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Development at Upper Hagg Farm

Phase II Interpretative Report

September 2022

Development at Upper Hagg Farm
Phase II Interpretative Report

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Project: Development at Upper Hagg Farm Phase II Intrusive Investigation

Client: Mr J. Bamforth

Job Number: RBG298

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

A handwritten signature in black ink that reads "REBlake". The signature is written in a cursive style and is contained within a thin black rectangular border.

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DISCLAIMER

This report was produced by **RB Geotechnical** for Mr J. Bamforth (The client), for the specific purposes of a Phase II Intrusive Investigation and Interpretative Report, for the proposed residential re-development at Upper Hagg Farm in Holmfirth, 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 Upper Hagg Farm in Holmfirth, West Yorkshire. The site is intended to have partial demolition and alterations to existing buildings, in order to form three new residential dwellings.

RB Geotechnical undertook an intrusive ground investigation on 15th July 2022, to gain the necessary information required to assess the underlying ground conditions. This assessment was designed to assess for possible soil contamination risks in addition to preliminary geotechnical considerations and a ground gas risk.

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 J. Bamforth, 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 third party in June 2022.

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;

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- To provide a quantitative risk assessment for the proposed end use of the site; and
- 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 soil contamination risks in addition to ground gas risks.

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:

- RGS, Report on a Phase One Desk Study, Upper Hagg Farm, C2730/22/E/4174, June 2022;
- Mugen Windowless Sample Borehole Logs, July 2022; and
- Socotec, August 2022, Project 22072017.

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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 0.72 ha sized site currently comprises a farm yard with concrete hardstanding and stone barns and sheds for cattle with a slurry pit located in the South. The buildings are all situated upon flat surface, but the North West and South East areas of the site are sloping. The National Grid Reference for the centre of the site is 414589, 410572.

2.2 Proposed Development

The proposed development is to comprise the alteration of existing barn buildings and concrete yards into residential properties.

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 have farm buildings since the mid-1850s, surrounded by farmland. By 1970, additional farm buildings have been constructed, and residential properties have been built from 20m to 250m to the North West of the site. The site and surrounding area remains unchanged beyond this date.

3.2 Geology, Hydrology and Hydrogeology

3.2.1 Geology

According to the published geological maps the site is underlain by bedrock of the Rosendale Formation Sandstone, Siltstone and Mudstone.

The geological outcrops suggested that underlying geological conditions and topography have been formed due to fluvial action.

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 or historic landfill sites within 1000m of the site.

3.3.2 Potentially Contaminative Land Uses

Historic potentially contaminative land uses mapped within 250m of the site boundary have been identified solely as the farm buildings which has been used for cattle and therefore the use of farming

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machinery. Possible sources of ground gas have also been identified due to the potential for Made Ground.

3.4 Preliminary Contamination Assessment

Due to the potential risk for onsite soil contamination and ground gases from Made Ground a Phase II Intrusive Investigation was recommended.

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4.0 INTRUSIVE INVESTIGATION

4.1 Design

The Ground Investigation was designed by RGS in their Phase I Assessment 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:

- Four Windowless Sample Boreholes to obtain shallow soil samples for soil contamination testing and for in-situ testing to allow for strength assessment of underlying soils;
- Installation of ground gas monitoring standpipe to allow for ground monitoring assessment;
- One Hand Excavated Trial Pit to obtain shallow soil samples for contamination testing; and
- Visual slope stability assessment.

This Ground Investigation was undertaken on 15th July 2022. The exploratory holes were logged and sampled by a qualified engineer.

An exploratory hole location plan is shown in Appendix A.

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4.3 Sampling and In-Situ Testing

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

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 Socotec, which is a registered UKAS Testing laboratory. 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	3
Cyanide	3
Sulphate	3
pH	3
Speciated PAH	3
Total TPH	3

4.5 Ground Gas Monitoring Standpipe

Ground gas monitoring standpipe was installed in three Windowless Sample Boreholes (WS02, WS03 and WS04), with the construction details as follows:

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- WS01: 1.0m plain pipe and 2.0m slotted, with bentonite seal to 1.0m and pea gravel from 1.0m to 3.0m;
- WS03: 1.0m plain pipe and 2.00m slotted, with bentonite seal to 1.0m and pea gravel from 1.0m to 3.0m; and
- WS04: 1.0m plain pipe and 2.0m slotted, with bentonite seal to 1.0m and pea gravel from 1.0m to 3.0m.

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

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5.0 INTRUSIVE GROUND INVESTIGATION FINDINGS

The exploratory hole location plan is shown in Appendix A and full exploratory hole logs are included as Appendix B.

5.1 Ground Conditions Encountered

5.1.1 Surfacing

The surfacing across the main development site is concrete, which ranges in thickness from 0.15m to 0.20m. This was present in all Windowless Sample Boreholes.

In exploratory hole HP01 (Hand Pit), the surfacing was found to comprise a dark brown and black silty TOPSOIL to 0.30mbgl (metres below ground level).

5.1.2 Made Ground

Made Ground was encountered in exploratory holes WS03 and WS04 only, beneath the concrete and extending to depths of 0.30m to 0.40m. This Made Ground was found to comprise a reworked black organic clay with fragments of brick.

5.1.3 Highly Weathered Bedrock (Silty Clay)

The Made Ground was found to be underlain by a largely soft to firm brown silty CLAY, which was found to extend to depths of 0.90m to 2.10m (deepest in WS04). In exploratory hole WS02 this was found to be organic.

Standard Penetration Testing (SPTs) were carried out within this stratum, with SPT N value found to range from 8 to 17.

5.1.4 Intact Bedrock

In exploratory hole HP01 located in the North West of the site on the slope, a weathered brown SANDSTONE was encountered immediately beneath the TOPSOIL at a depth of 0.30mbgl.

Across the rest of the site the bedrock was encountered as a clayey weathered MUDSTONE with IRONSTONE nodules in exploratory holes WS01 and WS02, encountered at depths from 0.90mbgl. In

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exploratory holes WS03 and WS04 the bedrock was encountered as a brown weathered SILTSTONE, at depths from 1.20mbgl and 2.10mbgl.

SPTs were carried out within the bedrock with N values ranging from 16 to 34, increasing with depth as the bedrock becomes less weathered.

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6.0 FOUNDATIONS AND SLOPE STABILITY ASSESSMENT

6.1 Foundation

Typical pad or strip foundations will be suitable for the new proposed buildings, placed within the weathered bedrock at depths from around 0.90mbgl. Within the underlying weathered bedrock, it envisaged that an allowable bearing pressure in the region of 150kPa is achievable.

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.

6.2 Slopes and Existing Retaining Walls

Slopes situated to the North West of the development site and South East of the development site were visually assessed for any signs of potential slope stability issues. Photos are shown in Appendix D. A number of parameters were taken into consideration for the slope stability assessment. These were:

- Evidence of Scarps (Bare surface of a slope left due to the removal of earth caused by landslide);
- Evidence of Slumping (Landslide material that has slipped down the slope to form a Slump);
- Waterlogging (Areas of overly wet/soaked sections of the slope); and
- Vegetation.

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Table 6.1 summarises the findings of the slope stability assessment.

Table 6.1 Summary of Visual Slope Stability Assessment

ASSESSMENT PARAMETER	NORTH WEST SLOPE	SOUTH EAST SLOPE
Evidence of Slope Scars	NO	NO
Evidence of Slumping	NO	NO
Evidence of Waterlogged Areas	NO	NO
Vegetation	Thick Grass	Thick Grass

In conclusion it can be seen that there was no clear visual evidence of historical slope failure anywhere on the site.

The current development area which contains barns and sheds is situated at the top of the South East Slope, with the existing buildings well in excess of 5m from the slope crest. The only new building is to be a small extension, which will only add minimal loads to the current development area.

Slope stability issues are therefore not considered a risk due to the new development.

Upon assessing the condition of the existing retaining walls on the site, it was evident that the overall condition of the walls were good and solid. Built out of large sandstone blocks, which seem to have been in place for many years with no evidence of failure. No cracks, settlement or obvious movement within the walls was identified.

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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 Lead were measured within the shallow Made Ground taken from a depth of 0.20mbgl in exploratory hole WS03 (situated in proposed soft landscaped garden area). Soil remedial measures will be required in this area of the site.

In exploratory hole WS04, which is situated in the South of the site by the manure/waste heap, a number of elevated levels of soil contaminants were measured, these being PAH, TPH, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-c,d)Pyrene and Dibenzo(a,h)anthracene. This area of the site is to remain as concrete hardstanding, whereby the underlying soils are not going to be disturbed during the proposed new development. No remedial measures are therefore necessary here.

No elevated levels of soil contamination were recorded within exploratory hole HP01 located in the North West of the site.

Table 8.8.1 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	10.1	WS03
Cadmium	17	11	0.50	WS04
Copper	NC	2400	132.3	WS03
Chromium Total	NC	910	74	WS04
Lead	210	NC	329.9	WS03
Mercury (elemental)	NC	1.2	<0.5	All
Nickel	NC	130	24.2	WS03
Selenium	NC	250	<1.0	All
Zinc	NC	3700	278.3	WS03
PAH (total)	NC	NC	1180	WS04

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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
TPH (total)	NC	150-550 ₍₄₎	5710	WS04
Naphthalene	NC	1.5	0.74	WS04
Acenaphthylene	NC	170	1.09	WS04
Acenaphthene	NC	210	2.69	WS04
Fluorene	NC	170	3.43	WS04
Phenanthrene	NC	95	44.3	WS04
Anthracene	NC	2400	24.0	WS04
Fluoranthene	NC	280	220	WS04
Pyrene	NC	620	197	WS04
Benzo(a)anthracene	NC	7.2	119	WS04
Chrysene	NC	15	113	WS04
Benzo(b)fluoranthene	NC	2.6	130	WS04
Benzo(k)fluoranthene	NC	77	40.2	WS04
Benzo(a)pyrene	3.2	2.2	122	WS04
Indeno(1,2,3-c,d)Pyrene	NC	2.3	82.9	WS04
Dibenzo(a,h)anthracene	NC	0.24	15.5	WS04
Benzo(g,h,i)perylene	NC	320	59.5	WS04
Others				
Cyanide (total)*	NC	5	<1	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 Lead and Zinc were identified in the location of WS03 (in an area of proposed soft landscaping). Remedial measures will therefore be necessary in this area prior to placement of the new soft landscaped garden.

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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	10.1	WS03
Copper	80	200	132.3	WS03
Nickel	50	110	24.2	WS03
Zinc	200	300	278.3	WS03
Cadmium	3	NL	0.5	WS04
Lead	300	NL	329.9	WS03
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 been used for farming. It was due to the construction of these buildings that the small amount of Made Ground was encountered. This Made Ground was identified as the main potential sources of on-site soil contamination in addition to possible ground gases resulting from potentially deeper Made Ground in areas of the site which are not to be redeveloped.

No off-site sources of contamination were identified.

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

Table 9.9.1 Summary of Contaminant Sources & Contaminants

Structure / Process	Contaminants Present on Site
Made Ground	<ul style="list-style-type: none"> Elevated levels of Lead, Zinc, PAH, TPH, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-c,d)Pyrene and Dibenzo(a,h)anthracene
Accumulations of Ground Gas	<ul style="list-style-type: none"> Ground Gas Monitoring Currently Ongoing

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 9.9.2 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 9.9.3 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 9.9.4 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

Table 9.9.5 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 Lead and Zinc</p> <p>Off Site:</p> <p>Ground Gas Monitoring ongoing.</p> <p>Elevated levels of PAH, TPH, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-c,d)Pyrene and Dibenzo(a,h)anthracene</p>	<p>Residential Homeowners</p>	<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. 	Moderate/Low	<p>Elevated levels of Lead and Zinc measured from within shallow soil samples taken in areas of proposed soft landscaped gardens.</p> <p>Ground gas monitoring is currently still ongoing.</p>	<p>Soil remedial measures will be required in the proposed back garden area of the site where exploratory hole WS03 was undertaken. These measures should include the removal of the top 0.30m of soils and replacement with 0.15m of sub-soil and a minimum of 0.15m of clean imported topsoil.</p> <p>The area away from the proposed development site is not to be disturbed and therefore no active pathway exists for these elevated levels of soil contamination to come into human contact. No further remedial measures are therefore necessary in this area of the site.</p>
	<p>Construction Workers</p>		Low	<p>Elevated levels of PAH, TPH, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-c,d)Pyrene and Dibenzo(a,h)anthracene in current hardstanding area down slope and away from proposed development site.</p>	<p>Suitable PPE must be worn at times.</p>

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	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
	Building	<ul style="list-style-type: none"> Accumulation of soil and water derived vapours/and or ground gas in enclosed spaces 	Low -Ground Gas Monitoring ongoing	Ground gas monitoring still ongoing
	Potable Water Supply Routes	<ul style="list-style-type: none"> Migration of contaminants into newly placed potable water supply routes 	Low	No Further Assessment Required

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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 encountered in the proposed soft landscaped back garden area of the site contains elevated levels of Lead and Zinc. Remedial measures will therefore be necessary in this area, as discussed in section 9.4.

Gas Monitoring is currently ongoing.

Therefore, the current risks to human health has currently been assessed to be **MODERATE/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

Ground Gas Monitoring is currently ongoing. The current risk to ground gas is therefore currently considered to be **LOW** until the monitoring assessment has been completed.

9.4 Recommended Remedial Measures

Due to the presence of elevated levels of Lead and Zinc in the proposed soft landscaped garden area of the new residential dwelling, soil remediation will be required. The following is deemed necessary as a minimum:

- Excavation of top 0.30m of mixed clayey Made Ground encountered across the whole proposed soft landscaped garden area, and replacement with a clean imported or site won soil and topsoil.

A remediation strategy report is recommended for the site.

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10.0 CONCLUSIONS

The Phase I Desk Study identified potential on-site sources of contamination due to the presence of buildings used for farming and possible contamination from vehicle and machinery used over the years. Additionally a risk of possible ground gases was also identified.

An intrusive investigation was therefore carried out across the site comprising a hand dug trial pit and four Windowless Sample Boreholes, to allow for collection of shallow soil samples to be tested for a range of soil contaminants.

Soil laboratory testing identified elevated levels of Lead and Zinc in one exploratory hole (WS03), situated in an area of the site which is proposed to be soft landscaped gardens. It was therefore recommended that remedial measures will be required in this area of the site. These remedial measures should comprise removal of the contaminated soil and replacement with a clean imported sub-soil and topsoil.

Elevated levels of a wide range of contaminants were also identified in exploratory hole WS04 (situated in the area of the slurry pit). As this area is not to be disturbed or developed upon, no further remedial measures were deemed necessary here.

At the time of writing, ground gas monitoring is currently ongoing, and a separate letter report will be issued when this has been completed.

Due to the presence of relatively shallow intact bedrock, it has been recommended that shallow strip or pad footings will suffice for the new building.

Additionally, a visual slope stability and retaining wall assessment was carried out whilst on site. It was found that no evidence of scars, slumping, waterlogging or a soft toe was identified and therefore the risks of historical or future slope stability issues arising due to the new development was deemed to be Low.

The existing retaining walls were found to be in good condition with no evidence of failure.

11.0 RECOMMENDATIONS

Due to the requirement for remedial measures in the proposed soft landscaped garden area, a remediation strategy report is recommended, detailing the requirements of the remediation.

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12.0 REFERENCES

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