

**PHASE I PRELIMINARY RISK
ASSESSMENT: RUABON BUSINESS
PARK, WREXHAM**

GSL2949

VERSION 2

25 AUGUST 2023

FINAL

Prepared for:

Wales & West Housing

Prepared by: R. Page

GroundSolve Ltd

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EXECUTIVE SUMMARY

Introduction	GroundSolve Ltd (GSL) were commissioned by Wales & West Housing to undertake a Phase I Report for an area of land referred to as Ruabon Business Park (the "Site").
Proposed land use	Current plans are to construct six industrial buildings with associated parking at the southern end of the site with the rest of the site being occupied by 43 residential properties along with associated parking and gardens with two areas of communal open space.
Site location and surrounding land uses	The site is located in Ruabon on Wynnstay Technology Park, Ruabon, Wrexham, LL14 6EN. To the north of the site is open arable land, to the east and south there is industrial buildings and to the west there are residential properties.
Site history	The site was an open field until approximately 1873 when a mine was constructed on site. This mine grew in size and became a site of infilling, likely of spoil from the larger colliery offsite to the south well until 1962 when the site was levelled. 1993 mapping shows the majority of the site is now within a cutting, likely due to remedial works undertaken to cap the mine shaft in 1991.
Geology, Hydrogeology and Hydrology	The superficial deposits present on site are expected to be Devensian Glacial Till with the solid geology being the Pennine Lower Coal Measures Formation And Pennine Middle Coal Measures Formation (Undifferentiated) - Mudstone, Siltstone And Sandstone. The superficial aquifer on site is classed as Secondary Undifferentiated of low vulnerability. The bedrock aquifer on site is classed as Secondary A of low vulnerability.
Ground Gases	There is a potential for ground gasses from backfill and made ground and possibly the mine shaft on site.
Radon Requirements	Basic protection measures are required as 5 to 10 % of properties are affected.
Potential contaminative features	Potential contamination features comprise substations, made ground, historic tramway, historic colliery and mine shaft.
Mining and quarrying	There is a history of mining and quarrying on site.
Previous investigations	GSL have previously conducted an investigation at the site in October 2020.

1 INTRODUCTION

GroundSolve Ltd (GSL) were commissioned by Wales & West Housing to undertake a Phase I Report for an area of land referred to as Ruabon Business Park (the "Site").

1.1 PROPOSED DEVELOPMENT

Current plans are to construct six light industrial units with associated parking adjacent to the southern boundary with the rest of the site being occupied by 43 residential properties along with associated parking and gardens with two areas of communal open space. Mature trees line the northeast and west boundaries including the boundary between the two proposed developments. The proposed development is shown in **Figure 1** below:



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Figure 1: Proposed development layout

Foundation loads are not known at this stage but based on experience are anticipated to be between 50 and 75kN/m run for two to three storey structures. Floor slab loading are anticipated to be low, probably not exceeding 5kN/m². In addition, development levels have not yet been set.

The recommendations in this report are based on these assumptions, consequently, they should be reviewed, and if necessary revised during the detailed design.

As such, in accordance with the '*Updated technical background to the CLEA model*' (Environment Agency, 2009) and '*Suitable 4 Use Levels*' (LQM / CIEH 2015) the proposed generic land use for this development is RESIDENTIAL WITH HOMEGROWN PRODUCE.

1.2 PREVIOUS REPORTS

GSL have previously conducted an investigation at the site in October 2020 and a CON29M Mining Report has been obtained from the Coal Authority. This should be read in conjunction with this report.

In addition, a log of the mine shaft that is present at the site has been made available by the British Geological Survey which details the lower strata.

1.3 OBJECTIVES

Taking into account the proposed development of the Site, the objectives of this appraisal were:

1. To determine the historical and current land use.
2. To establish the environmental setting of the Site.
3. To evaluate whether past mining or other extractive industries could have an influence on the Site.
4. To review previous pertinent third-party reports;
5. To determine likely ground and groundwater conditions.
6. To determine the potential risks to human health and the wider environment.
7. To determine potential risks posed to the Site from hazardous ground gases and / or vapours.
8. To derive a Preliminary Conceptual Site Model.

1.4 ASSUMPTIONS

The following assumptions are made in this report:

1. It is assumed that ground levels will not change significantly from those described in this report or as shown on proposed development drawings. If this is not the case, then amendments to the recommendations made in this report may be required.
2. Any references to observations of suspected asbestos-containing materials are for information only and should be verified by a suitably qualified asbestos specialist and/or confirmed by laboratory analysis.
3. The use of the term 'Topsoil' within this report is based on a visual identification only and that these materials have not necessarily been classified in accordance with BS3882:2015.
4. The comments and opinions presented in this report are based on the findings of the desk study performed by GroundSolve Ltd. There may be other conditions prevailing on the Site which have not been revealed by this investigation and which have not been taken into account by this report at this stage.
5. Responsibility cannot be accepted for any conditions not revealed by this investigation. Any diagram or opinion on the possible configuration of the findings is conjectural and given for guidance only. Confirmation of ground conditions should be undertaken if deemed necessary.
6. This report has been prepared for the sole use of the Client. No other third party may rely upon or reproduce the contents of this report without the written approval of GroundSolve Ltd. If any unauthorised third party comes into possession of this report, they rely on it entirely at their own risk.

2 SITE DETAILS AND DESCRIPTION

Table 2.1 - Current Site Overview

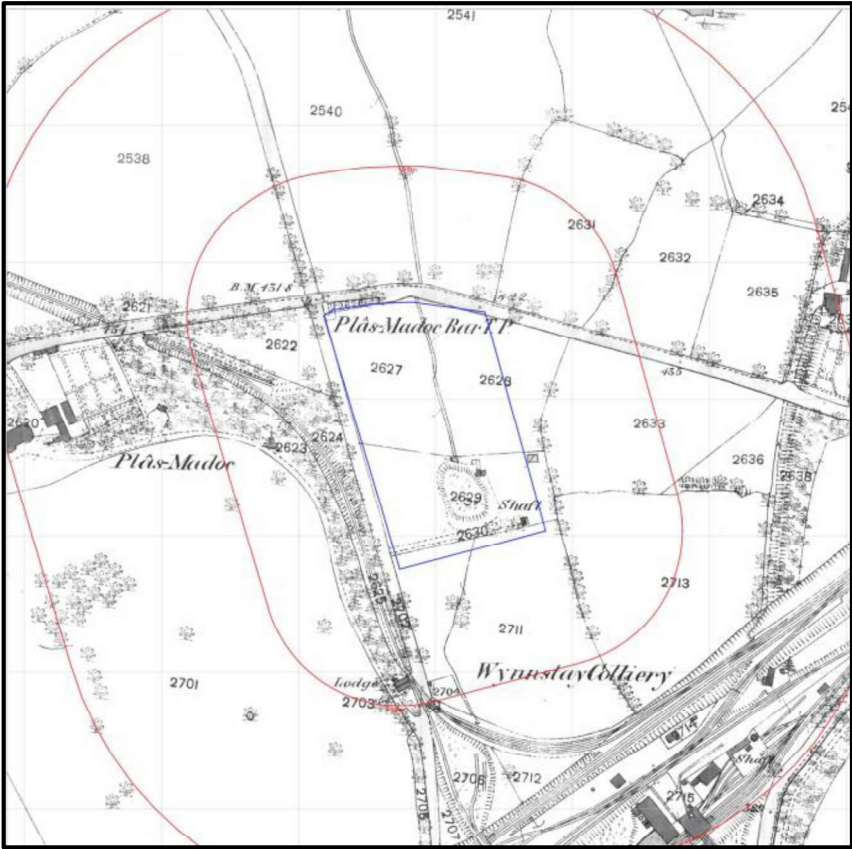
Site name	Wynnstay Technology Park
Site address	Wynnstay Technology Park, Ruabon, Wrexham, LL14 6EN.
National Grid Reference (NGR)	SJ 29204 43578
Approximate Site area	2 Hectares
	 Figure 2 - Site Extents
Site shape	Roughly rectangular
Current land use on the Site	Open wasteland
Surrounding land uses	Open agricultural fields to the north and industrial buildings to the east and south with residential housing to the west.
General topography and ground levels	The site is relatively flat sloping from 131m in the north of the site to 127m in the south

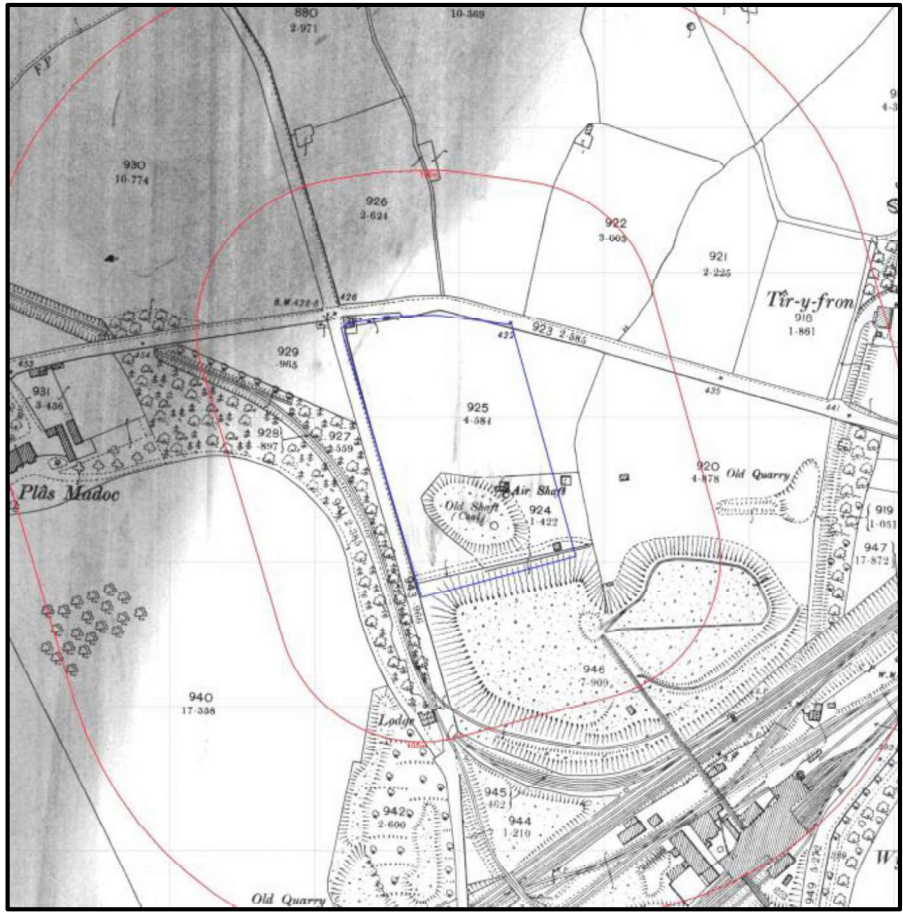
Relevant site photographs are presented in **Appendix A**.

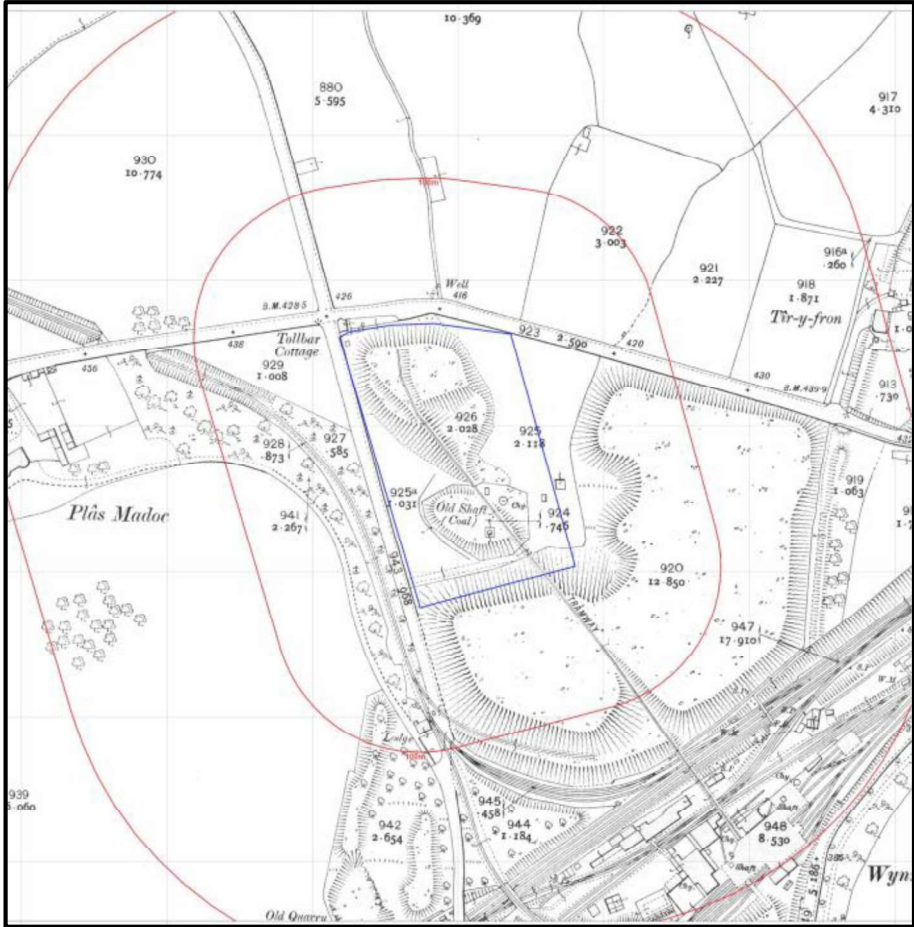
3 SITE HISTORY

Extracts of Ordnance Survey (OS) plans dated from 1873 were reviewed. These were obtained as part of the Groundsure Report for the Site, which is presented in **Appendix B**. **Error! Reference source not found.** below presents a summary of the main aspects of the Site relevant to the current and proposed future end uses. It is not the intention of this report to describe in detail all of the changes that have occurred on or adjacent to the Site, where these are not relevant to the land use.

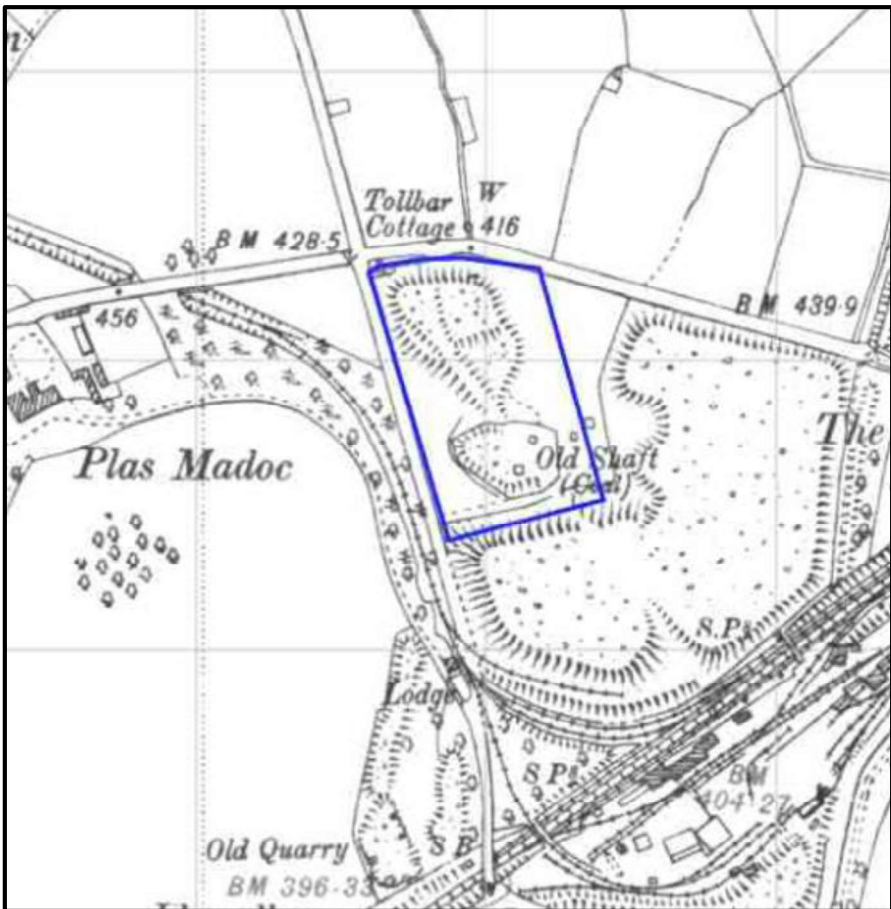
Table 2.1 - Site History

Time Period	On-Site features	Off-Site features
Pre-1873	 Figure 3: 1873 OS Map (Scale 1:2,500) • Shaft located in the southern half of the site, surrounded by a raised area of likely spoil. • Small stream running from the north of the site to the shaft.	• Rail line is located to the south of the site trending northeast to southwest with a branch to the north west which runs adjacent to the western boundary. • Agricultural land is immediately east and south with further agricultural land to the north and 50m west.

Time Period	On-Site features	Off-Site features
		- Wynnstay Colliery is located to the south approx 150m with a shaft located at the northeast part of the colliery. - Plas Madoc farm is located approx 120m west. - A road is located immediately west and north of the site.
1873 - 1899	 Figure 4: 1899 OS Map (Scale 1:2,500)	
	- Stream has been removed or diverted off site - The extents of the pit have grown and the shaft is now labelled as old shaft with an air shaft just to the north east.	- Wynnstay Colliery has expanded to beyond the railway line occupying the land immediately south of the site. - An old quarry is now located 100m east.

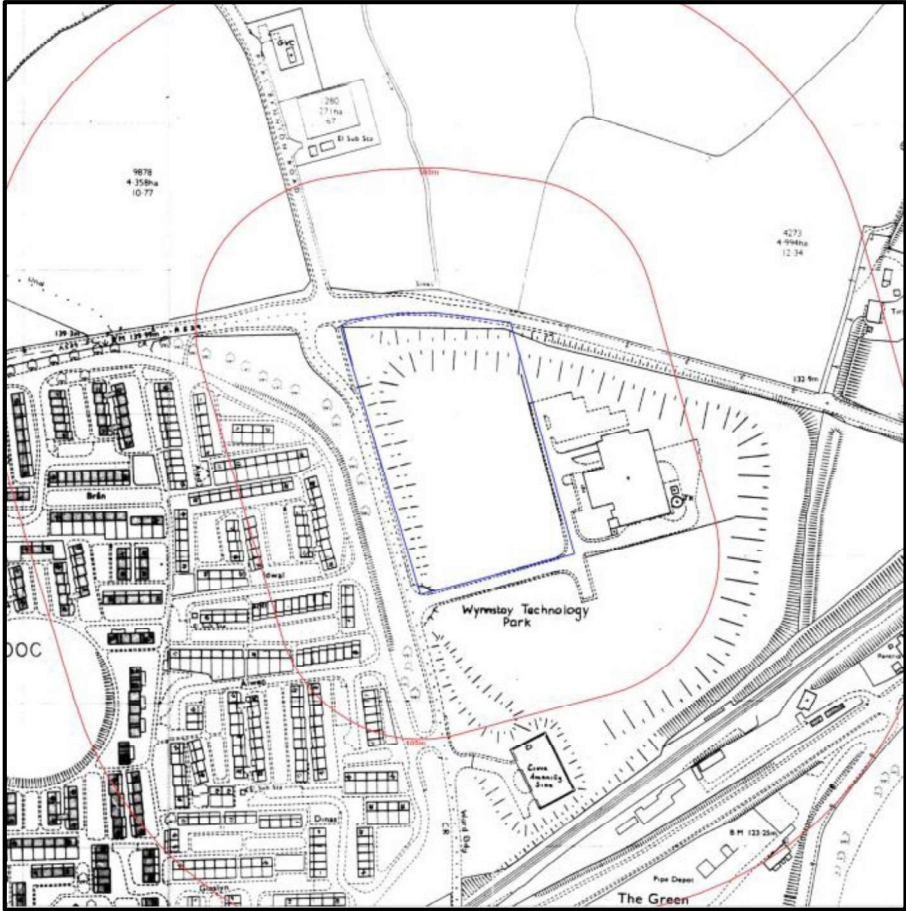
Time Period	On-Site features	Off-Site features
1899 - 1912	 Figure 5: 1912 OS Map (Scale 1:2,500)	
	- Colliery spoil on site has expanded - The air shaft is no longer shown (likely marked as chimney on the map). - Tramway present running NW to SE from Wynnstay Colliery.	- Wynnstay Colliery has expanded east of the site with the old quarry no longer shown. - A second shaft is now shown at the colliery.

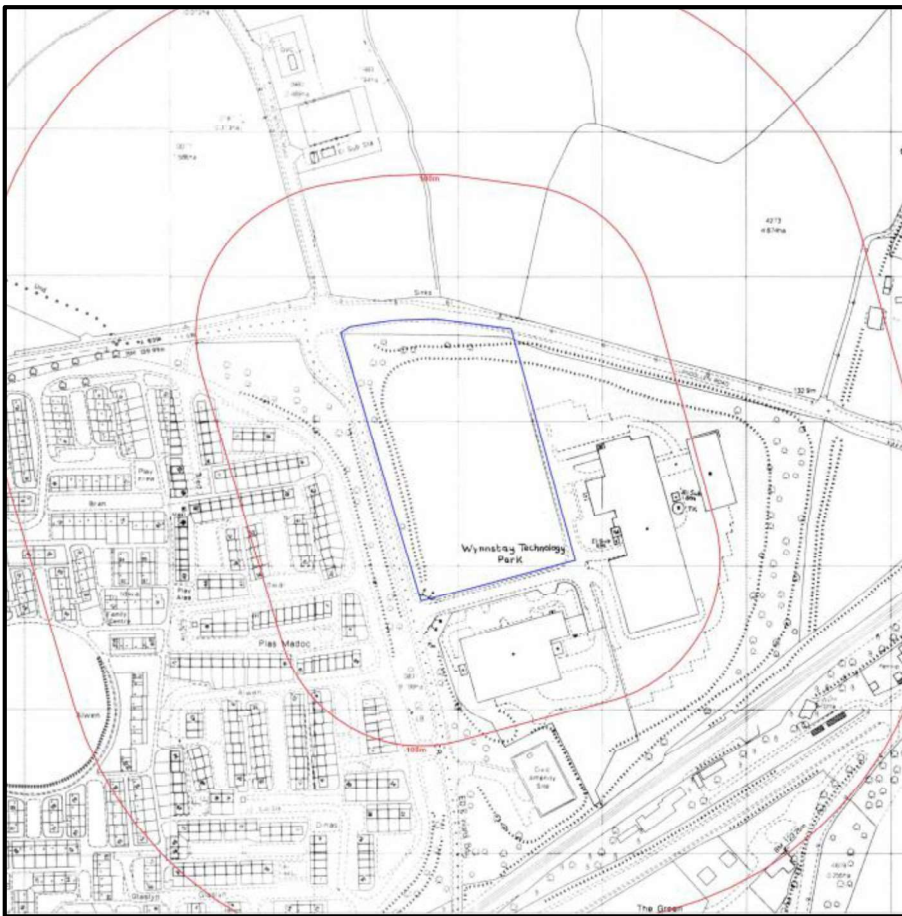
Time Period	On-Site features	Off-Site features
1912 - 1938	 Figure 6: 1938 OS Map (Scale 1:10,560)	
	No significant changes.	There is now an old quarry to the west of the colliery.

Time Period	On-Site features	Off-Site features
1938 - 1949	 Figure 7: 1949 OS Map (Scale 1:10,560)	
	The tramway is no longer shown.	No significant changes.

Time Period	On-Site features	Off-Site features
1949 – 1962	 Figure 8: 1962 OS Map (Scale 1:2,500)	
	• Shaft is now dissused. • Colliery is now disused and has been forested. • Electrical transmission pylon present on the northern boundary of the site.	• Wynnstay colliery is now disused and has been reforested. • Rail line to the west has now been removed. • Electricity sub station has been erected to the north of the site.

Time Period	On-Site features	Off-Site features
1962 – 1972	 Figure 9: 1972 OS Map (Scale 1:2,500)	
	• Site has now been leveled. • Pylon no longer present.	• Wynnstay Colliery has now been leveled and is now annotated Pipe Depot. • Rail lines to the south have decreased in number. • Significant residential housing has been erected to the west replacing Plas Madoc farm.

Time Period	On-Site features	Off-Site features
1972 – 1989	 Figure 10:1989 OS MAP (Scale 1:2,500)	
	Site has been raised at the northern and western sides.	- An industrial building has been erected immediately east of the site with road access along the southern boundary. - An amenity site has been constructed to the south of the site - The whole site has been lowered

Time Period	On-Site features	Off-Site features
1989 – 1994	 Figure 11: 1994 OS MAP (Scale 1:2,500)	
	No changes.	A new industrial building has been constructed to the south of the site, with the building to the east expanding further south.

Time Period	On-Site features	Off-Site features
1994 – 2003	 Figure 12: 2003 OS MAP (Scale 1:1,250)	
	No significant changes.	No significant changes.

Time Period	On-Site features	Off-Site features
2003 - 2023	 Figure 13: 2023 OS MAP (Scale 1:10,000)	
	No significant changes.	No significant changes.

4 ENVIRONMENTAL SETTING

4.1 GEOLOGY

Table 3 - Geological Summary

Maps and publications referenced	Paper 1:50,000 scale, England and Wales, Sheet 121, Wrexham, Series 5, Solid and Drift Edition 1994.
Made ground / artificial ground	No made ground recorded.
Drift geology	Devensian Glacial Till.
Solid geology	Pennine Lower Coal Measures Formation And Pennine Middle Coal Measures Formation (Undifferentiated) - Mudstone, Siltstone And Sandstone.
Faults	One minor fault running northeast to southwest through the site.
Coal seams	The site is located in an area of shallow coal although no seams are shown to outcrop on the site.

4.2 MINING AND QUARRYING

Table 4 - Coal Mining Activities

	Yes/No	Comments
Is the Site in an area of potential shallow coal workings?	No	Workings are present at depth (over 80.00mbgl)
Is the Site in a high risk development area?	Yes	With regards to one shaft onsite which is marked by the Coal Authority as treated.
Are there any known shafts, adits, tips, lagoons, or opencast workings likely to affect the Site?	Yes	Wynnstay Colliery, No 3 Shaft located at the south of the site (ref: 329343-194). Shaft is treated.
Is exploratory work required to investigate the potential risk from shallow mining or quarrying?	No	Risk to site only from the shaft which has been treated.

Table 5 - Other Extractive Industries

	Yes/No	Comments
Superficial drift deposits		
Evidence of extraction on or within 250 m of the Site?	Yes	Surface ground workings present.
Action required?	No	
Solid Strata		
Any evidence of mineral extraction on or within 250 m of the Site?	Yes	Disused mines and shafts present. Treated shaft onsite.
Action required?	Yes	Exploratory investigation to confirm the location of the shaft.

4.3 HYDROGEOLOGY

Table 6 - Groundwater Occurrence and Abstraction

	Presence/location	Comments
Environment Agency aquifer designation – Superficial Deposits	On Site	Secondary Undifferentiated of low groundwater vulnerability.
Environment Agency aquifer designation – Bedrock	On Site	Secondary A of low groundwater vulnerability.
Anticipated groundwater depth(s)	On Site	Presence of perched water.
Direction of flow	On / Off Site	Unknown.
Current licensed abstractions – potable	On / Off Site	None within 500m of the site.
Source Protection Zones	On / Off Site	None within 500m of the site.
Springs	On / Off Site	None within 500m of the site.

For definition of Source Protection Zones, see **Appendix D**.

4.4 HYDROLOGY

Table 7 - Surface Water Features

	Presence/location	Comments
Nearest surface water feature	On site	Small stream running north - south
Other surface water features	Off Site	23m north– Inland river not influenced by normal tidal action.
Canals, ponds, lakes, etc.	On / Off Site	None within 500m of the site.
Water Framework Directive (WFD) Surface Water Bodies	On / Off Site	None within 500m of the site.
Licensed surface water abstractions	On / Off Site	None within 500m of the site.

4.5 ENVIRONMENTAL DESIGNATIONS

Table 8 - Summary of Environmental Designations

	Presence/location	Comments
Sites of Special Scientific Interest (SSSI)	On / Off Site	None within 500m of the site.
Conserved wetland sites (Ramsar sites)	On / Off Site	None within 500m of the site.
Special Areas of Conservation (SAC)	On / Off Site	None within 500m of the site.
Special Protection Areas (SPA)	On / Off Site	None within 500m of the site.
National Nature Reserves (NNR)	On / Off Site	None within 500m of the site.
Local Nature Reserves (LNR)	On / Off Site	None within 500m of the site.
Designated Ancient Woodland	Within 500m	248m southeast Ancient Semi Natural Woodland 270m south Ancient Semi Natural Woodland 305m east Ancient Semi Natural Woodland 356m south Ancient Semi Natural Woodland 432m south Ancient Semi Natural Woodland 456m east Ancient Semi Natural Woodland
Biosphere Reserves	On / Off Site	None within 500m of the site.
Forest Parks	On / Off Site	None within 500m of the site.
Marine Conservation Zones	On / Off Site	None within 500m of the site.
Green Belt	On / Off Site	None within 500m of the site.

	Presence/location	Comments
Proposed Ramsar sites	On / Off Site	None within 500m of the site.
Possible Special Areas of Conservation (pSAC)	On / Off Site	None within 500m of the site.
Potential Special Protection Areas (pSPA)	On / Off Site	None within 500m of the site.
Nitrate Sensitive Areas	On / Off Site	None within 500m of the site.
Nitrate Vulnerable Zones	On / Off Site	None within 500m of the site.
SSSI Units	On / Off Site	None within 500m of the site.

4.6 LANDFILL AND WASTE MANAGEMENT ACTIVITY

Table 9 - Waste Management Activities

	Presence/location	Comments
Active or recent landfill	On / Off Site	None within 500m of the site.
Historical landfill (BGS records)	On / Off Site	None within 500m of the site.
Historical landfill (LA/mapping records)	On / Off Site	None within 500m of the site.
Historical landfill (EA/NRW records)	On / Off Site	None within 500m of the site.
Historical waste sites	Off Site	116m S - Tyre Recycling Plant
Licensed waste sites	Off Site	117m S - Household Waste Amenity Site 122m S - Household Waste Amenity Site 198m S - Household Waste Amenity Site
Waste exemptions	On / Off Site	None within 500m of the site.
Evidence of other landfilling or potential infilling on or within 250m of Site	Yes	Historic shallow mine and surface workings which have since been backfilled
Walkover evidence of fly-tipping on Site?	On Site	Yes
Is a landfill/ground gas risk assessment required?	On Site	Yes

4.7 LOCAL INDUSTRIAL LAND USES

Other potentially contaminative activities are shown in **Error! Reference source not found.** below with those features considered pertinent to the conceptual site model highlighted in **bold**. The entries relate to activities within *circa* 250 m of the Site, with the exception of COMAH facilities where the assessment is extended to a distance of *circa* 500m from the Site.

Table 10 - Other Potentially Contaminative Processes in the Locality

	Location	Comments
Recent industrial land uses	On Site	Technology Park – Business Park & Industrial Estate
	Off Site	2m northeast – Telecomms mast and electrical features 60m south – Wrexham Mineral Cables 77m – 182m – 5 No. Sub Stations 84m northwest – Power Station 144m south – Civic Amenity 202m northwest - Gas Valve Compound 242m southeast Clwyd Caravans and Leisure Ltd
Current or recent petrol stations	On / Off Site	None within 500m of the site.
Electricity cables	On / Off Site	None within 500m of the site.
Gas pipelines	On / Off Site	None within 500m of the site.
Sites determined as Contaminated Land	On / Off Site	None within 500m of the site.
Control of Major Accident Hazards (COMAH)	On / Off Site	None within 500m of the site.
Regulated explosive sites	On / Off Site	None within 500m of the site.
Hazardous substance storage/usage	On / Off Site	None within 500m of the site.
Historical licensed industrial activities (IPC)	On / Off Site	None within 500m of the site.
Licensed industrial activities (Part A(1))	On / Off Site	None within 500m of the site.
Licensed pollutant release (Part A(2)/B)	Off Site	53m east - Rolinx Performance Coatings - Coating Processes
Radioactive Substance Authorisations	On / Off Site	None within 500m of the site.

	Location	Comments
Licensed Discharges to controlled waters	Off Site	145m S – Ruabon Manned Container Site Wynnstay 234m N - Grange Plas Bennion Road
Pollutant release to surface waters (Red List)	On / Off Site	None within 500m of the site.
Pollutant release to public sewer	On / Off Site	None within 500m of the site.
List 1 Dangerous Substances	On / Off Site	None within 500m of the site.
List 2 Dangerous Substances	On / Off Site	None within 500m of the site.
Pollution Incidents (EA/NRW)	Off Site	286m southeast – Water, Category 3 (Minor). 342m south – Water, Category 3 (Minor), Land Category 4 (No Impact). 353m south – Water, Category 3 (Minor), Land Category 4 (No Impact). 406m southwest – Water & Land, Category 4 (No Impact). 476m southeast – Water & Air, Category 3 (Minor).
Pollution inventory substances	On / Off Site	None within 500m of the site.
Pollution inventory waste transfers	On / Off Site	None within 500m of the site.
Pollution inventory radioactive waste	On / Off Site	None within 500m of the site.

COMAH – Control of Major Accident Hazards (regulations); NIHHS – Notification of Installations Handling Hazardous Substances (regulations)

4.8 RADON RISK

Table 11 - Radon Risk Status

	Comments
Estimated properties affected	Between 5% and 10%.
Radon Protection Measures required?	Basic Protection Measures Required.

4.9 WASTE CLASSIFICATION AND MATERIALS RE-USE

If the Site is to be redeveloped and materials are disposed of off Site, the material exported from the Site to Landfill should be hauled by a register waste carrier in accordance with Duty of Care Regulations 1991 and the Hazardous Waste Regulations 2005.

Based on the history of the Site and the anticipated potential contaminants of concern, it is considered unlikely that hazardous waste soil materials may be present beneath the majority of the Site; however, this will be subject to confirmatory investigation, sampling, laboratory analysis and waste classification in accordance with the Guidance on the Classification and Assessment of Waste (WM3).

It will be necessary to register the Site in advance of the intended reclamation works with the Environment Agency before disposal to landfill can take place. There will be requirement for the waste producer to provide appropriate Waste Acceptance Criteria (WAC) testing of the Soils for disposal to ensure that the soils are appropriately classified and that the landfill is licensed to receive such soils. A consignment note shall be completed, signed and retained by all parties involved. The consignment note shall state the volume of waste, a physical description of the material and statement of its chemical composition. The waste consignment notes shall be kept by the contractor for a period of at least two years.

Subject to volumetric fill requirements and a future assessment of suitability of re-use (both chemically and geotechnically), some materials *may* be considered for potential re-use in line with an appropriate end-of-waste protocol such as WRAP Quality Protocol for Aggregates from Inert Waste, U1 Exemption or a Materials Management Plan in accordance with the CL:AIRE Definition of Waste Code of Practice (DoWCoP).

5 PRELIMINARY GEOTECHNICAL ASSESSMENT

5.1 ANTICIPATED GROUND CONDITIONS

There is the potential for made ground present on the site due to the history of the site. The BGS mapping for the site has indicated that there Glacial Till overlying the Pennine Lower Coal Measures Formation and Pennine Middle Coal Measures Formation.

5.2 SITE LEVELS, EARTHWORKS AND SITE PREPARATION

The relatively level nature of the site would suggest that significant cut/fill operations are not anticipated. Shallow excavations within the superficial deposits, should be feasible with conventional earthmoving equipment. Excavations will need shoring for safety reasons.

The site will require a large amount of vegetation clearance.

In the absence of direct site-specific evidence of water table levels, it would be prudent to assume at this stage the majority of water ingress will be from surface water and should be manageable via conventional pumping from sumps.

5.3 PRELIMINARY FOUNDATION SOLUTION

Due to the presence of made ground to approximately 2.00m it is anticipated that deep foundations are likely to be required for the proposed development.

5.4 ROADS AND HARDSTANDING

It is anticipated that the surface materials will require removal and replaced with engineered materials.

5.5 DRAINAGE

A new drainage system will have to be put in place to take waste off site.

5.6 PROTECTION OF BURIED CONCRETE

There is the possibility for low pH and high sulphate concentrations which could be detrimental to below ground concrete.

6 PREVIOUS INVESTIGATION FINDINGS

6.1 BRITISH GEOLOGICAL SURVEY

The log of the mine shaft that is present on site (No. 2 Pit) has been made available by the British Geological Society, which can be found in **Appendix C**, shows that the mine shaft reached a depth of 372.84 yards (340.90m). The log states that soil and made ground was present down to 2.99 yards (2.73m) which overlies made ground which reaches depths of 14.16 yards (12.94m). Below the made ground was a band of sand and gravel and a blue clay which reached depths of 14.76 yards (13.50m) and 15.67 yards (14.33m) respectively. Recorded below the blue clay is rock and metal (shale) which reaches depths of 22.75 yards (20.80m). Multiple coal seams are recorded on the logs but the first one is not encountered until 52.60 yards (48.10m) bgl.

6.2 COAL MINING REPORT

A coal mining report was conducted by The Coal Authority in November 2018 the findings of which can be found summarised below or in **Appendix C**.

The proposed development is in a surface area that could be affected by underground mining in 6 seams of coal at 140m to 320m depth, and last worked in 1927 however any movement in the ground due to coal mining activity associated with these workings should have stopped by now.

6.3 GROUND SOLVE LTD

An investigation and Phase II report was undertaken by GroundSolve (Ref: 2387) completed in October 2020 for Gratton Oaks Ltd for the site at Ruabon business park.

The site investigation undertaken on the 8th and 9th September 2020 comprised the following, the results of which can be found in **Appendix C**:

- Ten machine excavated trial pits to a maximum depth of 3.00m,
- Ten window sample boreholes to a maximum depth of 5.45m, with SPT's carried out at 1.00m intervals,
- Eighteen CBR tests using a TRL probe up to depths of 0.96m.
- Physical Testing
- Chemical Testing

Table 12 below summarises the strata encountered in the excavations during the site work.

Table 12 – Summary of Strata Encountered During Previous Investigation

BH/TP No.	Stratigraphy		
	Made Ground (m)	Glacial Till (m)	Granular Glacial Deposits (m)
WS1	0.00 – 2.00	2.00 – 5.42	-
WS2	0.00 – 2.50	2.50 – 5.45	-
WS3	0.00 – 1.50	1.50 – 5.45	-
WS4	0.00 – 1.50	1.50 – 4.37	-
WS5	0.00 – 1.00	1.00 – 5.20	-
WS6	0.00 – 1.90	1.90 – 3.00	3.00 – 4.41
WS7	0.00 - 1.50	1.50 – 5.36	-
WS8	0.00 – 2.00	2.00 – 5.45	-
WS9	0.00 – 2.18	-	-
WS10	0.00 – 1.70	1.70 – 3.72	-
TP1	0.00 – 1.30	1.30 – 3.00	-
TP2	0.00 – 1.80	1.80 – 2.10	2.10 – 2.50
TP3	0.00 – 1.80	1.80 – 2.50	2.50 – 3.00
TP4	0.00 – 1.70	1.70 – 2.40	2.40 – 3.00
TP5	0.00 – 1.60	1.60 – 2.30	2.30 – 3.00
TP6	0.00 – 1.30	1.30 – 1.80	1.80 -2.50
TP7	0.00 – 1.90	1.90 – 2.50	2.50 – 3.00
TP8	0.00 – 1.80	1.80 – 2.30	2.30 – 3.00
TP9	0.00 – 2.60	-	2.60 – 3.00
TP10	0.00 – 2.10	-	-

Particle size density testing was undertaken on a sample from each trial pit and compaction testing was undertaken on three samples from TP3, TP6 and TP9 the results of which are summarised below.

Table 13 - Summary of Previous Investigation PSD Testing

TP No	Silt/clay %	Sand %	Gravel %	Cobbles %	Uniformity co-efficient
TP 01	7	30	63	0	44.71
TP 02	4	14	78	4	29.77
TP 03	11	31	58	0	NA
TP 04	11	26	56	7	NA
TP 05	9	27	64	0	61.07
TP 06	9	24	67	0	102
TP 07	7	41	52	0	38
TP 08	15	31	52	0	NA
TP 09	7	21	72	0	59.8
TP 10	5	20	75	0	36.7

Table 14 - Summary of Previous Investigation Compaction Testing

TP No	Depth (m)	OMC %	MDD Mg/m ³	NMC %	Difference ±
TP 03	1.00	9.0	2.02	17.9	+8.9
TP 06	1.00	13.5	1.89	14.1	+0.6
TP 09	0.50	15.5	1.76	18.5	+3.0

A full suite of chemical testing was undertaken across nine samples and the results were compared to suitable generic assessment criteria (GACs), in order to allow a generic quantitative risk assessment (GQRA) to be carried out for the site and the proposed development.

All values were below the adopted GAC values for an end use of residential with gardens except one sample from TP2 at 0.50m bgl which contained a level of arsenic above the adopted guidance. Across all samples no asbestos was recorded.

7 PRELIMINARY CONCEPTUAL SITE MODEL

7.1 INTRODUCTION

Based on the information provided in the previous sections of this report a combined preliminary conceptual site model and conceptual exposure model has been developed for the proposed future land use. This summarises the understanding of surface and sub-surface features, the potential contaminant sources, transport pathways and receptors. In assessing the likely contaminants of concern present at the Site, reference has also been made to Defra and Environment Agency supporting documentation. A preliminary qualitative risk assessment has also been made of the likelihood of the linkage operating and its potential significance in accordance with CIRIA C552.

The preliminary conceptual model is presented in schematic form in **section 7.9**. The potential pollutant linkages identified and the qualitative risk assessment for these are presented in Conceptual Site Model.

The terms used in the preliminary qualitative risk assessment are defined in **Appendix D**.

The following sections discuss all the identified potential on and off-site sources, pathways, and receptors in the context of the proposed development and plausible pollutant linkages which may represent a risk to identified receptors such as human health and/or controlled waters from the data gained from the desk study. At this stage, the assessment is qualitative and aimed to determine all pollutant linkages, irrespective of significance or allowing for uncertainty.

Three impact potentials exist for any given site, these are:

- The site impacting upon itself;
- The site impacting on its surroundings; and
- The surroundings impacting on the site.

All three impacts need to be considered in a risk assessment.

- Sources; these are potential or known sources of contamination that may relate to a former land use or present site feature or process (e.g., Made Ground, infilled ground etc).
- Pathways; a pathway is defined as a mechanism or route by which a contaminant encounters, or otherwise affects a receptor. Pathways by which the identified receptors may be impacted upon in the context of the proposed development.
- Receptors; receptors are defined as people, living organisms, ecological systems, controlled waters, atmosphere, structures, and utilities that could be adversely affected by contaminant(s).

7.2 CONCEPTUAL SITE MODEL

Based on the data available the following Conceptual Site Model has been developed. The various components of the potential “source–pathway–receptor” pollutant linkages identified at the site.

7.3 HAZARDS IDENTIFIED WITH THE PROPOSED DEVELOPMENT

The hazard identification is based on the assumptions presented below:

- the site will be a residential and commercial development;
- the previous land use both on and off site could be a source of contamination due to possible infilled ground;
- drinking water will be from mains supply.

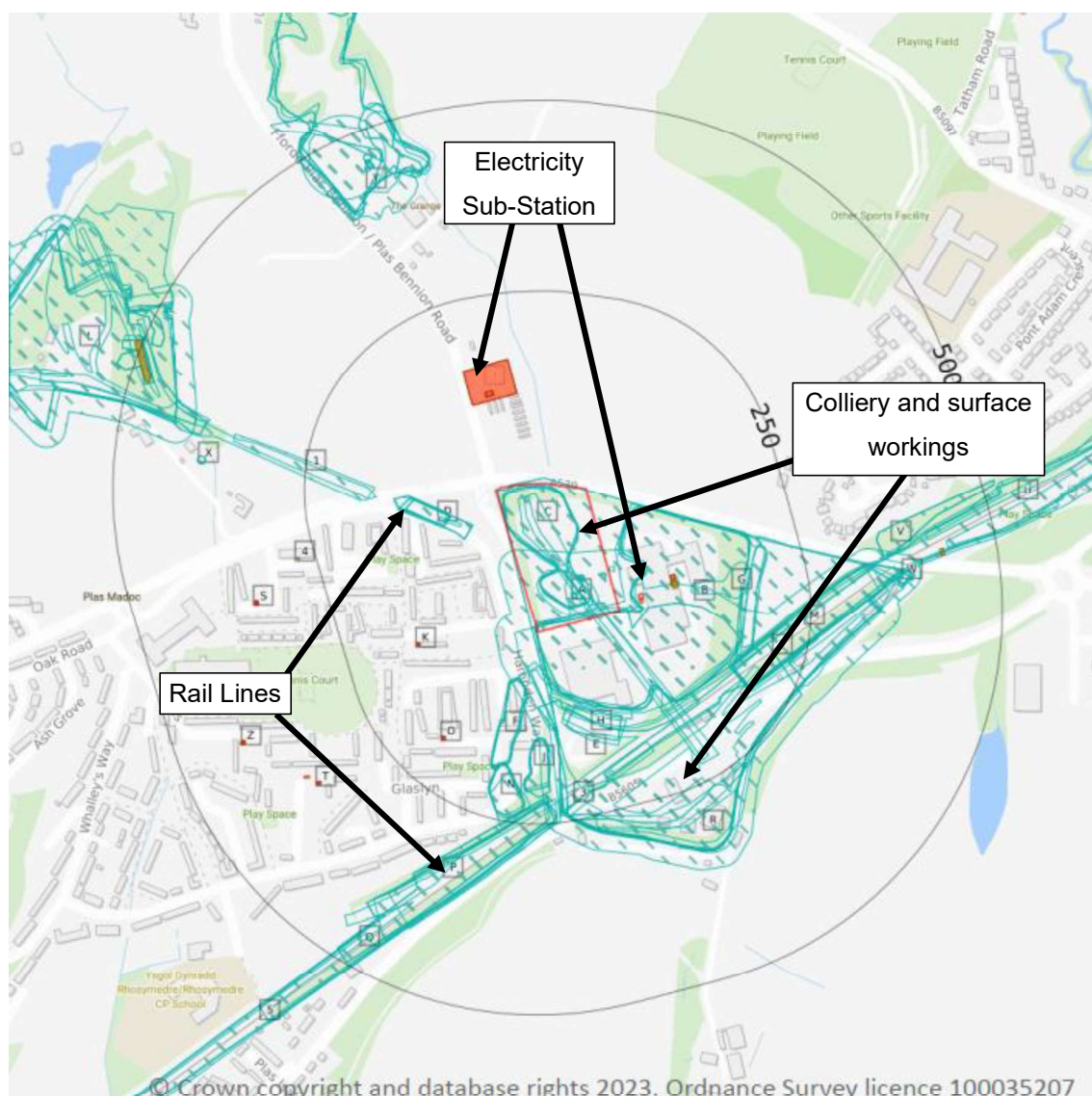


Figure 14: Extract from Groundsure Report - Past Land Uses

7.4 POTENTIAL SOURCES OF CONTAMINATION

For the purpose of this assessment the potential contaminants of concern have been considered according to whether they are likely to have originated from on-site or off-site sources.

Potential On-site Sources of Contamination

- Former railway and railway siding present on site. There is the potential for asbestos, toxic metal, PAH and hydrocarbon contamination;
- Raised and infilled ground onsite which is likely to consist of colliery spoil and may contain material such as ash and clinker. There is a potential for asbestos, heavy metals and PAHs.
- Shallow and deep coal workings. Ground gas source.

Potential Off-site Sources of Contamination

- Former railway and railway siding present off site. There is the potential for asbestos, toxic metal, PAH and hydrocarbon contamination;
- Substations around the site. Possible hydrocarbon contamination. PCB contamination is not considered a risk. PCBs were phased out by 1986 and the substations were constructed approximately late 1988 onwards;
- Shallow and deep coal workings. Ground gas source.
- The site is located on an industrial estate with industrial buildings to the east and south.

7.5 POTENTIAL RECEPTORS OF CONTAMINATION

Based on the data previously discussed, the following potential receptors to contamination have been identified:

Table 15 - Identified Potential Receptors

Sensitive Receptors	
A	Humans – Predevelopment completion, i.e. working on site during demolition and construction.
B	Humans living on the site post construction.
C	Controlled waters – Surface Waters (rivers and streams)
D	Groundwater in the secondary A aquifer.
E	Local flora and fauna during and post construction.
F	Building structure and services.

The possible contaminant linkages are discussed below. It should be noted not all may be formed between all sources and receptors.

The preliminary assessment of risks undertaken for the development considers potential risks to receptors A to F in **Table 15** above. The receptors A to F incorporate each of the receptors normally required by the Local Authority to be considered in their planning conditions relating to land contamination:

- Human Health (A & B)
- Property (including buildings, crops, livestock, pets, woodland, service lines) (E & F)
- Adjoining land (D & F)
- Groundwater and surface water (C & D)
- Ecological systems (E)
- Buildings and structures (F)

It should be noted that there are no archaeological sites or ancient monuments considered to be within the zone of influence of the site. They are therefore not considered in the risk assessment.

The possible contaminant linkages are discussed below. It should be noted not all may be formed between all sources and receptors.

7.6 IDENTIFICATION OF PATHWAYS

7.6.1 Pathways to Human Health

There are various routes by which a potential contaminant may reach a receptor. For example, in areas where contaminated material is exposed, dermal contact with the material, inhalation or ingestion of dust may occur.

Inhalation or ingestion of dust and water could occur during the construction and development phase at the site. Pathways from dermal contact with soil and groundwater may also arise. It is considered that the risk of short-term exposure for ground workers and other construction workers is low unless there are asbestos fibres are encountered.

Post construction, the surface of the development area will be occupied with buildings and hard standing, with smaller garden areas and open spaces. This will effectively eliminate the persistence of potential pathways such as long-term direct contact and dust inhalation/ingestion as long as the soil in the garden and open areas have no significant concentrations of contaminants.

7.6.2 Ground Gas

There is a credible on-site ground gas source due to the possibility of infilled ground from surface workings. Deep mine gas is also a potential ground gas source to the development; however Glacial Clay deposits is anticipated to underlie the site, which will limit migration. Gas monitoring is recommended to further assess the risk.

7.6.3 Pathways to Controlled Waters

Groundwater levels at the site are anticipated to be at a depth of more than 5.00 m within the bedrock. However, there is the possibility that perched groundwater will be present within shallow made ground or drift deposits. Lateral migration of potentially contaminated groundwater offsite (either via permeable made ground or the underlying aquifer) must be considered.

The vertical leaching of contaminants from any potential Made Ground into the groundwater is a potential pathway for contaminants to impact upon groundwater. Drift deposits are anticipated to be thick on site, therefore the pathway between the Made Ground and the bedrock is limited.

Surface run off from contaminated areas into surface watercourses must also be considered. Due to a lack of a hard standing site surface, this will be uncontrolled prior to and during the groundworks phase when this must be carefully managed.

Post construction the majority of the site and surface run-off will be limited and controlled through drains.

7.6.4 Other Pathways

Other potential pathways that are possibly less significant to the site but still require consideration are: potential phytotoxic effects on sensitive landscaping plants; chemical attack on foundations and services and permeation of contaminants through domestic water pipes. The risk to buildings from ground gases has been discussed under human health above.

7.7 CONTAMINANT LINKAGES

For each contamination source there are potential contaminant linkages with all receptors. However, in the context of this site, not all of the contaminant linkages are plausible, particularly those of potential groundwater contamination and lateral groundwater migration. The likelihood of the various pathways linking the contaminants to the receptors is presented in **Table 16** below:

Table 16 - Matrix of Contaminant Linkages

Source/ Contaminated Medium	Pathway	Receptor					
		A – Humans using the site pre-development completion	B – Humans living on the site post construction assuming clean garden soils	C – Surface water	D - Groundwater	E – Flora & Fauna Post Construction	F – Building & Services
Soil	Ingestion	S	P	-	-	U	-
	Dermal Contact/Direct Contact	S	P	-	-	U	P
	Inhalation	S	P	-	-	U	-
	Infrastructure/Drainage	P	U	P	P	U	P
	Groundwater	P	U	U	U	U	P
	Surface Water	P	U	P	P	U	P
Groundwater	Ingestion	P	U	-	-	U	-
	Inhalation	U	-	-	-	U	-
	Dermal Contact	P	U	-	-	U	-
	Groundwater	P	U	P	P	U	P
	Surface Water	P	U	P	P	U	P
Radon	Migration	-	S	-	-	-	-
Gas (CH4 CO2)	Migration	P	P	-	-	U	U
Key to significance of contaminant linkages S = Significant Pathway P = Possible Pathway U = Unlikely Pathway - = Not Applicable Only Significant and Possible contaminant linkages are taken forwards to the next part of the risk assessment.							

7.8 UNCERTAINTIES

The following uncertainties exist in the preliminary conceptual model:

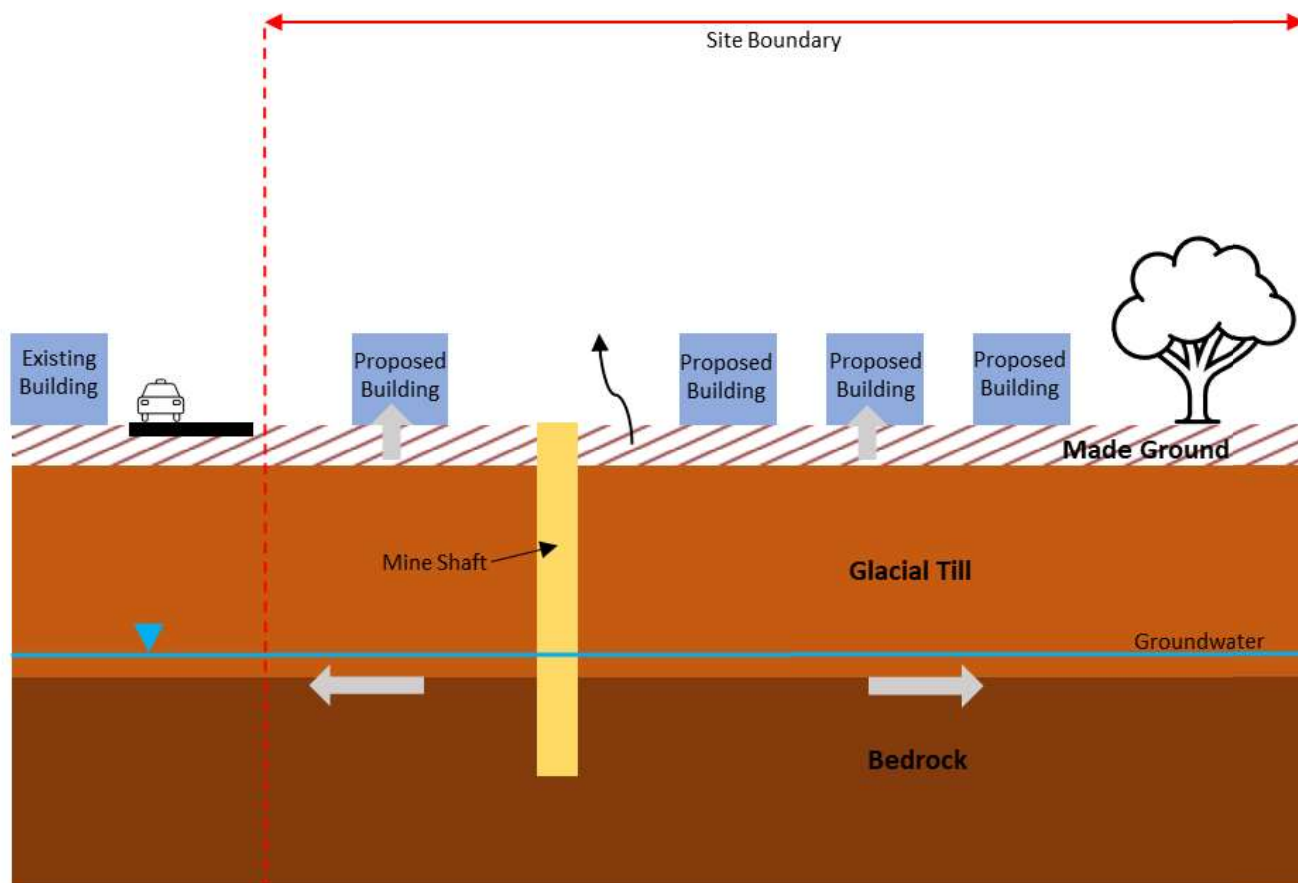
- The presence of any features unrecorded by the historic maps.
- Any unrecorded geological features.
- Any unrecorded pollution events during the Site's history.

7.9 CONCEPTUAL SITE MODEL

In accordance with BS 10175, a schematic section has been developed for the site based on the previously presented data and contaminant linkage assessment:

South

North



Key

Human health pathway/
buildings exposure ↑

Groundwater pathway ←
Vapour Exposure ↗

Figure 15: Preliminary Conceptual Site Model - Schematic Section (not to scale)

The model shows the predicted geology and topography, the major on site potential contamination sources and vulnerable receptors.

The information presented above represents the preliminary conceptual ground model that may need to be revised based on information obtained as part of any future intrusive investigation. A number of sensitive receptors and potential pathways and sources (in association with a list of likely contaminants) have been identified.

The ground model and proposed end use described above should be considered broadly representative of the standard housing (with vegetable uptake) as defined in SR3 "Updated Technical Model to the CLEA Model" (SC050021/SR3, 2011) for the purpose of this report.

7.10 PRELIMINARY ASSESSMENT OF POTENTIAL POLLUTANT LINKAGES

The preliminary hazard assessment is based on current available guidance published by a number of sources and is summarised in **Appendix D**. A preliminary conceptual site model for this site has been established using the desk study information and has been used as a basis for the preliminary hazard assessment. The significant and possible potential pathways are only considered for the hazard assessment.

The preliminary hazard assessment is a qualitative assessment of the risks posed by each viable pollution link identified. The hazard assessment leads to a recommended subsequent activity that could be:

- Action Required (AR) in the short term to break existing contaminant-pathway-receptor (CPR) link;
- Site Investigation Required (SIR) with objectives for risk estimation, or
- No Action Required (NAR) at this stage.

Hazard Identification				Hazard Assessment			
Link	Contaminant	Pathway	Receptor	Probability	Consequence	Risk	Hazard Assessment
1	Contaminated soil/groundwater Potential for Made Ground associated with railway, mine workings and surface ground workings Potential for hydrocarbon impacted material from small scale spillages	Ingestion (via soil dust) and inhalation (via soil dust and vapours), ingestion through dirty hands, dermal contact with soil/water.	A- Humans using the site during construction.	Low	Mild	Moderate (M)	SIR - Total soil concentration of relevant contaminants for contractors and designer's risk assessments.
2		Ingestion (via soil dust) and inhalation (via soil dust and vapours), ingestion through dirty hands, dermal contact with soil/water.	B- Humans using the site after development completion. No change of use.	Low	Mild	Low (L)	SIR- Total soil concentration of relevant contaminants for contractor's risk assessments.
3		Via service pipes	B- Humans using the site after construction. F- Building structures	Low	Medium	Mod/Low Risk (M/L)	SIR - Total soil concentration of relevant contaminants
4		Downward migration	D- Perched groundwater	Low	Medium	Mod/Low Risk (M/L)	SIR- Total soil concentration of relevant contaminants for contractor's risk assessments.
5		Downward migration	D - Secondary A bedrock aquifer /water supply	Low	Medium	Medium/ Low	SIR - Potential Made Ground is in direct contact with bedrock aquifer.
6	Gas – methane & carbon dioxide from Made Ground, mine shaft & Hydrocarbon vapours	Inhalation, explosion	A & B- Humans using the site during construction and after development completion.	Low/medium	Severe	Moderate (M)	SIR – Investigation to prove ground conditions and undertake monitoring.
7	Contaminated soil/waste/ groundwater	Ingestion, inhalation, dermal/direct contact	E- Ecology (Flora/Fauna)	Low/Unlikely	Minor	Very Low Risk (VL)	SIR - Investigation to confirm risk
8	Contaminated groundwater	Secondary Aquifer/ Surface water	E- Ecology (Flora/Fauna)	Low/Unlikely	Mild	Low	SIR - Investigation to confirm risk
9	Contaminated soil/groundwater	Direct contact.	F- Building structures.	Low to likely	Mild	Low	SIR - Investigation to confirm risk

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 ENVIRONMENTAL RISK ASSESSMENT

A preliminary risk assessment has been carried out based on the contaminant-pathway-receptor model as defined in Statutory Guidance to Part IIA of the Environment Protection Act, 1990, and in accordance with BS 10175: 2011 +A1 2013 "Investigation of Potentially Contaminated Sites – Code of Practice". The characteristic ground conditions and elements of the surrounding environment and has been summarised and a risk assessment carried out.

The site has historically been the site of a mine shaft and colliery since at least 1873 till 1962 when it became open land with no developments up to the present. There is the potential for Made Ground to be present on site, which may include metals, PAHs and asbestos. There is no evidence of any hydrocarbon storage or spills on the site but cannot be ruled out. There is a credible ground gas source on site in the form of infilled ground from the colliery and mine shaft along with radon being present. The site is located within a medium risk area and basic radon protective measures are required. The protection measures will comprise a radon-proof barrier across the ground floor and provision for subfloor depressurisation (a radon sump) or ventilation (a ventilated subfloor void). The design will comply with BRE Report BR211 (2015) Radon: Protective measures for new buildings.

There is current and historical off-site industrial land use within an influencing distance which may have had an impact on the site. The site was once a colliery which may have been backfilled with waste and/or spoil which may be a potential source of ground gas.

The results of the risk assessments indicate that there is low potential source of contaminants present at the site and these present a low risk to receptors including humans, structures, controlled surface waters and ecological receptors with the exception of radon.

In order to make a quantitative assessment of the potential risks and so any required remedial measures can be designed; we recommend that a ground investigation is carried out in accordance with BS 10175: 2011+A1 2013 with a suitably qualified geologist or engineer supervising all works. This should be combined with a geotechnical investigation carried out in accordance with BS 5930:2015 + A1:2020.

The objectives of the Ground Investigation will be:

- to determine shallow soil and groundwater (if encountered) conditions, including whether significant contamination has resulted from past or current land uses;
- to determine the risks posed by any ground contamination and provide recommendations on remedial measures to manage such risks;
- to determine the risks posed to the Site from hazardous ground gases;

- to determine the existence, and if applicable, the extent of contamination within local groundwater beneath the Site;
- to provide advice relating to geotechnical issues associated with the Site.

8.2 RESTRICTIONS

The main restriction present at the site is the disused mine shaft present at the southern end of the site. However, this has been mitigated against by the proposed placement of an open grassed area present in the area of the shaft in order to reduce the load on the shaft as well as create an exclusion zone around the shaft.

8.3 PROPOSED SCOPE OF WORKS

The following scope of works are proposed:

- 1 day of trial pitting for visual inspection of the ground and to allow for permeability testing.
- 5No. window sample boreholes with monitoring well installations.
- Gas monitoring – 6 visits over 3 months.
- In situ geotechnical testing to assist with foundation design and recommendations.
- Geoenvironmental chemical testing on selected soil samples to include metals, pH, speciated PAH, speciated TPH, phenol, sulphate, TOC and asbestos screens in order to assess potential risks to human health based on historical land uses on and within close proximity to the Site and to assist with basic waste characterisation. The sampling and testing will be focused on any made ground encountered and the high risk areas of the proposed development i.e. private gardens.

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