GEOENVIRO

SOLUTIONS LIMITED

PHASE II / GROUND INVESTIGATION AND UPDATED RISK ASSESSMENT REPORT FOR SCHOLES LANE, SCHOLES CLECKHEATON.

For: Riva Homes

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Report Reference: **GES 2077-21 Scholes Lane, Scholes PII Report**

Date: **January 2022**

Quality Assurance

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List Of Acronyms

Acronym	Meaning
BGS	British Geological Survey
BH	Borehole
CDM	Construction Design and Management
CL:AIRE	Contaminated Land: Applications In Real Environments
CLR	Contaminated Land Report
COSHH	Control Of Substances Hazardous to Health
CSM	Conceptual Site Model
DCP	Dynamic Cone Penetrometer
DEFRA	Department for Environment Foods and Rural Affairs
DP	Dynamic Probe
DoE	Department of Environment
DWS	Drinking Water Standard
EA	Environment Agency
EQS	Environmental Quality Standard
GAC	Generic Acceptance Criteria
HP	Hand Pit
HA	Hand Auger
LPA	Local Planning Authority
LQM	Land Quality Management
mbgl	Metres Below Ground Level
MP	Mackintosh Probe
NPPF	National Planning Policy Framework
NGR	National Grid Reference
OS	Ordnance Survey
SGV	Soil Guideline Value
SSV	Soil Screening Value
WSV	Water Screening Value
SPOSH	Significant Possibility of Significant Harm
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
TP	Trial Pit
TT	Trial Trench
WS	Windowless Sample / Window Sample

1. Introduction

GeoEnviro Solutions Ltd (GES) was instructed by Riva Homes Ltd (the Client) to conduct additional works to supplement and earlier Phase II geoenvironmental site investigation at a site encompassing the proposed new development of 4 properties at Scholes Lane, Scholes, Cleckheaton.

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.

This report is written in accordance with the guidance set out in Land Contamination Risk Management (LCRM), Guiding Principles for Land Contamination (GPLC) 1 – 3, and the National Planning Policy Framework (NPPF).

1.1 Objectives

The objectives of this Phase II / Ground Investigation report are to:

- To identify the ground conditions and provide details of their engineering properties in order to facilitate foundation design for the proposed development.

1.2 Background and Instruction

The site investigation undertaken was specified by the Client as a result of recommendations made in the previous report GES 2077-21 S1 Report-Reappraisal of J1504-17, to which this report should be read in conjunction with. As such this report seeks to address site work that could not be completed in the initial investigation due to access to restriction to the proposed location of one of the four property developments.

The site investigation was undertaken encompassed one area within the development site

1.3 Previous Investigations

GES has reproduced a previous report by RL testing and re-issued the report as below

- GES 2077-21 S1 Report-Reappraisal of J1504-17

1.4 Scope

Prior to commencing the site works the proposed scope of investigation was as follows:

- One day's trial pit excavation to three locations to a nominal depth of 3.0mbgl.
- Collection and subsequent environmental laboratory testing of samples.
- Collection and subsequent geotechnical laboratory testing of samples.
- Interpretation and risk assessment of the data in respect of potential contamination.
- Interpretation of the geotechnical data to provide details of their engineering properties in order to facilitate foundation design for the proposed development

However, the proposed scope will be subject to change dependent upon site conditions, access, restrictions and obstructions.

2. Physical Setting

2.1 Site Information

Location

The site is located at land off Scholes Lane, Scholes as part of Oldfield Nook at approximate National Grid Reference NGR: 416781: 425156 (centre of the site).

A site location plan is presented as Drawing No. GES 2077-21/ 01 in **Appendix 1**.

Topography

The site is sloped garden.

Access

The site is accessed of Scholes Lane, Scholes.

Site Description

A site reconnaissance was carried out on the December 21st, 2021. All details from the site reconnaissance are included in the site description below.

At the time of the investigation the site is currently occupied by the construction of one property and grass law and surrounded by trees with a large shrub hedge running east west across the site.

An approximate distribution of the surface covering is given below in Table 2.1: Site Surface Covering.

Table 2.1: Site Surface Covering

Type of Surface Cover	Distribution (%)
Soft Ground (grassed and landscaped areas)	75
Hardstanding	5
Roadways	
Buildings	20
Water (ponds, streams)	

2.2 Geology

The British Geological Survey shows the site to be underlain by the geological succession outlined below in Table 2.2: Published Geology.

Table 2.2: Published Geology

Geology	Description /strata
Artificial	None Recorded
Superficial	None Recorded
Bedrock	Pennine Lower Coal Measures Formation and Falhouse Rock

There are no known artificial deposits recorded underlying the site.

The bedrock geology beneath the site is shown to be the Pennine Lower Coal Measures Formation. As is typical of these strata, the Coal Measures are interbedded coal seams, sandstones, and mudstones, all of which are heavily faulted. The site is located close to two faults, which are almost coincident with the southern site boundary and close to the western edge of the site. Most of the site is underlain by Pennine Lower Coal Measures Formation however, the northwestern corner appears to be underlain by Falhouse Rock.

3. Proposed Development

An outline development drawing for the site as drawn by JG-D Architecture and Design, reference 01_ Site Drawing and dated September 15 can be reviewed within **Appendix 1**.

The risk assessment undertaken in this report is therefore based on the proposed development as outlined here. Any variation from this may require a re-assessment and the Conceptual Site Model updating accordingly.

4. Fieldworks

4.1 Site Investigation

All SI works were completed on December 20th, 2021, under the supervision of a Geo-Environmental Engineer from GES.

The ground investigation has been carried out in accordance with BS5930: 2015 and the UK Specification for Ground Investigation Second Edition 2012.

All strata descriptions were undertaken in accordance with BS5930: 2015 Amendment 1; EN ISO 14688 -1; EN ISO 14688 -2; and EN ISO 14689.

In summary the investigation included:

- Three trial pits (TP01, TP02 and TP03) were completed to a maximum depth of 3.0 mbgl, by a GES Geo-Environmental Engineer. The trial pits 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 observed changes in strata. 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.

The positions of the exploratory holes in relation to the intended site layout can be reviewed on drawing number GES 2077-21-22 / 02 within **Appendix 1**.

5. Geology and Ground Conditions

The following ground conditions were encountered during the site investigation.

5.1 General

A generalised summary of the ground conditions encountered, depths to base, and thickness recorded from the exploratory hole records is presented below in Table 5.1: Summary of Ground Conditions.

Table 5.1: Summary of Ground Conditions

Geology / Strata	Depth (mbgl)				Thickness (m)		Locations encountered
	Top		Base		Min	Max	
	Min	Max	Min	Max			
Topsoil	0		0.3	0.4			TP01, TP02, TP03
Firm, orange, brown mottled grey silty sandy gravelly cobbly CLAY	0.3	0.4	1.2	1.75			TP01, TP02, TP03
Firm, grey mottled orange, silty sandy gravelly cobbly CLAY	1.4	1.75	1.8	2.5			TP01, TP02, TP03
Carbonaceous material	1.2		1.4				TP02
Light brown silty sandy GRAVEL	1.8		2.0				TP02
Groundwater	**Strike depth (mbgl)**		**Rest Level (mbgl)**		**Locations encountered**		
	Min	**Max**	**Min**	**Max**			
Seepage	-	-	-	-			
Strike	-	-	-	-			
Standing Water Level	-	-	-	-			

Detailed strata descriptions are presented on the trial pit logs presented in **Appendix 2** and photographs of the exploratory points in **Appendix 3**.

5.2 Made Ground

No made ground or artificial deposits were encountered or observed during this ground investigation.

5.3 Topsoil

Topsoil was encountered in TP01, TP02 and TP03 from ground level to depths of between 0.3 and 0.4 mbgl, and generally comprised dark brown, silty sand. The sand was fine to coarse with root and rootlets noted.

5.4 Superficial Deposits (*None Recorded)*

Superficial deposits were not encountered during this ground investigation.

5.5 Bedrock (Pennine Lower Coal Measures Formation)

Deposits considered to represent the Pennie Lower Coal Measures Formation, were encountered in TP01, TP02 and TP03 directly beneath the topsoil and were proven to depths of between 2.0 and 2.5 mbgl.

5.6 Groundwater

Groundwater was generally not encountered during the site investigation.

5.7 Restrictions

No restrictions were encountered during this ground investigation.

5.8 Obstructions

No obstructions were encountered during this ground investigation.

5.9 Contamination

No visual or olfactory evidence of contamination was encountered or observed during this ground investigation, in particular no obvious visual or olfactory evidence of mobile contamination was observed during the ground investigation.

6. Laboratory Testing - Geotechnical

The following programme of laboratory testing has been undertaken on samples obtained during this investigation:

- Moisture content determinations — BS 1377: 1990: Pt2: 3.2
- Index properties (1 point) — BS 1377: 1990: Pt2: 4.4, 5.3 & 5.4

The test results are summarised in Table 7.1: Summary of Geotechnical Test Results, below:

Table 6.1: Summary of Geotechnical Test Results.

Table: Summary of Geotechnical Test Results				
Test type	**Number of tests**	**Results**		**Comments**
Moisture content determinations	4	23-29%		
Index Properties (1 Point)	4	LL PL PI	43-50% 21-28% 20-27%	Clay of medium plasticity 3-1.0 NHBC Class – medium

The test results are presented in **Appendix 4**.

The appropriate geotechnical properties are summarised in Table 7.2: Summary of Geotechnical Properties, below:

Table 7.2: Summary of Geotechnical Properties.

Table: Summary of Geotechnical Properties		
Property	**Range of values**	**Comments**
Volume change potential (HNBC)	Medium	-

8. Laboratory Testing – Sulphates

The following programme of chemical laboratory testing has been undertaken on samples obtained during this investigation:

Three samples of the underlying naturally occurring deposits in were submitted for assessment of water-soluble sulphate, total sulphate, pH value and total sulphur concentrations.

Water-soluble sulphate concentrations of <0.010g/l to 0.018g/l were recorded, total (acid) sulphate concentrations ranged from <100 mg/kg to 900 mg/kg, total sulphur concentrations ranged from 0.016% to 0.077% with pH values ranging from of 7.3 to 8.0 units. Total Potential Sulphates ranged between 0.048% and 0.231%.

Reference to BRE Special Digest 1 and the test results indicates the results from the fall within Design Sulphate Class DS-1. Consequently, concrete may be designed to AC-1s concrete classification.

9. Laboratory Testing – Contamination

9.1 Soil Testing

All samples were sent to a UKAS accredited chemical testing laboratory, and MCERTS were used where available. The analytical strategy focussed on a general suite of potential contaminants and the analytical suites are summarised in Table 9.1 Summary of Chemical Testing Suite below.

Table 9.1: Summary of Chemical Testing Suite

Testing	Comment	No. of soil samples analysed
General metals suite including Arsenic, cadmium, chromium, copper, cyanide, lead, mercury, nickel, phenol, selenium, zinc, pH, and water-soluble sulphate	General analysis of soils beneath the site to achieve general site coverage, and targeting former uses on site and off site within influencing distance	3
Speciated PAH and TPH CWG	General analysis of soils beneath the site to achieve general site coverage, and targeting former uses on site and off site within influencing distance	3
Asbestos Screen	General analysis of soils beneath the site to achieve general site coverage, and targeting former uses on site and off site within influencing distance	3

All chemical testing results are presented in **Appendix 5**.

10. Geotechnical Recommendations

10.1 Foundations

The weak, near surface soils and made ground are not considered suitable for the construction of shallow foundations due to the risk of unacceptable total and differential settlement occurring under moderately light surface loading.

The proposed areas of developments are likely to be capable of being constructed on conventional shallow spread/trench fill foundations. These could be placed at depths of greater than 1.50 mbgl in soils described in firm in situ conditions and below the carbonaceous material identified in TP02. However, final placement of foundation should be done in accordance with the guidance regards construction in shrinkable soils and taking cognisance of the clays of medium shrink potential. It is considered that spread foundation constructed with the underlying clays (weathered Mudstone of the Pennine Lower Coal Measures Formation) could be designed assuming an allowable increase in load given below in table 10.1: Allow increase in Stress.

Table 10.1: Allow Increase in Stress

Foundation type		Strip Footings			Spread Footings		
Foundation Breadth	(B)	0.6	1.0	1.5	1.0	2.0	3.0
Foundation Depth	(D)	1.0			1.0		
Allowable Increase in Stress	(kN/m²)	135	125	120	195	180	175

The allowable increase in stress given above assumes a factor of safety of 3 against general shear failure, with cohesion of 60kN/m^2 at the foundation depths. Settlements at the above loading intensities should remain within tolerable limits for the type of structure proposed provided that the underlying soils are carefully inspected immediately final trimming has taken place. Should any soft or weak material be encountered they should be locally removed and replaced with lean-mix concrete or compacted granular soil. It should be appreciated that should higher bearing capacities are required then these could be achieved by placing the foundation at greater depths within mudstone.

Any existing structures and foundations if found should be grubbed up and replaced with a suitable engineered granular backfill and should be compacted in layers

10.2 Excavations

Groundwater was not encountered during the investigation. However, it should be appreciated that groundwater levels are subject to seasonal variation or changes on local drainage conditions.

Groundwater is unlikely to represent a particular problem to the construction of the development. However, it should be recognized that slight seepages and minor water entries may combine in any long trench excavations to create a significant volume of water which may cause local problems during the construction phase. Any minor groundwater seepages or significant standing water within excavations made upon this site may be removed by using a simple form of de-watering. Such a system could include the excavation of sumps from which the water could be pumped. Advice on Groundwater Control is given in CIRIA Report No 515 – Groundwater Control Design and Practice.

The stability of the excavation faces cannot be guaranteed thus temporary support to the excavation faces may become necessary unless the foundations are constructed using trench-fill techniques.

In this method the foundation trenches should be excavated, inspected and backfilled with concrete as a continuous operation. Under no circumstances should operatives be allowed to enter unsupported excavations.

Subject to space constraints, excavations could be battered back to a suitable angle of repose (typically 1:1 for a 1.00m deep excavation). Alternatively, if there is a requirement to protect nearby structures or services, appropriate supports may be required. Advice on excavation support is given in CIRIA Report No 97 – Trenching Practice.

Where trench support/shoring is utilised an appropriately qualified and experienced engineer should design the support system. The shoring/support will require regular inspection in accordance with published guidelines to ensure that the support/shoring is adequate for the ground conditions present.

10.3 Groundworks Watching Brief

We would recommend that a watching brief be maintained during the course of the development, particularly during the ground works stage.

During construction works visual and olfactory appraisal of the underlying soils should be made. If during construction works any material is noted to show visual and/or olfactory signs of contamination an environmental consultant should be contacted to supervise/guide further works. This material should be stockpiled separately and tested prior to its appropriate removal off site or re-use as necessary.

If any landscaping materials are to be imported on site, they should be tested to check that they are suitable for the intended use. Clean, uncontaminated rock, subsoil brick rubble, crushed concrete, ceramics and topsoil only should be permitted as infill material.

10.4 Services

Given that 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.

10.5 Disposal of Arisings

If any soils are to be removed off site, it may be prudent to undertake Waste Acceptance Criteria (WAC) analyses on the soils to be removed.

All materials must be transported in compliance with the Duty of Care Regulations by authorising movements with Carrier’s individually numbered Duty of Care conveyance notes, complete with the appropriate EWC Codes. All relevant dockets will need to be kept; to provide evidence of the removal as these may be required as part of a Validation Report.

11. Contamination

11.1 Soil Testing

A total of three samples have been analysed by Chemtest 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, 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 residential and therefore screening has been made against a land use of 'Residential with homegrown produce'.

A set of Screening Values are provided in **Appendix 6.**

11.2 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).

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 criteria[i] 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 2.5% 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 <0.4-1.0%, and so this conservative approach is considered appropriate for initial screening.

Where no S4UL are available, the EIC/ AGS/ CL:AIRE/ GAC[ii] 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.

All of the GAC assume unsaturated soils. However, the use of the GAC is 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.

11.3 Soil Testing Results and Screening

All metals, PAHs, and TPH CWG analytes are presented in the following tables with units in mg/kg unless otherwise stated. Other potential contaminants of concern are only shown where there is at least one result exceeding the limit of detection.

The results of the chemical laboratory testing are provided in **Appendix 5**.

Tables 11.1: Metalloids Soil Exceedances, Table 11.2: PAH soil Exceedances and Table 11.3: TPH CWG Aliphatic/Aromatic Soil Exceedances overleaf summarize the soil testing results.

Metalloids

Table 11.1: Metalloids Soil Exceedances

Determinant	Min	Max	GAC	Number of exceedances	Location of exceedances
Arsenic	8.3	46	37*	1	TP01 0.4 mbgl
Cadmium	<0.1	<0.1	11	0	
Chromium total	16	26	910*	0	
Chromium (VI)	<0.5	<0.5	6*	0	
Copper	13	42	2400*	0	
Lead	21	63	200*	0	
Mercury	<0.10	0.16	40*[a]	0	
Nickel	11	48	180*[b]	0	
Selenium	<0.2	0.52	250*	0	
Zinc	48	110	3700*	0	
Total Phenols	<0.1	<0.1	550*	0	
Total Cyanide	<0.50	<0.50	34*	0	

**LQM/CIEH GAC for Public Open Space Near Residential' use scenario based on a sandy loam soil and 2.5% SOM.*
a) 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.
b) LQM issued an update to the nickel S4ULs in August 2015, and this has been taken into account.

Organics

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

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

Others

- The asbestos screening returned a negative result from all samples analysed.

12. 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 and are presented in Table 12.1: Updated conceptual Site model, below.

Table 12.1: Updated Conceptual Site Model.

Contaminant Source	Pathways	Receptor	Pollutant Linkage	Probability of Risk	Classification of Consequence	Level of Risk	Justification
On Site: Arsenic	Ingestion, dermal contact, inhalation of dusts/vapours	Future end users and site visitors	Considered Possible	Low Likelihood	Minor	Very Low ●	A very low risk has been attributed to this pollutant linkage based on the slightly elevated nature of one result. Identity near to the location of the proposed building, as such is likely to be removed as part of the ground works.
		Construction Workers	Considered Possible	Low Likelihood	Minor	Very Low ●	A very low risk has been attributed to this pollutant linkage based on the slightly elevated nature of one result. Identity near to the location of the proposed building, as such is likely to be removed as part of the ground works.
	Leaching through soils and migration via groundwater or soil pore moisture	Controlled Waters	Considered Possible	Low Likelihood	Minor	Very Low ●	A very low risk has been attributed to this pollutant linkage based on the slightly elevated nature of one result. Identity near to the location of the proposed building, as such is likely to be removed as part of the ground works.
	Permeation of water pipes	Construction materials, future end	Not Possible	-	-	Very Low	N/A

Contaminant Source	Pathways	Receptor	Pollutant Linkage	Probability of Risk	Classification of Consequence	Level of Risk	Justification
		users and site visitors				●	
	Uptake	Plant and Wildlife	Not Possible	-	-	Very low ●	N/A
On Site: Asbestos at/near ground surface in Made Ground soils.	Inhalation of fibres in airborne dust	Future end users and site visitors	Not Possible	-	-	Very Low ●	N/A
		Construction Workers	Not Possible	-	-	Very low ●	N/A
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.	Not Possible	-	-	Very Low ●	N/A
Off Site: Ground Gases (CH_4, CO_2, H_2S) from off-site historical landfilling activities.	Gas migration and build up within buildings (explosion/ asphyxiation risk)	Future end users and building structures.	Not Possible	-	-	Very low ●	N/A

13. Recommendations

The results of the general testing undertake across the site indicates that contamination is limited across the site.

13.1 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.

13.2 Gas Protection Measures

No site-specific gas protection measures are required.

13.3 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, GES 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.

13.4 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.

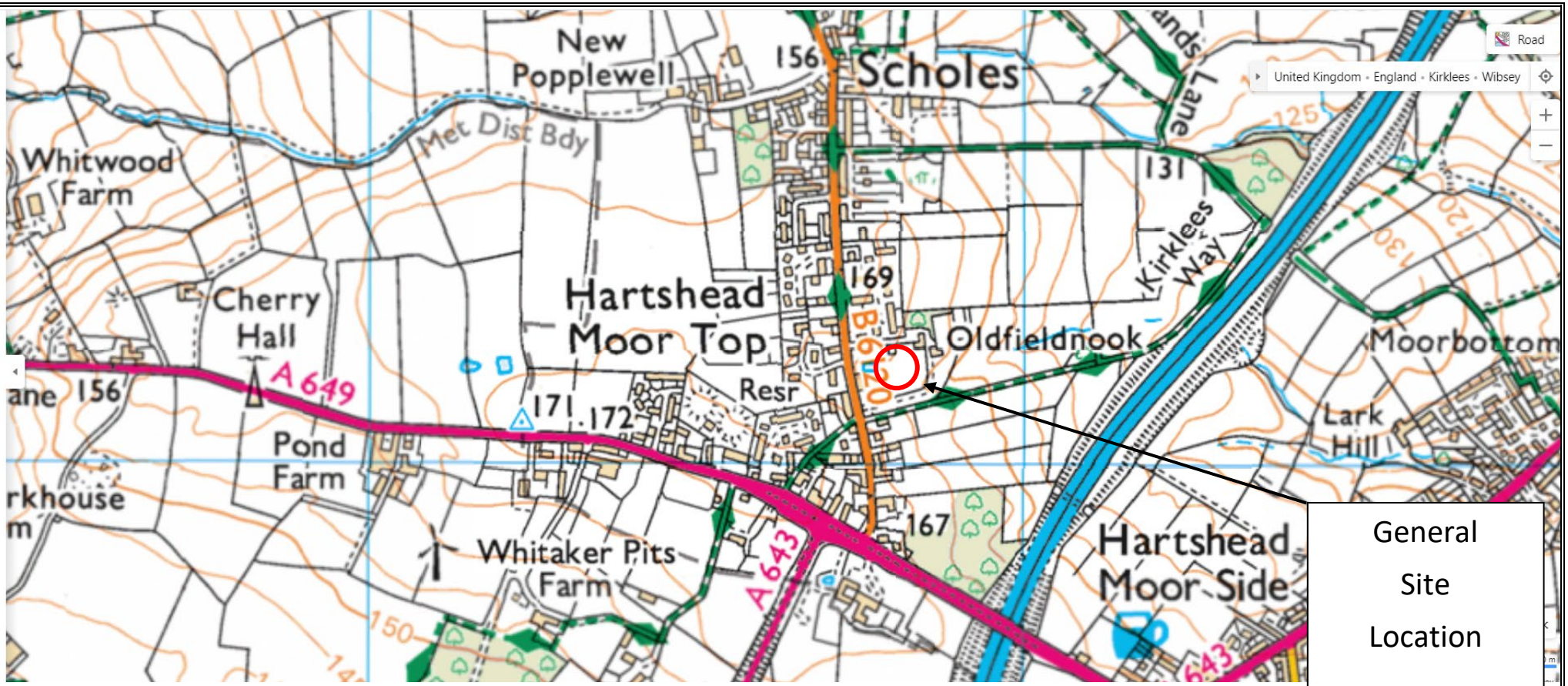
13.5 Surface Water

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.

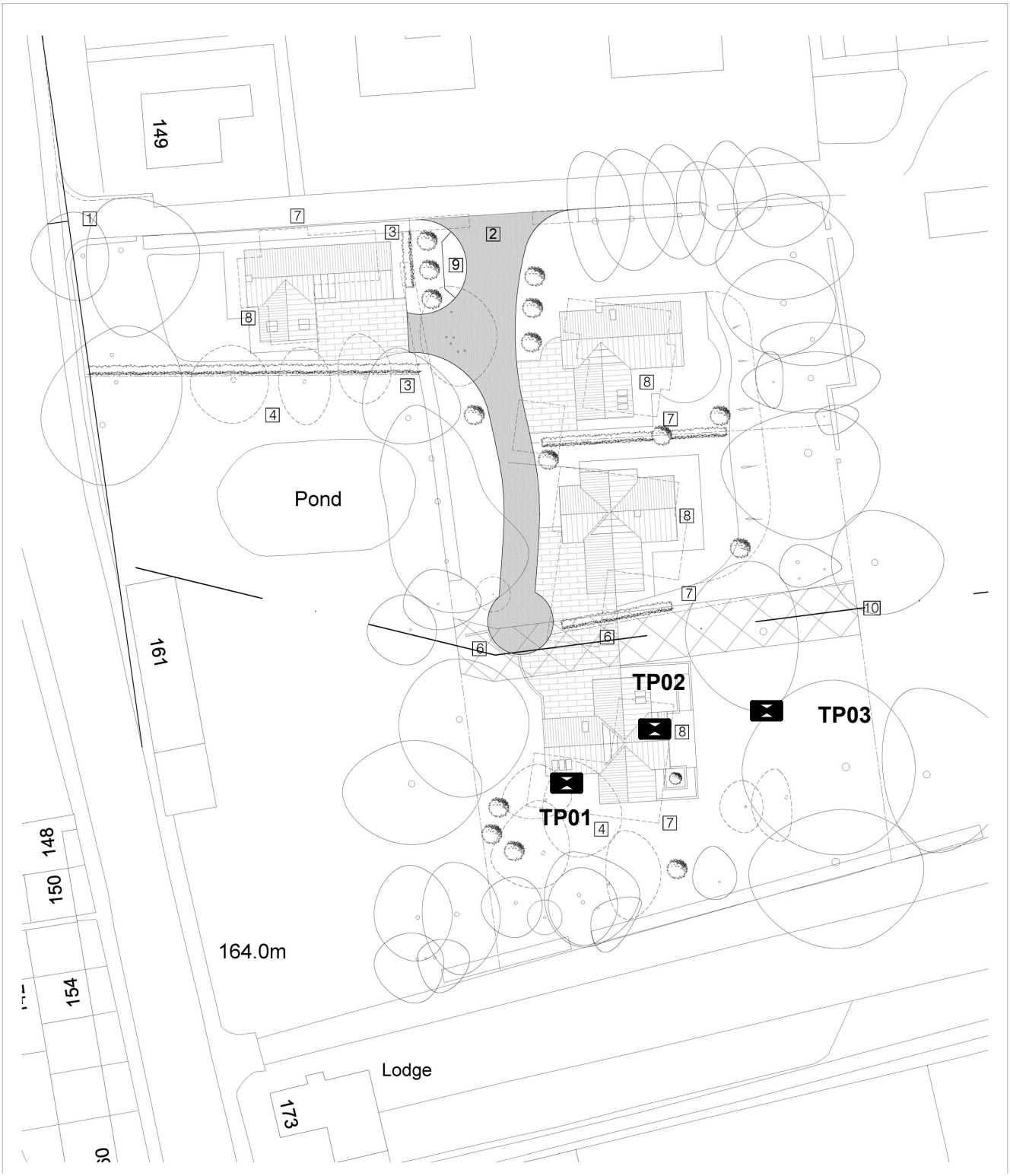
[i] Nathanail et al. (2015) The LQM/CIEH S4ULs for Human Health Risk Assessment. Land Quality Press, 2015. Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3495
[ii] CL:AIRE (2010) The EIC/AGS/CL:AIRE Generic Assessment Criteria for Human Health Risk Assessment

APPENDIX 1

DRAWINGS



GEOENVIRO SOLUTIONS LIMITED	GeoEnviro Solutions Ltd Unit 7 Springvale Works Brighouse West Yorkshire HD6 2RA Tel: 01484 986010 Email: info@geoenvirosolutions.com Web: www.geoenvirosoltions.com N	**PROJECT NAME** Scholes Lane, Scholes **PROJECT NUMBER** 2077-21 **TITLE** Site Location Plan	**DRAWING NO.** 2077-21/01 **DATE** January 2022	**SCALE** N.T.S **DRAWN BY** LW



Trial Pit Location

GEOENVIRO SOLUTIONS LIMITED	GeoEnviro Solutions Ltd Unit 7 Springvale Works Brighouse West Yorkshire HD6 2RA Tel: 01484 986010 info@geoenvirosolutions.com www.geoenvirosoltions.com	**PROJECT NAME** Scholes Lane, Scholes **PROJECT NUMBER** 2077-21	**DRAWING NO.** 2077-21/02	**SCALE** N.T.S
		TITLE Proposed Test Point Location Plan	**DATE** January 2022	**DRAWN BY** LW

APPENDIX 2

TRIAL PIT LOGS

Trial Pit Log

Project Name: Scholes Lane, Scholes	Client: Traditinal Stone	Date: 20/12/2021
Location: Scholes Lane, Scholes, Clekcheaton, BD19 6LX	Contractor:	
Project No. : 2077-21	Crew Name:	Equipment:

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP01	TP		LW	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.00 - 0.30	B					TOPSOIL: Dark brown, silty SAND. Sand is fine to coarse. Roots and rootlets noted.
		0.00 - 0.30	ES					
					0.30			
		0.30 - 1.40	B					Firm, orange brown mottled grey, silty sandy gravelly cobbley CLAY. Sand is fine to coarse. Gravel is fine to coarse of angular mudstone and sandstone. Cobbles of angular mudstone and sandstone.
		0.30 - 1.40	ES					
					1.40			
		1.40 - 2.00	B					Firm, grey mottled orange silty sandy gravelly cobbley CLAY. Sand is fine to coarse. Gravel is fine to coarse of angular mudstone and sandstone. Cobbles of angular mudstone and sandstone.
		1.40 - 2.00	ES					
					2.00			End of Borehole at 2.000m

1 2 3 4 5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks

Trial Pit Log

Project Name: Scholes Lane, Scholes	Client: Traditinal Stone	Date: 20/12/2021
Location: Scholes Lane, Scholes, Clekcheaton, BD19 6LX	Contractor:	
Project No. : 2077-21	Crew Name:	Equipment:

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP02	TP		LW	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.00 - 0.40	B					TOPSOIL: Dark brown, silty SAND. Sand is fine to coarse. Roots and rootlets noted.
		0.00 - 0.40	ES					
		0.40 - 1.20	B		0.40			Firm, Orange brown mottled grey, silty sandy gravelly cobbley CLAY. Sand is fine to coarse. Gravel is fine to coarse of angular mudstone and sandstone. Cobbles of angular mudstone and sandstone.
		0.40 - 1.20	ES					
		1.20 - 1.40	B		1.20			Black, very clayey, Carbonaceous material. Low vitreous, Sub-bituminous.
		1.40 - 1.80	B		1.40			Firm, grey mottled orange, silty sandy gravelly CLAY. and is fine to coarse. Gravel is fine to coarse of angular mudstone and sandstone
		1.40 - 1.80	ES					
		1.80 - 2.00	B		1.80			Light brown, silty sandy GRAVEL. Sand is fine to coarse of angular sandstone. With ornage brown weathering-Weathered Pennie Lower Coal Measures].
		1.80 - 2.00	ES					
					2.00			End of Borehole at 2.000m

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks

Trial Pit Log

Project Name: Scholes Lane, Scholes	Client: Traditinal Stone	Date: 20/12/2021
Location: Scholes Lane, Scholes, Clekcheaton, BD19 6LX	Contractor:	
Project No. : 2077-21	Crew Name:	Equipment:

Location Number	Location Type	Level	Logged By	Scale	Page Number
TP03	TP		LW	1:25	Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.00 - 0.40	B					TOPSOIL: Dark brown, silty SAND. Sand is fine to coarse. Roots and rootlets noted.
		0.00 - 0.40	ES					
		0.40 - 1.75	B		0.40			Firm, orange brown mottled grey , silty sandy gravelly cobbley CLAY. Sand is fine to coarse. Gravel is fine to coarse of angular mudstone and sandstone. Cobbles of angular mudstone and sandstone.
		0.40 - 1.75	ES					
		1.75 - 2.50	B		1.75			Firm, grey mottled orange silty sandy gravelly cobbley CLAY. Sand is fine to coarse. Gravel is fine to coarse of angular mudstone and sandstone. Cobbles of angular mudstone and sandstone.
		1.75 - 2.50	ES					*Diachronous coal seam*
					2.50			End of Borehole at 2.500m

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks

APPENDIX 3

PHOTOGRAPHS

Site: Scholes Lane, Scholes, Cleckheaton
Client: Traditional Stone
Job Reference: 2077-21, Dated: January 2022

GEOENVIRO
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A.

B.

C.

D.

A. TP01

B. TP01- Side view

C. TP01- Arisings

D. TP01- Reinstatement

Site: Scholes Lane, Scholes, Cleckheaton
Client: Traditional Stone
Job Reference: 2077-21, Dated: January 2022

GEOENVIRO
SOLUTIONS LIMITED

A.

B.

C.

D.

A. TP02

B. TP02- Side view with carbonaceous layer

C. TP02- Arisings

D. TP02- Reinstatement

Site: Scholes Lane, Scholes, Cleckheaton
Client: Traditional Stone
Job Reference: 2077-21, Dated: January 2022

GEOENVIRO
SOLUTIONS LIMITED

A.

B.

C.

D.

A. TP03

B. TP03- Closer view

C. TP03- Arisings

D. TP03-Reinistatement

APPENDIX 4

GEOTECHNICAL TESTING RESULTS

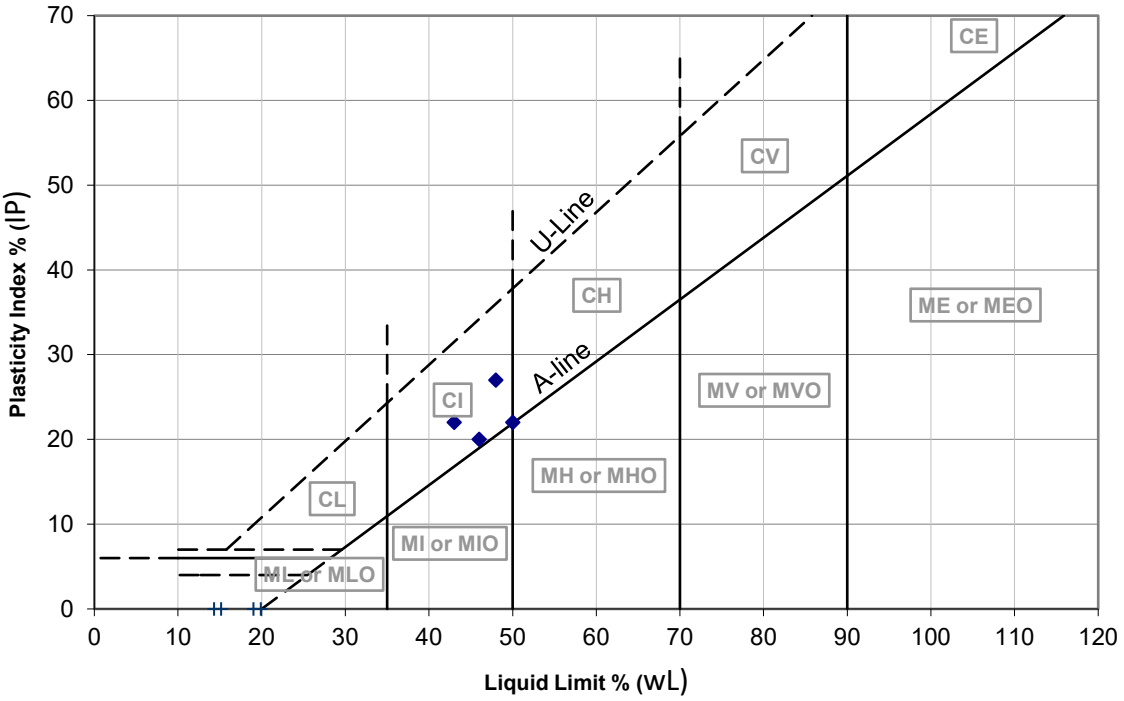
Borehole Solutions Group
Unit 7 Springvale Works,
Brookfoot Lane,Brighouse
HD6 2RA

Client: Traditional Stone

Job No:	Site:	Date:	Sheet:
2077-21	Scholes Lane	10/01/2021	1

Interpretation of Moisture Content, Liquid and Plastic Limits

Location	Depth	Moisture Content	Liquid Limit	Plastic Limit	Plasticity Index	Retained by 425mm	Modified	Modified	Liquidity/ Consistency		Casagrande Class	N.H.B.C Class
		(w)	(w_L)	(w_P)	(I_P)		(w')	(I_P')	(I_L)	(I_C)		
	(m)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)		(%)
TP01	0.3-1	24	46	26	20	0	24	20	-0.1	1.1	C I	MEDIUM
TP02	1.00	29	50	28	22	0	29	22	0.0	1.0	C H	MEDIUM
TP02	1.40	25	43	21	22	0	25	22	0.2	0.8	C I	MEDIUM
TP03	1.75	23	48	21	27	0	23	27	0.1	0.9	C I	MEDIUM



APPENDIX 5

CHEMICAL TESTING RESULTS

Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.:	21-45370-1
Initial Date of Issue:	10-Jan-2022
Client	Geoenviro Solutions Ltd
Client Address:	Unit 7 Springvale Works Brookfoot Lane Brighouse HD6 2RA
Contact(s):	Lewis Waller Sue Ellis
Project	2077-21 Scholeslare, Scholes

Quotation No.:		**Date Received:**	23-Dec-2021
Order No.:		**Date Instructed:**	23-Dec-2021
No. of Samples:	3		
Turnaround (Wkdays):	11	**Results Due:**	10-Jan-2022
Date Approved:	10-Jan-2022		

Approved By:

Details: Stuart Henderson, Technical Manager

Results - Soil

Project: 2077-21 Scholeslare, Scholes

Client: Geoenviro Solutions Ltd			**Chemtest Job No.:**		21-45370	21-45370	21-45370
Quotation No.:			**Chemtest Sample ID.:**		1345722	1345723	1345724
			Sample Location:		TP01	TP02	TP03
			Sample Type:		SOIL	SOIL	SOIL
			Top Depth (m):		0.00	0.70	1.00
			Bottom Depth (m):		0.40	0.70	1.00
			Date Sampled:		20-Dec-2021	20-Dec-2021	20-Dec-2021
			Asbestos Lab:		DURHAM	DURHAM	DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
ACM Type	U	2192		N/A	-	-	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.020	27	22	22
pH	U	2010		4.0	7.3	9.6	8.0
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.018	< 0.010	0.013
Total Sulphur	U	2175	%	0.010	0.077	0.032	0.016
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50
Sulphate (Total)	U	2430	mg/kg	100	900	310	< 100
Arsenic	U	2450	mg/kg	1.0	46	14	8.3
Cadmium	U	2450	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Chromium	U	2450	mg/kg	1.0	19	16	26
Copper	U	2450	mg/kg	0.50	42	13	32
Mercury	U	2450	mg/kg	0.10	0.16	< 0.10	< 0.10
Nickel	U	2450	mg/kg	0.50	21	11	48
Lead	U	2450	mg/kg	0.50	63	30	21
Selenium	U	2450	mg/kg	0.20	0.52	0.40	< 0.20
Zinc	U	2450	mg/kg	0.50	84	48	110
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50	< 0.50
Organic Matter	U	2625	%	0.40	11	3.5	1.6
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C21-C35	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0	< 5.0	< 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C21-C35	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0	< 5.0	< 5.0

Results - Soil

Project: 2077-21 Scholeslare, Scholes

Client: Geoenviro Solutions Ltd			**Chemtest Job No.:**		21-45370	21-45370	21-45370
Quotation No.:			**Chemtest Sample ID.:**		1345722	1345723	1345724
			Sample Location:		TP01	TP02	TP03
			Sample Type:		SOIL	SOIL	SOIL
			Top Depth (m):		0.00	0.70	1.00
			Bottom Depth (m):		0.40	0.70	1.00
			Date Sampled:		20-Dec-2021	20-Dec-2021	20-Dec-2021
			Asbestos Lab:		DURHAM	DURHAM	DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	< 10	< 10	< 10
Naphthalene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Fluorene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Anthracene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	U	2700	mg/kg	0.10	0.19	< 0.10	< 0.10
Pyrene	U	2700	mg/kg	0.10	0.20	< 0.10	< 0.10
Benzo[a]anthracene	U	2700	mg/kg	0.10	0.27	< 0.10	< 0.10
Chrysene	U	2700	mg/kg	0.10	0.44	< 0.10	< 0.10
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	U	2700	mg/kg	2.0	< 2.0	< 2.0	< 2.0
Benzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0
Toluene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0
m & p-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0
o-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0
Methyl Tert-Butyl Ether	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0
Total Phenols	U	2920	mg/kg	0.10	< 0.10	< 0.10	< 0.10

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2175	Total Sulphur in Soils	Total Sulphur	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Dichloromethane extraction / GCxGC FID detection
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

APPENDIX 6

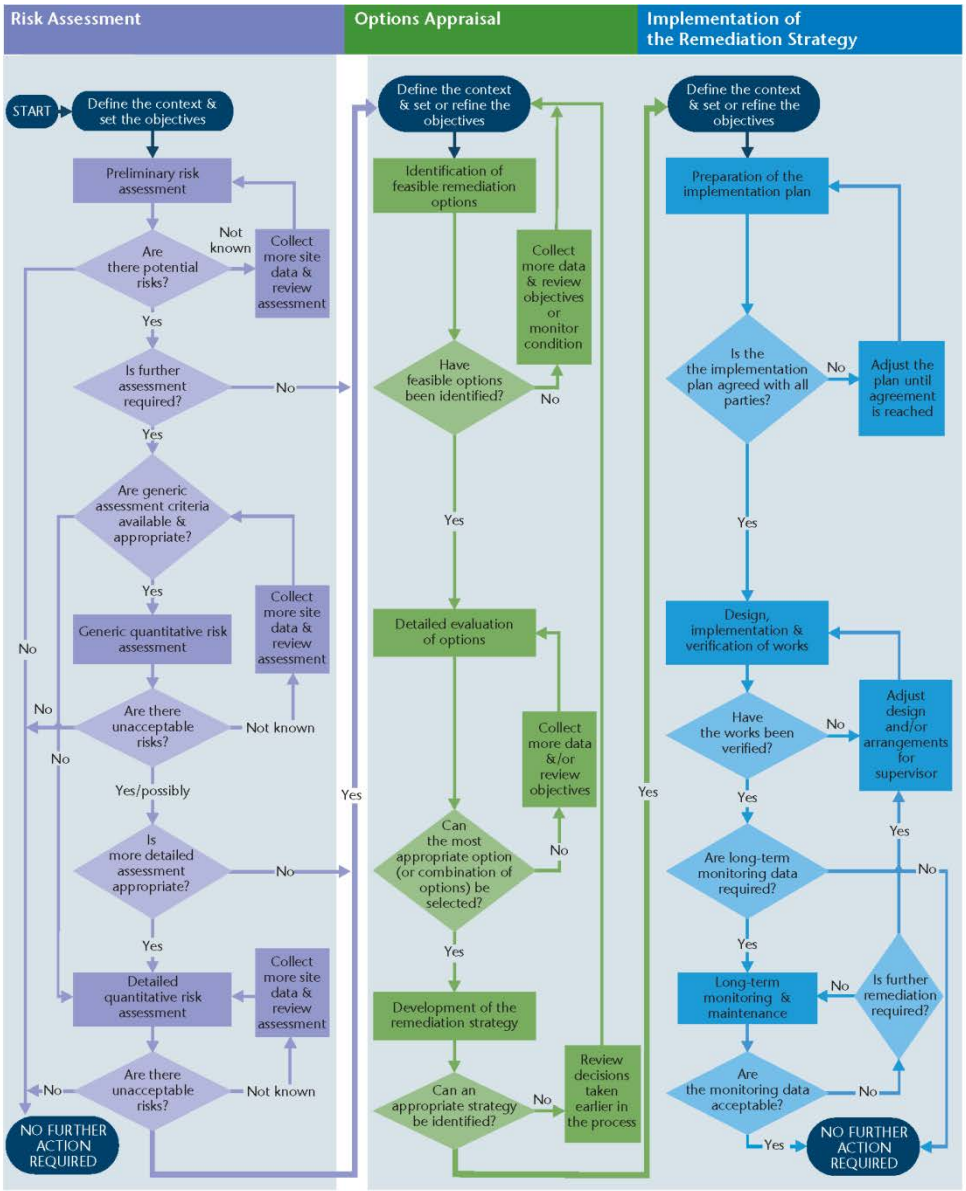
GACs Summary

APPENDIX H – HUMAN HEALTH ASSESSMENT CRITERIA

Context

Contaminated Land is defined under law through Part IIA of the Environmental Protection Act 1990, implemented through Section 57 of the Environment Act 1995 and associated guidance ("Part IIA"). These specify that a "suitable for use" approach is to be applied in the assessment of potentially contaminated land, implemented through a phased programme of site investigation and risk assessment appropriate to the site under consideration.

The assessment of potential risks posed by contaminated land is based upon the assessment of plausible contaminant source - pathway - receptor linkages ("pollutant linkages") for the current and/or proposed future use of the site. The process for the assessment of contaminated land adopted in this report is in line with guidance issued by DEFRA and Environment Agency (EA) 2004: "Model Procedures for the Management of Contaminated Land (CLR11)". The overall process for the management of land contamination is shown Figure 1 of CLR11 and reproduced below:



Note: The process may apply to one or more pollutant linkages each of which may follow a different route. For some linkages, it may be possible to stop at an early stage – others will progress all the way through the process. The level of complexity of each stage may also vary and in some cases may be very simple.

The risk assessment and subsequent investigation, remediation and verification must address all potential sources of pollutants that may be present on the site (the "hazards"), all receptors that may be harmed by these (e.g. human health, controlled waters, ecological receptors) and the pathways by which the contamination may be transported from the

contaminant source(s) to the receptor(s). This is defined within the conceptual model for the site, which represents the characteristics of the site in a form that shows the possible pollutant linkages. As further information becomes available (for example, through site investigation), so the conceptual model will be refined.

Remedial action can be specified at any phase within this assessment process to break the identified pollutant linkage In determining whether or not to undertake further assessment or to undertake remediation, the potential cost-savings arising from a more thorough assessment of the pollutant linkages and more tightly defined remedial strategy must be considered against the direct costs involved in the work and the time that this will take to execute and gain regulatory approval.

A different approach to the statistical appraisal of data is required depending on whether the assessment is being undertaken to assess land as Contaminated Land in accordance with the regulations or whether the assessment is to assess whether the site is suitable for new development in accordance with the Planning regime. The statistical approach to assessment is discussed further in CL:AIRE:2009 “Guidance on Comparing Data with a Critical Concentration”.

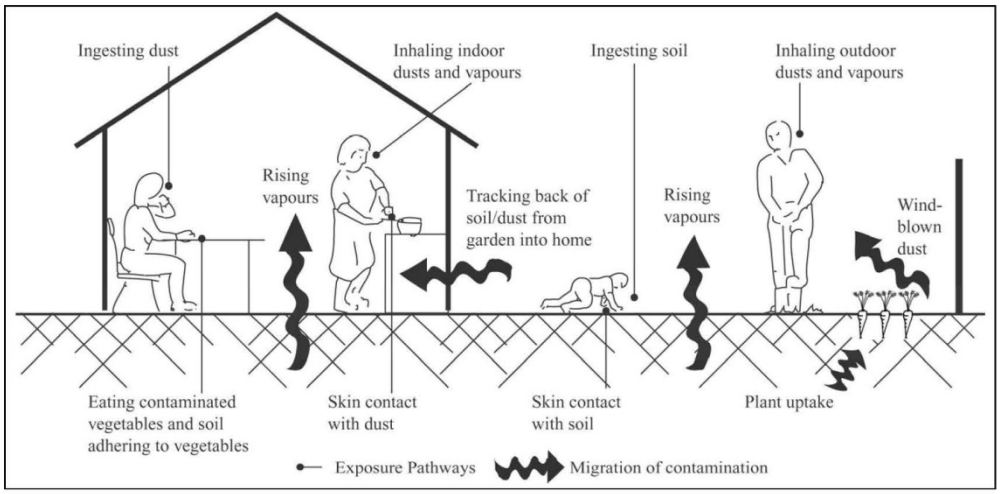
Some form of Detailed Quantitative Risk Assessment (DQRA) will be essential for those cases where appropriate GAC values cannot be established for the contaminant linkages under consideration.

Generic Assessment Criteria for Human Health Risk Assessment

In March 2002, the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency (EA) published the Contaminated Land Exposure Assessment (CLEA) Model and a series of related reports and guidance. These were designed to provide a scientifically based framework for the assessment of chronic risks to human health from contaminated land. The initial documents (CLR7 – 10) were withdrawn and replaced with revised guidance issued by the Environment Agency including:

- "Using Soil Guideline Values"; SC050021/SGV Introductions, EA,2009;
- "Human Health toxicology assessment of contaminants in soil"; SC050021/SR2, EA, 2009;
- "Update technical background to the CLEA model"; SC050021/SR3, EA, 2009;
- CLEA Software (Version) Handbook; SC050021/SR4; EA, 2008;
- Compilation of Data for priority Organic Contaminants for Derivation of Soil Guideline Values; Science Report SC050021/SR7, 2008; and,
- Guidance on Comparing Data with a Critical Concentration; CL:AIRE, 2009.

The CLEA model and associated guidance was developed to calculate an estimated tolerable daily intake (TDI) of contaminants for site users given a set of 'typical' human health exposure pathways which are detailed in "SR3: Updated technical background to the CLEA model" (Science Report SC050021/SR3, EA, 2009) and reproduced below.



- **Ingestion**
  - Outdoor soil;
  - Indoor dust;
  - Home grown produce;
  - Soil attached to home grown produce.
- **Dermal Contact**
  - Outdoor soil;
  - Indoor dust.
- **Inhalation**
  - Outdoor dust;
  - Indoor dust;
  - Outdoor vapour;
  - Indoor vapour.

It should be noted that the CLEA model does not include an exhaustive list of potential exposure pathways, e.g. certain compounds can pass through plastic water pipes into drinking water supply.

The potential significance of each of the exposure pathways is dependent upon the type of land use and the nature of the contaminant being considered. The CLEA model considers principal 'default' land use scenarios and makes a series of assumptions with regards to building type (where applicable), identification of the critical human receptor group, exposure frequency and duration. The definitions of the principal land use types given in SR3 (EA, 2009) are:

- **Residential land use;**
  A typical residential property consisting of a two story terraced house built on a ground-bearing slab of 0.15m thickness with a private garden consisting of lawn, flowerbeds, and a small fruit and vegetable patch. The occupants are assumed to be parents with young children, who make regular use of the garden. The critical receptor is a 0 – 6 year old female.

  Active exposure pathway are: ingestion of outdoor soil, ingestion of indoor dust, ingestion of home grown produce and soil adhering to home grown produce; direct dermal contact with outdoor soil and indoor dust; inhalation of outdoor dust and vapour and indoor dust and vapour.

- **Allotments**
  A plot of open space commonly made available by the Local Authority to tenants to grow fruit and vegetables for their own consumption. There are usually several plots to a site and the overall site area may cover more than one hectare. The tenants are assumed to be the parents or grandparents and that young children make occasional accompanied visits to the plots. The critical receptor is a 0 – 6 year old female and there is no building present on Site.

  Active exposure pathways are ingestion of outdoor soil, ingestion of home grown produce and soil adhering to home grown produce; direct dermal contact with outdoor soil; inhalation of outdoor vapour.

- **Commercial and industrial land use.**
  A typical commercial or light industrial property consisting of a three-story office building (pre-1970) with a ground bearing floor slab at which employees spend most time indoors and are involved in office based or related light physical work. The critical receptor is a working female adult aged 16 – 65 years.

  Active exposure pathway are ingestion of outdoor soil, ingestion of indoor dust; direct dermal contact with outdoor soil and indoor dust; inhalation of outdoor dust and vapour and inhalation of indoor dust and vapour.

Soil Guideline Values

Based on the assumption of each land use type, the EA and DEFRA developed and published Soil Guideline Value (SGV) using the CLEA model for a number of principal contaminants and 'default' end-use scenarios of residential, allotments and commercial/industrial use. The primary purpose of the SGVs are as trigger value for the tolerable daily intake (TDI), below which it can be assumed that the soil does not pose an unacceptable risk to the identified receptor. Where soils contamination is present above this level further assessment may be required. SGVs were developed for the following contaminants:

- Heavy metals and other inorganic compounds: arsenic, cadmium, chromium, cyanide, lead (now withdrawn), mercury, nickel and selenium;
- Benzene, ethylbenzene, toluene and xylenes;
- Phenol;
- Dioxins and dioxin-like polychlorinated biphenyls (PCBs)
- Polycyclic aromatic hydrocarbons (PAHs) – 11 substances

LQM/CIEH Generic Assessment Criteria of Human Health Risk Assessment

In addition, in 2009 CIEH through LQM and EIC published generic assessment criteria (GACs) for 82 substances including metals, petroleum hydrocarbons, PAHs and explosive substances for a variety of soil types and the three 'default' land uses – (residential, allotments and commercial end-uses) as described in SR3 (EA, 2009). These have been superseded as described below.

Category 4 Screening Values

In 2013 "SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination" (CL:AIRE 2013) was issued which detailed findings of a research project undertaken by CL:AIRE to set out the framework by which potential Category 4 Screening Levels (pC4SL) may be derived. This was supplemented in 2014 by "SP1010: Development of Category 4 Screening Levels for the Assessment of Land Affected by Contamination – Policy Companion Document" (DEFRA, 2014). SP1010 proposed several updated toxicology information relating to contaminant behaviour updated assumptions relating to the modelling of human exposure to soil contaminants, derivation of separate C4SLs for residential with the consumption of home grown produce, residential without the consumption of home grown produce, and two new land uses: public open spaces near residential housing (POS resi) and public parks (POS park).

- **Public Open Space: Residential**

  For public open space in close proximity to residential housing and the central green area around which houses are located, as on many housing estates from the 1930s to 1970s. It is also applicable for smaller areas commonly incorporated in newer developments as informal grassed areas or more formal landscaped areas with a mixture of open space and covered soil with planting. It is considered to be a generally grassed area up to 0.5ha with up to 50% bare soil. The land use is an important resource for children and the area is near the homes. The critical receptor is a female child age >3 - <9 years old (CLEA age class 4 – 9) as younger children are unlikely to play outdoors unsupervised.

  Active exposure pathways are: ingestion of outdoor soil, ingestion of indoor dust; direct dermal contact with outdoor soil and indoor soil derived dust; inhalation of outdoor and indoor dust and inhalation of outdoor vapour.

- **Public Open Space: Park**

  A public park is defined as an area of open space provided for recreational use and usually owned and maintained by the Local Authority. It is anticipated the park could be used for a wide range of activities, including the following:
  - Family visits and picnics;
  - Children's play area;
  - Sporting activities such as football on an informal basis (i.e. no a dedicated sports pitch); and
  - Dog walking.

  The park is modelled as an area >0.5 ha of predominantly grasses open space with no more than 25% of exposed soil.

  The critical receptor is a female child with CLEA age classes 1 – 6.

  Active exposure pathway are: ingestion of outdoor soil; direct dermal contact with outdoor soil; inhalation of outdoor dust and inhalation of outdoor vapour.

Furthermore the C4SLs are based on a different toxicological benchmark, the 'low level of toxicological concern' (LLTC). This difference in approach was adopted because the C4SLs were primarily intended for use under Part2A of the EPA 1990 to quickly screen out Category 4 sites where there is "*no risk or that the level of risk posed is low*". SGVs and LQM GACs are

based on the more conservative 'minimal or tolerable level of risk' as defined in SR2 (EA, 2009) and were derived for assessment of contamination for the Planning process.

Lead

The SGV for lead was withdrawn in 2011 and is not used in this report. The C4SL for lead provides a technically robust and conservative assessment tool using significantly updated toxicological modelling than the withdrawn SGV and derived in line with current science of lead toxicology.

LQM/CIEH Suitable 4 Use Levels (S4ULs)

The publication of the C4SLs resulted in considerable and inconclusive debate about the applicability of the lower level of protection of the C4SL, which are underlain by the LLTC, outside of the Part 2A context for which they were derived. In 2014 LQM/CIEH presented a Suitable 4 Use Levels (S4ULs), which incorporate the updated assumption exposure derived for the production of the C4SLs but within the context of deriving screening criteria above which further assessment of the risks or remedial action may be needed. The S4ULs replace the 82 substances, species and fractions and congeners contained in the previous LQM/CIEH GACs issued in 2009. Additionally, following changes and new land uses proposed in the C4SL research project, S4ULs have also been derived for the majority of substances for which the EA derived SGVs in 2009.

The GAC values adopted in this report are summarised in Table 1, below.

Parameter	Residential with homegrown produce (mg/kg, unless otherwise stated)			Residential without homegrown produce (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Public Open Space near Residential (mg/kg, unless otherwise stated)			Public Open Space - Park (mg/kg, unless otherwise stated)			Source
SOM	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	
Metals/metalloids																			
Arsenic	37			40			43			640			79			170			LQM (2014)
Beryllium	1.7			1.7			35			12			2.2			63			LQM (2014)
Boron	290			11000			45			240000			21000			46000			LQM (2014)
Cadmium	11			85			1.9			190			120			532			LQM (2014)
Chromium III	910			910			18000			8600			1500			33000			LQM (2014)
Chromium VI	6			6			1.8			33			7.7			220			LQM (2014)
Copper	2400			7100			520			68000			12000			44000			LQM (2014)
Lead	200			310			80			2330			630			1300			C4SL
Mercury (elemental)	1.2			1.2			21			58 (25.8)			16			30 (25.8)			LQM (2014)
Mercury (Inorganic)	40			56			19			1100			120			240			LQM (2014)
Methylmercury	11			15			6			320			40			68			LQM (2014)
Nickel	180			180			230			980			230			3400			LQM (2014)
Selenium	250			430			88			12000			1100			1800			LQM (2014)
Vanadium	410			1200			91			9000			2000			5000			LQM (2014)
Zinc	3700			40000			620			730000			81000			170000			LQM (2014)
Other																			
Total Sulphate	2,400			2,400			2,400			2,400			2,400			2,400			BRE (2005)
Water Soluble Sulphate (g/l)	0.5			0.5			0.5			0.5			0.5			0.5			BRE (2005)

Parameter	Residential with homegrown produce (mg/kg, unless otherwise stated)			Residential without homegrown produce (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Public Open Space near Residential (mg/kg, unless otherwise stated)			Public Open Space - Park (mg/kg, unless otherwise stated)			Source
SOM	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	
PAHs																			
Acenaphthene	210	510	1100	3000 (57)	4700(141)	6000 (336)	34	85	200	84000 (57)	97000 (141)	100000	15000	15000	15000	29000	30000	30000	LQM (2014)
Acenaphthylene	170	420	920	2900 (86.1)	4600 (212)	6000 (506)	28	69	160	8300 (86.1)	97000 (212)	100000	15000	15000	15000	29000	30000	30000	LQM (2014)
Anthracene	2400	5400	11000	31000 (1.17)	35000	37000	380	950	2200	520000	540000	540000	74000	74000	74000	150000	150000	150000	LQM (2014)
Benzo(a)anthracene	7.2	11	13	11	14	15	2.9	6.5	13	170	170	180	29	29	29	49	56	62	LQM (2014)
Benzo(a)pyrene	2.2	2.7	3	3.2	3.2	3.2	0.97	2	3.5	35	35	36	5.7	5.7	5.7	11	12	13	LQM (2014)
Benzo(b)fluoranthene	2.6	3.3	3.7	3.9	4	4	0.99	2.1	3.9	44	44	45	7.1	7.1	7.1	13	15	16	LQM (2014)
Benzo(g,h,i)perylene	320	340	350	360	360	360	290	470	640	3900	4000	4000	640	640	640	1400	1500	1600	LQM (2014)
Benzo(k)fluoranthene	77	93	100	110	110	110	37	75	130	1200	1200	1200	190	190	190	370	410	440	LQM (2014)
Chrysene	15	22	27	30	31	32	4.1	9.4	19	350	350	350	57	57	57	93	110	120	LQM (2014)
Dibenz(a,h)anthracene	0.24	0.28	0.3	0.31	0.32	0.32	0.14	0.27	0.61	3.5	3.6	3.6	0.57	0.57	0.58	1.1	1.3	1.4	LQM (2014)
Fluoranthene	280	560	890	1500	1600	1600	52	130	290	23000	23000	23000	3100	3100	3100	63	6300	6400	LQM (2014)
Fluorene	170	400	860	2800 (30.9)	3800 (76.5)	4500 (183)	27	67	160	63000 (30.9)	68000	71000	9900	9900	9900	20000	20000	20000	LQM (2014)
Indeno(1,2,3-cd)pyrene	27	36	41	45	46	46	9.5	21	39	500	510	510	82	82	82	150	170	180	LQM (2014)

Parameter	Residential with homegrown produce (mg/kg, unless otherwise stated)			Residential without homegrown produce (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Public Open Space near Residential (mg/kg, unless otherwise stated)			Public Open Space - Park (mg/kg, unless otherwise stated)			Source
SOM	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	
Naphthalene	2.3	5.6	13	2.3	5.6	13	4.1	10	24	190 (76.4)	460 (183)	1100 (432)	4900	4900	4900	1200 (76.4)	1900 (183)	3000	LQM (2014)
Phenanthrene	95	220	440	1300 (36)	1500	1500	15	38	90	22000	22000	23000	3100	3100	3100	6200	6200	6300	LQM (2014)
Pyrene	620	1200	2000	3700	3800	3800	110	270	620	54000	54000	54000	7400	7400	7400	15000	15000	15000	LQM (2014)
Coal Tar (BaP as surrogate marker)	0.79	0.98	1.1	1.2	1.2	1.2	0.32	0.67	1.2	15	15	15	2.2	2.2	2.2	4.4	4.7	4.8	LQM (2014)
BTEX and TPH																			
Benzene	0.087	0.17	0.37	0.38	0.7	1.4	0.017	0.034	0.075	27	47	90	72	72	73	90	100	110	LQM (2014)
Toluene	130	290	660	880 vap (869)	1900	3900	22	51	120	56000 vap (869)	110000 vap (1920)	180000 vap (4360)	56000	56000	56000	87000 vap (869)	95000 vap (1920)	100000 vap (4360)	LQM (2014)
Ethylbenzene	47	110	260	83	190	440	16	39	91	5700 vap (518)	13000 vap (1220)	27000 vap (2840)	24000	24000	25000	17000 vap (518)	22000 vap (1220)	27000 vap (2840)	LQM (2014)
Xylene - o	60	140	330	88	210	480	28	67	160	6600 (478)	15000 (1120)	33000 (2620)	41000	42000	43000	17000 (478)	24000 (1120)	33000 (2620)	LQM (2014)
Xylene - m	59	140	320	82	190	450	31	74	170	6200 (625)	14000 (1470)	31000 (3460)	41000	42000	43000	17000 (625)	24000 (1470)	32000 (3460)	LQM (2014)
Xylene - p	56	130	310	79	180	430	29	69	160	5900 (576)	14000 (1350)	30000 (3170)	41000	42000	43000	17000 (576)	23000 (1350)	31000 (3170)	LQM (2014)
Aliphatic EC 5-6	42	78	160	42	78	160	730	1700	3900	3200 (304)	5900 (558)	12000 (1150)	570000 (304)	590000	600000	95000 (304)	130000 (558)	180000 (1150)	LQM (2014)
Aliphatic EC >6-8	100	230	530	100	230	530	2300	5600	13000	7800 (144)	17000 (322)	40000 (736)	600000	610000	620000	150000 (144)	220000 (322)	320000 (736)	LQM (2014)

Parameter	Residential with homegrown produce (mg/kg, unless otherwise stated)			Residential without homegrown produce (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Public Open Space near Residential (mg/kg, unless otherwise stated)			Public Open Space - Park (mg/kg, unless otherwise stated)			Source
SOM	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	
Aliphatic EC >8-10	27	65	150	27	65	150	320	770	1700	2000 (78)	4800 (190)	11000 (451)	13000	13000	13000	14000 (78)	18000 (190)	21000 (451)	LQM (2014)
Aliphatic EC >10-12	130 (48)	330 (118)	760 (283)	130 (48)	330 (118)	760 (283)	2200	4400	7300	9700 (48)	23000 (118)	47000 (283)	13000	13000	13000	21000 (48)	23000 (118)	24000(283)	LQM (2014)
Aliphatic EC >12-16	1100 (24)	2400 (59)	4300 (142)	1100 (24)	2400 (59)	4300 (142)	11000	13000	13000	59000 (24)	82000 (59)	90000 (142)	13000	13000	13000	25000 (24)	25000 (59)	26000 (142)	LQM (2014)
Aliphatic EC >16-35	65000 (8.48)	92000 (21)	110000	65000 (8.48)	92000 (21)	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000	LQM (2014)
Aliphatic EC >35-44	65000 (8.48)	92000 (21)	110000	65000 (8.48)	92000 (21)	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000	LQM (2014)
Aromatic EC 5-7	70	140	300	370	690	1400	13	27	57	26000 (1220)	46000 (2260)	86000 (4710)	56000	56000	56000	76000 (1220)	84000 (2260)	92000 (4710)	LQM (2014)
Aromatic EC >7-8	130	290	660	860	1800	3900	22	51	120	56000 (869)	110000 (1920)	180000 (4360)	56000	56000	56000	87000 (869)	95000 (1920)	100000 (4360)	LQM (2014)
Aromatic EC >8-10	34	83	190	47	110	270	8.6	21	51	3500 (613)	8100 (1500)	17000 (3580)	5000	5000	5000	7200 (613)	8500 (1500)	9300 (3580)	LQM (2014)
Aromatic EC >10-12	74	180	380	250	590	1200	13	31	74	16000 (364)	28000 (899)	34000 (2150)	5000	5000	5000	9200 (364)	9700 (899)	10000	LQM (2014)
Aromatic EC >12-16	140	330	660	1800	2300 (419)	2500	23	27	130	36000 (169)	37000	38000	5100	5100	5000	10000	10000	10000	LQM (2014)
Aromatic EC >16-21	260	540	930	1900	1900	1900	46	110	260	28000	28000	28000	3800	3800	3800	7600	7700	7800	LQM (2014)
Aromatic EC >21-35	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	LQM (2014)

Parameter	Residential with homegrown produce (mg/kg, unless otherwise stated)			Residential without homegrown produce (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Public Open Space near Residential (mg/kg, unless otherwise stated)			Public Open Space - Park (mg/kg, unless otherwise stated)			Source
SOM	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	
Aromatic EC >35-44	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	LQM (2014)
Aromatic EC >44-75	1600	1800	1900	1900	1900	1900	1200	2100	3000	28000	28000	28000	3800	3800	3800	7800	7800	7900	LQM (2014)
VOCs																			
1,2-dichloroethane (1,2-DCA)	0.0071	0.011	0.019	0.0092	0.013	0.023	0.0046	0.0083	0.016	0.67	0.97	1.7	29	29	29	21	24	28	LQM (2014)
1,1,1-trichloroethane	8.8	18	39	9	18	40	48	110	240	660	1300	3000	140000	140000	140000	57000 (1425)	76000 (2915)	100000 (6392)	LQM (2014)
1,1,2,2,tetrachloroethane	1.6	3.4	7.5	3.9	8	17	0.41	0.89	2	270	550	1100	1400	1400	1400	1800	2100	2300	LQM (2014)
tetrachloroethene	0.18	0.39	0.9	0.18	0.4	0.92	0.65	1.5	3.6	19	45	95	1400	1400	1400	810 (424)	1100 (951)	1500	LQM (2014)
tetrachloromethane (Carbon tetrachloride)	0.026	0.056	0.13	0.026	0.056	0.13	0.45	1	2.4	2.9	6.3	14	890	920	950	190	270	400	LQM (2014)
Trichloroethene	0.016	0.034	0.075	0.017	0.036	0.08	0.041	0.091	0.21	1.2	2.6	5.7	120	120	120	70	91	120	LQM (2014)
Trichloromethane (chloroform)	0.91	1.7	3.4	1.2	2.1	4.2	0.42	0.83	1.7	99	170	350	2500	2500	2500	2600	2800	3100	LQM (2014)
Chloroethene (Vinyl chloride)	0.00064	0.00087	0.0014	0.00077	0.001	0.0015	0.00055	0.001	0.0018	0.059	0.077	0.12	3.5	3.5	3.5	4.8	5	5.4	LQM (2014)
2,4,6 Trinitrotoluene (TNT)	1.6	3.7	8.1	65	66	66	0.24	0.58	1.4	1000	1000	1000	130	130	130	260	270	270	LQM (2014)

Parameter	Residential with homegrown produce (mg/kg, unless otherwise stated)			Residential without homegrown produce (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Public Open Space near Residential (mg/kg, unless otherwise stated)			Public Open Space - Park (mg/kg, unless otherwise stated)			Source
SOM	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	1%	2.50%	6%	
RDX	120	250	540	13000	13000	13000	17	38	85	210000	210000	210000	26000	26000	27000	49000 (18.7)	51000	53000	LQM (2014)
HMX	5.7	13	26	6700	6700	6700	0.86	1.9	3.9	110000	110000	110000	13000	13000	13000	23000 (0.35)	23000 (0.39)	24000 (0.48)	LQM (2014)
Aldrin	5.7	6.6	7.1	7.3	7.4	7.5	3.2	6.1	9.6	170	170	170	18	18	18	30	31	31	LQM (2014)
Dieldrin	0.97	2	3.5	7	7.3	7.4	0.17	0.41	0.96	170	170	170	18	18	18	30	30	31	LQM (2014)
Atrazine	3.3	7.6	17.4	610	620	620	0.5	1.2	2.7	9300	9400	9400	1200	1200	1200	2300	2400	2400	LQM (2014)
Dichlovos	0.032	0.066	0.014	6.4	6.5	6.6	0.0049	0.01	0.022	140	140	140	16	16	16	26	26	27	LQM (2014)
Alpha-Endosulfan	7.4	18	41	160 (0.003)	280 (0.007)	410 (0.016)	1.2	2.9	6.8	5600 (0.003)	7400 (0.007)	8400 (0.016)	1200	1200	1200	2400	2400	2500	LQM (2014)
alpha-Hexachlorocyclohexane	0.23	0.55	1.2	6.9	9.2	11	0.035	0.087	0.21	170	180	180	24	24	24	47	48	48	LQM (2014)
beta-hexachlorocyclohexanes	0.085	0.2	0.46	3.7	3.8	3.8	0.013	0.032	0.077	65	65	65	8.1	8.1	8.1	15	15	16	LQM (2014)
gamma-hexachlorocyclohexanes	0.06	0.14	0.33	2.9	3.3	3.5	0.0092	0.023	0.054	67	69	70	8.2	8.2	8.2	14	15	15	LQM (2014)
Chlorobenzene	0.46	1	2.4	0.46	1	2.4	5.9	14	32	56	130	290	11000	13000	14000	1300 (675)	2000 (1520)	2900	LQM (2014)
1,2-Dichlorobenzene	23	55	130	24	57	130	94	230	540	2000 (571)	4800 (1370)	11000 (3240)	90000	95000	98000	24000 (571)	36000 (1370)	51000 (3240)	LQM (2014)
1,3-Dichlorobenzene	0.4	1	2.3	0.44	1.1	2.5	0.25	0.6	1.5	30	73	170	300	300	300	390	440	470	LQM (2014)

Parameter	Residential with homegrown produce (mg/kg, unless otherwise stated)			Residential without homegrown produce (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Public Open Space near Residential (mg/kg, unless otherwise stated)			Public Open Space - Park (mg/kg, unless otherwise stated)			Source
SOM	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	
1,4-Dichlorobenzene	61	150	350	61	150	350	15	37	88	4400 (224)	10000 (540)	25000 (1280)	17000	17000	17000	36000 (224)	36000 (540)	36000 (1280)	LQM (2014)
VOCs Continued																			
1,2,3-Trichlorobenzene	1.5	3.6	8.6	1.5	3.7	8.8	4.7	12	28	102	250	590	1800	1800	1800	770 (134)	1100 (330)	1600 (789)	LQM (2014)
1,2,4-Trichlorobenzene	2.6	6.4	15	2.6	6.4	15	55	140	320	220	530	1300	15000	17000	19000	1700 (318)	2600 (786)	4000 (1880)	LQM (2014)
1,3,5-Trichlorobenzene	0.33	0.81	1.9	0.33	0.81	1.9	4.7	12	28	23	55	130	1700	1700	1800	380 (36.7)	580 (90.8)	860 (217)	LQM (2014)
1,2,3,4-Tetrachlorobenzene	15	36	78	24	56	120	4.4	11	26	1700 (122)	3080 (304)	4400 (728)	830	830	830	1500 (122)	1600	1600	LQM (2014)
1,2,3,5-Tetrachlorobenzene	0.66	1.6	3.7	0.75	1.9	4.3	0.38	0.9	2.2	49 (39.4)	120 (98.1)	240 (235)	78	79	79	110 (39)	120	130	LQM (2014)
1,2,4,5-Tetrachlorobenzene	0.33	0.77	1.6	0.73	1.7	3.5	0.06	0.16	0.37	42 (19.7)	72 (49.1)	96	13	13	13	25	26	26	LQM (2014)
Pentachlorobenzene	5.8	12	22	19	30	38	1.2	3.1	7	640 (43)	770 (107)	830	100	100	100	190	190	190	LQM (2014)
Hexachlorobenzene	1.8 (0.2)	3.3 (0.5)	4.9	4.1 (0.2)	5.7 (0.5)	6.7 (1.2)	0.47	1.1	2.5	110 (0.2)	120	120	16	16	16	30	30	30	LQM (2014)
Phenol	280	550	1100	750	1300	2300	66	140	280	760 $_{dir}$ (31000)	1500 $_{dir}$ (35000)	3200 $_{dir}$ (37000)	760 $_{dir}$ (31000)	1500 $_{dir}$ (35000)	3200 $_{dir}$ (37000)	760 $_{dir}$ (31000)	1500 $_{dir}$ (35000)	3200 $_{dir}$ (37000)	LQM (2014)

Parameter	Residential with homegrown produce (mg/kg, unless otherwise stated)			Residential without homegrown produce (mg/kg, unless otherwise stated)			Allotment (mg/kg, unless otherwise stated)			Commercial / Industrial (mg/kg, unless otherwise stated)			Public Open Space near Residential (mg/kg, unless otherwise stated)			Public Open Space - Park (mg/kg, unless otherwise stated)			Source
SOM	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	**1%**	**2.50%**	**6%**	
Chlorophenols (excluding pentachlorophenol)	0.87 (g)	2	4.5	94	150	210	0.13 (g)	0.3	0.7	3500	4000	4300	620	620	620	1100	1100	1100	LQM (2014)
Pentachlorophenol	0.22	0.52	1.2	27 (16.4)	29	31	0.03	0.08	0.19	400	400	400	60	60	60	110	120	120	LQM (2014)
Carbon Disulphide	0.14	0.29	0.62	0.14	0.29	0.62	4.8	10	23	11	22	47	11000	11000	12000	1300	1900	2700	LQM (2014)
Hexachlorobutadiene	0.29	0.7	1.6	0.32	0.78	1.8	0.25	0.61	1.4	31	66	120	25	25	25	48	50	51	LQM (2014)

(g) derived based on 2,3,4,6-tetrachlorophenol; dir - based on a threshold protective of direct skin contact with phenol (guideline in brackets based on health effects following long term exposure provided for illustration only); (vap) calculated for vapour phase only. SOM – Soil Organic Matter; (4.5) solubility.

APPENDIX 7

RISK ASSESSMENT

MATRIX

Preliminary Risk Assessment Methodology (After NHBC Guidance for the Safe Development of Housing on Land Affected by Contamination (2008))

NHBC Guidance for the Safe Development of Housing on Land Affected by Contamination (2008) sets out a methodology for the estimation of risk.

At Phase I the risk estimation will take the form of a qualitative risk assessment, which will be entirely based on the conceptual model for each potential end-use of the site. Comments on level of uncertainty will also need to be included for each source-pathway-target linkage to allow the confidence in the assessed risks to be understood. The results of the qualitative risk assessment will allow the risk evaluation to be concisely described in the following chapters.

The methodology for risk evaluation is a qualitative method for interpreting the output for the risk estimation stage of the assessment. It involves the classification of the:

The magnitude of probability (i.e. likelihood).
[takes into account both the presence of the hazard and receptor and the integrity of the pathway]

The magnitude of the potential consequence (i.e. severity).
[takes into account both the potential severity of the hazard and the sensitivity of the receptor]

Classification of Probability

Classification	Definition	Examples
High likelihood (Hi)	There is a pollutant linkage and an event that either appears very likely in the short term and almost inevitable in the long term, or there is evidence at the receptor or harm or pollution.	*Elevated concentrations of toxic contaminants are present in soils in the top 0.5m in a residential garden.* *Ground/groundwater contamination could be present from chemical works, containing a number of USTs, having been in operation on the same site for over 50 years*
Likely (Li)	There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.	*Elevated concentrations of toxic contaminants are present in soils at depths of 0.5-1.0m in a residential garden, or the top 0.5m in public open space.* *Ground/groundwater contamination could be present from an industrial site containing a UST present between 1970 and 1990. The tank is known to be single skin. There is no evidence of leakage although there are no records of integrity tests.*
Low likelihood (Lw)	There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.	*Elevated concentrations of toxic contaminants are present in soils at depths >1m in a residential garden, or 0.5-1.0m in public open space.* *Ground/groundwater contamination could be present on a light industrial unit constructed in the 1990s containing a UST in operation over the last 10 years – the tank is double skinned but there is no integrity testing or evidence of leakage.*
Unlikely (Ul)	There is a pollutant linkage but circumstances are such that it is improbable that an event would occur even in the very long term.	*Elevated concentrations of toxic contaminants are present below hardstanding.* *Light industrial unit <10 yrs old containing a double skinned UST with annual integrity testing results available.*

Preliminary Risk Assessment Methodology (After NHBC Guidance for the Safe Development of Housing on Land Affected by Contamination (2008))

Classification of Consequence

	Definition	Examples
Severe (Sv)	Highly elevated concentrations likely to result in "significant harm" to human health as defined by the EPA 1990, Part 2A, if exposure occurs. A Category 1: Human Health risk is present. Equivalent to EA Category 1 pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point major impact on amenity value or major damage to agriculture or commerce. Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long - term maintenance of the population. Catastrophic damage to crops, buildings or property.	*Significant harm to humans is defined in circular 01/2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions.* *Major fish kill in surface water from large spillage of contaminants from site.* *Highly elevated concentrations of List I and substances present in groundwater close to small potable abstraction (high sensitivity).* *Explosion, causing building collapse (can also equate to immediate human health risk if buildings are occupied).*
Medium (Md)	Elevated concentrations which could result in "significant harm" to human health as defined by the EPA 1990, Part 2A if exposure occurs. A Category 2: Human Health risk is present. Equivalent to EA Category 2 pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long-term maintenance of the population. Significant damage to crops, buildings or property.	*Significant harm to humans is defined in circular 01/2006 as death, disease* serious injury, genetic mutation, birth defects or the impairment of reproductive functions.* *Damage to building rendering it unsafe to occupy e.g. foundation damage resulting in instability.* *Ingress of contaminants through plastic potable water pipes.*
Mild (Ml)	Exposure to human health unlikely to lead to "significant harm". A Category 3 Human Health risk is present. Equivalent to EA Category 3 pollution incident including minimal or short lived effect on water quality; marginal effect on amenity value, agriculture or commerce Minor or short lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that would endanger the long-term maintenance of the population Minor damage to crops, buildings or property.	*Exposure could lead to slight short - term effects (e.g. mild skin rash).* *Surface spalling of concrete.*
Minor (Mr)	No measurable effect on humans.A Category 4: Human Health risk is present. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structures and services.	*The presence of contaminants at such concentrations that protective equipment is required during site works.* *The loss of plants in a landscaping scheme.* *Discolouration of concrete.*

* For these purposes, disease is to be taken to mean an unhealthy condition of the body or a part of it and can include, for example, cancer, liver dysfunction or extensive skin ailments. Mental dysfunction is included only insofar as it is attributable to the effects of a pollutant on the body of the person concerned.

The classification of consequence does not take into account the probability of the consequence being realized. Therefore, there may be more than one consequence for a particular pollutant linkage. Both a severe and medium classification can result in death. Severe relates to short term (acute) risk while medium relates to long

term (chronic) risk. Mild relates to significant harm but to less sensitive receptors. Minor classification relates to harm which is not significant but could have a financial cost.

The classification gives a guide as to the severity and consequence of identified risk when compared with other risk presented on the site. It should be noted that if a risk is identified it cannot be classified as "no risk" but as "very low risk". Differing stakeholders may have a different view on the acceptability of a risk.

Risk Evaluation Matrix

		Consequence			
		Severe (Sv)	Medium (Md)	Mild (Mi)	Minor (Mr)
Probability	High likelihood (Hi)	Very high risk (VH)	High Risk (H)	Moderate Risk (M)	Mod/low risk (M/L)
	Likely (Li)	High risk (H)	Moderate risk (M)	Mod/low risk (M/L)	Low risk (L)
	Low likelihood (Lw)	Moderate risk (M)	Mod/low risk (M/L)	Low risk (L)	Very low risk (VL)
	Unlikely (Ul)	Mod/low risk (M/L)	Low risk (L)	Very low risk (VL)	Very low risk (VL)

Risk Categorizations

Very high risk (VH)	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realized, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High risk (H)	Harm is likely to arise to a designated receptor from an identified hazard. Realization of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short-term and are likely over the longer-term.
Moderate risk (M)	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer-term.
Low risk (L)	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realized, would at worst normally be mild.
Very low risk (VL)	There is a low possibility that harm could arise to a receptor. In the event of such harm being realized it is not likely to be severe.

Reference

Rudland, D J, Lancefield, R M, Mayell, P N; 2001; Contaminated land Risk Assessment. A guide to Good Practice; CIRIA Report C552.

The NHBC (National House-Building Council) the Environment Agency and the Chartered Institute of Environmental Health, 2008, Guidance for the Safe Development of Housing on Land Affected by Contamination R&D66.