



Your Environment

PHASE 2: SITE INVESTIGATION REPORT BRITANNIA ROAD, HUDDERSFIELD, HD3 4QB

For ECS Remediation Ltd

Your Environment

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1.0 Introduction

YourEnvironment (YE) was instructed by ECS Remediation (Quote No: Q1601, Dated: November 23rd 2021) to conduct a Site Investigation (SI) at a site located at Britannia Road, Huddersfield, HD3 4QB.

The SI undertaken is as a result of recommendations made by Dunelm Geotechnical & Environmental in their previously issued Phase 1: Desktop Study & Risk Assessment Report for the site (Report Reference: D8544, Issued: February 2018), to which this report should be read in conjunction with. As such this report seeks to address the potential pollutant linkages identified within the Preliminary Conceptual Site Model contained within our Phase 1: Desktop Study report.

We are content that as a result of the actual site investigation works and subsequent soil testing undertaken, as outlined within this report, we have characterised the ground conditions and consequently the potential for contamination to exist on site. These works and ensuing assessment have been detailed in this report.

The information contained in this report is intended for the use of the named client (or their approved contractors). Should any part of this report be relied on by a third party, that party does so wholly at its own risk and YE disclaims any liability to such parties. Should the purposes for which the report is used, or the proposed use of the site change, this report may no longer be valid and further use of, or reliance upon the report in those circumstances shall be at the client's sole and own risk. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. YE should in all such altered circumstances be commissioned to review and update this report accordingly.

2.0 Proposed Development

No formal plans were made available to YE at the time of preparing this report; however, it is understood that the development will be classified as 'residential with the consumption of homegrown produce'.

3.0 Physical Setting

3.1 Site Information

General

The site is approximately 3.5km west of Huddersfield town centre

Topography and Features

The site slopes down from north to south.

The southern perimeter of the site is formed by a drystone wall.

Several mature trees were noted on and around the site with evidence of trees having recently been cut down.

3.2 Geology

The relevant British Geological Survey (BGS) online mapping information indicates that the site is devoid of superficial ground deposits. The bedrock geology is composed of the Millstone Grit.

3.3 Hydrogeology

The Environment Agency designate aquifers in accordance with the Water Framework Directive. These designations reflect not only the importance of aquifers in terms of groundwater as a resource (drinking water supply) but also their role in supporting surface water flows and wetlands ecosystems. The aquifer designation data is based on geological mapping provided by the British Geological Survey.

As a result of the bedrock geology on site, the aquifer is designated as being a Secondary (A) Aquifer. These are defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as Minor Aquifers.

3.4 Hydrology

Groundwater Abstraction Licences

There are no active groundwater abstraction licences within 900m.

Surface Water Features

The closest surface water feature is 100m south for the Huddersfield Canal.

Source Protection Zones

The study site is not located within a Source Protection Zone.

3.5 Contaminant Sources

The desk study indicated that the site had not been previously developed and it was therefore considered unlikely that significant ground contamination was present.

However, the site is located in an area that has been industrialised in the past. Consequently, near-surface deposits may have been affected by slight contamination in the form of particulates emitted from chimneys or include localised ash deposits from domestic fires.

Also, infilled ground was noted within 250m of the site.

The contaminants associated with these sources are:

- Metals
- PAHs
- TPHs
- Ground gas

4.0 Fieldworks

4.1 Site Investigation

The following SI works were completed on November 27th 2020 under the supervision of a Geo-Environmental Engineer from YE. In summary, the investigation included:

- A two-man team ascertained the routes of any below ground services in close proximity to the proposed exploratory hole positions, using a CAT scan and lifting up of any man hole covers. Following the CAT scan, hand dug starter pits were completed to a depth of 1.20 metres below ground level (mbgl).
- Five (5no.) windowless sampler boreholes were completed, by means of an Archway rig, to a maximum depth of 5.00mbgl. The locations of exploratory positions were selected relative to the historic land use and current proposed redevelopment plans for the site whilst providing a broad coverage of the site as feasibly as possible.
- The windowless sampler boreholes were logged with any groundwater conditions noted and representative soil samples removed in accordance with current guidelines.
- Soil samples were removed from shallow sub surface locations, with further samples taken at depth every 1.00mbgl or when the underlying stratum changed. Samples were subsequently placed in suitable containers including 1kg tubs and 250ml glass jars and placed in cool boxes with cool packs prior to storage within our *in-house* laboratory fridges and then subsequent forwarding to our designated laboratory for analysis.
- Three boreholes (WS01, WS04 and WS05) were installed with a standpipe comprising of 50mm pipework to a maximum depth of 5.00mbgl to enable future gas and groundwater monitoring to be undertaken. This was completed with a lockable cover, flush with the ground, to protect the installation.
- Upon completion, all exploratory holes were back filled, compacted and made good to existing levels and finishes, with any surplus spoil bagged up and removed from site.

The positions of exploratory holes in relation to the existing site layout can be reviewed within **Appendix A**. Exploratory windowless sampler logs located in **Appendix B**.

4.2 Ground Gas and Groundwater Monitoring

Six rounds of ground gas and groundwater monitoring have been carried out dated 11th and 22nd of December, 6th and 19th of January and 4th and 16th of February using the standpipe installations of exploratory hole locations of WS01, WS04 and WS05.

4.2.1 Ground Gas

Ground gas monitoring was carried out in accordance with the guidelines presented in CIRIA C665 '*Assessing risk posed by hazard ground gases to buildings*' using a GA5000 and involved the following steps:

Flow was monitored for a period of two minutes where possible; maximum flow was recorded. Ground gases, including concentrations of methane, carbon dioxide, hydrogen sulphide and carbon monoxide were monitored for up to five minutes. During monitoring, ground gas readings were logged every thirty seconds.

4.2.2 Groundwater

A groundwater sample was recovered, where possible, from each of the installations.

Groundwater monitoring was completed in accordance with BS6068:2009 Water Quality Sampling: Guidance on Sampling of Groundwater.

A two phase dip meter was used to determine the presence of Light Non Aqueous Phase Liquids (LNAPL) and Dense Non Aqueous Phase Liquids (DNAPL). Each well was purged before a sample was taken and retained in a 1 litre coloured glass bottle (Winchester).

The monitoring results are presented in [Appendix E](#).

5.0 Geology & Ground Conditions

The following ground conditions were encountered during the SI;

Topsoil - in all positions to a maximum depth of 0.35mbgl.

Head Deposits - potential head deposits were encountered from depths of 0.30mbgl to a maximum depth of 5.45mbgl. This stratum generally comprised a firm orange dark brown very sandy gravelly CLAY. Gravel is fine to coarse angular to subangular of mudstone and sandstone.

6.0 Groundwater Conditions

Groundwater was not encountered during the site works completed. However, it was encountered within six of the monitoring rounds. The following table presents the levels recorded in each installation and round of monitoring.

Exploratory Hole	MON1 Standing Level (mbgl)	MON2 Standing Level (mbgl)	MON3 Standing Level (mbgl)	MON4 Standing Level (mbgl)	MON5 Standing Level (mbgl)	MON6 Standing Level (mbgl)
WS1	4.81	4.75	4.36	4.45	3.87	3.74
WS4	1.35	1.23	1.48	1.88	1.35	1.06
WS5	0.81	0.85	0.83	0.98	0.92	0.64

Table 1: Groundwater level recorded in installs

It should be noted that groundwater levels are dependent upon seasonal variations and can change after periods of prolonged rainfall or drought.

7.0 Visual and Olfactory Observations

No visual and/or olfactory evidence of potential contamination was noted within any soils encountered as part of the investigative works undertaken.

8.0 Contamination

8.1 Soil Testing

A total of ten (10no.) samples have been analysed by Chemtech Environmental Ltd in their UKAS and MCERTS accredited laboratory-testing facility in accordance with laboratory protocol.

The testing completed comprised of a focused suite of heavy metals, speciated Total Petroleum Hydrocarbons (TPH CWG Aromatic/aliphatic split) and speciated Polycyclic Aromatic Hydrocarbons (PAH) including the more carcinogenic benzo(a)pyrene (BaP) and naphthalene, asbestos, soil organic matter (SOM) content, pesticides, MTBE & BTEX, cyanide, pH and sulphates.

The results of this laboratory testing have been compared to the Soil Guideline Values (SGVs) as well as the CIEH 'LQM' guideline values for inorganic and organic contaminants in soils. The proposed development of the site is intended to comprise of residential and therefore screening has been made against a land use of 'residential with homegrown produce'.

8.2 Selection of Screening Criteria

The on site receptors for the study site are considered to be:

- Construction workers (during redevelopment of the site only);
- Future maintenance workers (following redevelopment);
- Future end users and site visitors (following redevelopment); and
- Trespassers (during redevelopment).

No off-site receptors for the site are identified due to the rural nature of the site.

Risks to construction workers during the redevelopment process will be mitigated by adhering to appropriate health and safety legislation, and the wearing of appropriate personal protective equipment (PPE). During redevelopment, the site will be securely fenced to prevent trespassers from accessing the site, and good site management practices will be implemented to mitigate exposure to off-site receptors.

The potential pathways for contaminants within the soil to human health receptors following redevelopment are considered to be:

- Direct ingestion of soil and soil derived dust;
- Dermal contact with soil outside and soil derived dust inside;
- Inhalation of soil derived dust inside and outside; and
- Inhalation of soil derived vapours inside and outside.

The potential pathways for contaminants within the soil to off-site human health receptors following redevelopment are considered to be:

- Direct ingestion of soil and soil derived dust;
- Dermal contact with soil outside and soil derived dust inside;
- Inhalation of soil derived dust inside and outside; and
- Inhalation of soil derived vapours inside and outside if contamination within soil is able to migrate across the site boundary within.

In the first instance, the results of this laboratory testing have been compared to generic assessment criteria (GAC) for the residential with homegrown produce land use scenario. These incorporate the following pathways:

- Direct ingestion of soil and soil derived dust;
- Dermal contact with soil outside and soil derived dust inside;
- Inhalation of soil derived dust inside and outside; and
- Inhalation of soil derived vapours inside and outside.

Contaminants have been screened against revised LQM/CIEH S4UL criteria¹ where available. These GAC have been designed for use under planning, using Health Criteria Values based on minimal risk, and updated exposure parameters. The S4UL are intended to replace the previous LQM/CIEH GAC. The S4UL are based on the assumption of a sandy loam soil the 1.0% soil organic matter (SOM) criteria have been used, where available and appropriate, in the first instance. All soil samples were analysed for %SOM, the range was from 0.1-3.3%, and so this conservative approach is considered appropriate for initial screening.

Where no S4UL are available, the EIC/ AGS/ CL:AIRE/ GAC² have been used. The toxicological criteria within these are also based on minimal risk. It is recognised that these criteria have not recently been updated, and in particular, do not incorporate the slightly higher inhalation rates that have been used within the S4UL. However, given that they incorporate additional pathways, they are considered suitable for an initial screen. The EIC/ AGS/ CL:AIRE/ GAC are also based on a sandy loam soil and the 1% SOM criteria have been used in the first instance.

There is neither an S4UL nor a EIC/ AGS/ CL:AIRE/ GAC available for lead. In the absence of a GAC based on minimal risk, the C4SL for lead has been used. It is recognised that this is based on a “low level of toxicological concern” rather than on a minimal risk level. However, it is considered appropriate for use under planning, especially for a site where there will effectively be no pathways for inorganic metals following redevelopment.

All the GAC are based on a sandy loam soil. This is considered appropriate for use for initial screening. Although it is apparent from the laboratory soil descriptions, that the Made Ground, by its very nature is heterogeneous, and often has a significant sand/gravel component, especially at shallow depths, it is noted that many of the soil descriptions have a significant clay component at increasing depth.

All of the GAC assume unsaturated soils. However, the use of the GAC are considered to be conservative, because they assume a certain air-filled porosity and water-filled porosity.

The GAC also assume that no free phase product is present, and are not intended for use in this instance. No free product was observed within soils during the site investigation.

8.3 Soil Testing Results & Screening

All metals, PAHs, and TPH CWG analytes are presented in the following tables. Other potential contaminants of concern are only shown where there is at least one result exceeding the limit of detection. All of the soil contamination laboratory analytical results are presented within **Appendix C**.

¹ Nathanail et al. (2015) The LQM/CIEH S4ULs for Human Health Risk Assessment. Land Quality Press, 2015. Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3495

² CL:AIRE (2010) The EIC/AGS/CL:AIRE Generic Assessment Criteria for Human Health Risk Assessment

Metals & Metalloids

Determinant	Min	Max	GAC	Number of exceedances
Arsenic	4.5	62	37*	5
Cadmium	<0.2	0.8	11*	0
Chromium (III)	80	135	910*	0
Chromium (VI)	<1	<1	6*	0
Copper	11	103	2400*	0
Lead	23	791	200*	1
Mercury	<0.5	<0.5	40* ^a	0
Nickel	7	35	180* ^b	0
Selenium	0.9	2.4	250*	0
Zinc	56	3880	3700*	1
Total Phenols	<0.5	1.7	420*	0
Total Cyanide	<1	1.2	140*	0

Table 2: Metalloids Soil Exceedances

*LQM/CIEH GAC for Residential with homegrown produce land use scenario based on a sandy loam soil and 1% SOM.

- Based on the inorganic mercury GAC as the conceptual site model does not suggest that other forms of mercury are likely to be present on site.
- LQM issued an update to the nickel S4ULs in August 2015 and this has been taken into account.

- There are seven exceedances for metals & metalloids screened, these are detailed below:
- Five are for arsenic (GAC 37mg/kg) within WS01 at 0.25mbgl (43mg/kg), WS02 at 0.20mbgl (44mg/kg), WS03 at 0.30mbgl (0.62mg/kg), WS04 at 0.20mbgl (39mg/kg) and WS05 at 0.15mbgl (45mg/kg).
 - One is for lead (GAC of 200mg/kg) in WS02 at 0.20mbgl (791mg/kg)
 - One is for zinc (GAC of 3700mg/kg) in WS02 at 0.20mbgl (3880mg/kg)

Organics

Determinant	Min	Max	GAC	Number of exceedances
Naphthalene	<0.02	0.21	2.3*	0
Acenaphthylene	<0.02	0.02	170*	0
Acenaphthene	<0.02	0.11	210*	0
Fluorene	<0.02	0.09	170*	0
Phenanthrene	<0.02	1.10	95*	0
Anthracene	<0.02	0.21	2400*	0
Fluoranthene	<0.02	1.35	280*	0
Pyrene	<0.02	1.27	620*	0
Benzo(a)anthracene	<0.02	0.60	7.2*	0
Chrysene	<0.03	0.70	15*	0

Benzo(b)fluoranthene	<0.02	0.74	2.6*	0
Benzo(k)fluoranthene	<0.03	0.30	77*	0
Benzo(a)pyrene	<0.02	0.62	2.2*	0
Indeno(1,2,3-cd)pyrene	<0.02	0.49	27*	0
Dibenz(a,h)anthracene	<0.02	0.07	0.24*	0
Benzo(ghi)perylene	<0.02	0.31	320*	0

Table 1: PAH Soil Exceedances

- There are no exceedances noted from the screening undertaken on PAH congeners.

Determinant	Min	Max	GAC	Number of exceedances
Aliphatic >C5 - C6	< 0.1	< 0.1	42*	0
Aliphatic >C6 - C8	< 0.1	< 0.1	100*	0
Aliphatic >C8 - C10	< 0.1	0.1	27*	0
Aliphatic >C10 - C12	< 4	< 4	130*	0
Aliphatic >C12 - C16	< 4	< 6	1100*	0
Aliphatic >C16 - C35	< 4	97	65000*	0
Aromatic >C5 - C7	< 0.01	< 0.01	70*	0
Aromatic >C7 - C8	< 0.01	< 0.01	130*	0
Aromatic >C8 - C10	< 0.01	< 0.01	34*	0
Aromatic >C10 - C12	< 1	< 1	74*	0
Aromatic >C12 - C16	< 1	< 1	140*	0
Aromatic >C16 - C21	< 1	5	260*	0
Aromatic >C21 - C35	< 1	5	1100*	0

Table 2: TPH CWG Aliphatic/Aromatic Soil Exceedances

* LQM/CIEH GAC Residential with Homegrown Produce land use scenario based on a sandy loam soil and 1.0% SOM. It is noted that the LQM/CIEH S4UL guidance recommends an additive approach for the TPH fraction, so that a hazard index approach is used. Based on a preliminary conservative comparison of maximum concentrations to S4ULs, no forward modelling is necessary to prove that this would still result in no exceedances at the site.

- There are no exceedances noted from the screening undertaken on the respective TPH CWG bands.

Others

- The asbestos screening returned a negative result for the presence of fibrous material from all samples analysed.
- There were no exceedances for BTEX/MTBE congeners, all of which were below the level of detection (LoD).

The soil contamination laboratory certificates can be reviewed within **Appendix D**.

8.4 Gas Monitoring Results

Gas monitoring was carried out on three separate occasions using a Gas monitor (GA5000). Readings were taken from the installed window sampler boreholes of WS01, WS04 and WS05.

The standpipe was tested for the presence of methane, oxygen, carbon dioxide and hydrogen sulphide. The flow rates of the gas and barometric pressure were also recorded.

Two of the rounds of monitoring were completed during rising pressure conditions, three during falling conditions and one within steady conditions.

Methane was recorded at a maximum peak concentration of 0.2% volume during the course of the monitoring rounds. Oxygen concentrations ranged from a minimum of 20.1% obtained during the 2nd monitoring round to a maximum of 21.9%. The maximum peak concentration of carbon dioxide of 0.9% was obtained during the 6th round of monitoring.

Flow rates were recorded during each round of monitoring from all installations, returning a flow of 0l/hr from all positions across all rounds. Concentrations of hydrogen sulphide were returned as 0.0ppm from all the rounds of monitoring undertaken. Concentrations of carbon monoxide were recorded from a maximum steady concentration of 0ppmv.

Barometric pressure ranged from a low of 972mBars during the 1st monitoring round to a high of 1021mBars attained during the 3rd monitoring round.

The recorded concentrations of methane and carbon dioxide have been used to calculate a Gas Screening Value (GSV) for the gassing regime at this site. This value has been subsequently compared against CIRIA values supplied within CIRIA Document C665 *Assessing risks posed by hazardous ground gases to buildings* (2007) using Situation B for carbon dioxide and methane.

The values used represent the worst case CO₂ and CH₄ concentrations across all installations.

The maximum flow rate was 0.0l/hr.

The GSV is calculated as:

(Worst case CO₂ and CH₄ concentration / 100) x worst case flow rate = GSV

Peak Flow Rate (l/hr)	Worst Case CO ₂	CO ₂ GSV	Worst Case CH ₄	CH ₄ GSV
0.0	0.9l/hr CO ₂	0.0l/hr CO ₂	0.2l/hr CH ₄	0.0l/hr CH ₄

Table 3: Calculated GSV's

This GSV is a conservative estimate based on the maximum concentrations and flow rate.

This approach has been taken at this stage based upon the three monitoring visits that have been undertaken.

Based on the maximum calculated GSV of 0.0l/hr, the site was below the threshold given by CIRIA C665 for Situation B and is characterised as 'Green'. Based on this data, the indication is that there is a negligible gas regime identified. As a consequence, gas protection measures are not considered necessary to be incorporated into the proposed development.

The full monitoring sheets can be viewed in [Appendix E](#).

9.0 Site Investigation Findings

9.1 Risks to Human Health

No visual and/or olfactory evidence of potential contamination was noted within any soils encountered during the SI works undertaken.

Seven of the selected soil samples from the SI which were submitted for the range of inorganic and organic analyses have returned concentrations below the available SGVs and LQM guidance values for each determinant which were adopted as Generic Assessment Criteria (GAC) within YE's risk assessment for the site.

Five of these exceedances were for arsenic with one position (WS02) also exceeding in lead and zinc. Given the shallow nature of these contaminants there is a potential risk.

9.2 Risks to Plants and Wildlife

A negligible risk has been attributed given the concentrations of phytotoxic contaminants below elevated concentrations often below the limit of detection returned.

9.3 Risks to Site Workers

Due to the returned elevated concentrations of determinants precautions should be taken to minimise exposure of site workers during ground works through the implementation of site safety procedures and the use of suitable personal protective equipment (PPE). Such precautions should include, but not be limited to:

- Personal hygiene, washing and changing procedures;
- Availability of site welfare;
- Provision of PPE appropriate to the task; and
- Daily safety briefings and tool box talks.

All site works will be undertaken in accordance with the guidelines prepared by the Health and Safety Executive (1991) and all work will be carried out in accordance with the Principal Contractor's Health and Safety Plan.

9.4 Risks to Proposed Structures

Based on the maximum calculated GSV of 0.0l/hr, the site was below the threshold given by CIRIA C665 for Situation B and is characterised as 'Green'. Based on this data, the indication is that there is a negligible gas regime identified. As a consequence, gas protection measures are not considered necessary to be incorporated into the proposed development.

10.0 Updated Conceptual Site Model and Risk Assessment

The Conceptual Site Model has been re-formulated based upon the results from the SI in accordance with BS10175:2015. It aims to provide information regarding the sources of contamination and the pathways in which contamination can migrate to a vulnerable receptor, all of which need to be present for there to be a risk. This is in relation to the proposed end use being classified as 'residential with homegrown produce'. The following linkages have been identified:

Contaminant Source	Pathways	Receptor	Potential Severity	Probability of Risk	Level of Risk	Justification
On Site: Made Ground soils on site containing Hydrocarbons (TPH, PAH) Heavy metals, phenols, BTEX, MTBE.	Ingestion, dermal contact, inhalation of dusts/vapours	Future end users and site visitors	Medium	Low Likelihood	Moderate/Low	Contact is likely between future residential occupiers/visitors and contaminants in the shallow soil in garden areas of the site, soil/dust tracked back into the house, from ingestion of home grown produce and from vapour intrusion. A moderate to low level of risk is assessed due to the returned laboratory results showing exceedances arsenic in all positions.
		Construction Workers	Medium	Likely	Moderate	Construction workers are likely to come into direct contact with soils during groundworks. Safe working practices should be implemented and appropriate personal protective equipment (PPE) should be used to mitigate any potential risk from contact with soils and shallow/perched groundwater.
	Leaching through soils and migration via groundwater or soil pore moisture	Controlled Waters	Mild	Low Likelihood	Low	Given the shallow nature of the identified contaminants, a low risk is assessed to groundwater. Furthermore, the groundwater on site is not considered to be sensitive in nature.
	Permeation of plastic water pipes	Construction materials, future end users and site visitors	Medium	Unlikely	Low	There were no exceedances for hydrocarbons in any of locations, so the risk posed to the permeation of the pipes is low. Provision of water supply pipes and connectors formed from proprietary "barrier pipe" materials (eg polyethylene-aluminium-polyethylene) may be required by the water supply company.
On site: Phytotoxic Contamination.	Uptake	Plant and Wildlife	Mild	Low Likelihood	Low	A low risk is assessed given the returned laboratory results which indicates there to be no significant concentrations of phytotoxic contamination.
On Site: Asbestos at/near ground surface in	Inhalation of fibres in airborne dust	Future end users and site visitors	Medium	Unlikely	Low	Although screening has revealed no asbestos to be present within the samples analysed from exploratory holes undertaken, it cannot be guaranteed that asbestos is not present within the soils across the site.

made ground soils.		Construction Workers	Medium	Unlikely	Low	Asbestos fibres have not been identified in the samples returned from laboratory analysis. However, Safe working practices should be implemented and appropriate personal protective equipment (PPE) should be used to mitigate any potential risk from asbestos in soils.
On Site: Ground Gases (CH ₄ , CO ₂) from on site Made Ground.	Gas migration and build up within buildings (explosion/asphyxiation risk)	Future end users and building structures.	Medium	Unlikely	Low	A low risk is assessed based on the calculated GSV of 0.0l/hr, the site was below the threshold given by CIRIA C665 for Situation B and is characterised as 'Green'. Therefore, no gas protection measures are considered necessary. Also, low levels of carbon dioxide were encountered, meaning a highly unlikely increase in flow rate would be required to elevate the risk.
Off Site: Limited off site development.	Leaching through soils and migration via groundwater or soil pore moisture	Future end users and site visitors	Mild	Low Likelihood	Low	A low risk is assessed based on the shallow nature of the encountered exceedances.
	Inhalation of vapours	Future end users and site visitors	Medium	Unlikely	Low	A low risk is assessed based on the lack of volatile compounds detected and the results of the ground gas monitoring.
Off Site: Ground Gases (CH ₄ , CO ₂ , H ₂ S) from off site Made Ground.	Gas migration and build up within buildings (explosion/asphyxiation risk)	Future end users and building structures.	Medium	Unlikely	Low	A low risk is assessed due to the returned gas monitoring results which indicated that there is no gas regime at the site.

Table 4: Updated Conceptual Site Model and Risk Assessment

11.0 Recommendations

The following recommendations are based on the results of chemical laboratory testing to date.

The following recommendations made do not constitute a formal remediation strategy and/or validation report. A remediation strategy should be agreed with the relevant local authority prior to such works commencing and/or the production of a validation report.

11.1 Soils

Given the identified lead and hydrocarbon contamination in the proposed area of soft landscaping, we would recommend that soils are removed in the garden area of the site to a depth of 450mm. The removal of this shallow subsoil from across the site would be sufficient to mitigate the risks posed by the contamination encountered during the site investigation.

As construction workers are likely to come into contact with contaminated soils during the removal of the soil and subsequent groundworks, safe working practices should be implemented and appropriate PPE should be used to mitigate the risks of contact with contaminated soils.

Alternatively, bio-accessibility testing could be carried out in regards to the arsenic on site, which could reduce the risk.

A remedial strategy should be formulated and presented to the Local Authority Planning Authority to seek their comments and approval in advance of such works proceeding.

11.2 Ground Gas

Based on the maximum calculated GSV of 0.0l/hr, the site was below the threshold given by CIRIA C665 for Situation B and is characterised as 'Green'. Based on this data, the indication is that there is a negligible gas regime identified. As a consequence, gas protection measures are not considered necessary to be incorporated into the proposed development.

11.3 Watching Brief and Discovery Strategy

A watching brief should be maintained by the Main Contractor at all times during the groundworks stage. Should any unforeseen contamination, such as oils or soils/groundwater with an unusual colour or odour, be encountered during groundworks then the following procedure should be implemented:

- Work to cease in that area to prevent exposure to ground workers and potential contaminants being spread around;
- Notify a Geo-Environmental Consultant, to attend site and sample material;
- Notify the Environmental Health Department / Contaminated Land Officer(s) of the Local Planning Authority.

If the nature and extent of the contamination is unmanageable under the procedure set out above, then a suitable management, mitigation or remediation procedure will be agreed with the CLO. However, this is considered unlikely at this particular site.

11.4 Asbestos

Although screening has revealed no asbestos to be present within the samples analysed from exploratory holes undertaken, it cannot be guaranteed that asbestos is not present within the soils across the remainder of the site. Consequently, we would recommend that a watching brief be adopted with regards to the site for the potential of finding any Asbestos Containing Materials (ACMs). If any ACMs are identified these need to be dealt with accordingly in relation to the Hazardous Waste Regulations 2005.

11.5 Services

If new services will be installed as part of the redevelopment of the site, we would recommend the local water board be contacted to determine their specification for the type of pipework which should be used on this site.

All services and in particular potable water supply pipework should comprise of material that is resistant to attack and degradation to chemical attack.

Further information can be found within the published guidance for the '*Selection of Water Supply Pipes to be used in Brownfield Sites*', issued in January 2011 by the UK Water Industry Research (UKWIR), this supersedes the Water Regulations Advisory Scheme (WRAS) Information and Guidance Note - '*Laying Pipes in Contaminated Land*' which has been withdrawn.

11.6 Surface Water

It should be noted that the Environment Agency does not recommend that soakaways be placed within Made Ground, potentially contaminative land or in ground previously identified as contaminated.

11.7 Installed Boreholes

The boreholes which have been installed may be required to be decommissioned in accordance with the EA guidance document '*Decommissioning Redundant Boreholes and Wells*'.

This should be undertaken once appropriate consultation has been concluded within the relevant consultees.

11.8 Verification Reporting

It is recommended that you confirm with the relevant environmental consultees whether they require a validation and/or closure report providing documentation/audit trail for the completion of any remediation/mitigation works completed on site.

If a verification Report is required it should include, but not be limited to, the following:

- Site visit records and photographic records from the watching brief;
- Site visit records and photos from visits completed by a Geo-Environmental Consultant;

- Duty of care records for disposal of waste material including the landfill site(s) or disposal facility where the material has been disposed and a copy of the Contractor's current waste carrier's licence (to be provided by Contractor);
- Records and test certificates relating to the management and disposal or unforeseen contaminants and/or ACMs (if any);
- Details of source and chemical test results for imported materials; and
- Confirmation of water supply pipe materials installed.

11.9 Report Submission

This report should be submitted to the Local Planning Authority at the earliest opportunity to seek their acceptance of the findings of this report.

12.0 Limitations

YE have prepared this report with all reasonable skill, care and diligence. The work undertaken to provide the basis of this report comprised a study of available documented information from a variety of sources.

The opinions given in this report have been dictated by the finite data on which are they based and are relevant only to the purpose for which the report was commissioned.

Information reviewed should not be considered exhaustive and has accepted in good faith as providing true and representative data with respect to site conditions. Should additional information become available which may influence the opinion expressed in this report, YE reserves the right to review such information and, if warranted, to alter the opinions accordingly.

It should be noted that any risks identified in this report are perceived risks based on the information reviewed.

The recommendations contained in this report represent our professional opinions. These opinions were arrived at in accordance with currently accepted industry practices at this time and as such is not a guarantee that the study site is free of hazardous conditions.

This report has been prepared solely for the use of the named client, and may not be relied upon by other parties without written consent from YE. YE disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.