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Development at Land Behind 34 Station Road

Phase II Interpretative Report

January 2022

Development at Land Behind 34 Station Road
Phase II Interpretative Report

RB Geotechnical

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Client: Mr S. Gantley

Job Number: RBG257

Prepared and Issued by Ross Blake BSc MSc FGS, Engineer. Signed:

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DISCLAIMER

This report was produced by RB Geotechnical for Mr S. Gantley (The client), for the specific purposes of a Phase II Intrusive Investigation and Interpretative Report, for the proposed residential development on the Land Behind 34 Station Road in Skelmanthorpe, West Yorkshire. This report may not be used by anyone else other than the client without their express permission. In any event, RB Geotechnical accepts no liability for any costs, liabilities or losses arising from the use of reliance upon the contents of this report by anyone other than the client.

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1.0 INTRODUCTION

1.1 Brief and Scope

RB Geotechnical was commissioned by the client, to carry out a Phase II Intrusive Site Investigation at Land Behind 34 Station Road in Skelmanthorpe, West Yorkshire. The site is intended to have a new detached residential dwelling constructed, along with new soft landscaped gardens.

RB Geotechnical undertook an intrusive ground investigation on 10th and 11th November 2022, to gain the necessary information required to assess the underlying ground conditions. This assessment was designed to assess for possible unrecorded mine workings, potential ground contamination and gas risks.

This report discusses the findings of this ground investigation and provides an analysis which includes a series of conclusions and recommendations relating to the potential risks and constraints of the proposed development.

1.2 Terms and Conditions

This report has been prepared for Mr S. Gantley, for the purpose of discharging the necessary planning conditions related to the proposed development. The environmental information in this report has been summarised following a review of the Phase I assessment carried out by RB Geotechnical in October 2021.

1.3 Scope and Objectives of Report

The purpose of this report is to provide factual and interpretative information required to comply with the requirements of a Phase II Intrusive Site Investigation and land contamination as required by the planning regime. The scope of the report is as follows:

- To provide general information on the site such as location and description;
- To summarise the environmental and historical setting of the site; e.g. landfills, permits, sensitive land uses and historical land uses;
- To summarise the ground investigation and its findings;
- Provide factual information and descriptions of ground conditions;
- To assess geotechnical parameters of the site;
- To provide a quantitative risk assessment for the proposed end use of the site; and

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- To provide recommendations for further works where necessary.

1.4 Constraints and Limitations

This report is intended for the client for assisting them in assessing the site for possible historical mining related risks and possible ground contamination.

RB Geotechnical has endeavoured to assess all information provided to them. The report includes summaries of information from external sources and cannot offer any guarantees or warranties for the completeness or accuracy of information relied upon.

The conclusions resulting from this study are not necessarily indicative of future conditions or operating practices at or adjacent to the site.

It should be noted that although every effort has been made to ensure the accuracy of the data obtained from the investigation, the possibility exists for variations in ground and groundwater conditions between and around the borehole locations. In addition, groundwater levels will vary seasonally and with changes in weather conditions.

1.5 Sources of information

The existing environmental and historical information within this report has been obtained following a review of the Phase I Desk Study.

Environmental information has been obtained following a review of the contaminated land laboratory test results, along with the findings of the intrusive ground investigation.

The sources of information used for this report are:

- RB Geotechnical, Phase I Desk Study Report, Land Behind 34 Station Road, RBG254, October 2021;
- RB Geotechnical, Coal Mining Risk Assessment Report, Land Behind 34 Station Road, RBG254, October 2021;
- Cape Site Services Ltd, Rotary Open Hole Boreholes Logs, November 2021; and

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- I2 Laboratory, November 2021, Report No.21-22845.

Although every effort has been made to ensure the accuracy of the information contained herein, no checks have been carried out to ensure the accuracy of information obtained from third parties and no liability can be accepted for any errors or misinterpretation of the third party information where it has been incorporated into this report.

2.0 SITE DETAILS

2.1 Site Location and Description

The 0.07ha sized site, is situated at a square plot of undeveloped land behind number 34 Station Road in Skelmanthorpe, West Yorkshire. The site is accessed down a hardstanding track beside number 2 Spencer Street, which leads to an area of now stripped land, with some bushes and trees. The National Grid Reference for the centre of the site is 423092, 410933.

2.2 Proposed Development

The proposed development is to comprise the construction of a residential dwelling, with space for car parking and a small landscaped garden.

The proposed development and exploratory hole location plan is included as Appendix A.

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3.0 EXISTING INFORMATION

3.1 General Site History

The site was shown to be an undeveloped area of land, up until the early 1900s when a row of buildings is shown across the centre and development of houses and other buildings was first shown adjacent to the site. By the 1980s the original buildings on the site have been demolished, and instead two new small buildings exist on site. The site remains this way until recently, when all buildings have been demolished and removed, and the site was cleared of all vegetation.

The surrounding area has changed slightly through the years, with it initially comprising open fields and quarries, now with new roads and houses.

3.2 Geology, Hydrology and Hydrogeology

3.2.1 Geology

According to the published geological maps the site is underlain by bedrock of the Pennine Lower Coal Measures in the North and Penistone Flags Sandstone in the South. A number of faults are shown close to the site, and the nearest coal seam is located 100m to the North at the Black Band Coal Seam.

3.2.2 Hydrology

There are no nearby surface water features. The EnviroInsight Report indicates that there are no groundwater, surface water or potable water abstraction licences situated within 1000m of the site.

The site is deemed to be at a Very Low risk of flooding.

3.2.3 Hydrogeology

The underlying bedrock is classified as being a Secondary A Aquifer with a High Leaching Potential.

3.3 Environmental Considerations

3.3.1 Landfill Sites

There are no recorded active landfill sites within 1000m of the site. Two historical EA landfill sites have been mapped 179m and 282m from the site, both noted to be taking commercial waste.

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3.3.2 Potentially Contaminative Land Uses

Historic potentially contaminative land uses mapped within 250m of the site boundary have been identified as railway sidings 46m to the North, railway cuttings, collieries from 56m to the North, old quarries, mills and unspecified workings. Current potentially contaminative land uses mapped within 250m have been identified only as an Electricity Sub-Station 95m to the South West.

3.4 Preliminary Contamination Assessment

The Phase I Desk Study identified the site as being once occupied by a number of buildings which have since been demolished. It is likely that these old buildings will have resulted in Made Ground across the site which could contain a number of contaminants.

A number of infilled land features were identified within 250m of the site boundary, mainly associated with old quarries, ground workings and a nearby colliery.

Due to the potential risk for onsite soil contamination from Made Ground and off-site contamination in the form of ground gases, a Phase II Intrusive Investigation was recommended.

It was therefore recommended that Phase II Intrusive Investigation be carried out to assess these potential contamination risks.

3.5 Desk Based Coal Mining Risk Assessment (CMRA)

The CMRA identified that the site was found to be in an area of possible shallow coal which could have been mined in the past, in addition to a nearby historical colliery which indicates mining activity in the close surrounding area. It was found that the nearby coal seams to the site were identified to have been widely worked in the past. It was therefore concluded that a risk of potential unrecorded mine workings exists on the site, and therefore a Phase II Intrusive Investigation was deemed necessary to properly assess this risk.

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4.0 INTRUSIVE INVESTIGATION

4.1 Design

The Ground Investigation was designed by RB Geotechnical to investigate the ground conditions of the site. The scope of the investigation was determined based on the findings of the Phase I Contaminated Land Desk Study.

4.2 Ground Investigation Activities

The Ground Investigation was undertaken in general accordance with:

- BS 5930 (1999). Code of Practice for Ground Investigation;
- BS1377. Methods of test for Soils for Civil Engineering Purposes; and
- BS 10175:2011 (2011). Investigation of Potentially Contaminated Sites – Code of Practice.

The Ground Investigation comprised the following:

- Three Rotary Open Hole Boreholes to depths of 30.0mbgl to assess for potential unrecorded mine workings;
- Installation of ground gas monitoring standpipe to allow for ground monitoring assessment;
- Three Hand Excavated Trial Pits to obtain shallow soil samples for contamination testing.

This Ground Investigation was undertaken on 10th and 11th November 2021. The exploratory holes were logged and sampled by a qualified engineer.

An exploratory hole location plan is shown in Appendix A.

4.3 Sampling and In-Situ Testing

Small, disturbed samples were recovered from the hand dug trial pits and stored in plastic pots and jars placed into a cool box.

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4.4 Laboratory Testing – Environmental

All chemical (contamination) laboratory testing was scheduled by RB Geotechnical and was intended to provide contamination data for the specific areas sampled. The scope of the testing was designed to enable comments regarding characterisation of potential contamination on site.

A total of four soil samples were sent to i2 Analytical Ltd of Watford, which is registered as UKAS Testing laboratory No. 4041. Table 4.1 summaries the Laboratory Testing carried out. Full chemical laboratory testing results are shown in Appendix C.

Table 4.1 Summary of Chemical Laboratory Testing

Analysis	Total number of Samples
Heavy Metals	4
Cyanide	4
Sulphate	4
pH	4
Speciated PAH	4
Total TPH	4
Asbestos ID	4

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5.0 INTRUSIVE GROUND INVESTIGATION FINDINGS

An Intrusive Investigation was carried out on the site on 10th November 2021 and 11th November 2021, comprising three shallow hand dug trial pits to obtain shallow soil samples for contamination testing, and three Rotary Open Hole Boreholes, to assess for potential unrecorded mine workings beneath the site. The exploratory hole location plan is shown in Appendix A and full Rotary Open Hole Borehole Logs are included as Appendix B.

5.1 Hand Dug Trial Pits

Hand dug trial pits were excavated to depths up to 0.50mbgl, in three different areas of the site, concentrating in areas which are proposed to be newly soft landscaped gardens. Ground conditions within these exploratory holes were found to comprise a mixed reworked clayey, sandy topsoil material with fragments of mudstone. This fill material extends to a depth of around 0.40mbgl, before being underlain by a highly weathered clayey Mudstone. Hand Dug Trial Pit logs are shown in Appendix B.

5.2 Rotary Open Holes

Three Rotary Open Hole boreholes were carried out across the proposed development site, with the logs shown in Appendix B. Upon using this drilling method, whereby a water flush is utilised, it ensures that there is no danger should mine gas be encountered. This drilling method is used to identify a void or mine working, whereby a sudden loss of water flush is encountered during drilling. Where voids or mine workings are not encountered, the water flush would continue to flow into the borehole at a generally consistent rate. Table 4.1 shows a summary of the findings of the Rotary Open Hole Drilling.

Note *: CIRIA (Construction over abandoned mine workings, 1989), suggests a thickness of solid rock through which a void can migrate is 7h to 10h above the roof of the workings, where h is the height of the workings (generally assumed to be similar to the seam thickness). The lower end of this range (7h) is generally only applicable where the overlying strata are predominantly thickly bedded sandstones, which are not typical of this site. Therefore the 10h rule should be used.

Table 5.1 shows that no coal was encountered within any of the Rotary Open Hole Boreholes. There was no evidence of removed coal or void migration in any of the locations drilled. Intact bedrock was encountered in all exploratory holes at depths from 0.40mbgl as a highly weathered Mudstone. As there

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was no evidence of worked coal seams or historical mining activity beneath the site, no remedial measures will be required related to coal mining legacy.

Table 5.1 Summary of Rotary Open Hole Findings

Borehole ID		RO1	RO2	R03
Final Depth (mbgl)		30.00	30.00	30.00
Depth to Rockhead (mbgl)		0.40	0.40	0.40
Coal Seam	Depth (mbgl)	Not Encountered	Not Encountered	Not Encountered
	Thickness (m)	Not Encountered	Not Encountered	Not Encountered
10 x Competent Cover (CIRIA 1989)*		Not Applicable	Not Applicable	Not Applicable
Evidence of Ground Gases		NO	NO	NO
Void/Loss of flush	Depth (mbgl)	Not Encountered	Not Encountered	Not Encountered
	Thickness (m)	Not Encountered	Not Encountered	Not Encountered
10 x Competent Cover (CIRIA 1989)*		YES	YES	YES
Other Information		No loss of flush recorded throughout drilling	No loss of flush recorded throughout drilling	No loss of flush recorded throughout drilling

Full Rotary Open Hole borehole logs are presented in Appendix B.

5.3 Groundwater and Ground Gas Monitoring Standpipe

Gas and groundwater monitoring standpipes were installed into all three boreholes (R01, R02 and R03). During the drilling of the boreholes continuous gas monitoring was carried out to assess for mine gases. It was found that levels of ground gas were nil. Additionally, the absence of any coal seams and evidence of

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mine workings, lead RB Geotechnical to confidently believe that the risk of mine gases to the site was now Very Low. Ground gas monitoring standpipe installation construction details were as follows:

- R01: 1.0m of plain standpipe and 7.0m of slotted screen standpipe.
- R02: 1.0m of plain standpipe and 7.0m of slotted screen standpipe.
- R03: 1.0m of plain standpipe and 3.0m of slotted screen standpipe.

In-situ gas monitoring was carried out in each of these Boreholes, using a portable gas meter which measures Oxygen, Methane, Carbon Dioxide, air pressure and flow rate.

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6.0 FOUNDATIONS AND GROUND GAS RISKS

6.1 Foundation

Typical pad or strip foundations will be suitable for the new proposed house, placed either within the highly weathered bedrock at a depth from around 0.80mbgl.

All foundation excavations must be inspected to ensure that no footings are placed upon any existing weak Made Ground, softer materials, or any other weak materials that would be incapable of safely sustaining the applied foundation loads. This is particularly important wherever any appreciable amounts of Made Ground occur. Additionally, all foundation excavations should be inspected to confirm that the proposed bearing stratum is rid of any largely clayey spots and is uniformly compacted.

Wherever any suspect Made Ground is encountered at proposed foundation level, then that footing must be deepened until a satisfactory bearing medium is obtained.

The absence of evidence of mine workings, indicates that no additional remedial measures will be necessary, related to ground conditions.

6.2 Ground Gas Risk Assessment

The risks associated with ground gases have been considered in accordance with British Standard BS 8485:2015+A1:2019 "Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings" and CIRIA Report C665 "Assessing Risks Posed by Hazardous Gases to Buildings".

Ground Gas Monitoring was carried out by GeoEnginSeer Ltd, with the full results and assessment included as Appendix D. During the gas monitoring, VOC's were also assessed using a PID.

The methodology used to carry out a semi-quantitative estimate of the risks from ground gas at the site is that described in BS8485:2015+A1:2019 and CIRIA Report C665 which recommends following the classification system proposed by Wilson and Card in CIRIA Report 149.

Following the ground gas assessment it was established that a Characteristic Situation 1 standard applies,

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whereby no ground gas protective measures are necessary.

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7.0 GROUND CONTAMINATION – GENERIC QUANTITATIVE RISK ASSESSMENT

The following assessment was performed in the context of the planning regime and considering Part 2A of the Environmental Protection Act (1990) to determine if unacceptable risks to humans, vegetation or to specific parts of the wider environment are present on the site. The risk assessment follows the source, pathway, receptor methodology, as described in Contaminated Land Report (CLR) 11, which is used to build a conceptual site model to determine the presence of any pollutant linkages at the site. Should pollutant linkages exist at the site it is deemed necessary to further develop the risk assessment by comparing contamination test results with generic or site-specific assessment criteria in order to determine if an unacceptable level of risk is present at the site. If legislation or guidance changes, or the proposed end use is modified, then it will be necessary to reassess the risks which may require further sampling and testing.

We understand our brief to comprise the following items related to the contamination aspects of this investigation.

- Compare laboratory test results with generic assessment criteria;
- Determine a conceptual site model and identify any pollutant linkages at the site;
- Determine the level of risk posed by environmental hazards on site to human health, vegetation, controlled waters and structures; and
- Make recommendations for further work or remediation strategies.

Soil samples were recovered in accordance with current industry practice and were sent to i2 Analytical Ltd to be analysed for the determinants listed in section 4.4 of this report.

The results of these analyses are included in Appendix C of this report.

7.1 Human Health Assessment

UK guidance recommends that a risk-based approach is taken for the assessment of contaminated land and as such, DEFRA have introduced the CLEA methodology, SGV's and Category 4 Screening Values (C4SL). The CLEA methodology is a deterministic risk assessment model that estimates the long-term

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exposure to contaminants in the soil for children and adults and predicts the amount of contaminant to which a person might be exposed based on a given soil concentration. By comparison with relevant health criteria on tolerable or acceptable intakes of various contaminants the model was used by DEFRA and the Environment Agency to generate SGV's and C4SL's.

At the time of writing this report the DEFRA and Environment Agency has not published SGV's/C4SL using the CLEA 1.071 software for all anthropogenic toxic substances with C4SL's for further contaminants due to be produced at some point in the future. As such, it was necessary to use other methods to generate target concentrations for contaminants of concern on site.

In order to generate generic assessment criteria which are protective of human health, for use in human health risk assessment, where CLEA SGV's and C4SL's are not available the Environment Agency recommends the use of the CLEA 1.071 software in conjunction with advice found on the GOV.UK CLEA web pages. Accordingly, the Chartered Institute of Environmental Health (CIEH) in partnership with Land Quality Management (LQM) derived a set of Generic Assessment Criteria Values following the approach set out in the DEFRA research project SP1010, C4SL. The GAC for missing contaminants of concern were calculated using the CLEA 1.06 software released in July 2009 and termed Suitable 4 Use Levels (S4UL's). The input parameters used for calculating each S4UL value are listed in the substance specific chapters of the reference document associated with the S4UL's, namely 'The LQM/CIEH S4ULs for Human Health Risk Assessment (Land Quality Press, 2015). Where published UK guidance values are not available (i.e., for TPH), the results have been determined in-house using published toxicological data and UK government endorsed risk models.

The current view of the Environment Agency is that the C4SL's are considered to be a trigger value at which an exceedance may cause concern for human health and generally requiring further investigation and/or assessment.

The DEFRA C4SL and LQM/CIEH S4UL's for a residential with gardens land use has been selected as this matches the proposed future land use.

7.2 Vegetation Assessment

As the CLEA methodology only takes account of the risks to human health, a different approach is required to determine the risks to vegetation. In order to determine if levels of phyto-toxic contaminants in soil, not

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normally considered to be harmful to humans, are suitable to maintain growth of vegetation the published reference values produced by the Ministry of Agriculture, Fisheries and Food (MAFF) have been used in this assessment.

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8.0 DISCUSSION OF RESULTS**8.1 Human Health Hazards**

Elevated levels of a range of soil contaminants were measured in the shallow Made Ground soil samples taken from depths of 0.15mbgl in HP01, 0.10mbgl in HP02 and 0.10mbgl in HP03. The contaminants encountered elevated levels of Arsenic, Chrysene, Benzo(a)Pyrene and Dibenzo(a,h)perylene. These contaminants are likely to be present due to historical demolition across the site throughout the years.

All of the hand dug trial pits and soil samples collected were excavated in proposed soft landscaped areas. However, as the client is to strip all site levels by a further 500mm, thus removing all Made Ground from the site, no further remedial measures will be necessary.

Table 8.1 Comparison of Soil Test Results with Residential with Gardens C4SI/S4UL

Determinant	Assessment Criteria (mg/kg)		Recorded Concentrations Across The Site (mg/kg)	
	C4SL Screening Levels	S4UL Generic Assessment Criteria/RB Geotechnical Generic Assessment Criteria	Highest Recorded Value	Location of Highest Recorded Value and other Exceedances
Metals, semi- metals and non-metals				
Arsenic	37	37	47	HP01
Cadmium	17	11	<0.2	All
Copper	NC	2400	140	HP03
Chromium Total	NC	910	34	HP03
Lead	210	NC	190	HP01
Mercury (elemental)	NC	1.2	0.5	HP01
Nickel	NC	130	40	HP03
Selenium	NC	250	<1.0	All
Vanadium	NC	410	59	HP03
Zinc	NC	3700	420	HP03
PAHs				
PAH (total)	NC	NC	41.1	HP01
TPH (total)	NC	150-550 ₍₄₎	130	HP01
Other				
Naphthalene	NC	1.5	0.37	HP01
Acenaphthylene	NC	170	0.32	HP03

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Determinant	Assessment Criteria (mg/kg)		Recorded Concentrations Across The Site (mg/kg)	
	C4SL Screening Levels	S4UL Generic Assessment Criteria/RB Geotechnical Generic Assessment Criteria	Highest Recorded Value	Location of Highest Recorded Value and other Exceedances
Acenaphthene	NC	210	<0.05	All
Fluorene	NC	170	0.40	HP03
Phenanthrene	NC	95	5.6	HP03
Anthracene	NC	2400	0.83	HP01
Fluoranthene	NC	280	7.0	HP01
Pyrene	NC	620	6.0	HP01
Benzo(a)anthracene	NC	7.2	3.9	HP01
Chrysene	NC	15	3.5	HP01
Benzo(b)fluoranthene	NC	2.6	4.4	HP01/HP02/HP03
Benzo(k)fluoranthene	NC	77	2.4	HP01
Benzo(a)pyrene	3.2	2.2	3.6	HP01/HP02/HP03
Indeno(1,2,3-c,d)Pyrene	NC	2.3	2.1	HP01
Dibenzo(a,h)anthracene	NC	0.24	0.70	HP01/HP02
Benzo(g,h,i)perylene	NC	320	2.6	HP01
Others				
Cyanide (total)*	NC	5	<1	All
Asbestos In Soil	NC		Not - Detected	All

NOTES:

(1) C4SL/LQM S4UL 2015 for Residential with gardens land use scenario at 1% organic matter content

(2) *= Dutch Target value used as screening value for cyanide.

(3) NC = No criterion.

(4) Limit based on CCME sum of C10-C34 (for most conservative screening value). Includes C₁₀ – C₁₆ limit = 150mg/kg (worst case minimum value) and C₁₆ – C₃₄ = 400mg/kg. Only for use as preliminary screening value, where hydrocarbons not suspected. If TPH>150mg/kg the value will be assessed in addition to levels of other related inorganics from the same sample, to establish if further assessment is necessary.

8.2 Vegetation Hazards

The concentrations of the various phytotoxic contaminants encountered in the shallow soils indicate that elevated levels of Copper were identified in the location of HP03. However, as noted previously the client is to strip all site levels by a further 500mm, thus removing all Made Ground from the site, no further remedial measures will be necessary.

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Table 8.2 Soil Test Results Vs Phyto-Toxic Chemical Assessment Criteria

Determinant	MAFF Reference Value (mg/kg)		Recorded Concentrations Across Sampled Area (mg/kg)	
	Maximum Permissible Concentration		Highest Recorded Value	Location of Highest Recorded Value
	pH 5.0-5.5	pH >7		
Metals and semi- metals				
Arsenic	50	NL	47	HP01
Copper	80	200	140	HP03
Nickel	50	110	40	HP03
Zinc	200	300	420	HP02
Cadmium	3	NL	<0.2	All
Lead	300	NL	190	HP01
Selenium	3	NL	<1.0	All

NOTES: (1) NL = indicates that no level has been set

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9.0 CONCEPTUAL SITE MODEL

9.1 Introduction

The information obtained from the Phase I Desk Study as well as from this investigation has been collated and evaluated to develop a refined Conceptual Model for the site.

The site has been assessed in line with current UK guidelines, namely the Contaminated Land (England) Regulations 2000 and Part IIA of the Environmental Protection Act 1990 and follows the procedures set out in the Environmental Agency 'Model Procedures for the Management of Land Contamination – Contamination Land Report (CLR).11'.

CLR.11 provides the technical framework for structured decision making about land contamination and builds on previous work carried out under the Contaminated Land Research Programme of the former Department of the Environment. CLR 11 has adopted and refined the methodology and terminology that has been used in contaminated land risk assessment for a number of years.

CLR.11 defines the three essential elements to any risk:

- A **contaminant source** - a substance that is in, on or under land and has the potential to cause harm or to cause pollution of controlled waters;
- A **receptor** – in general terms, something that could be adversely affected by a contaminant, such as people, an ecological system, property or a water body; and
- A **pathway** - a route or means by which a receptor can be exposed to or affected by a contaminant.

Each of these elements can exist independently, but they create a risk only where they are linked together, so that a particular contaminant affects a particular receptor through a particular pathway. This kind of linked combination of source-pathway-receptor is described as a **pollutant linkage**.

This report presents a Phase 2 Conceptual Model and Quantitative Risk Assessments for the site, based on the proposed conservative end use of residential with home grown vegetables.

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9.2 Hazard Identification**9.2.1 Potential Contamination Sources**

Historically the site has had buildings which have since been demolished, and this has likely resulted in the layer of Made Ground that was encountered across the site. This Made Ground was identified as the main potential sources of on-site soil contamination.

Off-site sources of contamination were identified as possible accumulations of ground gas resulting from nearby infilled land features such as quarries and the colliery.

A summary of potentially significant sources of contamination encountered are presented in Table 9.1.

Table 9.1 Summary of Contaminant Sources & Contaminants

Structure / Process	Contaminants Present on Site
Made Ground	<ul style="list-style-type: none"> Elevated levels of Copper, Arsenic, Chrysene, Benao(a)Pyrene and Dibenzo(a,h)Anthracene.
Accumulations of Ground Gas from nearby quarries and colliery.	<ul style="list-style-type: none"> No elevated levels of ground gas measured.

9.2.2 Potential Receptors

The following are considered as potential receptors in relation to the current and proposed use of the site.

- **Future Residential users** – Female child aged 0-6 years using communal gardens;
- **Utility / Construction / Demolition / Site Investigation workers** – Workers undertaking routine / non-routine work involving ground disturbance works and maintenance of below ground services (assuming workers are only wearing standard construction / utility worker PPE);
- Underlying **Principal Aquifer** – Underlying bedrock
- **New potable water supply pipes**
- **Ingress of ground gases into structures**

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9.2.3 Potential Contamination Pathways

The following are considered plausible contamination pathways given the nature of the site and the potential contaminative sources identified, and assuming a continued current use.

- Dermal contact and ingestions of soils;
- Inhalation of dust/fibres and vapours;
- Ingestion of home grown produce; and
- Risk from ground gases, asphyxiation or explosion.

9.2.4 Quantitative Risk Assessment

By considering the sources, pathways and receptors, an assessment of the environmental risks is made with reference to the significance and degree of the risk. This assessment is based on consideration of whether the source contamination can reach a receptor and hence whether it is of major or minor significance.

An initial conceptual model of the source-pathway-receptor linkages has been developed based on the information derived from the Phase I Desk Study and this intrusive investigation. The Conceptual Site Model has been used to identify Relevant Pollutant Linkages for the current and proposed end uses which have been assessed quantitatively and qualitatively using CIRIA 552 guidance, as described in Table 9.2 and Table 9.3.

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Table 9.2 Methodology for Assessing Consequence of Harm

Consequence	Criteria
Severe	Short term (acute) risk to Human Health likely to result in “significant harm” as defined by the Environmental Protection Act 1990, Part IIa. Short term risk of pollution of sensitive water resource. Catastrophic damage to buildings / property
Moderate	Chronic damage to Human Health likely, over a long term, to result in “significant harm” as defined by the Environmental Protection Act 1990, Part IIa. Pollution of sensitive water resources
Mild	Health effects to Human Health that are unlikely to result in “significant harm” as defined by the Environmental Protection Act 1990, Part IIa. Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services. Damage to sensitive buildings / structures / services or the environment
Negligible	Non-permanent health effects to Human Health that are unlikely to result in “significant harm” as defined by the Environmental Protection Act 1990, Part IIa. Those that are easily prevented by means such as personal protective clothing. Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve.

Table 9.3 Methodology for Assessing Likelihood of Consequence Occurring

Probability	Criteria
Almost Certain	Circumstances are such that an event either appears very likely in the short term and almost inevitable over the long term or there is evidence of currently harm occurring
Likely	Circumstances are such that an event, whilst not inevitable, is possible in the short term and is likely to occur over the long term
Unlikely	Circumstances are such that it is possible an event could occur, but it is by no means certain to occur even over a longer period, and it is less likely in the shorter term
Very Unlikely	Pollutant linkage may be present, but the circumstances under which harm would occur are improbable even in the medium to long term
Extremely Unlikely	Pollutant linkage may be present, but the circumstances under which harm would occur are highly improbable even in the long term

The risk assessment table and apportioned scores presented in Table 9.4 are in general accordance with CIRIA 552. The main exception is that irreversible risks to human health are considered to have a severe consequence irrespective of whether the effects are chronic or acute in nature.

Table 9.4 Comparison of Consequence and Likelihood

Consequence Probability	Severe	Moderate	Mild	Negligible
Almost Certain	Very High Risk	High Risk	Moderate Risk	Low Risk
Likely	High Risk	Moderate Risk	Moderate/ Low Risk	Low Risk
Unlikely	Moderate Risk	Moderate/ Low Risk	Low Risk	Very Low Risk
Very Unlikely	Low Risk	Low Risk	Very Low Risk	Very Low Risk
Extremely Unlikely	Very Low Risk	Very Low Risk	Very Low Risk	Very Low Risk

The categories of risk are defined as follows:

Very High Risk: There is a probability that severe harm is almost certain to arise to a designated receptor from an identified source, or there is evidence that severe harm to a designated receptor is currently occurring.

High Risk: There is a probability that severe harm is likely to arise to a designated receptor from an identified source, or there is a probability that moderate harm is almost certain to arise.

Low Risk: There is a possibility that harm could arise to a designated receptor from an identified source, but it is likely that this harm, if realised, would be mild at worst.

Very Low Risk: There is a very low possibility that harm could arise to the receptor, but it is likely that this harm, if realised, would be mild at worst.

In accordance with CLR11, professional judgement has been employed to evaluate the risk on a qualitative basis using available information.

A summary of the pollution linkages is provided in Table 9.5

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Table 9.5 Conceptual Site Model (Revised Following Phase II Investigation)

Source	Receptor	Pathway	Risk	Pollutants Encountered/Chemicals of Concern	Remedial Option(s)/Next Steps
<p>On Site:</p> <p>Elevated levels of Copper, Arsenic, Chrysene, Benzo(a)Pyrene and Dibenzo(a,h)Perylene.</p>	Residential Homeowners	<ul style="list-style-type: none"> • Dermal contact or ingestion contaminants in soil-derived dust and entrained surface water run-off from areas where soil is exposed at the surface or where excavation takes place and in shallow groundwater in the natural strata if excavation takes place below the water table. • Inhalation of contaminants in soil derived dust from areas where soil is exposed at the surface of where excavation takes place. • Inhalation of soil and water derived vapours and ground gas outdoors • Inhalation of soil derived, and water derived vapours and ground gas indoors where it may have accumulated in buildings and enclosed spaces. 	Low	Elevated levels of Copper, Arsenic, Chrysene, Benzo(a)Pyrene and Dibenzo(a,h)Perylene, measured from within shallow soil samples taken in areas of proposed soft landscaped gardens.	The client is to strip the site of a further 500mm to reduce ground levels prior to construction. This will therefore remove all Made Ground from the site and remove the risk of contaminated soils coming into human contact. No further remedial measures are therefore deemed necessary.
	Construction Workers		Low	Elevated levels of TPH and Arsenic.	Suitable PPE must be worn at times.
<p>No elevated levels of ground gas recorded</p>	Groundwater within the underlying bedrock (Secondary A Aquifer)	<ul style="list-style-type: none"> • Leaching of contaminants and/or migration of free phase contaminants from the unsaturated zone soils to groundwater in the natural strata • Vertical migration of contaminants in shallow groundwater to deeper strata and aquifer. 	Low	No Further Assessment Required	
	Surface Water	<ul style="list-style-type: none"> • Lateral migration of contaminants and/or migration of free phase contaminants present in the Made Ground via groundwater to surface water discharge • Lateral migration of contaminants and/or migration of free phase contaminants present in the Made Ground and entrained in surface water runoff 	Low	No Further Assessment Required	

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	Building	<ul style="list-style-type: none"> Accumulation of soil and water derived vapours/and or ground gas in enclosed spaces 	Low	No Further Assessment Required	
	Potable Water Supply Routes	<ul style="list-style-type: none"> Migration of contaminants into newly placed potable water supply routes 	Low	Elevated levels of Arsenic and Copper	As the site levels are to be stripped by 500mm, all contaminated Made Ground is to be removed and therefore no further remedial measures are necessary.

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9.3 Discussion of Risks

The risk assessment presented in the above sections and summarised within the CSM presented in Table 9.5 shows that Contaminant Linkages have been identified at the site. The following sections provide a discussion of the environmental risks based on the ground investigation and laboratory data as well as the desk study information.

9.3.1 Human Health

Proposed residential property users

The ground investigation and laboratory testing showed that the Made Ground across the site contains elevated levels of Copper, Arsenic, Chrysene, Benzo(a)Pyrene and Dibenzo(a,h)Perylene. The site is to be stripped of 500mm of soil to reduce levels prior to construction, therefore removing the risks posed by these contaminated soils. No further remedial measures are therefore deemed necessary.

The gas monitoring that was carried out showed very low levels of both Carbon Dioxide and Methane. No further assessment is therefore required related to ground gas.

Therefore, the current risks to human health has been assessed to be **LOW**

Utility / Construction / Demolition / Site Investigation (i.e. Ground Disturbance) Workers

The probability of contact with contaminated soils increases for workers involved with ground excavation (e.g. during development, site investigation or maintenance works). However, due to the exposure time to contaminants on site and the assumption that appropriate PPE will be worn the risks to site operatives is considered **LOW**.

9.3.2 Principal Aquifer

The risks to the underlying aquifer has been assessed to be **LOW**.

9.3.3 Surface Water

The risk of contaminants to controlled waters is considered to be **LOW**.

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9.3.4 Potable Water Supply Pipes

As the site levels are to be reduced by 500mm, thus removing the contaminated soils, there is no risk of coming into contact with new potable water supply pipes. Therefore, the current risk is considered to be **LOW**.

9.3.5 Buildings

Levels of ground gas were measured to be very low. The current risk to ground gas is therefore considered to be **LOW**.

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10.0 CONCLUSIONS

The Phase I Desk Study identified potential on-site sources of contamination due to historical buildings on the site. Additionally, off-site risks of potential ground gases were identified due to nearby quarries and a colliery. Following a desk based coal mining risk assessment it was established that a risk of possible unrecorded mine workings also exists.

An intrusive investigation was therefore carried out across the site comprising Rotary Open Hole boreholes to allow for installation of ground gas monitoring standpipe and shallow hand dug trial pits to allow for shallow soil sampling for contamination testing.

The ground investigation found that no risk of unrecorded mine workings was encountered. Additionally no risk of dangerous levels of ground gases were identified during the ground gas monitoring assessment. Soil laboratory testing did however identify a number of elevated levels of a range of soil contaminants, likely related to the shallow Made Ground across the site.

The site is however to be stripped of a further 500mm of soil prior to construction in order to reduce levels. This will therefore remove all Made Ground and contaminated soils from the site and therefore remove the risks of contaminated soils coming into human contact. No further remedial measures are therefore deemed necessary.

The favourable ground conditions encountered, indicate that shallow strip or pad footings will suffice for the new buildings, placed at depths ranging from 0.60mbgl to 0.90mbgl, within the shallow weathered bedrock.

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11.0 REFERENCES

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