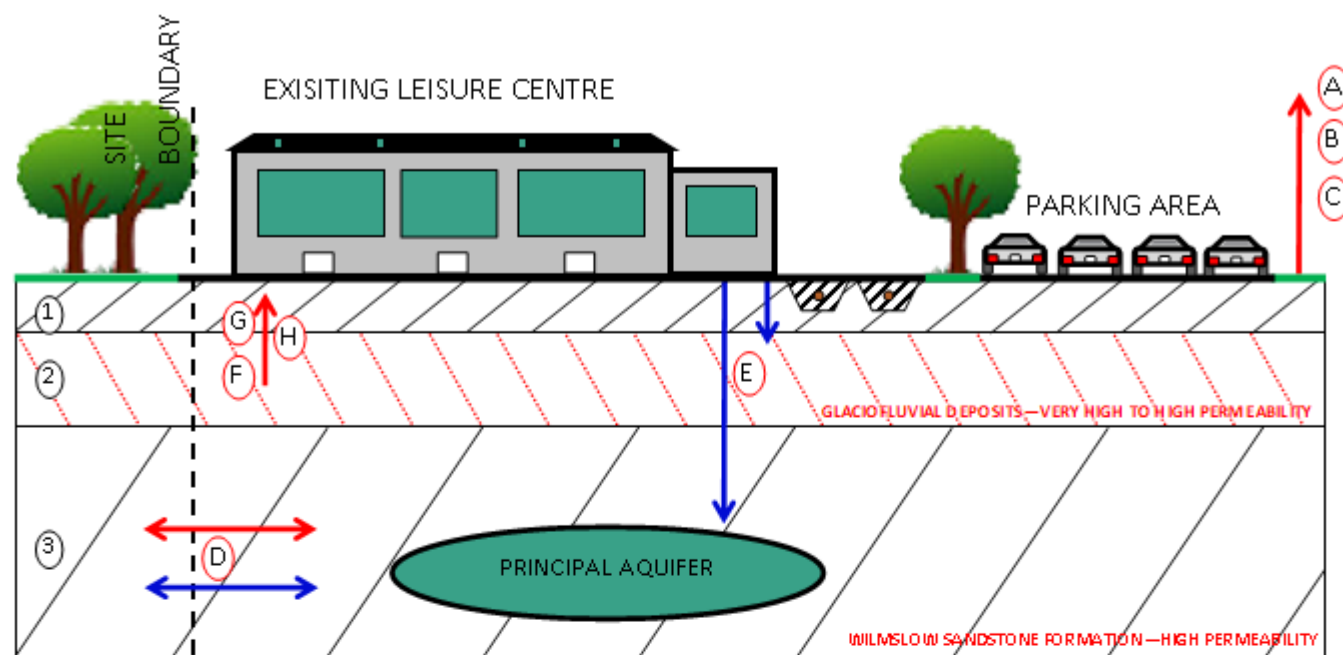
4.2 Risk Assessment

The desk study has highlighted the presence of possible sources of contamination potentially affecting the site, the initial primary features of interest were the adjacent infilled ponds (marl pits) and the multiple development that has occurred on site (Commercial and Residential). However, after reviewing the previous ground investigation and remediation to the site, it is considering that the hazardous gas and contamination conditions have already been evaluated and assessed to be of very low risk or hazards have been identified and mitigated. Following from the GroundSure report, the construction of the leisure centre and presence of the electricity substation post the remediation of the site, could have led to further contamination, although this should be unlikely given the relatively recent date of construction.

Contamination from there external sources would require a favourable pathway for migration into the site and the majority of external sources of contamination are likely to be too distant, minor or mitigated to pose any significant risk, however, considering the presence of the principal aquifer, contamination testing would be prudent. The BGS mapping and previous ground workings both suggest that the superficial deposits include sand and clay deposits which could exhibit reasonably high and then low permeability. As such, it is currently considered possible that a pathway for contamination migration into or out of the site could exist.

Potential receptors at the site would include the end users of the site (customers/employees), workers employed in the construction of the new development, the buildings themselves and their services, plants and vegetation, neighbouring sites (and their users/occupants), nearby surface water and ground water at depth. A representation of the potential hazards and pollutant linkages is shown in Figure 1 overleaf.

Figure 1 – Conceptual Ground Hazard Model of site including a Source, Pathway and Receptor Model



① SURFACE — TOPSOIL AND MADE GROUND. HARDSTANDING IN AREAS OF CAR PARK

② SUPERFICIAL GEOLOGY — GLACIOFLUVIAL DEPOSITS (SAND AND GRAVEL)

③ BEDROCK GEOLOGY — WILMSLOW SANDSTONE FORMATION (SANDSTONE)

IDENTIFIED HAZARDS Including Potential CONTAMINATION SOURCES

- Previous developments on site, comprising of the construction and removal of residential and commercial features on and near to the site.
- Construction and presence of electrical substation on site.
- Ground instability from geotechnical hazards.

IDENTIFIED RECEPTORS and ASSOCIATED PATHWAY

- A—** End Users through Direct Contact / Inhalation / Ingestion. Buildings and hard standing will encompass most of the site, removing any pathway to end users through direct contact in these areas.
- B—** Plants and Trees through uptake.
- C—** End Users through cultivation and consumption of vegetables / fruit. Impossible given the intended end use of the site
- D—** Neighbouring Sites through lateral migration (in soil and water, including surface water run off)
- E—** Ground water through leaching of sub-soil
- F—** Buildings and services through direct contact.
- G—** End users and buildings through ground gas migration.
- H—** Structures through vegetation induced shrinkage-swelling of clay soils, and heave risk following vegetation removal.

The CGHM and the summary table below (Table 4) present the most likely potential sources of contamination, gas or geotechnical risk that are considered to be possible either within or near to the study site.

The identified potential contamination sources could feasibly have given rise to harmful and potentially mobile contamination of made ground and/or natural deposits which might underlie the site. Superficial deposits may include higher permeability sand/ gravel deposits, underlain by lower permeability clay deposits and so it is currently considered possible that contamination migration into or out of the site could occur / have occurred. As the site is underlain by a principal aquifer, notwithstanding the forgoing, it is considered appropriate to carry out further contamination testing. These testing areas should be located away from the previous remediation.

As previously mentioned, the sources of contamination and hazardous gas that have been identified within this Phase 1, such as the infilled ponds, marl pits, construction, and presence of roads nearby to the site, due to the previous ground investigation that occurred on the site, it is considered that risks have been mitigated. Therefore, this phase 1 has only considered any risks post the 2013 assessment, such as the electricity substation.

Note that, due to the potentially contaminative historical land uses / features that have been identified within the study site boundary (Development of the leisure centre and electricity substation on site) the risk *to* external sites or ground/surface waters through contamination migration *from* the study site is currently expected to be more significant/likely than any risks posed *to* the study site from external sources.

Therefore, assuming the worst-case scenario, the potential for harmful contamination to exist at the site from historical sources is assessed to be low (as opposed to very low or negligible) owing to the potentially contaminative activities located near to and/or within the study area.

The hazardous gas risk is currently assessed to be low as it is unlikely that any significant potential hazardous gas source exists at or the site or within influencing distance. As the proposed site development will not include any enclosed spaces, the gas risk could be reassessed to very low, perhaps negligible.

The actual current level of risk to the development and its users can only be ascertained for certain through confirmation of the ground conditions by a Phase 2 intrusive investigation, involving a contamination survey, which will be carried out to assess if any contamination has occurred post the remediation and if there any other areas of contamination that were not recognised in the initial ground investigation.

Table 4: Summary of Conceptual Ground Hazard Model

Potential Source	Nature of Hazard	Associated Contaminants	Pathway	Receptor	Preliminary Risk Rating
Historical land use and development. Made ground. Electricity substation.	Inorganic and organic chemical contaminants within soil.	-Trace metals -PAHs -Petroleum hydrocarbons -Asbestos -Pesticides -Pathogens (microbiology)	-Direct human contact -Ingestion of soil -Ingestion of dust -Inhalation of vapour -Leaching into ground or surface waters -Overground migration to external sites (soil and water)	-Site Operatives -End Users -Vegetation -Controlled waters -Structures and services -Neighbouring sites/users	Low
Possible made ground	Hazardous ground gas migration.	Landfill-type gases (CO ₂ , CH ₄ etc.)	-Inhalation -Explosion risk	-Site Operatives -End Users -Structures	Very low
Local Geology	Radon gas migration	Radon gas	-Inhalation	-End Users	Negligible
Shrink-swell clays	Ground instability vegetation influence / heave	N/A	Direct	-End Users -Structures	Low
Infilled/made ground	Ground instability via risk of settlement	N/A	Direct	-End Users -Structures	Low

NB. Arbitrary potential hazard assessment: High (Red), Moderate (Amber), Low (Yellow), Very Low (Green), Negligible (uncoloured)

5. Conclusions

A summary of the anticipated ground conditions, risks and implications based on the findings of Sections 3 and 4 of this report is presented in Table 5 below:

Table 5: Summary of Phase 1 Desk Study Findings

Concern	Desk Study Finding	Initial Risk Assessment	Potentially Useful Action in a Phase 2 Site Investigation
Normal Foundations	Bedrock expected to be present at shallow depth with drift deposits of competent boulder clay anticipated, based upon the previous ground investigation.	Likely to be suitable	Currently not considered necessary for the proposed development
Soakaways	Sand and gravel soils likely to be present which might offer good permeability, underlain by Clay soils unlikely to offer low permeability.	Unlikely to be suitable	Currently not considered necessary for the development.
Radon Gas	Less than 1% of properties effected	Negligible	None. No radon protection required.
Chemical Contamination	Historical nearby and on-site land uses potentially giving rise to a range of inorganic and organic contaminants including asbestos, metals/metalloids, PAHs and petroleum hydrocarbons.	Low	Chemical analysis for potential contaminants in soil samples (and potentially leachate). Samples should be recovered from made ground (if found) and topsoil, and also potentially underlying natural sub soils to check for potential leaching and/or migration into the site from possible external sources.
Hazardous Gas	Possible chance for significant potential source of hazardous gas. Development will not involve any enclosed spaces/buildings.	Very low	Ground gas monitoring unlikely to be required unless significant (>1m deep) made ground deposits are encountered. Alternative means of assessment may be useful such as those described in CL:AIRE RB17. As the development will not include any enclosed spaces/buildings, hazardous gas risk is further assessed to be of negligible risk.
Ground Instability/ subsidence	Potential for vegetation influence on shrink-swell clays which may be present, including risk of soil heave.	Low	Currently not considered necessary for the development.
	Potential for significant deposits of compressible made/infilled ground.	Low	

NB. Arbitrary potential hazard assessment: High (Red), Moderate (Amber), Low (Yellow), Very Low (Green), Negligible (uncoloured)

The initial risk assessment provided above is tentative as it is based only on the Phase 1 desk study. The risks will need to be reassessed and may perhaps change significantly becoming higher or lower depending on the results of the Phase 2 intrusive investigation and contamination/gas survey, should these be undertaken.

6. Recommendations

In light of the Phase 1 desk study findings, it is recommended that a Phase 2 investigation be undertaken at the site to better explore the possible risks that have been identified. This should include contamination analyses of the site to establish any further or remaining contamination that may be on the site. As there are relative uncertainties, this work is recommended in order to establish the actual site conditions and to properly assess both geotechnical and environmental risks.

The Phase 2 investigation should be designed to focus on the potential contaminants highlighted in the CGHM (Figure 1 and Table 4). As there is a potential hazardous gas risk, a gas survey is recommended.

Table 6: Proposed Phase 2 Site Investigation Specification

Action	Quantities	Justification/Details
Hand excavated trial pits	Up to 6 (up to 1m in depth – if achievable)	Further inspect condition and composition of soils and recover additional samples for contamination analyses, including in locations which may be difficult for plant to access.
Chemical Contamination Analysis of Soils and Leachate (and possibly ground water if pertinent)	Up to 6 No. samples from topsoil and/or made ground at shallow depth (<1m) and potentially also deeper natural strata or made ground (if encountered).	Quantify risk posed to receptors identified in CGHM (see Figure 1) for revised risk assessment. Determinands should include a range of metals/metalloids, speciated PAH content, petroleum hydrocarbon content, BTEX, asbestos presence, and soil organic matter content (to aid in revised risk assessment).
Gas monitoring	Up to 6 No. visits over 3 months. Preferably including occasions of <1000mb and after sharp drop (may only be required in made ground encountered at site).	Quantify risk posed by potential hazardous gas from made/in-filled ground. Possible analysis of Total Organic Carbon (TOC) to support gas measure recommendations (or in the absence of gas monitoring data) using guidance published in CL:AIRE research bulletin RB17. If no evidence of shallow mining or significant (>1m deep) made ground deposits are encountered, then monitoring may not be necessary or may be cut short (i.e. if there is no feasible significant gas sources). <u>Considered unlikely to be necessary</u>
Provision of Factual and Interpretive Report	N/A	Presentation of findings and implications including: • Site plan • Trial pit logs • Results of geotechnical testing • Contamination analysis results • Results of water infiltration testing • Ground gas measurements (if appropriate) • Revised CGHM and chemical contamination risk assessment including appropriate soil assessment criteria. • Advice regarding any necessary remediation/validation • Advice regarding foundation design etc.

It should be noted that the scope, extent and cost of the Phase 2 work may increase if extensive ground contamination, or extensive amounts of made ground or drift deposits were found to exist at the site and/or the Local Authority or the Environment Agency require additional information.

END OF REPORT



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