

## **Proposed re-development at Colne Vale Business Park**

### **Phase II Interpretative Report**

**May 2024**

Proposed Re-development at Colne Vale Business Park  
Phase II Interpretative Report

RB Geotechnical

**Document Control**

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**Client:** Investigation  
Colin Thwaites  
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## **DISCLAIMER**

This report was produced by **RB Geotechnical** for Colin Thwaites (The client), for the specific purposes of a Phase II Intrusive Investigation and Interpretative Report, for the proposed construction of three new industrial units along with associated parking at the Colne Vale Business Park in Milnsbridge, Huddersfield, 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.

## Phase II Interpretative Report

### 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 the site of Colne Vale Business Park in Milnsbridge, West Yorkshire. The site is intended to form a set of three new industrial units, with associated car parking.

RB Geotechnical undertook an intrusive ground investigation on 14<sup>th</sup> March 2024, 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 a ground gas risk assessment.

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 Colin Thwaites, for the purpose of assessing the ground conditions on site.

#### 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 assessment. 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
- To provide recommendations for further works where necessary.

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### 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

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, Phase I Environmental Desk Study Report, Colne Vale Industrial Estate, Phase I Desk Study Report, C4013/23/E/6099, January 2024;
- Mugen Windowless Sample Borehole Logs, March 2024; and
- Envirolab Job No. 24/02940, 21<sup>st</sup> April 2024.

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 0.10ha sized site, is situated at Colne Vale Business Park on Colne Vale Road in Milnsbridge, West Yorkshire. The site currently comprises a concrete storage yard, containing heavy plant and vehicles that are associated with the business park. The National Grid Reference for the centre of the site is 411130, 415793.

### **2.2 Proposed Development**

The proposed development is to comprise the construction of three new industrial units, with a smaller unit set in the South East of the site and another in the centre of the site, with associated car parking around these. A larger industrial unit is then proposed to occupy the North of the site, also with associated car parking.

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

### **3.0 EXISTING INFORMATION**

#### **3.1 Site History**

The earliest historical map of 1854 shows the site as an undeveloped parcel of land set between two rivers. By 1890 Milnsbridge Bottom Chemical Works is mapped on site, with the rest of the site being a yard for these works. The site remains unchanged up until some point between 1930 and 1956 when it becomes renamed as Colne Vale Dye & Chemical Works. Other than an Electrical Sub-Station being constructed in the South West of the site at some point between 1982 and 1985, the site remains unchanged to the present day.

#### **3.2 Geology, Hydrology and Hydrogeology**

##### **3.2.1 Geology**

According to the published geological maps the site is mapped as being underlain by superficial deposits of mixed silty clay alluvium, underlain by bedrock of the Millstone Grit Sandstone, Mudstone and Siltstone.

##### **3.2.2 Hydrology and Hydrogeology**

The underlying geology is mapped as being a Secondary A Aquifer, which is defined as being a rock or soil with permeable layers that are capable of supporting water supplies at a local rather than strategic scale. The site is also within a Zone 2 and Zone 3 Fluvial Model floodplain and is classified as being at a HIGH risk of flooding from Rivers or Sea.

#### **3.3 Preliminary Contamination Assessment**

The sites historical construction and demolition of buildings in addition to its overall historical industrial use including the presence of various chemicals, have been identified as the main possible sources of contamination. These sources could result in soil contamination in the form of heavy metals and inorganics, in addition to ground gas accumulations of Carbon Dioxide and Methane.

It was recommended that a Phase II Intrusive Investigation be carried out in order to assess the site for potential soil contamination and potential ground gas risks.

## **4.0 INTRUSIVE INVESTIGATION**

### **4.1 Design**

The Ground Investigation was designed by **RB Geotechnical** to investigate the ground conditions of the site.

### **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 Windowless Sample Boreholes to obtain shallow soil samples for soil contamination I testing and for in-situ testing to allow for strength assessment of underlying soils; and
- Installation of ground gas monitoring standpipe in three Windowless Sample Boreholes; and
- Ground Gas Monitoring Assessment

This Ground Investigation was undertaken on 14<sup>th</sup> March 2024. 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 boreholes and stored in plastic pots and jars placed into a cool box.

The cool boxes were then sent to the laboratory and the samples stored appropriately in a refrigerator until testing.

#### 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 three soil samples were sent to Envirolab, 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
Speciated PAH	3
TPH CWG	3
Asbestos	3

#### 4.5 Ground Gas Monitoring Standpipe

Ground gas monitoring standpipe was installed in three Windowless Sample Boreholes (WS01, WS02 and WS03), with the construction details as follows:

- WS01: 1.00m plain pipe and 3.00m slotted, with bentonite seal to 1.00m and pea gravel from 1.00m to 4.00m;
- WS02: 0.50m plain pipe and 0.60m slotted, with bentonite seal to 0.50m and pea gravel from 0.50m to 1.10m; and

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- WS03: 0.50m plain pipe and 1.05m slotted, with bentonite seal to 0.50m and pea gravel from 0.50m to 1.55m.

In-situ gas monitoring is to be carried out in each of these Boreholes, using a portable gas meter which measures Oxygen, Methane, Carbon Dioxide and air pressure. Ground gas monitoring results are shown in Appendix D.

## 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 Tarmac

The site was surfaced with a Tarmac, which had been broken out and returned as a gravel, from ground level to 0.10mbgl (metres below ground level)

#### 5.1.2 Made Ground

This tarmac was found to be underlain by a mixed red, yellow and black slightly gravelly sandy clay MADE GROUND with gravels of sandstone, brick, concrete, coal and ash. This MADE GROUND was found to extend to a depth of 1.60mbgl in WS01, 1.10mbgl in WS02 and 1.55mbgl in WS03.

In WS02 and WS03 this MADE GROUND and the borehole refused on solid concrete at depths of 1.10mbgl and 1.55mbgl respectively. This concrete is likely to be associated with historical footings or sub-surface structures associated with historical buildings on the site.

#### 5.1.3 Alluvium (Gravelly Silty Clay)

A firm soft, pale greyish brown slightly gravelly sandy silty CLAY/SILT with sandstone gravels, was encountered beneath the MADE GROUND in WS01 at a depth of 1.60mbgl extending to a depth of at least 4.0mbgl.

Standard Penetration Testing (SPTs) were carried out within this stratum, with SPT N values found to range from 7 to 27, indicating a wide range of strength with depth, likely associated with the mixed composition of this stratum.

This borehole was unable to extend beyond 4.0mbgl, as groundwater was encountered at 3.23mbgl, resulting in the silty soils beneath it collapsing during drilling.

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## 5.2 Ground Gas Monitoring

Ground gas monitoring standpipe was installed into three boreholes (WS01, WS02 and WS03)

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 on six separate occasions following the intrusive Ground Investigation on the following dates: 18<sup>th</sup> March 2024, 25<sup>th</sup> March 2024, 2<sup>nd</sup> April 2024, 11<sup>th</sup> April 2024, 16<sup>th</sup> April 2024 and 25<sup>th</sup> April 2024. Ensuring that a range of Atmospheric Pressures were encountered in addition to differing pressure patterns. Full gas monitoring results are shown in Appendix D.

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.

Gas Screening Values (GSV) for the site was calculated using the highest gas values (using both Methane and Carbon Dioxide) and flow rate. The highest measured gas value on this site was Carbon Dioxide of 1.80%, with a Flow Rate of 0.10l/hr. The GSV for the site can therefore be calculated as  $0.018 \times 0.10 = 0.0018$  l/hr.

Using Table 2 from BS8485:2015+A1:2019, the site GSV of 0.0018/hr classifies it as having a 'Low' Hazard Potential, with a CS value of CS1.

Using Table 3 from BS8485:2015+A1:2019, the site can be defined as being building type 'Type B', which is defined as being a private or commercial/public building.

Using Table 4 from BS8485:2015+A1:2019, the gas protection score by CS and type of building, for this site is: 0, and therefore no ground gas protective measures are needed.

Groundwater was encountered during the intrusive investigation in exploratory hole WS01 at a depth of 3.23mbgl. During gas monitoring groundwater was encountered within this borehole throughout, at depths from 3.10mbgl to 3.20mbgl.

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**6.0 GROUND CONTAMINATION – GENERIC QUANTITATIVE RISK ASSESSMENT**

The following assessment was performed in the context of the planning regime and in line with current UK guidelines which follows the procedures set out in the Environmental Agency 'Land Contamination Risk Management' (LCRM) web pages which are accessible via the government website. LCRM 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. LCRM has adopted and refined the methodology and terminology that has been used in contaminated land risk assessment for a number of years.

This is used 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 Envirolab 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.

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**6.1 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 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 commercial land use has been selected as this matches the proposed future land use.

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**7.0 DISCUSSION OF RESULTS****7.1 Human Health Hazards**

The results shown in Table 7.1, confirm that no elevated levels of contaminants were measured within the shallow soils, however Asbestos was identified in all three samples in the form of Chrysotile. Levels of asbestos identified were all <0.1% and therefore this will not be classed as hazardous waste. No remedial measures are therefore required on site prior to construction.

**Table 7.1 Comparison of Soil Test Results with Commercial End Use C4SI/S4UL**

Determinant	Assessment Criteria	(mg/kg) Recorded Concentrations Across The Site	
	S4UL Generic Assessment Criteria	Highest Recorded Value	Location of Highest Recorded Value and other exceedances
<b>Metals, semi- metals and non-metals</b>			
Arsenic	640	30	WS03
Cadmium	190	1.0	WS03
Copper	68000	134	WS03
Chromium Total	8600	87	WS03
Lead	450	135	WS03
Mercury (elemental)	58	<0.17	All
Nickel	980	52	WS03
Selenium	12000	<1	All
Zinc	730000	133	WS03
<b>Others</b>			
Naphthalene	190	0.34	WS03
Acenaphthylene	83000	0.17	WS03
Acenaphthene	84000	1.06	WS03
Fluorene	63000	0.96	WS03
Phenanthrene	22000	6.26	WS03
Anthracene	520000	1.93	WS03
Fluoranthene	23000	11.7	WS03
Pyrene	54000	10.6	WS03
Benzo(a)anthracene	170	6.09	WS03
Chrysene	350	5.49	WS03
Benzo(b)fluoranthene	44	6.70	WS03
Benzo(k)fluoranthene	77	2.30	WS03
Benzo(a)pyrene	35	6.23	WS03
Indeno(1,2,3-c,d)Pyrene	500	4.27	WS03
Dibenzo(a,h)anthracene	3.5	0.85	WS03
Benzo(g,h,i)perylene	3900	3.91	WS03
<b>Others</b>			
Cyanide (total)*	5	<1	All

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Determinant	Assessment Criteria	(mg/kg) Recorded Concentrations Across The Site (mg/kg)	
	S4UL Generic Assessment Criteria	Highest Recorded Value	Location of Highest Recorded Value and other exceedances
Asbestos In Soil	NC	0.009	WS01/WS02/WS03
<b>Speciated TPH</b>			
Aliphatic EC5-6	3400	<0.01	All
Aliphatic EC6-8	8300	<0.01	All
Aliphatic EC8-10	2100	1	WS01
Aliphatic EC10-12	10000	1	WS01
Aliphatic EC12-16	61000	<1	All
Aliphatic EC16-35	1600000	541	WS03
Aromatic EC5-7	28000	<0.01	All
Aromatic EC7-8	59000	<0.01	All
Aromatic EC8-10	37000	2	WS01/WS02
Aromatic EC10-12	17000	1	WS01
Aromatic EC12-16	36000	52	WS03
Aromatic EC16-21	28000	156	WS03
Aromatic EC21-35	28000	467	WS03

**NOTES:**  
(1) C4SL/LQM S4UL 2015 for Commercial Use  
(2) \*= Dutch Target value used as screening value for cyanide.  
(3) NC = No criterion.

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## 8.0 CONCEPTUAL SITE MODEL

### 8.1 Introduction

The information obtained from this investigation has been collated and evaluated to develop a refined Conceptual Model for the site.

The following assessment was performed in the context of the planning regime and in line with current UK guidelines which follows the procedures set out in the Environmental Agency 'Land Contamination Risk Management' (LCRM) web pages which are accessible via the government website. LCRM 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. LCRM has adopted and refined the methodology and terminology that has been used in contaminated land risk assessment for a number of years.

The site has been assessed in line with current UK guidelines, namely the 'Land Contamination Risk Management' (LCRM) web pages which are accessible via the government website 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.

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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 commercial end use.

## 8.2 Hazard Identification

### 8.2.1 Potential Contamination Sources

Historically the site has contained a chemical works. This in addition to historical demolition and construction across the site results in potential contamination in the shallow soils, associated with any Made Ground that has been placed or fuel/chemical leaks over the years.

During the intrusive investigation it was established that no elevated levels of soil contaminants were identified, neither were elevated gases recorded. Asbestos was however encountered in the shallow Made Ground, but levels are very low.

A summary of potentially significant sources of contamination encountered are presented in Table 8.1.

**Table 8.1 Summary of Contaminant Sources & Contaminants**

Structure / Process	Contaminants Present on Site
Made Ground	<ul style="list-style-type: none"> <li>Asbestos</li> </ul>

### 8.2.2 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);

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- Underlying **Aquifer** – Underlying bedrock
- **New potable water supply pipes**
- **Ingress of ground gases into structures**

### 8.2.3 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.

### 8.2.4 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 8.2 and Table 8.3.

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**Table 8.2 Methodology for Assessing Consequence of Harm**

Consequence	Criteria
<b>Severe</b>	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
<b>Moderate</b>	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
<b>Mild</b>	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
<b>Negligible</b>	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 8.3 Methodology for Assessing Likelihood of Consequence Occurring**

Probability	Criteria
<b>Almost Certain</b>	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
<b>Likely</b>	Circumstances are such that an event, whilst not inevitable, is possible in the short term and is likely to occur over the long term
<b>Unlikely</b>	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
<b>Very Unlikely</b>	Pollutant linkage may be present, but the circumstances under which harm would occur are improbable even in the medium to long term
<b>Extremely Unlikely</b>	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 8.4 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 8.4 Comparison of Consequence and Likelihood**

<b>Consequence Probability</b>	<b>Severe</b>	<b>Moderate</b>	<b>Mild</b>	<b>Negligible</b>
<b>Almost Certain</b>	Very High Risk	High Risk	Moderate Risk	Low Risk
<b>Likely</b>	High Risk	Moderate Risk	Moderate/ Low Risk	Low Risk
<b>Unlikely</b>	Moderate Risk	Moderate/ Low Risk	Low Risk	Very Low Risk
<b>Very Unlikely</b>	Low Risk	Low Risk	Very Low Risk	Very Low Risk
<b>Extremely Unlikely</b>	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 8.5

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Table 8.5 Conceptual Site Model

Source	Receptor	Pathway	Risk	Pollutants Encountered/Chemicals of Concern	Remedial Option(s)/Next Steps
On Site: Made Ground	Employees	<ul style="list-style-type: none"> <li>• 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.</li> <li>• Inhalation of contaminants in soil derived dust from areas where soil is exposed at the surface of where excavation takes place.</li> </ul>	Low	Asbestos	Although asbestos was encountered in WS01, WS02 and WS03, the levels of asbestos (<0.1%) does not class the soil here as being hazardous waste. Although no remedial measures will be required, appropriate PPE must be ensured during any excavation of soils on site.
	Construction Workers		Low		
	Groundwater within the underlying superficial soils and bedrock	<ul style="list-style-type: none"> <li>• Leaching of contaminants and/or migration of free phase contaminants from the unsaturated zone soils to groundwater in the natural strata</li> <li>• Vertical migration of contaminants in shallow groundwater to deeper strata and aquifer.</li> </ul>	Low	No Further Assessment Required	
	Surface Water	<ul style="list-style-type: none"> <li>• Lateral migration of contaminants and/or migration of free phase contaminants present in the Made Ground via groundwater to surface water discharge</li> <li>• Lateral migration of contaminants and/or migration of free phase contaminants present in the Made Ground and entrained in surface water runoff</li> </ul>	Low	No Further Assessment Required	
	Building	<ul style="list-style-type: none"> <li>• Accumulation of soil and water derived vapours/and or ground gas in enclosed spaces</li> </ul>	Low	No Further Assessment Required	
	Potable Water Supply Routes	<ul style="list-style-type: none"> <li>• Migration of contaminants into newly placed potable water supply routes</li> </ul>	Low	No Further Assessment Required	

### 8.3 Discussion of Risks

The risk assessment presented in the above sections and summarised within the CSM presented in Table 8.5 shows that Contaminant Linkages have been identified at the site from on-site sources. The following sections provide a discussion of the environmental risks based on the ground investigation and laboratory data.

#### 8.3.1 Human Health

##### Proposed property users

The ground investigation and laboratory testing showed no elevated levels of contaminants on site that could affect the proposed development.

Therefore, the current risks to human health has currently 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**.

#### 8.3.2 Aquifer

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

#### 8.3.3 Surface Water

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

#### 8.3.4 Potable Water Supply Pipes

The current risk to proposed new utility routes is **LOW**.

**8.3.5 Buildings**

Ground gas monitoring did not identify any elevated levels of ground gases. The risk of ground gases into the new building are therefore currently considered to be **LOW**.

## 9.0 CONCLUSIONS

Potential on-site sources of contamination were identified as possibly contaminated Made Ground associated with historical demolition and construction of buildings on the site in addition to its past use as a chemical works.

An intrusive investigation was therefore carried out across the site comprising three Windowless Sample Boreholes, to allow for collection of shallow soil samples to be tested for a range of soil contaminants in addition to installation of ground gas monitoring standpipe to allow for a ground gas assessment.

Soil contamination testing was carried out and no elevated levels of soil contamination was identified and therefore no remedial measures will be necessary.

Asbestos was identified in the shallow soils taken from areas beneath the building footprint. However, the levels were minimal and not believed to class the soils as being hazardous waste. Should the soils require excavation in these areas, appropriate PPE must be worn by are construction workers to prevent the risks caused by potential asbestos fibres.

No ground gases were identified and therefore no ground gas protective measures are necessary.

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**10.0 REFERENCES**

- BRE Special Digest 1:2005: Concrete in aggressive ground, BRE Construction Division
- BS 5930: (2015): Code of Practice for Site Investigation. British Standards Institution
- BS 10175: (2011): Code of Practice for the Investigation of Potentially Contaminated Sites. British Standards Institution
- BS 8485: (2015); Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings
- CIRIA Special Publication (2002) Construction over abandoned mine workings.
- CIRIA C665 (2007) Assessing risks posed by hazardous ground gases to buildings
- CL:AIRE (2013) SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination
- DEFRA and Environment Agency (2004) Model Procedures for the Management of Land Contamination, R&D Publication CLR11.
- Environment Agency (2009) CLEA Software (Version 1.06) Handbook, Scientific Report SC050021/SR4
- Environment Agency (2009) Updated technical background to the CLEA Model, Scientific Report SC050021/SR3
- Environment Agency (2000) Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination, R&D Technical Report P5-066/TR.
- Interim Advice Note 73/06 (2009) Design Guidance for Road Pavement Foundations, Draft HD25.
- Meyerhof, G (1957) The Ultimate Bearing Capacity of Foundations on Slopes, Proceedings of the 4<sup>th</sup> International Conference, Vol. 3, pp. 384 – 386.

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- Ministry of Agriculture, Fisheries and Food (1998) Code of Good agricultural Practice for the Protection of Soil. MAFF Publications, London
- Nathanail, C.P., McCafferey. C., Gillett, A., Ogden, R.C., and Nathanail, J.F. (2015) The LQM/CIEH S4ULs for Human Health Risk Assessment. Land Quality Press, Nottingham.
- NHBC (2007) Guidance on Evaluation of Development Proposals on Sites Where Methane and Carbon Dioxide are Present, Report Edition No. 4.
- NHBC (2008) Guidance for the Safe Development of Housing on Land Affected by Contamination.
- NHBC (2022) Part 4 Building Near Trees