Hampshire Homes Group Limited

Land at 31A North Street, Emsworth

Geo-environmental Site Assessment

305019 R02 (00)

SEPTEMBER 2018

RSK GENERAL NOTES

Project No.: 305019 R02 (00)

Title: Geo-environmental Site Assessment – Land at 31A North Street, Emsworth

Client: Hampshire Homes Group Limited

Date: September 2018

Office: RSK, Unit 26, Abbey Enterprise Centre, Premier Way, Romsey SO51 9AQ

Status: Final

Author	Andy Denton	**Technical reviewer**	Kirsten Fairall
Signature	[redacted]	Signature	[redacted]
Date:	September 2018	Date:	September 2018
Project manager	Andy Denton	**Quality reviewer**	Carys Baker
Signature	[redacted]	Signature	[redacted]
Date:	September 2018	Date:	September 2018

RSK Environment Limited (RSK) has prepared this report for the sole use of the client, showing reasonable skill and care, for the intended purposes as stated in the agreement under which this work was completed. The report may not be relied upon by any other party without the express agreement of the client and RSK. No other warranty, expressed or implied, is made as to the professional advice included in this report.

Where any data supplied by the client or from other sources have been used, it has been assumed that the information is correct. No responsibility can be accepted by RSK for inaccuracies in the data supplied by any other party. The conclusions and recommendations in this report are based on the assumption that all relevant information has been supplied by those bodies from whom it was requested.

No part of this report may be copied or duplicated without the express permission of RSK and the party for whom it was prepared.

Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK Environment Ltd.

CONTENTS

1 INTRODUCTION 1
1.1 Objective 1
1.2 Scope 1
1.3 Existing reports 2
1.4 Limitations 2
2 THE SITE 3
2.1 Site location and description 3
2.2 Proposed development 3
2.3 Summary of previous reports 4
2.3.1 Preliminary Risk Assessment (RSK, 2018) 4
3 SITE INVESTIGATION METHODOLOGY 11
3.1 Sampling strategy and methodology 11
3.1.1 Health, safety and environment considerations 11
3.1.2 Investigation locations 11
3.1.3 Soil sampling, in-situ testing and laboratory analysis 12
3.1.4 Groundwater monitoring and levelling 13
3.1.5 Ground gas monitoring 13
4 GROUND CONDITIONS 14
4.1 Soil 14
4.1.1 Made Ground 14
4.1.2 Alluvium 14
4.1.3 Head Deposits 15
4.1.4 London Clay Formation 15
4.1.5 Groundwater 16
4.1.6 Visual/olfactory evidence of soil and groundwater contamination 17
4.2 Ground gas regime 17
4.3 Refinement of the initial conceptual site model 18
5 QUANTITATIVE RISK ASSESSMENT 20
5.1 Linkages for assessment 20
5.2 Methodology and results 21
5.2.1 Direct contact with impacted soil by future residents 21
5.2.2 Inhalation exposure of future residents to contaminants in the vapour phase 22
5.2.3 Inhalation exposure of future residents to asbestos fibres 22
5.2.4 Uptake of contaminants by vegetation potentially inhibiting plant growth 22
5.2.5 Impact of organic contaminants on potable water supply pipes 23
5.2.6 Leaching of contaminants to groundwater in principal aquifer and subsequent migration to surface watercourse 23
5.2.7 Migration of dissolved phase contaminants to wider secondary aquifer body 23
5.2.8 Ground gas assessment 23
5.3 Environmental assessment conclusions 25
6 GEOTECHNICAL SITE ASSESSMENT 26

6.1 Engineering considerations 26
6.2 Geotechnical hazards 26
6.3 Foundations 27
6.3.1 General suitability 27
6.3.2 Piled foundations 28
6.3.3 Foundation works risk assessment 29
6.3.4 Floor slabs 29
6.3.5 Roads, hardstanding and drainage 29
6.3.6 Chemical attack on buried concrete 29
6.3.7 Soakaways 30
7 REUSE OF MATERIALS AND WASTE 31
7.1 Reuse of suitable materials 31
7.2 Treatment to meet suitable-for-use criteria 32
7.3 Reuse of waste materials 32
7.4 Wastes for landfill disposal 32
7.4.1 Waste acceptance criteria 33
7.4.2 Waste sampling plan 33
7.4.3 Preliminary waste assessment 33
7.4.4 Asbestos within waste soils 34
7.5 Landfill tax 34
7.6 Groundwater 34
7.7 Recommendations 35
8 CONCLUSIONS AND RECOMMENDATIONS 36
8.1 Environmental 36
8.1.1 Recommendations 36
8.2 Reuse of materials and waste 36
8.3 Geotechnical 37
8.3.1 Recommendations 37
BIBLIOGRAPHY 38
Managing Unexpected Contamination 5
Identification of potential contaminated material 5
Managing Suspicious Ground Conditions 5
Asbestos Containing Materials (ACMs) 6

TABLES

Table 1: Site setting 3
Table 2: Risk estimation for potentially complete pollutant linkages 6
Table 3: Exploratory hole and monitoring well location rationale 12
Table 4: Scheduled analysis – soil 12
Table 5: General succession of strata encountered 14
Table 6: Summary of in-situ and laboratory test results for the Head Deposits 15
Table 7: Summary of in-situ and laboratory test results for the London Clay Formation 15
Table 8: Groundwater results during investigation 16
Table 9: Groundwater monitoring data 07/09/2018, 12/09/2018, 21/09/2018 and 28/09/2018 17

Table 10: Summary of ground gas monitoring results 18
Table 11: Linkages for generic quantitative risk assessment 20
Table 12: Summary table of exceedances in soil GAC 21
Table 13: Summary of main potential geotechnical hazards that may affect site 26
Table 14: Design and construction of piled foundations 28

FIGURES

Figure 1 Site location plan
Figure 2 Proposed development plan
Figure 3 Exploratory hole location plan

APPENDICES

Appendix A Service constraints
Appendix B Summary of legislation and policy relating to contaminated land
Appendix C Exploratory hole records
Appendix D Ground gas and groundwater monitoring data
Appendix E Laboratory certificates for soil analysis
Appendix F Human health generic assessment criteria
Appendix G Human health soil vapour generic assessment criteria
Appendix H Phytotoxicity generic assessment criteria
Appendix I Potable water supply pipe generic assessment criteria
Appendix J Comparison of measured concentrations of contaminants to GAC
Appendix K Certificates of geotechnical analysis
Appendix L Haswaste assessment
Appendix M Discovery strategy

1 INTRODUCTION

RSK Environment Limited (RSK) was commissioned by Hampshire Homes Group Limited to carry out a geo-environmental assessment of the land at 31A North Street, Emsworth. It is understood the site is being considered for redevelopment as residential housing.

This report is subject to the RSK service constraints given in **Appendix A**.

A summary of legislation and policy relating to contaminated land is given in **Appendix B**.

1.1 Objective

The objective of the work is to evaluate client liabilities as part of the due diligence process by way of assessing the contamination status and geotechnical properties of the soils underlying the site. In addition, the works are also intended to subsequently support a planning application in relation to the proposed redevelopment works.

1.2 Scope

The scope of the investigation and layout of this report has been designed with consideration of CLR11 (Environment Agency, 2014) and BS 10175: 2013 (BSI, 2013) and guidance on land contamination reports issued by the Environment Agency (EA) (2010a).

The project was carried out to an agreed brief as set out in RSK's proposal (ref. 305019 T01 AD, dated 5th July 2018). The scope of works for the assessment included:

- a review of published geological data to assess ground stability;
- an intrusive investigation consisting of 4 No. drive-in sampler boreholes with laboratory analysis plus subsequent groundwater and gas monitoring;
- development of a refined conceptual site model followed by generic quantitative risk assessment (GQRA) to assess complete pollutant linkages that may require the implementation of mitigation measures to facilitate redevelopment;
- identification of outline mitigation measures for complete pollutant linkages or recommendations for further work;
- interpretation of ground conditions and geotechnical data to provide recommendations with respect to foundations and infrastructure design;
- a factual and interpretative report with recommendations for further works (i.e. undertake a remedial options appraisal to identify appropriate mitigation measures/produce a remedial implementation and verification plan) and/or remediation as necessary; and,
- an assessment of the potential waste classification implications of soil arisings.

1.3 Existing reports

RSK have previously undertaken a preliminary risk assessment at the site, which was reported under the following:

- RSK Report 305019 R01 (00) – Preliminary Risk Assessment (PRA), dated July 2018

This has been summarised in **Section 2**.

1.4 Limitations

The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels and ground gas concentrations and flows may vary from those reported due to seasonal, or other, effects.

During the site works, the RSK engineer noted that the roofing of the on-site buildings could contain asbestos, however, no access could be gained to the roofing material to assess the observation.

2 THE SITE

2.1 Site location and description

The site is located on land at 31A North Street, Emsworth PO10 7DA, at National Grid reference 474919, 106078, as shown on **Figure 1**.

The area around the site is a mixture of residential and commercial properties as detailed in **Table 1** below.

Table 1: Site setting

To the north:	Palmer's Road immediately north of the northern boundary with residential housing and an industrial estate beyond. To the north of the western section of the northern boundary are residential and commercial properties. A gas holder is present ~20 m to the north east.
To the east:	Residential properties immediately east with Palmer's Road beyond. An industrial estate lies beyond Palmer's Road with the River Ems (~89 m) and Brook Meadow beyond. Coombe Repair Group, a car maintenance company, is noted immediately east of the site.
To the south:	Residential properties immediately south with Palmer's Road beyond. Commercial properties lie over Palmer's Road.
To the west:	Residential and commercial properties with North Street beyond.

The site covers approximately 0.1 hectares at an elevation of approximately 8 m above Ordnance Datum (AOD) and comprises the following main attributes:

- Shared hardstanding entrance way;
- Hardstanding courtyard area in the central portion;
- Single storey brick-built warehouse / workshop structure in the north;
- Two storey brick built commercial unit adjoining workshop to the south along the eastern boundary;
- Two-storey brick built office building on the western side of the courtyard, along the western boundary.

2.2 Proposed development

The site in question is being considered for redevelopment as a three-storey residential flat building. The planned layout of the site is shown on **Figure 2**. The current proposed development comprises the construction of 10 No. units including 6 No. 1-bed single storey units, 2 No. 2-bed single storey units and 2 No. 2-bed two storey units. The remained of the site is proposed as car parking including 7 No. parking bays and 4 No. garages. No soft landscaping is proposed within the development. A basement has not been proposed as part of the development.

2.3 Summary of previous reports

2.3.1 Preliminary Risk Assessment (RSK, 2018)

2.3.1.1 Scope of works

The scope of the preliminary risk assessment (PRA) was designed with consideration of CLR11 (Environment Agency, 2014) and BS 10175: 2011 (BSI, 2011) and guidance on land contamination reports issued by the Environment Agency (EA) (2010a). The scope of works included:

- A site walkover inspection, including the identification of surrounding land use and location of possible sensitive environmental receptors in the site vicinity.
- A review of the geology and hydrogeology of the site to enable assessments to be made on the migration potential for contaminants that may be present on the site or in and around adjacent properties.
- A review of a commercially available environmental database to determine:

  Records of past pollution or other incidents relevant to the site

  Information regarding the location of recorded landfill sites within the site vicinity

  Details of groundwater abstractions (location, water use, source strata)

  Details of surface water quality classifications

  Information relating to ground stability

  A review of historical maps included with the database report to identify historical uses of the site and surrounding area.
- The identification of potential geological hazards, including radon.
- Preliminary UXO assessment.
- Production of a conceptual model identifying potentially complete contaminant linkages and qualitative risk assessment to identify the linkages for which further work may be necessary, e.g. site investigation.
- Recommended scope of Phase II intrusive investigations.

2.3.1.2 Preliminary risk assessment & Conceptual Site Model

Published geological records for the area (British Geological Survey, July 2018) indicated that the site is underlain by superficial River Terrace Deposits and superficial Head Deposits along the eastern boundary both deposits have an estimated thickness of 4 – 6 m. Bedrock deposits of the London Clay Formation are shown to underlie the site. An area of Alluvium is recorded approximately 75 m to the east of the site, associated with the River Ems.

Based on the published geological map referred to above, the hydrogeology of the site is likely to be characterised by the presence of an unconfined shallow aquifer comprising the River Terrace Deposits overlying the London Clay Formation.

The anticipated depth to the groundwater table is in the order of 2 – 3 m below ground level (bgl). Shallow groundwater in the site area is anticipated to flow in a south easterly direction, towards and in the direction of flow of the River Ems. Upon review of the historic maps it was noted that Southleigh Stream, approximately 177 m west of the site, was tidal to a point further north from the coast than the subject site. This suggests that the groundwater underlying the site is likely to be subject to tidal variation.

Superficial River Terrace Deposits beneath the site are classified by the Environment Agency as a Secondary (A) Aquifer. The London Clay Formation is classified as an unproductive strata. The site does not lie within any groundwater Source Protection Zones (SPZs). There are no records of licensed groundwater or surface water abstractions within a 1 km radius of the site.

The nearest identified surface watercourse to the site is the River Ems located approximately 89 m to the east of the site, flowing to the south.

The tidal Southleigh Stream lies approximately 177 m west of the site, flowing to the south, towards the Emsworth Channel.

Reference to historical mapping suggests the site was developed by at least 1866. The development comprised terraced houses and a Smithy in the south west of the site.

These properties remained on site until the 1950s, when buildings, industrial in appearance, are noted across the northern and southern portions of the site. In the 1960s the site is noted as a Builder's Yard which, in the 1970s became a Works. From interviews with the current land owner's it was ascertained that the Works comprised a machine engineering works. The owner also confirmed the presence of the reinforced concrete across the site from before their ownership began in the 1970s. No further on-site changes were noted within the historical mapping.

Various contaminative activites have been identified within 250 m radius of the site, including Gas Works / Gas Holders (~20 - 90 m north), a Railway Line (~180 m north), Industrial Works (north and east), Tanks (~50 m north and ~60 m east), a Hospital (~120 m south) and Electrical Substations (~70 m south east, ~80, 140 and 150 north and ~140 m west).

No landfills or refuse tips were noted within 1 km of the site boundary.

The information reviewed was used to compile an outline Conceptual Site Model (CSM) for the site, which is presented in **Table 2** overleaf.

Table 2: Risk estimation for potentially complete pollutant linkages

Potential Contaminant	Potential receptor	Possible pathway	Likelihood	Severity	Risk and justification
On site					
Smithy (*c.*1866 - 1930s)	Future site occupants	Direct contact	Low likelihood	Medium	**Moderate/Low**: Potential for chronic levels of contamination to be present beneath the existing hardstanding on site.
	Adjacent site occupants				
	Building materials above and below ground	Chemical attack of infrastructure	Low likelihood	Medium	**Moderate/Low**: Potential Made Ground beneath the site may be contaminated from the historic Smithy. Due to the age of the contaminant source risk is assessed to be moderate to low.
	Water supply pipes	Permeation into water supply	Low likelihood	Medium	**Moderate/Low**: Potential Made Ground beneath the site may be contaminated from the historic Smithy. Due to the age of the contaminant source risk is assessed to be moderate to low.
	Groundwater beneath the site	Leaching followed by vertical and lateral migration	Low likelihood	Medium	**Moderate/Low**: Potential Made Ground beneath the site may be contaminated from the historic Smithy. Lateral migration is possible within the superficial River Terrace Deposits however due to the age of the contaminant source risk is assessed to be moderate to low.

Potential Contaminant	Potential receptor	Possible pathway	Likelihood	Severity	Risk and justification
Builder's Yard (1960s - 1970s)	Future site occupants	Direct contact	Low likelihood	Medium	**Moderate/Low**: Potential for chronic levels of contamination to be present beneath the existing hardstanding on site. Potentially asbestos containing materials were noted during the site walkover in the building make-up, the year of construction would correlate with the use of asbestos in the buildings.
	Adjacent site occupants				
	Building materials above and below ground	Chemical attack of infrastructure	Low likelihood	Medium	**Moderate/Low:** Due to the relatively short time the Builder's Yard was present on the site (<10 years) it is not considered likely that large amounts of Made Ground are present underlying the site. However, the make-up of Made Ground underlying the hardstanding on site is unknown.
	Water supply pipes	Permeation into water supply	Low likelihood	Medium	
	Groundwater beneath the site	Leaching followed by vertical and lateral migration	Low likelihood	Medium	
Engineering Works (1980s - *c.* 2017)	Future site occupants	Direct contact	Unlikely	Medium	**Low**: Potential Made Ground from the Engineering Works is not considered likely to be present due to the presence of hardstanding across the site from beginning of tenure. Interviews undertaken during the site walkover confirm that the hardstanding was present throughout the time of the Works.
	Adjacent site occupants				
	Building materials above and below ground	Chemical attack of infrastructure	Unlikely	Medium	
	Water supply pipes	Permeation into water supply	Unlikely	Medium	
	Groundwater beneath the site	Leaching followed by vertical and lateral migration	Unlikely	Medium	

Potential Contaminant	Potential receptor	Possible pathway	Likelihood	Severity	Risk and justification
Off site					
Gas Works / Gasholder ~20 - 50 m north and north west (*c.*1866 - present)	Future site occupants	Direct contact / inhalation of soil vapour	Low likelihood	Severe	**Moderate**: Made Ground is not expected to be present from this source on the site. Historical Gas Works not always well maintained and due to its close proximity to the site, there is potential for lateral migration of gases.
	Adjacent site occupants				
Alluvial Deposits ~75 m east	Future site occupants	Direct contact / inhalation of soil vapour	Low likelihood	Severe	**Moderate**: Alluvium is a known ground gas producing deposit. Alluvium is not expected to be present on site due to the distance between the eastern boundary and the recorded deposits.
	Adjacent site occupants				
Electrical substations ~80 and 150 m north, ~70 m south east and ~140 m west (1960s - present)	Future site occupants	Direct contact	Unlikely	Medium	**Low:** The contaminants found within electrical substations are found within close proximity to the substations themselves as they bind strongly to soils. Due to the distance of the substations from the site, these are a low risk.
	Adjacent site occupants				
	Water supply pipes	Permeation into water supply	Unlikely	Medium	**Low:** The contaminants found within electrical substations are found within close proximity to the substations themselves as they bind strongly to soils. Due to the distance of the substations from the site, these are a low risk.
	Groundwater beneath the site	Leaching followed by vertical and lateral migration	Unlikely	Medium	**Low:** The contaminants found within electrical substations are found within close proximity to the substations themselves as they bind strongly to soils. This minimises the possibility that the contaminants will pass into the groundwater.

Potential Contaminant	Potential receptor	Possible pathway	Likelihood	Severity	Risk and justification
Various industrial land uses including Works, Coachworks, Bus Depots to the north and east	Future site occupants	Direct contact	Unlikely	Medium	**Low:** The site was developed prior to the development of these potential sources. No evidence of fill being imported onto the site is present. Potential for Made Ground containing contaminants from these sources being present on site is considered low.
	Adjacent site occupants				
	Building materials above and below ground	Chemical attack of infrastructure	Unlikely	Medium	
	Water supply pipes	Permeation into water supply	Unlikely	Medium	
	Groundwater beneath the site	Leaching followed by vertical and lateral migration	Unlikely	Medium	**Low:** The sources in question are not up the likely groundwater gradient and as such pose a low risk to the site through lateral migration.

2.3.1.3 Recommendations

Based on the results of the PRA, an intrusive investigation was recommended to include:

- Up to 5 No. approximately 5 m deep drive-in sampler boreholes to confirm the shallow ground conditions across the site and to enable ground gas monitoring well installation.
- Associated sampling and on-site testing, including the use of a photo-ionisation detector (PID) to screen for the presence of volatile organic compounds;
- Testing of approximately ten to fifteen (10 - 15 No.) soils samples for a range of potential contaminants including metals, PCBs and PAHs with a number of samples for TPH and asbestos;
- A programme of geotechnical laboratory testing to reflect the encountered geology, to inform foundation design;
- 3 - 6 No. post fieldwork visits to monitor ground gas and groundwater levels over a 1 - 2 month period;
- Development of a refined conceptual site model followed by generic quantitative risk assessment (GQRA) to assess complete pollutant linkages that may require mitigation measures to be implemented to facilitate the proposed development; and,
- Combined factual and interpretative report.

3 SITE INVESTIGATION METHODOLOGY

RSK carried out intrusive investigation work on the 29th August 2018. Subsequent ground gas and groundwater monitoring was undertaken on 4 No. weekly occasions between 7th and 28th September, to further investigate the potential pollutant linkages identified in the outline conceptual model and to inform geotechnical constraints.

3.1 Sampling strategy and methodology

The techniques adopted for the investigation have been chosen considering the anticipated ground conditions, existing land use and the proposed development.

Four (4 No.) drive-in sampler boreholes were advanced using a dynamic sampling rig. A dynamic sampling rig was selected owing to the restricted head height within the buildings on-site and the shallow nature of the investigation. Selected soil samples were obtained for environmental and geotechnical assessment as discussed further in **Section 3.1.3**.

During the intrusive works, the entire site was observed to be covered with concrete hard standing, as such a hydraulic breaker was used in each borehole location to break through the hard-standing surfacing.

3.1.1 Health, safety and environment considerations

Prior to intrusive investigation works, reference was made to existing service drawings for the site to prevent damage to underground utilities, in addition, each of the exploratory locations was cleared and marked out by a service clearance company.

The RSK engineer carried out a scan of each exploratory hole location using a Cable Avoidance Tool (CAT) as a final check prior to commencement of drilling.

3.1.2 Investigation locations

The site work was carried out by RSK on 29th August 2018, and comprised the activities summarised in **Table 3Error! Reference source not found.**, along with a justification for each exploratory hole location. The investigation and the soil descriptions were carried out in general accordance with BS5930: 2015 - Code of Practice for Ground Investigations. The exploratory hole logs and other site work records are presented in **Appendix C**.

The locations of the intrusive investigations are shown in **Figure 3**. The rationale for these locations is given in **Table 3**.

Table 3: Exploratory hole and monitoring well location rationale

Investigation Type	Exploratory hole number	Response zone (m bgl)	Rationale
Boreholes – by drive-in-sampler	WS1 - WS4	~0.6 - 4.00	Non-targeted placement to determine the contamination status of the ground. Shallow soil vapour, ground gas and groundwater monitoring installations to target stratum suspected of generating gas (Made Ground and Alluvium).

The investigation and the soil descriptions were carried out in general accordance with 'BS 5930:2015 Code of Practice for Ground Investigations' (BSI, 2015) and BS 8576:2013. The exploratory hole records are presented in **Appendix C**.

The investigation points were located approximately, by reference to physical features present on the site at the time of investigation.

3.1.3 Soil sampling, in-situ testing and laboratory analysis

Soils collected for laboratory analysis were collected in a variety of containers appropriate to the anticipated testing suite required. Samples were stored in accordance with the RSK quality procedures to maintain sample integrity and preservation and to minimise the chance of cross contamination.

Selected samples were placed in polythene bags for headspace screening with a photo-ionisation detector (PID) fitted with a 10.2 eV bulb.

32 No. soil samples were taken and are recorded together with their depths and the PID screening results on the exploratory hole records in **Appendix C**. Selected samples were transported to the laboratory in chilled cool boxes. Laboratory chain of custody forms can be provided if required. The rationale for soil sample chemical analysis is presented in **Table 4**.

Table 4: Scheduled analysis – soil

Exploratory hole no. and sample depth (m bgl)	Analyte	Rationale
WS1 (0.2, 0.5, 0.8), WS2 (0.5, 0.8), WS3 (0.2, 0.5, 0.8) and WS4 (0.3, 0.8)	Envirolab Suite 2 – Speciated TPH, Speciated PAH, metals (As, Cd, Cr, Cu, Hg, Pb, Ni, Se, Zn) and pH	Standard suite of contaminants to assess quality of underlying soils.
WS1 (0.2, 0.5), WS2 (0.5), WS3 (0.5), WS4 (0.3)	Asbestos in Soils	Identify any asbestos containing materials.
WS1 (0.8), WS2 (0.8), WS3 (0.2)	Total Organic Carbon (TOC)	Used to calculate percentage Soil Organic Matter (SOM) when comparing results to human health GAC.

Exploratory hole no. and sample depth (m bgl)	Analyte	Rationale
WS1 (2.5), WS2 (1.4), WS3 (2.0)	BRE SD1 Suite	Used to calculate Aggressive Chemical Environment for Concrete (ACEC).
WS1 (1.4, 1.8), WS2 (1.0, 2.5), WS3 (1.5, 2.5), WS4 (2.0)	Moisture content and 1-point Plasticity Limits	Used to calculate plasticity of soils underlying the site.

Standard penetration tests (SPTs) were carried out within cohesive deposits at regular intervals of approximately 1 m in accordance with part 9 of BS 1377:1990 (BSI, 1990). Test results are given on the borehole records presented in **Appendix C** and within the summary table included within each geological strata description in **Section 4**.

3.1.4 Groundwater monitoring and levelling

Depths to groundwater were recorded using an electronic dip meter on 29th August 2018 and during subsequent ground gas and groundwater monitoring on the 7th, 12th, 21st and 28th September 2018. The monitoring results are given in **Section 4.1.5**.

3.1.5 Ground gas monitoring

In line with the conceptual model which indicated potential gas sources on-site and within the surrounding areas, response zones were installed to target the sources or pathways as detailed in **Table 2**. Dual gas taps were installed in line with BS8576.

4 No. monitoring rounds have been undertaken to provide data to support the conceptual model. Monitoring included periods of falling atmospheric pressures and after/during rainfall.

An infrared gas meter was used to measure gas flow, concentrations of carbon dioxide (CO_2), methane (CH_4) and oxygen (O_2) in percentage by volume, while hydrogen sulphide (H_2S) and carbon monoxide (CO) were recorded in parts per million. Initial and steady state concentrations were recorded.

The atmospheric pressure before and during monitoring, together with the weather conditions, was recorded.

All monitoring results together with the temporal conditions are contained within **Appendix D** and discussed in **Section 4.2**.

4 GROUND CONDITIONS

The results of the intrusive investigation and subsequent laboratory analysis undertaken are detailed below. The descriptions of the strata encountered, notes regarding visual or olfactory evidence of contamination, list of samples taken, field observations of soil and groundwater, in-situ testing and details of monitoring well installations are included on the exploratory hole records presented in **Appendix C**.

4.1 Soil

The exploratory holes revealed that the site is underlain by a variable thickness of Made Ground over Alluvium with Head Deposits encountered overlying the London Clay Formation at depth. This appears to contradict the stratigraphical succession described within the initial conceptual model. For the purpose of discussion, the ground conditions are summarised in **Table 5** and the strata discussed in subsequent subsections

Table 5: General succession of strata encountered

Strata	Exploratory holes encountered	Depth to top of stratum m bgl	Thickness (m)
Made Ground	WS1 - WS4	Ground Level	0.50 - 0.90
Alluvium	WS1 and WS3	0.80	0.60 - 0.70
Head Deposits	WS1 - WS4	0.50 - 1.40	0.30 - 1.50
London Clay Formation	WS1 - WS4	1.20 - 2.20	>2.25 - >2.80*
* Base of the London Clay Formation not proven during the investigation			

4.1.1 Made Ground

The Made Ground comprised reinforced concrete over dark brown to black sandy slightly clayey GRAVEL to sandy gravelly CLAY, sand is medium to coarse, gravel is subangular to subrounded, fine to coarse flint, brick, glass, concrete and carbonaceous material. Made Ground was encountered from ground level in all locations and varied in thickness from 0.50 to 0.90 m bgl. A thin strata of reworked natural soils was encountered within WS2 between 0.80 and 0.90 m bgl comprising a brown sandy gravelly CLAY. Sand is medium, gravel is subangular to subrounded, fine to medium brick and concrete.

4.1.2 Alluvium

This stratum was encountered beneath the Made Ground in WS1 and WS3 only and comprised a layer of soft dark grey sandy gravelly CLAY to gravelly silty CLAY. Sand is medium, gravel is subangular to subrounded, fine to medium flint. This stratum was encountered from 0.80 m bgl and extended to between 1.40 - 1.50 m bgl. Based on field observation this layer has high moisture content and as such is likely to be highly compressible.

4.1.3 Head Deposits

Superficial Head Deposits were encountered, in all locations, at a depth of between 0.50 and 1.40 m bgl, below the Alluvium in WS1 and WS3 and underlying the Made Ground in WS2 and WS4. The Head Deposits were between 0.30 and 1.50 m in thickness. The Head Deposits were described as a firm to stiff brown with occasional orange and grey mottling slightly gravelly to gravelly silty CLAY. Gravel is subangular to subrounded, fine siltstone and flint.

A summary of the in-situ and laboratory test results in this stratum is presented in **Table 6** and shown fully in **Appendices C and K**.

Table 6: Summary of in-situ and laboratory test results for the Head Deposits

Soil parameters	Range	Reference
Liquid limit (%)	68 - 72	Appendix K
Plasticity limit (%)	30 - 35	
Plasticity index (%)	32 - 42	
Plasticity term	Intermediate to Very High	
Moisture content (%)	30 - 34	
Modified Plasticity Index (%)	30.45 - 39.06	NHBC Standards Chapter 4.2
Volume Change Potential	Medium	
SPT 'N' values	5	Appendix C
Undrained shear strength inferred from SPT 'N' values (kN/m^2)	22.5	-
Stiffness term	Soft	-

4.1.4 London Clay Formation

The London Clay Formation was encountered at depths of between 1.20 - 2.20 m bgl to the full depth of investigation. The base of this unit was not proved. The London Clay encountered was described as a firm to stiff brown with grey to bluish grey mottling occasionally gravelly silty CLAY. Gravel was encountered in WS2 only and comprised subangular to subrounded, fine siltstone. The consistency described above is the engineers field observation and the calculated classification, from SPT results, is presented in **Table 7**.

A summary of the in-situ and laboratory test results in this stratum is presented in **Table 7** and shown fully in **Appendices C and K**.

Table 7: Summary of in-situ and laboratory test results for the London Clay Formation

Soil parameters	Range	Reference
Liquid limit (%)	67 - 72	Appendix K
Plasticity limit (%)	26 - 34	

Soil parameters	Range	Reference
Plasticity index (%)	34 - 41	
Plasticity term	High to Very High	
Moisture content (%)	27 - 29	
Modified Plasticity Index (%)	32.98 - 41.00	NHBC Standards Chapter 4.2
Volume Change Potential	Medium to High	
SPT 'N' values	6 - 20	Appendix C
Undrained shear strength inferred from SPT 'N' values (kN/m^2)	27 - 90	-
Stiffness term	Soft to Stiff	-
pH	8.12 - 8.49	Appendix E
Water soluble sulphate (2:1) (mg/l)	56 - 94	

4.1.5 Groundwater

Groundwater was encountered during the investigation as detailed in **Table 8**.

Table 8: Groundwater results during investigation

Location	Stratum	Strike (m bgl)
WS1	Base of Head Deposits	2.00
WS2	London Clay Formation	2.65
WS3	Alluvium	1.20 (seepage)
WS4	London Clay Formation	2.70

It should be noted that groundwater levels might fluctuate for a number of reasons including seasonal and tidal variations.

The results of the subsequent groundwater monitoring are summarised in **Table 9**.

Table 9: Groundwater monitoring data 07/09/2018, 12/09/2018, 21/09/2018 and 28/09/2018

	Monitoring well			
	WS1	WS2	WS3	WS4
Depth to water (m bgl) 07/09/2018	DRY	0.84	0.84	2.43
Depth of well (m bgl) 07/09/2018	3.50	3.45	3.46	3.50
Depth to water (m bgl) 12/09/2018	1.22	0.73	0.92	1.07
Depth of well (m bgl) 12/09/2018	3.53	3.43	3.46	3.48
Depth to water (m bgl) 21/09/2018	1.45	0.65	0.70	1.40
Depth of well (m bgl) 21/09/2018	3.55	3.42	3.46	3.52
Depth to water (m bgl) 28/09/2018	2.04	0.74	0.81	2.50
Depth of well (m bgl) 28/09/2018	3.62	3.41	3.45	3.53

The findings reflect the perched groundwater table in the Head Deposits. The results are considered to be variable. This variation is likely to be a result of tidal influence on the sites groundwater regime.

4.1.6 Visual/olfactory evidence of soil and groundwater contamination

It was noted during the site works that the Made Ground deposits were dark / black in colour with occasional carbonaceous material. No other visual or olfactory evidence of contamination was noted during the works.

4.2 Ground gas regime

The results of the ground gas monitoring carried out between 07/09/2018 and 21/09/2018 are given in **Appendix D**. The minimum and maximum results are recorded in **Table 10**.

Table 10: Summary of ground gas monitoring results

Borehole	Response zone	Probable source(s) of ground gas	Number of monitoring visits	Methane (%)	Carbon dioxide (%)	Oxygen (%)	Flow rate (l/hr)	Water level (m bgl)	Atmospheric pressure (mbar)
WS1	0.65 - 3.65	MG / All	4	0.5	2.0	14.8	0.3	1.22	985 - 1030
WS2	0.65 - 3.65	MG	4	0.0	0.9	18.1	0.5	0.65	
WS3	0.50 - 3.50	MG / All	4	0.0	0.2	18.2	-0.4	0.70	
WS4	0.60 - 3.60	MG	4	0.1	0.5	14.4	0.2	1.07	

Note: MG - Made Ground, All - Alluvium

Steady state gas concentrations and flows are presented in this table. The highest reported carbon dioxide and methane results are given alongside the lowest reported oxygen results. The shallowest groundwater levels recorded across the two monitoring rounds are given.

It is noted that during all monitoring visits groundwater has been <1 m bgl within locations WS2 and WS3. All monitoring wells were installed with a shorter length of plain pipe to allow for the assessment of ground gas present under high water table conditions, thus the measured water depth is not considered to affect the ground gas monitoring results.

4.3 Refinement of the initial conceptual site model

The intrusive element of the investigation has provided clarity on the geological strata underlying the site and has allowed the assumptions within the PRA to be updated. The exploratory holes revealed that the site is underlain by a variable thickness of reinforced concrete and Made Ground. Alluvium was encountered in the east of the site underlying the Made Ground over superficial Head Deposits. The Made Ground in the west of the site was found to lie directly on top of the Head Deposits. The London Clay Formation was encountered within all locations underlying the Head Deposits. The Made Ground encountered to between 0.50 and 0.90 m, beneath the reinforced concrete, indicates reworking of soils and intermixing of anthropogenic materials, which is considered likely to be associated with the development of the site in c. 1950s.

Groundwater was identified between 1.20 and 2.70 m bgl across the site during the intrusive investigation, however, during subsequent monitoring visits it's level was noted to have risen to between 0.73 and 1.21 m bgl. This is thought to represent perched groundwater lying on the cohesive Head Deposits.

The ground conditions encountered differ from those considered within the outline CSM within the PRA. The Alluvium encountered during the investigation was considered to be present to the east of the site. It's presence on site could affect the ground gas regime as Alluvium is a known methane producing strata.

The following pollutant linkages are considered to require assessment:

- Ground gas production by on site geology / off site land uses; and,
- Chemical composition of Made Ground present on site.

5 QUANTITATIVE RISK ASSESSMENT

In line with CLR11 (EA, 2004), there are two stages of quantitative risk assessment, generic and detailed. The GQRA comprises the comparison of soil, groundwater, soil gas and ground gas results with generic assessment criteria (GAC) that are appropriate to the linkage being assessed. This comparison can be undertaken directly against the laboratory results or following statistical analysis depending upon the sampling procedure that was adopted.

5.1 Linkages for assessment

Section 4.3 presents the refined conceptual model which identified the linkages that required assessment after the findings of the site investigation had been considered. These linkages together with the method of assessment are presented in **Table 11**.

Table 11: Linkages for generic quantitative risk assessment

Potentially relevant pollutant linkage	Assessment method
1. Direct contact with impacted soil by future residents	Human health GAC in **Appendix F** for a proposed residential end use without private gardens since proposed end use will not include residential gardens.
2. Inhalation exposure of future residents to contaminants in the vapour phase	Human health GAC in **Appendix G** for soil and groundwater based on indoor inhalation exposure to vapour-phase volatile organic compounds (VOC). Modified inhalation reference concentrations for comparison with measured concentrations of VOC in soil gas.
3. Inhalation exposure of future residents to asbestos fibres	Qualitative assessment based on the asbestos minerals present, their form, concentration, location and the nature of the proposed development.
4. Uptake of contaminants by vegetation potentially impacting plant growth	Comparison of soil data to GAC in **Appendix H**.
5. Contaminants permeating potable water supply pipes	Comparison of soil data to GAC in **Appendix I** for plastic water supply pipes using UKWIR (2010) guidance.
6. Leaching of soil contaminants and dissolved phase and vertical migration to the underlying secondary A aquifer	Since no leachate data is available the potential for leaching has been considered qualitatively using soil and groundwater results.
7. Migration of contaminants to wider secondary A aquifer body and controlled water receptors	Since no groundwater data is available the potential for migrating has been considered qualitatively using soil results.
8. Concentrations of methane and carbon dioxide in ground	Gas screening values (GSV) have been calculated using maximum methane and carbon dioxide concentrations with maximum flow rates recorded at the site. The GSV have

Potentially relevant pollutant linkage	Assessment method
gas entering and accumulating in: depressions and excavations that could affect workers enclosed spaces or small rooms in new buildings, which could affect future residents. In the case of methane this could create a potentially explosive atmosphere, while death by asphyxiation could result from carbon dioxide.	been compared with the revised Wilson and Card classification presented within CIRIA report C665 (Wilson et al., 2007) owing to the development comprising buildings with a ground floor slab or the generic Traffic Lights, as presented within the NHBC ground gases guide (Boyle and Witherington, 2007) and the aforementioned CIRIA report C665, owing to the development comprising low-rise housing with suspended floors. In addition, the gas regime is considered within the context of a conceptual model as required by both aforementioned guidance documents and BS8576
Notes: N/A	

5.2 Methodology and results

The methodology and results of the GQRA are presented for each relevant pollutant linkage in turn.

5.2.1 Direct contact with impacted soil by future residents

The results of the laboratory soil analysis have been evaluated in the following subsections.

It has been determined that the use of the generic assessment criteria (GAC) for Residential Properties without Home Grown Produce (RwoHP) is most appropriate for the proposed development. **Table 12** below summarises the results obtained in the investigation. Only those determinands where exceedances have been reported are included within the table.

Table 12: Summary table of exceedances in soil GAC

Zone/ material	Determinant	No. of samples tested	GAC (mg/kg)	No of excee-dances	Maximum concentration (mg/kg)		Locations exceeding GAC / depth
					Value	Location / depth	
MG	Benzo(a)-anthracene	10	5.30	1	5.53	WS1 - 0.20	WS1 - 0.20
MG	Benzo(a)-fluoranthene	10	4.00	1	6.81	WS1 - 0.20	WS1 - 0.20
MG	Dibenzo(ah)-anthracene	10	0.32	1	0.87	WS1 - 0.20	WS1 - 0.20

MG	Lead	10	310	3	1800	WS3 - 0.20	WS2 - 0.50 WS3 - 0.20 WS3 - 0.50
Notes: MG – made ground							

Of the ten (10 No.) samples tested, only one exceeded the GAC for PAH concentrations. The sample from WS1 at 0.20 m bgl showed exceedances for benzo(a)anthracene (5.53 mg/kg), benzo(a)fluoranthene (6.81 mg/kg) and dibenzo(a,h)anthracene (0.87 mg/kg). These exceedances are considered marginal and this stratum is likely to be removed during the site strip, or capped by the proposed buildings, eliminating the pollutant pathway.

Three (3 No.) samples of those tested exceeded the GAC for lead concentration. Samples from WS2 at 0.50 (411 mg/kg) and WS3 at 0.20 (1800 mg/kg) and 0.50 (519 mg/kg). These samples were taken within the top 0.50 m of ground, this is likely to be removed during the site strip, thus removing the pollutant pathway. If these soils are not planned to be removed during the works, hotspot removal of these soils will be required.

5.2.2 Inhalation exposure of future residents to contaminants in the vapour phase

Inhalation exposure to VOC has initially been assessed through the direct comparison of soil and groundwater data with the following criteria:

- VOC in soil – human health soil SGV/GAC which either include or are specific to inhalation exposure pathways (**Appendix G**)

Comparison of the soil to GACs applicable to inhalation pathways showed no exceedances for a residential without home-grown produce land-use scenario.

5.2.3 Inhalation exposure of future residents to asbestos fibres

The laboratory screening for asbestos identified detectable asbestos fibres within 1 No. sample of Made Ground (WS1 - 0.20 m). This samples were then further analysed and the presence of fibres of chrysotile, in the form of microscopic fibre bundles, were confirmed, with a maximum of <0.001% by weight present in the sample from WS1 at 0.20 m bgl. This strata is likely to be removed during the site strip or capped by the proposed buildings, thus removing the pollutant pathway. If the soils in this area are not to be removed from site, protection measures, such as damping down of soil, should be put in place if the soils are to be exposed.

5.2.4 Uptake of contaminants by vegetation potentially inhibiting plant growth

The results have been compared with the GAC presented in **Appendix H** for this linkage. Comparison of the soil data to the GAC indicate that a relevant pollutant is likely to exist associated with phytotoxic effects from measured concentrations of lead and mercury encountered within WS2 and WS3. At the time of issue of this report, no vegetation is proposed within the development, if soft landscaping areas are proposed then removal of phytotoxic soils will be required.

5.2.5 Impact of organic contaminants on potable water supply pipes

For initial assessment purposes, the results of the investigation have been compared with the GAC presented in **Appendix I** for this linkage, which are reproduced from *UKWIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (UKWIR, 2010).

The results indicate that a relevant linkage is likely to exist associated with organic contaminants (aromatic and aliphatic C_5 - C_{10}) and therefore pollutant polyethylene (PE) and polyvinyl chloride (PVC) water supply pipes are expected to be unsuitable for use on the development unless remedial measures are implemented that mitigate the risk.

It should be noted that at the time of this investigation the future routes of water supply pipes had not been established, hence the investigation and sampling strategy may not be fully compliant with UKWIR recommendations. Consequently, a targeted investigation and specific sampling/analytical strategy may be required at a later date once the route(s) of the supply pipe(s) are known. In addition, it is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements for assessment, which may not necessarily be the same as those recommended by UKWIR.

5.2.6 Leaching of contaminants to groundwater in principal aquifer and subsequent migration to surface watercourse

Soil samples were not analysed for leachable PAH or TPH. The concentrations of PAH and TPH, particularly the more mobile and persistent compounds, indicate that leaching to groundwater is unlikely to be a relevant pollutant linkage.

5.2.7 Migration of dissolved phase contaminants to wider secondary aquifer body

Groundwater samples were not obtained as part of this investigation. The concentrations of contaminants observed in the soil testing data are not considered high enough to pose a significant risk to the wider aquifer body.

5.2.8 Ground gas assessment

The results have been assessed in accordance with the guidance provided in BS8576, NHBC guidance and *CIRIA Report C665*. In the assessment of risks and selection of appropriate mitigation measures, both reports highlight the importance of the conceptual model.

5.2.8.1 Summary of CSM

The Made Ground encountered on-site, the presence of natural Alluvium deposits and the gas works / gas holder north east of the site have been identified as potential sources of ground gases, which may pose significant risks to human health and proposed infrastructure associated with redevelopment of the site for residential housing.

5.2.8.2 General

CIRIA C665 identifies two types of development, termed Situation A (modified Wilson and Card method), appropriate to all development excluding traditional low-rise construction,

and Situation B (National House-Building Council, NHBC) only appropriate to traditional low-rise construction with ventilated sub-floor voids.

Both methods are based on calculations of the limiting borehole gas volume flow for methane and carbon dioxide, renamed as the gas screening value (GSV). The GSV (litres of gas per hour) is calculated by multiplying borehole flow rate (litres per hour) and gas concentration (percent by volume).

In both situations, it is important to note that the GSV thresholds are guideline values and not absolute. The GSV thresholds may be exceeded in certain circumstances, if the site conceptual model indicates it is safe to do so. Similarly, consideration of additional factors such as very high concentrations of methane, should lead to consideration of the need to adopt a higher risk classification than the GSV threshold indicates.

The site is to be redeveloped with residential flats and therefore falls under Situation A.

Situation A relates to all development types except low-rise housing and, by combining the qualitative assessment of risk (see refined conceptual model in **Section 4.3**) with the gas monitoring results, provides a semi-quantitative estimate of risk for a site. The method uses both gas concentrations and borehole flow rates to define a characteristic situation for a site based on the limiting borehole gas volume flows for methane and carbon dioxide. Having calculated the worst case GSVs for methane and carbon dioxide, the Characteristic Situation is then determined from Table 8.5 of CIRIA C665.

5.2.8.3 Assessment of data

The site is to be redeveloped with residential flats and therefore falls under Situation A.

In order to characterise the residential development area GSVs have been calculated for each location.

Site redevelopment assessment (including locations WS1, WS2, WS3 and WS4):

- Methane - maximum concentration of 0.5 %v/v (WS1);
- Carbon dioxide - maximum concentration of 2.0 %v/v (WS1); and,
- Flow - maximum positive steady rate 0.5 l/hr (WS2).

Based on the above concentrations, GSVs can be calculated as follows:

$GSV_{METHANE}$ = (0.5 / 100) * 0.5 = 0.0025 l/hr; and,

$GSV_{CARBON\ DIOXIDE}$ = (2.0 / 100) * 0.5 = 0.01 l/hr.

Trace gas carbon monoxide was also encountered at a maximum concentration of 6.0 ppm.

The gas monitoring data has identified a maximum methane concentration of 0.5 % and a maximum concentration of carbon dioxide of 2.0 %. A maximum gas flow rate of 0.5 l/hr has been recorded. The calculated GSV for methane is 0.0025 l/hr and the GSV for carbon dioxide is 0.01 l/hr. Based on the GSVs the site has been characterised CS1, where no protection methods are required.

5.3 Environmental assessment conclusions

The relevant pollutant linkages that require further action are:

- Contaminant concentrations exceeding relevant GACs including lead, benzo(a)anthracene, benzo(a)fluoranthene and dibenzo(a,h)anthracene; and,
- Presence of asbestos fibres in near surface Made Ground.

6 GEOTECHNICAL SITE ASSESSMENT

6.1 Engineering considerations

It is understood that the proposed development is to involve the construction of a single block comprising 10 No. flats and associated infrastructure as described in **Section 2.2** and as shown in **Figure 2**.

6.2 Geotechnical hazards

A summary of commonly occurring geotechnical hazards is given in **Table 13** together with an assessment of whether the site may be affected by each of the stated hazards.

Table 13: Summary of main potential geotechnical hazards that may affect site

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
Sudden lateral changes in ground conditions	✓ (variable superficial geology)	The thickness of Made Ground varies between 0.50 m and 0.90 m. Soft alluvium comprising sandy, gravelly clay with organic inclusions was encountered in WS1 and WS3, however was not present in WS2 and WS4.		Likely to affect ground engineering and foundation design and construction.
Shrinkable clay soils	✓	Cohesive soils have been assessed to be of medium to high shrinkage potential.		Design to NHBC Standards Chapter 4 or similar
Highly compressible and low bearing capacity soils, (including peat and soft clay)	✓	Soft alluvium in WS1 and WS3.		Likely to affect ground engineering and foundation design and construction
Silt-rich soils susceptible to rapid loss of strength in wet conditions	✓	Encountered in the superficial Head Deposits and bedrock London Clay Formation		Likely to affect ground engineering and foundation design and construction
Running sand at and below water table			✓	Likely to affect ground engineering and foundation design and construction

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
Ground subject to or at risk from coastal or river erosion			✓	Likely to require special protection/stabilisation measures
High groundwater table (including waterlogged ground)	✓	Groundwater assessed to be within 1 m of the surface.		Will affect temporary and permanent works. Perched groundwater has been recorded <1 m during monitoring.
Rising groundwater table due to diminishing abstraction in urban area			✓	May affect deep foundations, basements and tunnels
Underground mining			✓	Likely to require special stabilisation measures
Existing sub-structures (e.g. tunnels, foundations, basements, and adjacent sub-structures)		✓		Likely to affect ground engineering and foundation design and construction
Filled and made ground (including embankments, infilled ponds and quarries)	✓	Made Ground encountered in all locations to relatively shallow depths (0.5 - 0.9 m bgl)		Likely to affect ground engineering and foundation design and construction
Adverse ground chemistry (including expansive slags and weathering of sulphides to sulphates)		✓		May affect ground engineering and foundation design and construction
Note: Seismicity is not included in the above table as this is not normally a design consideration in the UK.				

6.3 Foundations

6.3.1 General suitability

Given the presence of relatively soft compressible alluvium and shallow groundwater, the ground conditions are not considered suitable for the adoption of spread foundations due to depth of a suitable founding stratum and the potential for groundwater ingress resulting in foundation excavation instability. Consideration has been given to the adoption of various ground improvement to support shallow foundations but have been discounted

due to technical issues and environmental constraints. On this basis, it is recommended that piled foundations be adopted.

6.3.2 Piled foundations

The shallow boreholes undertaken to date are not suitable for the design of piled foundations. At least one deep cable percussive borehole is recommended. The borehole should be taken to a minimum of 5m below the toe of the deepest pile. For the pile loads and ground conditions envisaged, it is considered that a single, 20m deep borehole is appropriate.

The design and construction of piled foundations in relation to the ground conditions identified beneath the site are set out in **Table 14**. These are preliminary recommendations at this time and will need to be revised following the findings of the deep borehole.

Table 14: Design and construction of piled foundations

Design/construction considerations	Design/construction recommendations
Pile type	Given the presence of the London Clay at a relatively shallow depth, it is considered that both bored and driven piles are technically feasible at the site.
Possible constraints on choice of pile type	Given the site setting i.e. located within an urban environment, vibration/noise associated with driven piles is unlikely to be acceptable.
Temporary casing	Given the presence of shallow groundwater and the potential for seepages associated with any claystone horizons in the London Clay if encountered, bored piles will require temporary casing throughout their depth. Alternatively, the use of continuous-flight-auger (CFA) injected bored piles usually overcomes this issue
Made ground and s. oft superficial deposits	It is considered that the made ground and alluvium will not contribute to the load carrying capacity of the piles (to be provided following the deep borehole). The designer may want to consider this further.
Hard strata	An allowance should be made for chiselling thin 'rock' bands (claystone), within the London Clay Formation
Special precautions relating to bored pile shafts and bases	Bored pile concrete should be cast as soon after completion of boring as possible and in any event the same day as boring. Prior to casting the base of the pile bore should be clean, otherwise a reduced safe working load will be required. Similarly, if the pile bore is left open the shaft walls may relax/soften, leading to a reduced safe working load.

The design procedure for piles varies considerably, depending on the proposed type of pile.

6.3.3 Foundation works risk assessment

It is considered that a foundation works risk assessment report will not be required for the development because the contaminants of concern are likely to be removed during the site strip. Also, the site is underlain by the London Clay which is a non-aquifer.

6.3.4 Floor slabs

The site is generally underlain by more than 600 mm of existing made ground and by soft alluvium. The alluvium is normally consolidated and may be subject to consolidation settlement from floor loads and by the raising of site levels. It is therefore recommended that suspended floors be adopted.

Suspended floors should be designed in accordance with National House-Building Council (NHBC) standards, Chapter 5.2, 'Suspended ground floors'.

6.3.5 Roads, hardstanding and drainage

In the 1 m to 1.5 m below the proposed finished ground level, the boreholes have revealed a soil profile comprising Made Ground underlain by Alluvium, Head Deposits and the London Clay Formation. The potentially poorest sub-grade material within this profile is the Made Ground and the underling soft alluvium.

In pavement design terms, the groundwater conditions are anticipated to comprise a high to intermediate water table, i.e. within 300 mm to between 300 mm and 1000 mm of the pavement formation level.

Due to the presence of soft alluvium, it is recommended that a CBR of 1% be adopted for preliminary design purposes. Subject to plate loading tests on proposed sub-grade soils, a higher CBR may be achievable.

Currently, the sub-grade soils can be regarded as non-frost-susceptible, based upon the criteria given in Appendix 1 of TRRL (1970) Report Road Note 29.

Due to the potential for consolidation settlement of the alluvium, site levels should not be raised significantly above current levels.

6.3.6 Chemical attack on buried concrete

This assessment of the potential for chemical attack on buried concrete at the site is based on *BRE Special Digest 1: Concrete in aggressive ground*, which represents the most up-to-date guidance on this topic currently available in the UK.

For the purposes of assessing the aggressive chemical environment, the site should be considered as a site that is underlain by natural ground i.e. alluvium and the London Clay that is likely to contain pyrite.

Based on the characteristic water-soluble sulphate concentration in the soil of 94 mg/l (SO_4), the Design Sulphate (DS) class Result 1 for the site is DS-1, as determined from Table C2 of *BRE Special Digest 1*.

Groundwater was not assessed, therefore there is no Result 2.

As the site is considered likely to contain pyrite, the characteristic percentage of oxidisable sulphide (OS) in the soil has been calculated as 0.1%, which is below the 0.3% limit set in *BRE Special Digest 1*. As such, the soil can be considered non-pyritic. Based upon the total potential sulphate of 0.03%, Result 3 is therefore DS-1.

In consideration of Results 1 and 3, it is recommended that buried concrete be designed assuming a Design Sulphate Class DS-1.

Based on the mobile groundwater conditions and the characteristic pH value of 8.49, the aggressive chemical environment for concrete (ACEC) is AC-1.

6.3.7 Soakaways

No soakaway testing has been completed to date, however, the ground conditions do not appear suitable for the use of pit soakaways. Subject to regulatory approvals, consideration could be given to discharging to the existing storm water / foul sewer system.

7 REUSE OF MATERIALS AND WASTE

7.1 Reuse of suitable materials

Under the Waste Framework Directive, naturally occurring soils are not considered waste if reused on the site of origin for the purposes of development.

In accordance with the definition provided in the Waste Framework Directive, materials are only considered waste if 'they are discarded, intended to be discarded or required to be discarded, by the holder'. Thus, soils that are not of clean and natural origin, i.e. made ground (whether contaminated or not) and other materials such as recycled aggregate, do not become waste until the aforementioned criteria are met.

The Definition of Waste: Development Industry Code of Practice (CL:AIRE, 2011) (CoP) was developed in consultation with the Environment Agency and development industry to enable the re-use of materials under certain scenarios and subject to demonstrating that specific criteria are met. The current reuse scenarios covered by the CoP comprise

- reuse on the site of origin (with or without treatment)
- direct transfer of clean and natural soils between sites
- use in the development of land other than the site of origin following treatment at an authorised Hub site (including a fixed soil treatment facility).

The importation of made ground soils (irrespective of contamination status) or crushed demolition materials is not permitted currently under the CoP and requires either a standard rules environmental permit or a U1 waste exemption (see below).

In the context of excavated materials used on sites undergoing development, four factors are considered to be of particular relevance in determining if the material is a waste or when it ceases to be waste:

- the aim of the Waste Framework Directive is not undermined, i.e. if the use of the material will create an unacceptable risk of pollution of the environment or harm to human health it is likely to be waste
- the material is certain to be used
- the material is suitable for use both chemically and geotechnically
- only the required quantity of material will be used.

The CoP requires the preparation of a materials management plan (MMP) that confirms the above factors will be met. This plan needs to be reviewed by a 'Qualified Person' (QP) who will then issue a declaration form to the EA. As the project progresses, data must be collated and on completion a verification report produced that shows the MMP was followed and describes any changes.

The MMP establishes whether specific materials are classified as waste and how excavated materials will be treated and/or reused in line with the CoP. The MMP is likely to form part of the site waste management plan.

The site has been developed previously and the investigation has confirmed the presence of made ground. Therefore, before any excavation works begin on-site, an MMP will need to be prepared, reviewed by a QP; and a Declaration lodged with the EA.

As noted above, under the Waste Framework Directive naturally occurring soils are not considered waste and therefore arisings of clean natural soils, e.g. from foundation and drainage excavations, may be reused on the site. However, it is important that these soils should be stockpiled separately and not become cross-contaminated with made ground / contaminated soils or construction wastes.

If it were proposed to import clean and naturally occurring soils direct from another site, the receiving site's MMP would need to be updated in advance of importation.

7.2 Treatment to meet suitable-for-use criteria

Where materials do not meet the suitable for use criteria, it may be possible to treat them under an environmental permit (mobile treatment licence) to enable them to be reused on-site.

To enable the treatment options to be determined, an options appraisal and a remediation strategy document will be necessary to support discussion of the issues with regulators and third parties.

7.3 Reuse of waste materials

If material is discarded as waste then its reuse on site may still be possible. Waste soils and recycled aggregate can be reused on site under a standard rules environmental permit or a U1 waste exemption from the Environmental Permitting (England and Wales) Regulations 2010 provided that they are suitable for the proposed use, i.e. not cause harm to human health or the environment. However, it should be noted that these have strict limits on the quantity of material that can be reused.

7.4 Wastes for landfill disposal

Wastes require pre-treatment prior to disposal at landfill. Pre-treatment must be a physical, thermal, chemical or biological process (including sorting) that changes the characteristics of the waste to reduce its volume, reduce its hazardous nature, facilitate its handling and enhance its recovery.

The latest edition of the EA's 'Technical Guidance WM3' (2018), Guidance on the classification and assessment of waste, requires that within a mixed waste the separately identifiable wastes are assessed separately. Mixing of different types of hazardous waste and hazardous waste with other waste substances is prohibited under the Waste Framework Directive. Wastes that have been mixed must be separated whenever possible.

It is best practice to provide your waste carrier (or the disposal site) with details of how the waste has been treated. Your waste carrier may provide a pre-treatment confirmation form or space on the waste transfer note to detail the pre-treatment.

The classification of waste soil is a two-stage process, the first being an assessment of whether the soil is considered hazardous or not following the guidance within Technical Guidance WM3. For off-site disposal to landfill the results of Waste Acceptance Criteria (WAC) testing must then be reviewed to establish if the soil is acceptable at the relevant class of landfill or requires pre-treatment to reduce specific hazardous properties.

7.4.1 Waste acceptance criteria

All inert, stable non-reactive hazardous and hazardous wastes have limit values (waste acceptance criteria) set out in legislation that must be met before that class of landfill can accept the waste. Currently, no WAC are in place for non-hazardous waste.

Soil and other materials that are found not to be hazardous may be classified as either non-hazardous or inert. In order to determine whether they can be classed as inert the soil must be tested and found to be below the inert waste acceptance criteria.

7.4.2 Waste sampling plan

Technical Guidance WM3 sets out in Appendix D requirements for waste sampling. It is a legal requirement to correctly assess and classify waste. The level of sampling should be proportionate to the volume of waste and its heterogeneity. At this stage, RSK consider that the level of soil sampling is/is not sufficient to categorise the material robustly/fully.

RSK recommends that a Sampling Plan be prepared to support any waste classifications and hazardous waste assessments, prior to development.

7.4.3 Preliminary waste assessment

Given the level of data obtained, scale of the development and heterogeneity of the site soils, the following assessment should be considered indicative and further assessment should be undertaken following the preparation of a waste sampling plan.

Envirolab, an RSK company, has developed a waste soils characterisation assessment tool (HASWASTE), which follows the guidance within Technical Guidance WM3. The analytical results have been assessed using this tool for potential off-site disposal of materials in the future. The results are summarised below and presented in full in **Appendix L**.

Samples collected from the following locations were found to contain measured concentrations of contaminants, in excess of hazardous waste thresholds:

- Made Ground, WS3 at 0.20 m bgl, carcinogenic properties of lead.

The results indicate that the Made Ground fill materials beneath the site are anticipated to be classified as non-hazardous waste or hazardous waste (approximately 85% to 15% respectively based on the data collected to date). The natural deposits beneath the site are anticipated to be classified as inert based on the testing results, however it is noted that this assessment is based on a small data set.

Once development is underway, waste acceptance criteria (WAC) testing may be required to further classify the material prior to offsite disposal.

7.4.4 Asbestos within waste soils

The latest edition of Technical Guidance WM3 requires that within a mixed waste the separately identifiable wastes be assessed separately.

For instance, where waste soil contains identifiable pieces of asbestos (visible to the naked eye) the asbestos should, where feasible, be separated from the soil and classified separately.

The scheduled laboratory screening for asbestos found detectable chrysotile asbestos fibre bundles within 1 No. of 5 samples of Made Ground scheduled for analysis.

Subsequent quantification analysis reported asbestos to be <0.001 % by weight in the sample.

Based on the quantification results, the detection of asbestos in WS1 at 0.20 m bgl, is not considered to pose an unacceptable risk to the human health of construction workers, future residents and surrounding users via the inhalation pathway.

Asbestos is often distributed discretely and given the history of the site, there is potential for asbestos fibres and ACM to be present in other areas of the site not investigation or for different forms of ACM and asbestos types to be encountered. This issue will need to be managed through the development process.

Given that the analysis confirmed that the percentage of asbestos fibres is less than 0.1 % by weight, the waste could be disposed of within a non-hazardous waste landfill (assuming it is non-hazardous for other contaminants, which a number of locations across the site have been found to be).

7.5 Landfill tax

Waste producers disposing of material to landfill are required to pay landfill tax by HM Revenue and Customs.

The tax is chargeable by weight (tonnage) and two rates apply, either standard or lower rate. The lower rate only applies to those less polluting wastes as set out in the Landfill Tax (Qualifying Material) Order 2011, which include naturally occurring rock and soil, concrete, some minerals, some furnace slags and ash, and some low-activity organic compounds. Evidence confirming that the waste qualifies for the lower rate will be required, and standard rate tax will apply for the whole waste load for any loads of mixed waste.

Currently (since 1 April 2018), standard rate landfill tax is £88.95 per tonne.

The lower rate of landfill tax applicable to less polluting wastes (i.e. ‘inert’ wastes) remains at £2.80 per tonne.

Material disposed of at a soil treatment centre will not be subject to landfill tax.

7.6 Groundwater

When there is an intention to discard groundwater, chemical test results will indicate the appropriate disposal options. This could include disposal to treatment facility, via consent

(issued by the water authority) to foul sewer or via consent (issued by the EA) to a watercourse or land.

7.7 Recommendations

RSK recommends that consideration as to how potentially waste soils will be dealt with as part of this development is given as early in the project planning process as possible. Such planning can lead to cost savings where potentially waste soils are viewed as a resource and retained on-site as part of the development. We also recommend, where off-site disposal is being considered, that appropriate facilities are identified and discussions initiated to confirm suitability of the facility to take the material. Potentially, these may include soil treatment facilities as well as landfills.

RSK can provide specialist advice to assist in this process, which can be complex and subject to regular regulatory change.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Environmental

The investigation has revealed Made Ground materials located in shallow soils sampled within WS1, WS2 and WS3 potentially pose a risk to construction workers and future residents via direct contact pathways and therefore any material removed from these locations during the site strip are not to be reused on site. The proposed development currently includes residential flats positioned over the location of WS1 and close to WS3. The contaminants within WS1 and WS3 will likely be removed during the construction works or capped by the structure upon construction. The remainder of the site including the location of WS2 will be hardstanding and as such any contaminants will be removed during the site strip or capped. Loose asbestos fibres were identified within 1 No. soil sample during the investigation. The inhalation risk is considered low, due to the <0.001% by weight quantification. The area in which the asbestos was identified is below the proposed building and will be removed or capped during development.

At the time of issuing this report a preliminary gas assessment has been carried out which revealed a CS1 designation is applicable to the site.

The investigation indicates that linkages associated with organic contaminants are likely to exist therefore PE and PVC water supply pipes are anticipated to be unsuitable for use on the development.

8.1.1 Recommendations

During site clearance and excavation works (particularly in the areas of WS1 and WS3) operatives and ground workers should wear appropriate PPE and RPE for the duration of the works. Suitable protection measures should be put in place for areas where asbestos containing materials have been identified. In the event that any unexpected contamination or suspicious ground condition are identified (such as hydrocarbon stained soils or free phase product) works should cease in the impacted area and the procedures outlines in the discovery strategy presented in **Appendix M** must be implemented.

8.2 Reuse of materials and waste

Given the level of data obtained, scale of the development and heterogeneity of the site soils the preliminary waste assessment should be considered indicative and further assessment may be required following the preparation of a waste sampling plan.

Made Ground was encountered in all intrusive locations at generally shallow depths, all remaining soils encountered were natural soils.

Waste Acceptance Criteria (WAC) testing has not been undertaken as part of this assessment. WAC testing will be required for submission to landfill facilities in order for them to accept waste from the site.

RSK recommends that consideration as to how potentially waste soils will be dealt with as part of this development is given as early in the project planning process as possible. Such planning can lead to cost savings where potentially waste soils are viewed as a

resource and retained on-site as part of the development. We also recommend, where off-site disposal is being considered, that appropriate facilities are identified, and discussions initiated to confirm suitability of the facility to take the material.

8.3 Geotechnical

The ground conditions comprises Made Ground to a maximum depth of 0.90 m bgl overlying soft alluvial clay (WS1 and WS3) to a maximum depth of 1.50 m bgl and superficial Head Deposits (WS1 - WS4). Underlying the Head Deposits in each location was bedrock deposits of the London Clay Formation, the base of which was not encountered.

8.3.1 Recommendations

The ground conditions are not considered suitable for the adoption of spread foundations. Recourse to piled foundations is recommended. At least one deep borehole (approx. 20 m deep) would be required to facilitate pile design. This assumes a minimum of 5 m beyond the anticipated depth of the deepest pile.

BIBLIOGRAPHY

AGS Interim Guidance (2013), 'Site investigation and asbestos risk assessment for the protection of site investigation and geotechnical laboratory personnel', February.

Baker, K., Hayward, H., Potter, L., Bradley, D. and McLeod, C. (2009), *CIRIA Report C682. The VOCs Handbook. Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination* (London: CIRIA).

Barton, N. J. (1992), *The Lost Rivers of London: A Study of Their Effects Upon London and Londoners, and the Effects of London and Londoners on Them* (London: Historical Publications).

Boyle, R. A. and Witherington, P. J. (2007), 'Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present', National House-Building Council and RSK Group.

British Geological Survey (1998), Sheet Number 316, Solid & Drift Edition, 1:50,000.

British Standards Institution (BSI) (1990), 'BS 1377:1990. Methods of test for soils for civil engineering purposes'.

British Standards Institution (2015), 'BS 5930:2015. Code of practice for ground investigations'.

British Standard Institution (BSI) (2015), 'BS 8485:2015. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings '.

British Standards Institution (2011), 'BS 10175:2011 + A2:2017. Investigation of potentially contaminated sites: Code of practice'.

British Standards Institution (2013), BS8576:2013. Guidance on investigations for ground gas – permanent gases and volatile organic compounds (VOCs)

Building Research Establishment (BRE) (2001), *BRE Report 414. Protective measures for housing on gas-contaminated land* (London: BRE).

Building Research Establishment (2005), *BRE Special Digest 1: Concrete in aggressive ground* (London: BRE).

Building Research Establishment (2016) *BRE Digest 365. Soakaway design* (London: BRE).

Card, G. B. (1995), *CIRIA Report 149. Protecting development from methane* (London: CIRIA).

Chandler R. J. and Forster A., (2001) CIRIA Report C570, Engineering in Mercia Mudstone.

Chartered Institute for Environmental Health and Land Quality Management (2009), 'The LQM/CIEH Generic Assessment Criteria for Human Health', second edition.

Chartered Institute of Environmental Health (CIEH) and CL:AIRE (2008), *Guidance on Comparing Soil Contamination Data with a Critical Concentration* (London: CIEH).

CIRIA (2014). Good practice on the testing and verification of protection systems for buildings against hazardous ground gases

CL:AIRE (2009), *Soil Generic Assessment Criteria for Human Health Risk Assessment* (London: CL:AIRE).

CL:AIRE (2011), *CL:AIRE Code of Practice. The Definition of Waste: Development Industry Code of Practice, Version 2* (London: CL:AIRE).

Dangerous Substances Directive (76/464.EEC).

Department for Environment, Food and Rural Affairs (2010), *The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010* (London: HMSO).

Department of the Environment (1996), *Code of Practice for Agricultural Use of Sewage Sludge* (London: HMSO).

Environment Agency (2018), 'Technical Guidance WM3. Guidance on the classification of and assessment of waste. 1st Edition.

Environment Agency (2004), *Model Procedures for the Management of Contaminated Land. Contaminated Land Report Number 11 (CLR11),* September (Bristol: Environment Agency).

Environment Agency (2004b), 'Policy Number 199_04, dated 9 March 2004, Part IIA – Detailed Quantitative Assessment of Chronic Risks to Human Health from Contaminated Soils'.

Environment Agency (2006a), 'Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination'.

Environment Agency (2006b), 'The Knotweed Code of Practice – managing Japanese Knotweed on development sites'.

Environment Agency (2008), *Science Report SC050021/SR7. Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values* (Bristol: Environment Agency).

Environment Agency (2009a), Contaminated Land Exposure Assessment (CLEA) software, version 1.06.

Environment Agency (2009b), *Human health toxicological assessment of contaminants in soil. Science Report – Final SC050021/SR2*, January (Bristol: Environment Agency).

Environment Agency (2009c), 'Science Report SC050021/benzene SGV, toluene SGV, ethylbenzene SGV, xylene SGV, mercury SGV, selenium SGV, nickel SGV, arsenic SGV, cadmium SGV, phenol SGV, dioxins, furans and dioxin like PCBs SGVs', 'Supplementary information for the derivation of SGV for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', and 'Contaminants in soil: updated collation of toxicological data and intake values for humans: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', March 2009, May 2009 and September 2009.

Environment Agency (2009d), *Science Report – SC050021/SR3. Updated technical background to the CLEA model* (Bristol: Environment Agency).

Environment Agency (2010a), 'GPLC1 – Guiding Principles of Land Contamination', 'GPLC2 – Frequently Asked Questions, Technical Information, Detailed Advice and References', and 'GPLC3 – Reporting Checklists', all March.

Environment Agency (2010b), 'Horizontal Guidance Note H1 - Environmental risk assessment for permits'.

Environment Agency (2010c), 'Status Report: Management of the London Basin Chalk Aquifer'.

Environment Agency (2011) Chemical Standards Database.

Environment Agency (no date) Freshwater environmental quality standards.

Environment Agency www.environment-agency.gov.uk/.

Environmental Permitting (England and Wales) Regulations 2010 (London: HMSO).

Hartless, R. (1991), 'BRE Report 212: Construction of new buildings on gas-contaminated land', Building Research Establishment.

Hazardous Waste Regulations 2005 (London: HMSO).

Knipp, C. V., Lloyd, J. W., Lerner, D. N. and Greswell, R. (1993), *CIRIA Special Publication 92. Rising groundwater levels in Birmingham, and their engineering significance* (London: CIRIA).

Lord, J. A., Clayton, C. R. I. and Mortimore, R. N. (2002), *CIRIA Report C574 Engineering in chalk* (London: CIRIA).

National House-Building Council (1999), 'Chapter 5.2: Suspended Ground Floors' in *NHBC Standards*, revised September 1999, effective January 2000.

Norbury, D. (2010), *Soil and Rock Description in Engineering Practice* (Caithness: Whittles).

Part IIA of the Environmental Protection Act (Contaminated Land Regulations (England) 2002 (London: HMSO).

Rudland, D. J., Lancefield, R. M. and Mayell, P. N. (2001), *CIRIA C552. Contaminated Land Risk Assessment: A Guide to Good Practice* (London: CIRIA).

Simpson, G., Blower, T., Craig, R. N. and Wilkinson, W. B. (1989), *CIRIA Special Publication 69. The engineering implications of rising groundwater levels in the deep aquifer beneath London* (London: CIRIA).

Stone, K., Murray, A., Cooke, S., Foran, J., Gooderham, L., (2009) CIRIA C681, Unexploded Ordnance (UXO). A guide or the construction industry.

The Building Regulations (revised December 2004) 'Approved Document C. Department of the Environment and The Welsh Office'.

The Surface Waters (Abstraction for Drinking Water) (Classification) Regulations 1996 (London: HMSO).

The Surface Waters (Dangerous Substances) (Classification) Regulations 1998 (London: HMSO).

The Water Supply (Water Quality) Regulations 1989, 2000 and 2001 (London: HMSO).

Transport and Road Research Laboratory (1970), 'TRRL Road Note 29 (Appendix 1). Road pavement design'.

Transport and Road Research Laboratory (1984), 'TRRL Report LR1132 (Table C1)'.

UK Water Industry Research (2010) *UKWIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (London: UKWIR).

Water Framework Directive (2000/60/EC).

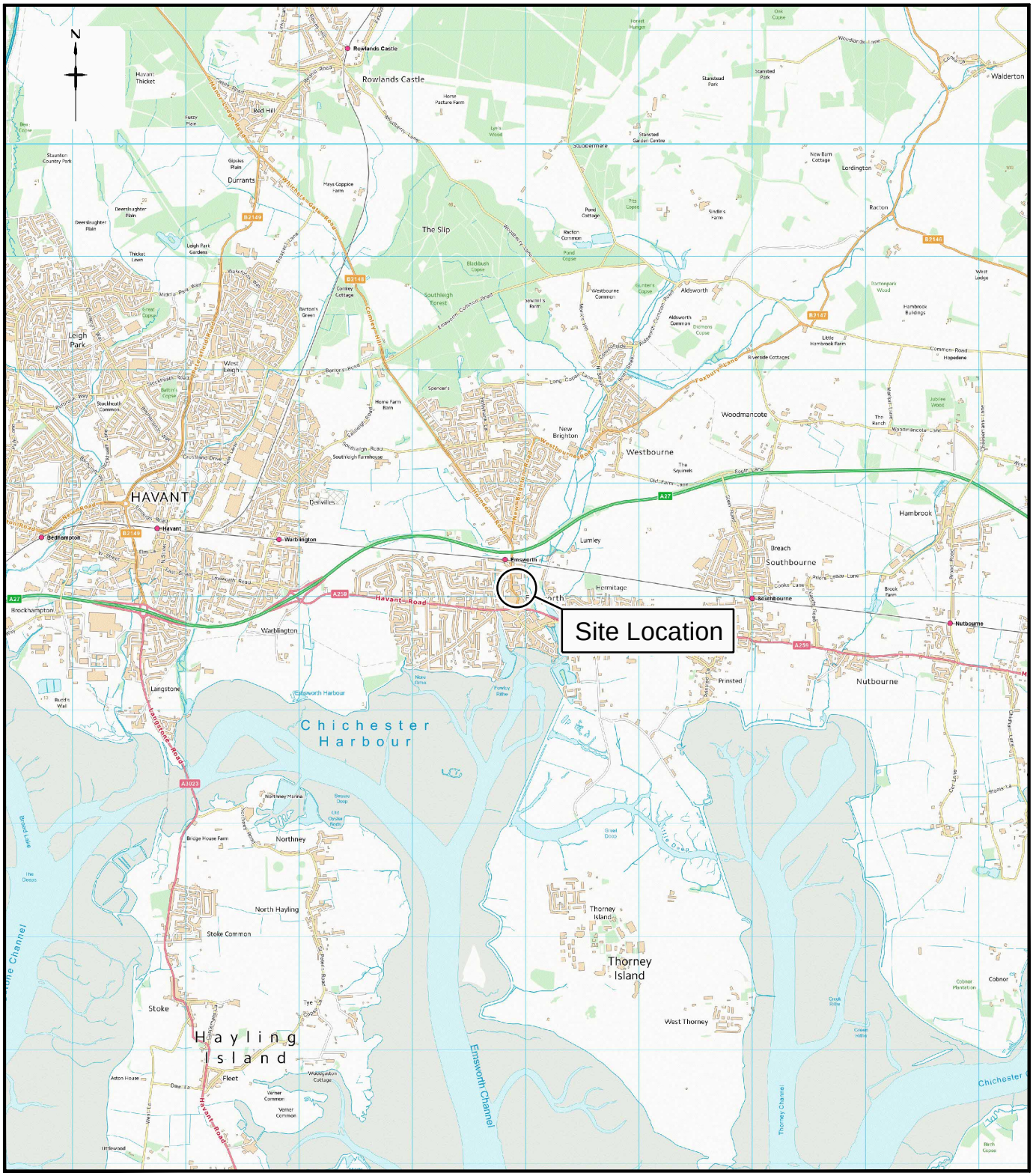
Wilson, S. A. and Card, G. B. (1999), 'Reliability and risk in gas protection design', *Ground Engineering*, February: 33–6.

Wilson, S., Oliver, S., Mallet, H., Hutchings, H. and Card, G. (2007), *CIRIA Report C665: Assessing risks posed by hazardous ground gases to buildings* (London: CIRIA).

World Health Organization (2004), *Guidelines for drinking-water quality*, 3rd edn (Geneva: WHO).

WRc plc (2002), 'Polycyclic Aromatic Hydrocarbons (PAH): Priorities for Environmental Quality Standard Development, R&D Technical Report P45'.

FIGURES



Contains Ordnance Survey data © Crown copyright and database right 2013

RSK

18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT
United Kingdom

Tel: +44 (0) 1442 437500
Fax: +44 (0) 1442 437550
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client: HAMPSHIRE HOMES GROUP

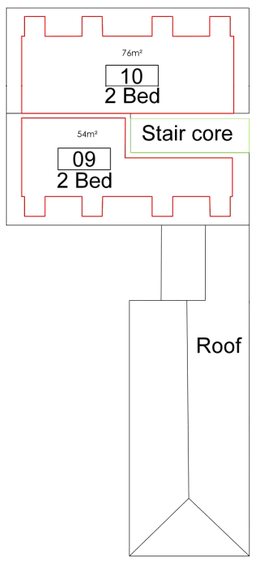
Project Title: LAND AT 31a NORTH STREET, EMSWORTH

Drawing Title: SITE LOCATION PLAN

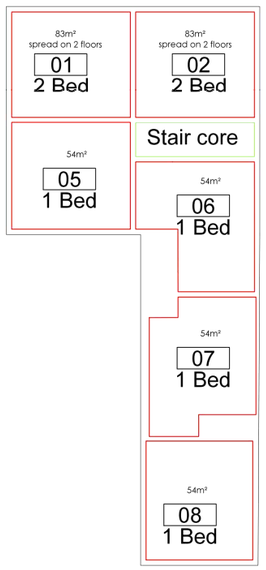
Rev	Drawn	Date	Checked	Date	Approved	Date
01	AP	04.09.18	AD	04.09.18	KF	04.09.18

Dimensions	Scale	Original Size
m	1:50,000	A4

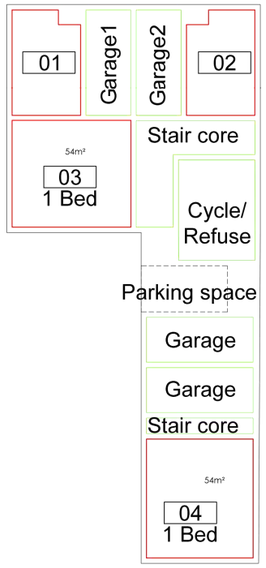
Project Number	Drawing File	Drawing Number
305019 - R02 (00)	305019 - SLP.dwg	FIGURE 1



Second floor

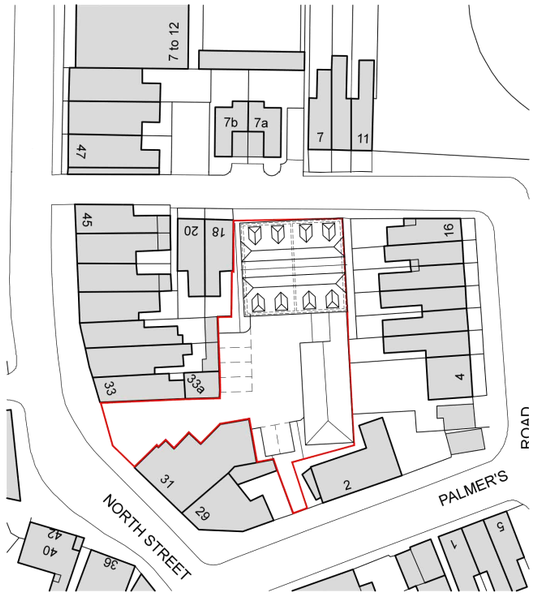


First floor



Ground floor

Floor Plan 1:400



Block Plan 1:1000

LEGEND

Site Boundary

Rev.	Date	Amendment	Drawn	Chkd.	Appd.

RSK

18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT
United Kingdom

Tel: +44 (0) 1442 437500
Fax: +44 (0) 1442 437550
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client

HAMPSHIRE HOMES GROUP

Project Title

LAND AT
31a NORTH STREET,
EMSWORTH

Drawing Title

PROPOSED
DEVELOPMENT
PLAN

Drawn	Date	Checked	Date	Approved	Date
AP	04.09.18	AD	04.09.18	KF	04.09.18

Scale	Orig Size	Dimensions
1:1000	A3	m

Project No.	Drawing File
305019 - R02 (00)	305019 (R02-00) Fig 2.dwg

Drawing No.	Rev.
FIGURE 2	P1

Scale 1 : 1000

0 10 20 30 40 50m

LEGEND

Site Boundary

Window Sample Location

Rev.	Date	Amendment	Drawn	Chkd.	Appd.

RSK

18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT
United Kingdom

Tel: +44 (0) 1442 437500
Fax: +44 (0) 1442 437550
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client

HAMPSHIRE HOMES

Project Title

LAND AT
31a NORTH STREET,
EMSWORTH

Drawing Title

EXPLORATORY HOLE
LOCATION PLAN

Drawn	Date	Checked	Date	Approved	Date
AP	04.09.18	AD	04.09.18	KF	04.09.18

Scale	Orig Size	Dimensions
1:1000	A3	m

Project No.	Drawing File
305019 - R02 (00)	305019 (R02-00) Fig 3.dwg

Drawing No.	Rev.
FIGURE 3	P1

Scale 1 : 1000

0 10 20 30 40 50m

APPENDIX A
SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Hampshire Homes Group Limited (the "client") in accordance with the terms of a contract between RSK and the "client", dated 16th July 2018. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.

2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.

3. Unless otherwise agreed in writing the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**

4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.

5. 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. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.

6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.

7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.

8. The intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (boreholes, trial pits etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.

APPENDIX B
SUMMARY OF LEGISLATION AND POLICY RELATING TO CONTAMINATED LAND

Part IIA of the Environmental Protection Act 1990 (EPA) and its associated Contaminated Land Regulations 2000 (SI 2000/227), which came into force in England on 1 April 2000, formed the basis for the current regulatory framework and the statutory regime for the identification and remediation of contaminated land. Part IIA of the EPA 1990 defines contaminated land as 'any land which appears to the Local Authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that significant harm is being caused, or that there is significant possibility of significant harm being caused, or that pollution of controlled waters is being or is likely to be caused'. Controlled waters are considered to include all groundwater, inland waters and estuaries.

In August 2006, the Contaminated Land (England) Regulations 2006 (SI 2006/1380) were implemented, which extended the statutory regime to include Part IIA of the EPA as originally introduced on 1 April 2000, together with changes intended chiefly to address land that is contaminated by virtue of radioactivity. These have been replaced subsequently by the Contaminated Land (England) (Amendment) Regulations 2012, which now exclude land that is contaminated by virtue of radioactivity.

The intention of Part IIA of the EPA is to deal with contaminated land issues that are considered to cause significant harm on land that is not undergoing development (see Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, April 2012). This document replaces Annex III of Defra Circular 01/2006, published in September 2006 (the remainder of this document is now obsolete).

Water Framework Directive (WFD)

The Water Framework Directive 2000/60/EC is designed to:

- enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands that depend on the aquatic ecosystems
- promote the sustainable use of water
- reduce pollution of water, especially by 'priority' and 'priority hazardous' substances
- ensure progressive reduction of groundwater pollution.

The WFD requires a management plan for each river basin be developed every six years.

Groundwater Directive (GWD)

The 1980 Groundwater Directive 80/68/EEC and the 2006 Groundwater Daughter Directive 2006/118/EC of the WFD are the main European legislation in place to protect groundwater. The 1980 Directive is due to be repealed in December 2013. The European legislation has been transposed into national legislation by regulations and directions to the Environment Agency.

Environmental Permitting Regulations (EPR)

The Environmental Permitting (England and Wales) Regulations 2010 provide a single regulatory framework that streamlines and integrates waste management licensing, pollution prevention and control, water discharge consenting, groundwater authorisations, and radioactive substances regulation. Schedule 22, paragraph 6 of EPR 2010 states: 'the regulator must, in exercising its relevant functions, take all necessary measures - (a) to prevent the input of any hazardous substance to groundwater; and (b) to limit the input of non-hazardous pollutants to groundwater so as to ensure that such inputs do not cause pollution of groundwater.'

Water Resources Act (WRA)

The Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009 updated the Water Resources Act 1991, which introduced the offence of causing or knowingly permitting pollution of controlled waters. The Act provides the Environment Agency with powers to implement remediation necessary to protect controlled waters and recover all reasonable costs of doing so.

Priority Substances Directive (PSD)

The Priority Substances Directive 2008/105/EC is a 'Daughter' Directive of the WFD, which sets out a priority list of substances posing a threat to or via the aquatic environment. The PSD establishes environmental quality standards for priority substances, which have been set at concentrations that are safe for the aquatic environment and for human health. In addition, there is a further aim of reducing (or eliminating) pollution of surface water (rivers, lakes, estuaries and coastal waters) by pollutants on the list. The WFD requires that countries establish a list of dangerous substances that are being discharged and EQS for them. In England and Wales, this list is provided in the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. In order to achieve the objectives of the WFD, classification schemes are used to describe where the water environment is of good quality and where it may require improvement.

Planning Policy

Contaminated land is often dealt with through planning because of land redevelopment. This approach was documented in Planning Policy Statement: Planning and Pollution Control PPS23, which states that it remains the responsibility of the landowner and developer to identify land affected by contamination and carry out sufficient remediation to render the land suitable for use. PPS23 was withdrawn early in 2012 and has been replaced by much reduced guidance within the National Planning Policy Framework (NPPF), reference ISBN: 978-1-4098-5302-2, July 2018.

The new framework has only limited guidance on contaminated land, as follows:

- *"planning policies and decisions should also ensure that:*
    - *the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;*

- *after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and*
- *adequate site investigation information, prepared by a competent person, is presented".*

APPENDIX C
EXPLORATORY HOLE RECORDS

FINAL

WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Land at 31A North Street, Emsworth	**Hampshire Homes Group Limited**	**WS1**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
305019	**29.08.18** End: **29.08.18**	**---**	**---**	**1** of **1**

Progress: Window Run	Samples / Tests: Depth	No	Type	Results	Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
							REINFORCED CONCRETE	0.20	
	0.20 0.20	ES1	ES PID	0.5ppm			MADE GROUND: Dark brown / black sandy slightly clayey subangular to subrounded, fine to coarse GRAVEL of flint, brick, concrete and glass with occasional brick cobbles. Sand is medium to coarse.	0.40	
	0.50	ES2	ES				MADE GROUND: Dark brown / black sandy gravelly CLAY. Sand is medium. Gravel is subangular to subrounded, fine to coarse brick, glass and slate.	(0.40) 0.80	
	0.80 0.80	ES3	ES PID	0.0ppm			(Soft) Dark grey sandy gravelly CLAY with occasional organic matter. Sand is medium. Gravel is subangular to subrounded, fine to medium flint. (ALLUVIUM)	(0.60) 1.40	
	1.20-1.65	1	SPT	N=4					
	1.40	1	D				Soft brown slightly gravelly silty CLAY. Gravel is subangular to subrounded, fine siltstone. (HEAD DEPOSITS)	(0.60) 2.00	
	1.80	2	D		▼				
	2.00-2.45	2	SPT	N=11			Firm to stiff brown with bluish grey mottling silty CLAY. (LONDON CLAY FORMATION)		
	2.50	3	D						
	3.00-3.45 3.10	3 4	SPT D	N=16				(2.45)	
	4.00-4.45	4	SPT	N=20				4.45	
							Window sample terminated at 4.45 m bgl.		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. Inspection hand pit excavated to 1.20 m bgl.
2. Groundwater encountered at 2.00 m bgl
3. Standpipe installed to 3.65 m depth; 0.65 m plain with bentonite, 3.00 m slotted with 10 mm gravel.
4. (Soft) - Field measurement of consistency

All dimensions in metres | Scale: **1:28**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Tracked window	**Premier Compact 110**	**P J Drilling**	**ADenton**	

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_018 PrjVersion: v8_06 - Core+Logs - 002 | Log WINDOW SAMPLE LOG - A4P | 305019 - NORTH STREET, EMSWORTH.GPJ - v8_06. | 28/09/18 - 14:59 | AD8 |

FINAL

WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Land at 31A North Street, Emsworth	**Hampshire Homes Group Limited**	**WS2**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
305019	**29.08.18** End: **29.08.18**	**---**	**---**	**1** of **1**

Progress: Window Run	Samples / Tests: Depth	No	Type	Results	Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
							REINFORCED CONCRETE	0.20	
	0.20 0.20	ES1	ES PID	6.3ppm			MADE GROUND: Black sandy slightly clayey subangular to subrounded, fine to coarse GRAVEL of brick, concrete and carbonaceous material. Sand is medium to coarse.	(0.60)	
	0.50 0.50	ES2	ES PID	0.0ppm				0.80	
	0.80 0.80	ES3	ES PID	0.0ppm			REWORKED GROUND: Brown sandy gravelly CLAY. Sand is medium. Gravel is subangular to subrounded, fine to medium brick and concrete.	0.90 (0.30)	
	1.00	1	D				Soft brown gravelly silty CLAY. Gravel is subangular to subrounded, fine siltstone. (HEAD DEPOSITS)	1.20	
	1.20-1.65	1	SPT	N=6			Stiff brown with grey mottling slightly gravelly silty CLAY. Gravel is subangular to subrounded, fine siltstone. (LONDON CLAY FORMATION)		
	1.40	2	D						
	1.90	3	D						
	2.00-2.45	2	SPT	N=15			. . . Clay becomes darker in colour and mottling becomes bluish grey at 2.00 m bgl		
	2.50	4	D		1		. . . Gravel band between 2.65 and 2.80 m bgl. Groundwater encountered within the gravel	(2.80)	
	3.00-3.45 3.00	3 5	SPT D	N=13			. . . 50 % recovery between 3.00 and 3.50 m bgl due to groundwater		
	3.55-4.00	4	SPT	N=18			SPT undertaken at 3.55 m bgl	4.00	
							Window sample terminated at 4.00 m bgl due to low recovery		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. Inspection hand pit excavated to 1.20 m bgl.
2. Groundwater encountered within a gravel band at 2.65 m bgl.
3. Standpipe installed to 3.65 m bgl; 0.65 m plain with bentonite, 3.00 m slotted with 10 mm gravel.

All dimensions in metres | Scale: **1:28**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Tracked window	**Premier Compact 110**	**P J Drilling**	**ADenton**	

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_018 PrjVersion: v8_06 - Core+Logs - 002 | Log WINDOW SAMPLE LOG - A4P | 305019 - NORTH STREET, EMSWORTH.GPJ - v8_06. | 28/09/18 - 14:59 | AD8 |

FINAL

WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Land at 31A North Street, Emsworth	**Hampshire Homes Group Limited**	**WS3**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
305019	**29.08.18** End: **29.08.18**	**---**	**---**	**1** of **1**

Progress: Window Run	Samples / Tests: Depth	No	Type	Results	Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
							REINFORCED CONCRETE	0.20	
	0.20 0.20	ES1	ES PID	0.0ppm			MADE GROUND: Black / dark brown sandy gravelly CLAY. Sand is medium to coarse. Gravel is subangular to subrounded, fine to medium brick, concrete, glass and flint.	(0.60) 0.80	
	0.50 0.50	ES2	ES PID	1.0ppm					
	0.80 0.80	ES3	ES PID	6.0ppm			Soft dark grey gravelly silty CLAY with frequent organic matter. Gravel is subangular to subrounded, fine to medium flint and siltstone. (ALLUVIUM)	(0.70) 1.50	
	1.20-1.65	1	SPT	N=4	≈				
	1.50	1	D				Soft brown with occasional grey mottling slightly gravelly silty CLAY. Gravel is subangular to subrounded, fine siltstone and flint. (HEAD DEPOSITS)	(0.70) 2.20	
	2.00-2.45 2.00	1 2	SPT D	N=9					
	2.50	3	D				Firm to stiff brown with bluish grey mottling silty CLAY. (LONDON CLAY FORMATION)	(2.25) 4.45	
	3.00-3.45 3.00	1 4	SPT D	N=13			. . . 80 % recovery from 3.00 to 4.00 m bgl		
	3.50	5	D						
	4.00-4.45	1	SPT	N=17					
							Window sample terminated at 4.45 m bgl.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. Inspection hand pit excavated to 1.20 m bgl.
2. Perched water encountered at 1.20 m bgl.
3. Standpipe installed to 3.50 m bgl; 0.50 m plain with bentonite, 3.00 m slotted with 10 mm gravel.

All dimensions in metres | Scale: **1:28**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Tracked window	**Premier Compact 110**	**P J Drilling**	**ADenton**	

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_018 PrjVersion: v8_06 - Core+Logs - 002 | Log WINDOW SAMPLE LOG - A4P | 305019 - NORTH STREET, EMSWORTH.GPJ - v8_06. | 28/09/18 - 14:59 | AD8 |

FINAL

WINDOW SAMPLE LOG

Contract:	Client:	Window Sample:
Land at 31A North Street, Emsworth	**Hampshire Homes Group Limited**	**WS4**

Contract Ref:	Start:	Ground Level:	Co-ordinates:	Sheet:
305019	**29.08.18** End: **29.08.18**	**---**	**---**	**1** of **1**

Progress: Window Run	Samples / Tests: Depth	No	Type	Results	Water	Backfill & Instru-mentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
							REINFORCED CONCRETE	(0.30) 0.30	
	0.30 0.30	ES1	ES PID	2.2ppm			MADE GROUND: Dark brown sandy gravelly CLAY. Sand is medium. Gravel is subangular to subrounded, fine to medium brick, concrete and flint.	0.50	
	0.50 0.50	ES2	ES PID	0.0ppm			Soft brown with orange mottling slightly gravelly silty CLAY. Gravel is subangular to subrounded, fine siltstone and flint. (HEAD DEPOSITS) . . . Flint cobble at 0.80 m bgl. . . . Whitish brown pockets noted at 1.00, 1.30 and 1.80 m bgl.		
	0.80 0.80	ES3	ES PID	0.0ppm					
	1.20-1.65 1.20	1 1	SPT D	N=5				(1.50)	
	1.50	2	D					2.00	
	2.00-2.45 2.00	2 3	SPT D	N=7			Soft brown with bluish grey mottling silty CLAY. (LONDON CLAY FORMATION)		
	2.50	4	D		1				
	3.00-3.45 3.00	3 5	SPT D	N=6				(2.45)	
	3.50	6	D						
	4.00-4.45	4	SPT	N=6				4.45	
							Window sample terminated at 4.45 m bgl.		

Drilling Progress and Water Observations

Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)

General Remarks

1. Inspection hand pit excavated to 1.20 m bgl.
2. Groundwater encountered at 2.70 m bgl.
3. Standpipe installed to 3. m bgl; 0.60 m plain with bentonite, 3.00 m slotted with 10 mm gravel.

All dimensions in metres | Scale: **1:28**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Inspection pit + Tracked window	**Premier Compact 110**	**P J Drilling**	**ADenton**	

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_018 PrjVersion: v8_06 - Core+Logs - 002 | Log WINDOW SAMPLE LOG - A4P | 305019 - NORTH STREET, EMSWORTH.GPJ - v8_06. | 28/09/18 - 14:59 | AD8 |

APPENDIX D
GROUND GAS MONITORING DATA

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round 1	Constant	Constant	1019	1019	Ground: Dry + Wind: None

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
WS1	1	50	1	3.65	---	0.65 to 3.65	07/09/2018 09:48:33	-	1019	$0.3_{(SS)}$	-	0.0	0.0	20.3	0.0	0	0
WS1	1	50	1		---	0.65 to 3.65	15 secs	-	1019	$0.3_{(SS)}$	-	1.8	0.0	15.3	0.0	0	0
WS1	1	50	1		---	0.65 to 3.65	30 secs	-	1019	$0.3_{(SS)}$	-	1.8	0.0	15.0	0.0	5	0
WS1	1	50	1		---	0.65 to 3.65	60 secs	-	1019	$0.3_{(SS)}$	-	1.8	0.5	14.9	9.0	5	0
WS1	1	50	1		---	0.65 to 3.65	90 secs	-	1019	$0.3_{(SS)}$	-	1.9	0.5	14.8	9.0	5	0
WS1	1	50	1		---	0.65 to 3.65	120 secs	-	1019	$0.3_{(SS)}$	-	1.9	0.5	14.8	9.0	5	0
WS1	1	50	1		---	0.65 to 3.65	180 secs	-	1019	$0.3_{(SS)}$	-	1.8	0.5	14.9	8.0	5	0
WS1	1	50	1		---	0.65 to 3.65	240 secs	-	1019	$0.3_{(SS)}$	-	1.8	0.5	14.9	8.0	4	0
WS1	1	50	1		---	0.65 to 3.65	300 secs	-	1019	$0.3_{(SS)}$	-	1.7	0.5	15.0	8.0	5	0
WS1	1	50	1		3.50	0.65 to 3.65	360 secs	-	1019	$0.3_{(SS)}$	DRY	1.7	0.5	15.0	8.0	5	0
WS2	1	50	1	3.65	---	0.65 to 3.65	07/08/2018 09:34:55	-	1019	$0.5_{(SS)}$	-	0.0	0.0	20.4	0.0	0	0
WS2	1	50	1		---	0.65 to 3.65	15 secs	-	1019	$0.5_{(SS)}$	-	0.1	0.0	19.7	0.0	0	0
WS2	1	50	1		---	0.65 to 3.65	30 secs	-	1019	$0.5_{(SS)}$	-	0.1	0.0	19.4	0.0	0	0
WS2	1	50	1		---	0.65 to 3.65	60 secs	-	1019	$0.5_{(SS)}$	-	0.1	0.0	19.4	0.0	1	0
WS2	1	50	1		---	0.65 to 3.65	90 secs	-	1019	$0.5_{(SS)}$	-	0.1	0.0	19.3	0.0	1	0
WS2	1	50	1		---	0.65 to 3.65	120 secs	-	1019	$0.5_{(SS)}$	-	0.1	0.0	19.3	0.0	1	0
WS2	1	50	1		3.45	0.65 to 3.65	180 secs	-	1019	$0.5_{(SS)}$	0.84	0.1	0.0	19.3	0.0	1	0
WS3	1	50	1	3.50	---	0.50 to 3.50	07/09/2018 10:02:23	-	1019	$0.2_{(SS)}$	-	0.1	0.0	20.3	0.0	0	0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Unit 26 Basepoint Abbey
Enterprise Centre
Premier Way, Romsey
SO51 9AQ

Compiled By	Date	Checked By	Date	Contract Ref:
	28/09/18			305019

Contract: **Land at 31A North Street, Emsworth**

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
WS3	1	50	1		---	0.50 to 3.50	15 secs	-	1019	$0.2_{(SS)}$	-	0.0	0.0	20.4	0.0	3	0
WS3	1	50	1		---	0.50 to 3.50	30 secs	-	1019	$0.2_{(SS)}$	-	0.0	0.0	20.4	0.0	3	0
WS3	1	50	1		---	0.50 to 3.50	60 secs	-	1019	$0.2_{(SS)}$	-	0.0	0.0	20.4	0.0	3	0
WS3	1	50	1		---	0.50 to 3.50	90 secs	-	1019	$0.2_{(SS)}$	-	0.0	0.0	20.4	0.0	3	0
WS3	1	50	1		3.46	0.50 to 3.50	120 secs	-	1019	$0.2_{(SS)}$	0.84	0.0	0.0	20.4	0.0	3	0
WS4	1	50	1	3.60	---	0.60 to 3.60	07/09/2018 10:13:42	-	1019	$0.2_{(SS)}$	-	0.0	0.0	20.5	0.0	0	0
WS4	1	50	1		---	0.60 to 3.60	15 secs	-	1019	$0.2_{(SS)}$	-	0.4	0.0	18.4	0.0	5	0
WS4	1	50	1		---	0.60 to 3.60	30 secs	-	1019	$0.2_{(SS)}$	-	0.4	0.0	18.3	0.0	5	0
WS4	1	50	1		---	0.60 to 3.60	60 secs	-	1019	$0.2_{(SS)}$	-	0.4	0.0	18.3	0.0	5	0
WS4	1	50	1		---	0.60 to 3.60	90 secs	-	1019	$0.2_{(SS)}$	-	0.4	0.0	18.3	0.0	5	0
WS4	1	50	1		---	0.60 to 3.60	120 secs	-	1019	$0.2_{(SS)}$	-	0.4	0.0	18.3	0.0	6	0
WS4	1	50	1		---	0.60 to 3.60	180 secs	-	1019	$0.2_{(SS)}$	-	0.3	0.0	18.4	0.0	6	0
WS4	1	50	1		3.50	0.60 to 3.60	240 secs	-	1019	$0.2_{(SS)}$	2.43	0.3	0.0	18.4	0.0	6	0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Unit 26 Basepoint Abbey
Enterprise Centre
Premier Way, Romsey
SO51 9AQ

Compiled By	Date	Checked By	Date	Contract Ref:
	28/09/18			305019

Contract: **Land at 31A North Street, Emsworth**

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round 2	Falling	Constant	997	997	Ground: Damp + Wind: Light

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
WS1	1	50	2	3.65	---	0.65 to 3.65	12/09/2018 09:24:00	-	997	$0.3_{(SS)}$	-	0.0	0.0	20.5	0.0	0	0
WS1	1	50	2		---	0.65 to 3.65	15 secs	-	997	$0.3_{(SS)}$	-	1.6	0.0	18.1	0.0	0	0
WS1	1	50	2		---	0.65 to 3.65	30 secs	-	997	$0.3_{(SS)}$	-	1.7	0.1	17.3	2.0	0	0
WS1	1	50	2		---	0.65 to 3.65	60 secs	-	997	$0.3_{(SS)}$	-	1.7	0.1	17.2	2.0	0	0
WS1	1	50	2		---	0.65 to 3.65	90 secs	-	997	$0.3_{(SS)}$	-	1.7	0.1	17.1	2.0	0	0
WS1	1	50	2		---	0.65 to 3.65	120 secs	-	997	$0.3_{(SS)}$	-	1.8	0.1	17.1	2.0	0	0
WS1	1	50	2		---	0.65 to 3.65	180 secs	-	997	$0.3_{(SS)}$	-	1.7	0.1	17.1	2.0	0	0
WS1	1	50	2		3.53	0.65 to 3.65	240 secs	-	997	$0.3_{(SS)}$	1.22	1.7	0.1	17.1	2.0	0	0
WS2	1	50	2	3.65	---	0.65 to 3.65	12/09/2018 09:14:00	-	997	$0.3_{(SS)}$	-	0.0	0.0	20.4	0.0	0	0
WS2	1	50	2		---	0.65 to 3.65	15 secs	-	997	$0.3_{(SS)}$	-	0.6	0.0	19.8	0.0	0	0
WS2	1	50	2		---	0.65 to 3.65	30 secs	-	997	$0.3_{(SS)}$	-	0.7	0.0	19.6	0.0	0	0
WS2	1	50	2		---	0.65 to 3.65	60 secs	-	997	$0.3_{(SS)}$	-	0.7	0.0	19.6	0.0	0	0
WS2	1	50	2		---	0.65 to 3.65	90 secs	-	997	$0.3_{(SS)}$	-	0.7	0.0	19.6	0.0	0	0
WS2	1	50	2		3.43	0.65 to 3.65	120 secs	-	997	$0.3_{(SS)}$	0.73	0.7	0.0	19.6	0.0	0	0
WS3	1	50	2	3.50	---	0.50 to 3.50	12/09/2018 09:35:00	-	997	$0.2_{(SS)}$	-	0.1	0.0	20.4	0.0	0	0
WS3	1	50	2		---	0.50 to 3.50	15 secs	-	997	$0.2_{(SS)}$	-	0.0	0.0	20.4	0.0	0	0
WS3	1	50	2		---	0.50 to 3.50	30 secs	-	997	$0.2_{(SS)}$	-	0.0	0.0	20.4	0.0	0	0
WS3	1	50	2		---	0.50 to 3.50	60 secs	-	997	$0.2_{(SS)}$	-	0.0	0.0	20.4	0.0	1	0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Unit 26 Basepoint Abbey
Enterprise Centre
Premier Way, Romsey
SO51 9AQ

Compiled By	Date	Checked By	Date	Contract Ref:
	28/09/18			305019

Contract: **Land at 31A North Street, Emsworth**

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)
WS3	1	50	2		---	0.50 to 3.50	90 secs	-	997	$0.2_{(SS)}$	-	0.0	0.0	20.4	0.0	1	0
WS3	1	50	2		---	0.50 to 3.50	120 secs	-	997	$0.2_{(SS)}$	-	0.0	0.0	20.4	0.0	1	0
WS3	1	50	2		3.46	0.50 to 3.50	180 secs	-	997	$0.2_{(SS)}$	0.92	0.0	0.0	20.4	0.0	1	0
WS4	1	50	2	3.60	---	0.60 to 3.60	12/09/2018 09:46:00	-	997	$0.2_{(SS)}$	-	0.2	0.0	20.4	0.0	0	0
WS4	1	50	2		---	0.60 to 3.60	15 secs	-	997	$0.2_{(SS)}$	-	0.4	0.1	19.5	1.0	0	0
WS4	1	50	2		---	0.60 to 3.60	30 secs	-	997	$0.2_{(SS)}$	-	0.4	0.1	19.4	1.0	0	0
WS4	1	50	2		---	0.60 to 3.60	60 secs	-	997	$0.2_{(SS)}$	-	0.4	0.1	19.2	1.0	1	0
WS4	1	50	2		---	0.60 to 3.60	90 secs	-	997	$0.2_{(SS)}$	-	0.4	0.1	19.1	1.0	1	0
WS4	1	50	2		---	0.60 to 3.60	120 secs	-	997	$0.2_{(SS)}$	-	0.4	0.1	19.1	1.0	1	0
WS4	1	50	2		---	0.60 to 3.60	180 secs	-	997	$0.2_{(SS)}$	-	0.3	0.1	19.1	1.0	1	0
WS4	1	50	2		---	0.60 to 3.60	240 secs	-	997	$0.2_{(SS)}$	-	0.3	0.1	19.1	1.0	1	0
WS4	1	50	2		3.48	0.60 to 3.60	300 secs	-	997	$0.2_{(SS)}$	1.07	0.3	0.1	19.1	1.0	1	0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Unit 26 Basepoint Abbey
Enterprise Centre
Premier Way, Romsey
SO51 9AQ

Compiled By	Date	Checked By	Date	Contract Ref:
	28/09/18			305019

Contract: **Land at 31A North Street, Emsworth**

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round 3	Falling	Rising	985	985	Ground: Dry + Wind: Light

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
WS1	1	50	3	3.65	---	0.65 to 3.65	21/09/2018 09:11:00	-	985	$0.0_{(SS)}$	-	0.0	0.0	20.8	0	0	
WS1	1	50	3		---	0.65 to 3.65	15 secs	-	985	$0.0_{(SS)}$	-	1.6	0.0	18.2	0	0	
WS1	1	50	3		---	0.65 to 3.65	30 secs	-	985	$0.0_{(SS)}$	-	1.6	0.0	18.0	0	0	
WS1	1	50	3		---	0.65 to 3.65	60 secs	-	985	$0.0_{(SS)}$	-	1.7	0.0	17.9	0	0	
WS1	1	50	3		---	0.65 to 3.65	90 secs	-	985	$0.0_{(SS)}$	-	1.7	0.0	17.9	0	0	
WS1	1	50	3		3.55	0.65 to 3.65	120 secs	-	985	$0.0_{(SS)}$	1.45	1.7	0.0	17.9	0	0	
WS2	1	50	3	3.65	---	0.65 to 3.65	21/09/2018 09:01:00	-	985	$0.0_{(SS)}$	-	0.0	0.0	20.5	0	0	
WS2	1	50	3		---	0.65 to 3.65	15 secs	-	985	$0.0_{(SS)}$	-	0.5	0.0	19.9	0	0	
WS2	1	50	3		---	0.65 to 3.65	30 secs	-	985	$0.0_{(SS)}$	-	0.6	0.0	19.8	0	0	
WS2	1	50	3		---	0.65 to 3.65	60 secs	-	985	$0.0_{(SS)}$	-	0.6	0.0	19.8	0	0	
WS2	1	50	3		3.42	0.65 to 3.65	90 secs	-	985	$0.0_{(SS)}$	0.65	0.6	0.0	19.8	0	0	
WS3	1	50	3	3.50	---	0.50 to 3.50	21/09/2018 09:20:00	-	985	$0.0_{(SS)}$	-	0.0	0.0	20.7	0	0	
WS3	1	50	3		---	0.50 to 3.50	15 secs	-	985	$0.0_{(SS)}$	-	0.1	0.0	20.8	0	0	
WS3	1	50	3		---	0.50 to 3.50	30 secs	-	985	$0.0_{(SS)}$	-	0.1	0.0	20.8	0	0	
WS3	1	50	3		---	0.50 to 3.50	60 secs	-	985	$0.0_{(SS)}$	-	0.1	0.0	20.7	0	0	
WS3	1	50	3		---	0.50 to 3.50	90 secs	-	985	$0.0_{(SS)}$	-	0.1	0.0	20.7	0	0	
WS3	1	50	3		3.46	0.50 to 3.50	120 secs	-	985	$0.0_{(SS)}$	0.70	0.1	0.0	20.7	0	0	
WS4	1	50	3	3.60	---	0.60 to 3.60	21/09/2018 09:30:00	-	985	$0.0_{(SS)}$	-	0.0	0.0	20.8	0	0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Unit 26 Basepoint Abbey
Enterprise Centre
Premier Way, Romsey
SO51 9AQ

Compiled By	Date	Checked By	Date	Contract Ref:
	28/09/18			305019

Contract: **Land at 31A North Street, Emsworth**

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
WS4	1	50	3		---	0.60 to 3.60	15 secs	-	985	$0.0_{(SS)}$	-	0.1	0.0	20.7	0	0	
WS4	1	50	3		---	0.60 to 3.60	30 secs	-	985	$0.0_{(SS)}$	-	0.2	0.0	20.6	0	0	
WS4	1	50	3		---	0.60 to 3.60	60 secs	-	985	$0.0_{(SS)}$	-	0.2	0.0	20.6	0	0	
WS4	1	50	3		---	0.60 to 3.60	90 secs	-	985	$0.0_{(SS)}$	-	0.2	0.0	20.6	0	0	
WS4	1	50	3		3.52	0.60 to 3.60	120 secs	-	985	$0.0_{(SS)}$	1.40	0.2	0.0	20.6	0	0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round 4	Rising	Falling	1030	1028	Ground: Dry + Wind: Light

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
WS1	1	50	4	3.65	---	0.65 to 3.65	28/09/2018 10:00:00	-	1030	$0.0_{(SS)}$	-	0.0	0.0	20.4	0	0	
WS1	1	50	4		---	0.65 to 3.65	15 secs	-	1030	$0.0_{(SS)}$	-	1.9	0.0	17.3	0	0	
WS1	1	50	4		---	0.65 to 3.65	30 secs	-	1030	$0.0_{(SS)}$	-	2.0	0.0	16.5	0	0	
WS1	1	50	4		---	0.65 to 3.65	60 secs	-	1030	$0.0_{(SS)}$	-	2.0	0.0	16.4	0	0	
WS1	1	50	4		---	0.65 to 3.65	90 secs	-	1030	$0.0_{(SS)}$	-	2.0	0.0	16.4	0	0	
WS1	1	50	4		3.62	0.65 to 3.65	120 secs	-	1030	$0.0_{(SS)}$	2.04	2.0	0.0	16.4	0	0	
WS2	1	50	4	3.65	---	0.65 to 3.65	28/09/2018 10:07:00	-	1029	$0.0_{(SS)}$	-	0.9	0.0	17.7	0	0	
WS2	1	50	4		---	0.65 to 3.65	15 secs	-	1029	$0.0_{(SS)}$	-	0.7	0.0	18.0	0	0	
WS2	1	50	4		---	0.65 to 3.65	30 secs	-	1029	$0.0_{(SS)}$	-	0.7	0.0	18.1	0	0	
WS2	1	50	4		---	0.65 to 3.65	60 secs	-	1029	$0.0_{(SS)}$	-	0.7	0.0	18.1	0	0	
WS2	1	50	4		---	0.65 to 3.65	90 secs	-	1029	$0.0_{(SS)}$	-	0.7	0.0	18.1	0	0	
WS2	1	50	4		3.41	0.65 to 3.65	120 secs	-	1029	$0.0_{(SS)}$	0.74	0.7	0.0	18.1	0	0	
WS3	1	50	4	3.50	---	0.50 to 3.50	28/09/2018 10:14:00	-	1029	$-0.3_{(I)}$	-	0.2	0.0	20.8	0	0	
WS3	1	50	4		---	0.50 to 3.50	15 secs	-	1029	$-0.4_{(SS)}$	-	0.1	0.0	18.4	0	0	
WS3	1	50	4		---	0.50 to 3.50	30 secs	-	1029	$-0.4_{(SS)}$	-	0.1	0.0	18.2	0	0	
WS3	1	50	4		---	0.50 to 3.50	60 secs	-	1029	$-0.4_{(SS)}$	-	0.1	0.0	18.2	0	0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Unit 26 Basepoint Abbey
Enterprise Centre
Premier Way, Romsey
SO51 9AQ

Compiled By	Date	Checked By	Date	Contract Ref:
	28/09/18			305019

Contract: **Land at 31A North Street, Emsworth**

GINT_LIBRARY_V8_06.GLB : E - GAS MON - STANDARD - 6B - A4L : 305019 - NORTH STREET, EMSWORTH.GPJ : 28/09/18 15:09 : AD8 :

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
WS3	1	50	4		---	0.50 to 3.50	90 secs	-	1029	-0.4$_{(SS)}$	-	0.1	0.0	18.2	0	0	
WS3	1	50	4		3.45	0.50 to 3.50	120 secs	-	1029	-0.4$_{(SS)}$	0.81	0.1	0.0	18.2	0	0	
WS4	1	50	4	3.60	---	0.60 to 3.60	28/09/2018 10:22:00	-	985	0.0$_{(SS)}$	-	0.1	0.0	18.6	0	0	
WS4	1	50	4		---	0.60 to 3.60	15 secs	-	985	0.0$_{(SS)}$	-	0.5	0.0	14.4	0	0	
WS4	1	50	4		---	0.60 to 3.60	30 secs	-	985	0.0$_{(SS)}$	-	0.5	0.0	14.9	0	0	
WS4	1	50	4		---	0.60 to 3.60	60 secs	-	985	0.0$_{(SS)}$	-	0.4	0.0	15.4	0	0	
WS4	1	50	4		---	0.60 to 3.60	90 secs	-	985	0.0$_{(SS)}$	-	0.4	0.0	16.3	0	0	
WS4	1	50	4		---	0.60 to 3.60	120 secs	-	985	0.0$_{(SS)}$	-	0.4	0.0	16.6	0	0	
WS4	1	50	4		---	0.60 to 3.60	180 secs	-	985	0.0$_{(SS)}$	-	0.3	0.0	16.7	0	0	
WS4	1	50	4		---	0.60 to 3.60	240 secs	-	985	0.0$_{(SS)}$	-	0.3	0.0	16.7	0	0	
WS4	1	50	4		3.53	0.60 to 3.60	300 secs	-	985	0.0$_{(SS)}$	2.50	0.3	0.0	16.7	0	0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Unit 26 Basepoint Abbey
Enterprise Centre
Premier Way, Romsey
SO51 9AQ

Compiled By	Date	Checked By	Date	Contract Ref:
	28/09/18			305019

Contract: **Land at 31A North Street, Emsworth**

APPENDIX E
LABORATORY CERTIFICATES FOR SOIL ANALYSIS

Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client: RSK Environment Ltd Southampton, Unit 26 , Basepoint Abbey Enterprise Centre, Premier Way, Romsey,, Hampshire, UK, SO51 9AQ

Project: Land at 31A North Street, Emsworth

Clients Project No: 305019

Project No: 18/06954

Date Instructions Received: 31/08/2018 (am)

Cool Box Temperatures (°C): 16.8

NO DEVIATIONS IDENTIFIED

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT
SUPPLEMENT TO TEST REPORT 18/06954/1

Envirolab Job Number: 18/06954
Issue Number: 2 **Date:** 19 September, 2018

Client: RSK Environment Ltd Southampton
Unit 26
Basepoint Abbey Enterprise Centre
Premier Way
Romsey,
Hampshire
UK
SO51 9AQ

Project Manager: Andrew Denton; All RSK Southampton
Project Name: Land at 31A North Street, Emsworth
Project Ref: 305019
Order No: N/A
Date Samples Received: 31/08/18
Date Instructions Received: 31/08/18
Date Analysis Completed: 18/09/18

Prepared by:

[redacted]

Richard Wong
Client Manager

Approved by:

[redacted]

Gill Walker
Director/Laboratory Manager

mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME
UKAS TESTING 1247

Envirolab Job Number: 18/06954

Client Project Name: Land at 31A North Street, Emsworth

Client Project Ref: 305019

Lab Sample ID	18/06954/1	18/06954/2	18/06954/3	18/06954/4	18/06954/5	18/06954/6	18/06954/7	18/06954/8		
Client Sample No										
Client Sample ID	WS1-ES1	WS1-ES2	WS1-ES3	WS1-D3	WS2-ES2	WS2-ES3	WS2-D2	WS3-ES1		
Depth to Top	0.20	0.50	0.80	2.50	0.50	0.80	1.40	0.20		
Depth To Bottom										
Date Sampled	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - D	Soil - ES	Soil - ES	Soil - D	Soil - ES		
Sample Matrix Code	4AB	6A	6A	5	6A	6A	5A	5A		
% Stones >10mm$_{A}$	<0.1	18.7	41.5	<0.1	20.9	17.0	13.3	29.6	% w/w	A-T-044
Asbestos in soil (+concrete, ballast, rocks and aggregates)$_{A}^{\#}$	Appended	Appended	-	-	Appended	-	-	-		Subcon DETS
Asbestos % composition (SOIL) Gravimetric Stage 2 only$_{A}^{\#}$	Appended	-	-	-	-	-	-	-	%	Subcon DETS
pH$_{D}^{M\#}$	11.14	8.10	7.91	-	8.20	8.30	-	10.54	pH	A-T-031s
pH BRE$_{D}^{M\#}$	-	-	-	8.12	-	-	8.41	-	pH	A-T-031s
Ammonium NH4 BRE (water sol 2:1)$_{D}$	-	-	-	2.13	-	-	4.11	-	mg/l	A-T-033s
Chloride BRE, SO4 equiv. (water sol 2:1)$_{D}^{M\#}$	-	-	-	47	-	-	38	-	mg/l	A-T-026s
Nitrate BRE, SO4 equiv. (water sol 2:1)$_{D}$	-	-	-	0.7	-	-	0.9	-	mg/l	A-T-026s
Sulphate (water sol 2:1)$_{D}^{M\#}$	0.06	0.04	0.04	-	0.02	0.02	-	0.11	g/l	A-T-026s
Sulphate BRE (water sol 2:1)$_{D}^{M\#}$	-	-	-	94	-	-	74	-	mg/l	A-T-026s
Sulphate (acid soluble)$_{D}^{M\#}$	2000	830	460	-	720	600	-	2500	mg/kg	A-T-028s
Sulphate BRE (acid sol)$_{D}^{M\#}$	-	-	-	0.03	-	-	0.04	-	% w/w	A-T-028s
Sulphur BRE (total)$_{D}$	-	-	-	0.02	-	-	0.02	-	% w/w	A-T-024s
Magnesium BRE (water sol 2:1)$_{D}$	-	-	-	20	-	-	10	-	mg/l	A-T-SOLMETS
Total Organic Carbon$_{D}^{M\#}$	-	-	0.91	-	-	2.63	-	3.79	% w/w	A-T-032s
Arsenic$_{D}^{M\#}$	19	17	5	-	9	7	-	16	mg/kg	A-T-024s
Cadmium$_{D}^{M\#}$	0.8	0.7	<0.5	-	0.6	0.6	-	1.3	mg/kg	A-T-024s
Copper$_{D}^{M\#}$	43	38	10	-	114	45	-	218	mg/kg	A-T-024s
Chromium$_{D}^{M\#}$	17	24	17	-	18	21	-	18	mg/kg	A-T-024s
Lead$_{D}^{M\#}$	190	210	48	-	411	251	-	1800	mg/kg	A-T-024s
Mercury$_{D}$	0.81	0.54	0.20	-	1.03	0.91	-	3.86	mg/kg	A-T-024s
Nickel$_{D}^{M\#}$	25	28	10	-	19	19	-	21	mg/kg	A-T-024s
Selenium$_{D}^{\#}$	<1	<1	<1	-	<1	<1	-	<1	mg/kg	A-T-024s
Zinc$_{D}^{M\#}$	164	124	36	-	127	107	-	796	mg/kg	A-T-024s

Envirolab Job Number: 18/06954

Client Project Name: Land at 31A North Street, Emsworth

Client Project Ref: 305019

Lab Sample ID	18/06954/1	18/06954/2	18/06954/3	18/06954/4	18/06954/5	18/06954/6	18/06954/7	18/06954/8		
Client Sample No										
Client Sample ID	WS1-ES1	WS1-ES2	WS1-ES3	WS1-D3	WS2-ES2	WS2-ES3	WS2-D2	WS3-ES1		
Depth to Top	0.20	0.50	0.80	2.50	0.50	0.80	1.40	0.20		
Depth To Bottom										
Date Sampled	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - D	Soil - ES	Soil - ES	Soil - D	Soil - ES		
Sample Matrix Code	4AB	6A	6A	5	6A	6A	5A	5A		
PAH-16MS										
Acenaphthene$_{A}^{M\#}$	0.03	0.02	<0.01	-	<0.01	<0.01	-	0.02	mg/kg	A-T-019s
Acenaphthylene$_{A}^{M\#}$	0.27	0.06	<0.01	-	0.05	<0.01	-	0.13	mg/kg	A-T-019s
Anthracene$_{A}^{M\#}$	0.44	1.03	<0.02	-	0.08	<0.02	-	0.17	mg/kg	A-T-019s
Benzo(a)anthracene$_{A}^{M\#}$	7.30	2.48	<0.04	-	0.72	<0.04	-	1.06	mg/kg	A-T-019s
Benzo(a)pyrene$_{A}^{M\#}$	5.53	1.18	<0.04	-	0.62	<0.04	-	1.11	mg/kg	A-T-019s
Benzo(b)fluoranthene$_{A}^{M\#}$	6.81	1.47	<0.05	-	0.78	<0.05	-	1.34	mg/kg	A-T-019s
Benzo(ghi)perylene$_{A}^{M\#}$	1.90	0.36	<0.05	-	0.30	<0.05	-	0.81	mg/kg	A-T-019s
Benzo(k)fluoranthene$_{A}^{M\#}$	2.80	0.57	<0.07	-	0.27	<0.07	-	0.45	mg/kg	A-T-019s
Chrysene$_{A}^{M\#}$	6.79	1.80	<0.06	-	0.88	<0.06	-	1.27	mg/kg	A-T-019s
Dibenzo(ah)anthracene$_{A}^{M\#}$	0.87	0.17	<0.04	-	0.11	<0.04	-	0.20	mg/kg	A-T-019s
Fluoranthene$_{A}^{M\#}$	9.87	4.31	<0.08	-	1.20	<0.08	-	2.20	mg/kg	A-T-019s
Fluorene$_{A}^{M\#}$	0.09	0.14	<0.01	-	0.02	<0.01	-	0.05	mg/kg	A-T-019s
Indeno(123-cd)pyrene$_{A}^{M\#}$	2.95	0.62	<0.03	-	0.48	<0.03	-	1.05	mg/kg	A-T-019s
Naphthalene$_{A}^{M\#}$	0.05	<0.03	<0.03	-	<0.03	<0.03	-	0.04	mg/kg	A-T-019s
Phenanthrene$_{A}^{M\#}$	2.38	1.36	<0.03	-	0.41	<0.03	-	0.94	mg/kg	A-T-019s
Pyrene$_{A}^{M\#}$	8.38	3.25	<0.07	-	1.02	<0.07	-	1.89	mg/kg	A-T-019s
Total PAH-16MS$_{A}^{M\#}$	56.5	18.8	<0.08	-	6.94	<0.08	-	12.7	mg/kg	A-T-019s

Envirolab Job Number: 18/06954

Client Project Name: Land at 31A North Street, Emsworth

Client Project Ref: 305019

Lab Sample ID	18/06954/1	18/06954/2	18/06954/3	18/06954/4	18/06954/5	18/06954/6	18/06954/7	18/06954/8		
Client Sample No										
Client Sample ID	WS1-ES1	WS1-ES2	WS1-ES3	WS1-D3	WS2-ES2	WS2-ES3	WS2-D2	WS3-ES1		
Depth to Top	0.20	0.50	0.80	2.50	0.50	0.80	1.40	0.20		
Depth To Bottom										
Date Sampled	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - D	Soil - ES	Soil - ES	Soil - D	Soil - ES		
Sample Matrix Code	4AB	6A	6A	5	6A	6A	5A	5A		
TPH CWG										
Ali >C5-C6$_{A}^{\#}$	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	mg/kg	A-T-022s
Ali >C6-C8$_{A}^{\#}$	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	mg/kg	A-T-022s
Ali >C8-C10$_{A}^{M\#}$	<1	<1	<1	-	<1	<1	-	<1	mg/kg	A-T-055s
Ali >C10-C12$_{A}^{M\#}$	<1	<1	<1	-	<1	<1	-	<1	mg/kg	A-T-055s
Ali >C12-C16$_{A}^{M\#}$	<1	<1	<1	-	<1	<1	-	2	mg/kg	A-T-055s
Ali >C16-C21$_{A}^{M\#}$	6	<1	1	-	<1	<1	-	3	mg/kg	A-T-055s
Ali >C21-C35$_{A}$	78	13	9	-	4	1	-	26	mg/kg	A-T-055s
Total Aliphatics >C5-C35$_{A}$	83	15	11	-	5	1	-	31	mg/kg	A-T-055s
Aro >C5-C7$_{A}^{\#}$	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	mg/kg	A-T-022s
Aro >C7-C8$_{A}^{\#}$	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	mg/kg	A-T-022s
Aro >C8-C10$_{A}^{M\#}$	3	2	1	-	2	<1	-	2	mg/kg	A-T-055s
Aro >C10-C12$_{A}^{M\#}$	2	<1	<1	-	<1	<1	-	2	mg/kg	A-T-055s
Aro >C12-C16$_{A}$	6	3	1	-	5	1	-	7	mg/kg	A-T-055s
Aro >C16-C21$_{A}^{M\#}$	17	9	2	-	26	<1	-	27	mg/kg	A-T-055s
Aro >C21-C35$_{A}^{M\#}$	113	44	7	-	155	3	-	194	mg/kg	A-T-055s
Total Aromatics >C5-C35$_{A}$	141	59	11	-	189	4	-	231	mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35)$_{A}$	225	74	22	-	194	6	-	262	mg/kg	A-T-055s
BTEX - Benzene$_{A}^{\#}$	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	mg/kg	A-T-022s
BTEX - Toluene$_{A}^{\#}$	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	mg/kg	A-T-022s
BTEX - Ethyl Benzene$_{A}^{\#}$	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	mg/kg	A-T-022s
BTEX - m & p Xylene$_{A}^{\#}$	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	mg/kg	A-T-022s
BTEX - o Xylene$_{A}^{\#}$	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	mg/kg	A-T-022s
MTBE$_{A}^{\#}$	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	mg/kg	A-T-022s

Envirolab Job Number: 18/06954

Client Project Name: Land at 31A North Street, Emsworth

Client Project Ref: 305019

Lab Sample ID	18/06954/9	18/06954/10	18/06954/11	18/06954/12	18/06954/13					
Client Sample No										
Client Sample ID	WS3-ES2	WS3-ES3	WS3-D2	WS4-ES1	WS4-ES3					
Depth to Top	0.50	0.80	2.00	0.30	0.80					
Depth To Bottom										
Date Sampled	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18					
Sample Type	Soil - ES	Soil - ES	Soil - D	Soil - ES	Soil - ES					
Sample Matrix Code	6A	6A	5	6A	5A					
% Stones >10mm$_{A}$	25.2	<0.1	<0.1	26.3	12.2				% w/w	A-T-044
Asbestos in soil (+concrete, ballast, rocks and aggregates)$_{A}^{\#}$	Appended	-	-	Appended	-					Subcon DETS
pH$_{D}^{M\#}$	8.75	7.93	-	9.03	8.28				pH	A-T-031s
pH BRE$_{D}^{M\#}$	-	-	8.49	-	-				pH	A-T-031s
Ammonium NH4 BRE (water sol 2:1)$_{D}$	-	-	3.39	-	-				mg/l	A-T-033s
Chloride BRE, SO4 equiv. (water sol 2:1)$_{D}^{M\#}$	-	-	71	-	-				mg/l	A-T-026s
Nitrate BRE, SO4 equiv. (water sol 2:1)$_{D}$	-	-	<0.4	-	-				mg/l	A-T-026s
Sulphate (water sol 2:1)$_{D}^{M\#}$	0.04	<0.01	-	0.06	0.03				g/l	A-T-026s
Sulphate BRE (water sol 2:1)$_{D}^{M\#}$	-	-	56	-	-				mg/l	A-T-026s
Sulphate (acid soluble)$_{D}^{M\#}$	820	580	-	550	360				mg/kg	A-T-028s
Sulphate BRE (acid sol)$_{D}^{M\#}$	-	-	0.04	-	-				% w/w	A-T-028s
Sulphur BRE (total)$_{D}$	-	-	0.02	-	-				% w/w	A-T-024s
Magnesium BRE (water sol 2:1)$_{D}$	-	-	11	-	-				mg/l	A-T-SOLMETS
Arsenic$_{D}^{M\#}$	12	8	-	2	6				mg/kg	A-T-024s
Cadmium$_{D}^{M\#}$	0.5	0.6	-	<0.5	0.7				mg/kg	A-T-024s
Copper$_{D}^{M\#}$	58	39	-	22	12				mg/kg	A-T-024s
Chromium$_{D}^{M\#}$	11	28	-	21	42				mg/kg	A-T-024s
Lead$_{D}^{M\#}$	519	62	-	52	14				mg/kg	A-T-024s
Mercury$_{D}$	1.66	<0.17	-	<0.17	0.32				mg/kg	A-T-024s
Nickel$_{D}^{M\#}$	14	28	-	17	38				mg/kg	A-T-024s
Selenium$_{D}^{\#}$	<1	<1	-	<1	<1				mg/kg	A-T-024s
Zinc$_{D}^{M\#}$	171	78	-	60	49				mg/kg	A-T-024s

Envirolab Job Number: 18/06954

Client Project Name: Land at 31A North Street, Emsworth

Client Project Ref: 305019

Lab Sample ID	18/06954/9	18/06954/10	18/06954/11	18/06954/12	18/06954/13					
Client Sample No										
Client Sample ID	WS3-ES2	WS3-ES3	WS3-D2	WS4-ES1	WS4-ES3					
Depth to Top	0.50	0.80	2.00	0.30	0.80					
Depth To Bottom										
Date Sampled	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18					
Sample Type	Soil - ES	Soil - ES	Soil - D	Soil - ES	Soil - ES					
Sample Matrix Code	6A	6A	5	6A	5A					
PAH-16MS										
Acenaphthene$_{A}^{M\#}$	<0.01	<0.01	-	<0.01	<0.01				mg/kg	A-T-019s
Acenaphthylene$_{A}^{M\#}$	0.04	<0.01	-	<0.01	<0.01				mg/kg	A-T-019s
Anthracene$_{A}^{M\#}$	0.06	<0.02	-	<0.02	<0.02				mg/kg	A-T-019s
Benzo(a)anthracene$_{A}^{M\#}$	0.51	<0.04	-	0.09	<0.04				mg/kg	A-T-019s
Benzo(a)pyrene$_{A}^{M\#}$	0.46	<0.04	-	0.11	<0.04				mg/kg	A-T-019s
Benzo(b)fluoranthene$_{A}^{M\#}$	0.57	<0.05	-	0.11	<0.05				mg/kg	A-T-019s
Benzo(ghi)perylene$_{A}^{M\#}$	0.27	<0.05	-	0.08	<0.05				mg/kg	A-T-019s
Benzo(k)fluoranthene$_{A}^{M\#}$	0.20	<0.07	-	<0.07	<0.07				mg/kg	A-T-019s
Chrysene$_{A}^{M\#}$	0.62	<0.06	-	0.11	<0.06				mg/kg	A-T-019s
Dibenzo(ah)anthracene$_{A}^{M\#}$	0.09	<0.04	-	<0.04	<0.04				mg/kg	A-T-019s
Fluoranthene$_{A}^{M\#}$	0.95	<0.08	-	0.13	<0.08				mg/kg	A-T-019s
Fluorene$_{A}^{M\#}$	0.02	<0.01	-	<0.01	<0.01				mg/kg	A-T-019s
Indeno(123-cd)pyrene$_{A}^{M\#}$	0.40	<0.03	-	0.11	<0.03				mg/kg	A-T-019s
Naphthalene$_{A}^{M\#}$	<0.03	<0.03	-	<0.03	<0.03				mg/kg	A-T-019s
Phenanthrene$_{A}^{M\#}$	0.43	<0.03	-	0.04	<0.03				mg/kg	A-T-019s
Pyrene$_{A}^{M\#}$	0.77	<0.07	-	0.12	<0.07				mg/kg	A-T-019s
Total PAH-16MS$_{A}^{M\#}$	5.39	<0.08	-	0.90	<0.08				mg/kg	A-T-019s

Envirolab Job Number: 18/06954

Client Project Name: Land at 31A North Street, Emsworth

Client Project Ref: 305019

Lab Sample ID	18/06954/9	18/06954/10	18/06954/11	18/06954/12	18/06954/13					
Client Sample No										
Client Sample ID	WS3-ES2	WS3-ES3	WS3-D2	WS4-ES1	WS4-ES3					
Depth to Top	0.50	0.80	2.00	0.30	0.80					
Depth To Bottom										
Date Sampled	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18	29-Aug-18					
Sample Type	Soil - ES	Soil - ES	Soil - D	Soil - ES	Soil - ES					
Sample Matrix Code	6A	6A	5	6A	5A					
TPH CWG										
Ali >C5-C6$_{A}^{\#}$	<0.01	0.01	-	<0.01	<0.01				mg/kg	A-T-022s
Ali >C6-C8$_{A}^{\#}$	<0.01	<0.01	-	<0.01	<0.01				mg/kg	A-T-022s
Ali >C8-C10$_{A}^{M\#}$	<1	<1	-	<1	<1				mg/kg	A-T-055s
Ali >C10-C12$_{A}^{M\#}$	<1	<1	-	<1	<1				mg/kg	A-T-055s
Ali >C12-C16$_{A}^{M\#}$	<1	<1	-	<1	<1				mg/kg	A-T-055s
Ali >C16-C21$_{A}^{M\#}$	<1	<1	-	<1	<1				mg/kg	A-T-055s
Ali >C21-C35$_{A}$	5	3	-	3	<1				mg/kg	A-T-055s
Total Aliphatics >C5-C35$_{A}$	8	3	-	3	<1				mg/kg	A-T-055s
Aro >C5-C7$_{A}^{\#}$	<0.01	<0.01	-	<0.01	<0.01				mg/kg	A-T-022s
Aro >C7-C8$_{A}^{\#}$	<0.01	<0.01	-	<0.01	<0.01				mg/kg	A-T-022s
Aro >C8-C10$_{A}^{M\#}$	2	1	-	2	<1				mg/kg	A-T-055s
Aro >C10-C12$_{A}^{M\#}$	<1	<1	-	<1	<1				mg/kg	A-T-055s
Aro >C12-C16$_{A}$	3	1	-	2	<1				mg/kg	A-T-055s
Aro >C16-C21$_{A}^{M\#}$	6	<1	-	3	<1				mg/kg	A-T-055s
Aro >C21-C35$_{A}^{M\#}$	44	4	-	19	1				mg/kg	A-T-055s
Total Aromatics >C5-C35$_{A}$	56	7	-	27	1				mg/kg	A-T-055s
TPH (Ali & Aro >C5-C35)$_{A}$	63	9	-	30	1				mg/kg	A-T-055s
BTEX - Benzene$_{A}^{\#}$	<0.01	<0.01	-	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Toluene$_{A}^{\#}$	<0.01	<0.01	-	<0.01	<0.01				mg/kg	A-T-022s
BTEX - Ethyl Benzene$_{A}^{\#}$	<0.01	<0.01	-	<0.01	<0.01				mg/kg	A-T-022s
BTEX - m & p Xylene$_{A}^{\#}$	<0.01	<0.01	-	<0.01	<0.01				mg/kg	A-T-022s
BTEX - o Xylene$_{A}^{\#}$	<0.01	<0.01	-	<0.01	<0.01				mg/kg	A-T-022s
MTBE$_{A}^{\#}$	<0.01	<0.01	-	<0.01	<0.01				mg/kg	A-T-022s

REPORT NOTES

General:
This report shall not be reproduced, except in full, without written approval from Envirolab.
All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.
Analytical results reflect the quality of the sample at the time of analysis only.
Opinions and interpretations expressed are outside the scope of our accreditation.
If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any “A” subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:
Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.
Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

Key:
IS indicates Insufficient Sample for analysis.
US indicates Unsuitable Sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Superscript "M" indicates method accredited to MCERTS.
Subscript "A" indicates analysis performed on the sample as received.
Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Certificate of Analysis

Certificate Number	18-20980-1
Client	Envirolab Ltd Units 7&8 Sandpits, Business Park Mottram Road Hyde SK14 3AR
Our Reference	18-20980-1
Client Reference	18/06954
Order No	P0738914
Contract Title	(not supplied)
Description	5 Soil samples.
Date Received	03-Sep-18
Date Started	03-Sep-18
Date Completed	17-Sep-18
Test Procedures	Identified by prefix DETSn (details on request).
Notes	**This report supersedes 18-20980. Extra testing** Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

17-Sep-18

Approved By [redacted]

Adam Fenwick
Contracts Manager

UKAS TESTING
2139

Summary of Asbestos Analysis
Soil Samples

Our Ref 18-20980-1
Client Ref 18/06954
Contract Title

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
1387358	18/06954/1 WS1-ES1 0.20	SOIL	Chrysotile	Chrysotile present as microscopic fibre bundles	D Wilkinson
1387359	18/06954/2 WS1-ES2 0.50	SOIL	NAD	none	D Wilkinson
1387360	18/06954/5 WS2-ES2 0.50	SOIL	NAD	none	D Wilkinson
1387361	18/06954/9 WS3-ES2 0.50	SOIL	NAD	none	D Wilkinson
1387362	18/06954/12 WS4-ES1 0.30	SOIL	NAD	none	D Wilkinson

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * -not included in laboratory scope of accreditation.

Summary of Asbestos Quantification Analysis
Soil Samples

Our Ref 18-20980-1
Client Ref 18/06954
Contract Title

Lab No	1387358
Sample ID	18/06954/1
Depth	0.20
Other ID	WS1-ES1
Sample Type	SOIL
Sampling Date	29/08/18
Sampling Time	

Test	Method	Units	
Total Mass% Asbestos (a+b+c)	DETSC 1102	Mass %	**< 0.001**
Gravimetric Quantification (a)	DETSC 1102	Mass %	na
Detailed Gravimetric Quantification (b)	DETSC 1102	Mass %	<0.001
Quantification by PCOM (c)	DETSC 1102	Mass %	na
Potentially Respirable Fibres (d)	DETSC 1102	Fibres/g	na
Breakdown of Gravimetric Analysis (a)			
Mass of Sample		g	232.96
ACMs present*		type	
Mass of ACM in sample		g	
% ACM by mass		%	
% asbestos in ACM		%	
% asbestos in sample		%	
Breakdown of Detailed Gravimetric Analysis (b)			
% Amphibole bundles in sample		Mass %	na
% Chrysotile bundles in sample		Mass %	<0.001
Breakdown of PCOM Analysis (c)			
% Amphibole fibres in sample		Mass %	na
% Chrysotile fibres in sample		Mass %	na
Breakdown of Potentially Respirable Fibre Analysis (d)			
Amphibole fibres		Fibres/g	na
Chrysotile fibres		Fibres/g	na

* Denotes test or material description outside of UKAS accreditation.
% asbestos in Asbestos Containing Materials (ACMs) is determined by
by reference to HSG 264.
Recommended sample size for quantification is approximately 1kg
# denotes deviating sample

Information in Support of the Analytical Results

Our Ref 18-20980
Client Ref 18/06954
Contract

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1387358	18/06954/1 0.20 SOIL	29/08/18	GJ 250ml		
1387359	18/06954/2 0.50 SOIL	29/08/18	GJ 250ml		
1387360	18/06954/5 0.50 SOIL	29/08/18	GJ 250ml		
1387361	18/06954/9 0.50 SOIL	29/08/18	GJ 250ml		
1387362	18/06954/12 0.30 SOIL	29/08/18	GJ 250ml		

Key: G-Glass J-Jar

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-
Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

APPENDIX F
HUMAN HEALTH GENERIC ASSESSMENT CRITERIA

Generic assessment criteria for human health: residential scenario without home-grown produce

Background

RSK's generic assessment criteria (GAC) were initially prepared following the publication by the Environment Agency (EA) of soil guideline value (SGV) and toxicological (TOX) reports, and associated publications in 2009[1]. RSK GAC were updated following the publication of GAC by LQM/CIEH in 2009[2]. RSK GAC are periodically revised when updated information on toxicological, land use or receptor parameters is published.

Updates to the RSK GAC

In 2014, the publication of Category 4 Screening Levels (C4SL)[3,4], as part of the Defra-funded research project SP1010, included modifications to certain exposure assumptions documented within EA Science Report SC050221/SR3 (herein after referred to as SR3)[5] used in the generation of SGVs.

C4SL were published for six substances (cadmium, arsenic, benzene, benzo(a)pyrene, chromium VI and lead) for a sandy loam soil type with 6% soil organic matter, based on a low level of toxicological concern (LLTC; see Section 2.3 of research project report SP1010[3]). Where a C4SL has been published, the RSK GAC duplicates the C4SL published values using all input parameters within the SP1010 final project report[3] and associated appendices[6], and adopts them as GAC for these six substances.

For all other substances the C4SL exposure modifications relevant for residential without home-grown produce end use have been applied to the current RSK GAC. These include alterations to daily inhalation rates for residential and commercial scenarios, reducing soil adherence factors in children (age classes 1 to 12 only) and reducing exposure frequency for dermal contact outdoors.

The RSK GAC have also been revised with updated toxicology published by LQM/CIEH in 2015[7] or by the USEPA[14], where a C4SL has not been published.

RSK GAC derivation for metals and organic compounds

Model selection

Soil assessment criteria (SAC) were calculated using the Contaminated Land Exposure Assessment (CLEA) tool v1.071, supporting EA guidance[5,8,9] and revised exposure scenarios published for the C4SL[3]. The SAC are also termed GAC.

Conceptual model

In accordance with SR3[5], the residential <u>without</u> home-grown produce scenario considers risks to a female child between the ages of 0 and 6 years old as the highest risk scenario. In accordance with Box 3.1 of SR3[5], the pathways considered for production of the SAC in the residential without home-grown produce scenario are

- direct soil and dust ingestion in areas of soft landscaping
- dermal contact with soil and indoor dust

- inhalation of indoor and outdoor dust and vapours.

Figure 1 is a conceptual model illustrating these linkages.

In line with guidance in the EA SGV report for cadmium[1], the RSK GAC for cadmium has been derived based on estimates representative of lifetime exposure. Although young children are generally more likely to have higher exposures to soil contaminants, the renal toxicity of cadmium, and the derivation of the TDI_{oral} and TDI_{inh}, are based on considerations of the kidney burden accumulated over 50 years or so. It is therefore reasonable to consider exposure not just in childhood but averaged over a longer period.

With respect to volatilisation, the CLEA model assumes a simple linear partitioning of a chemical in the soil between the sorbed, dissolved and vapour phase[9]. The upper boundaries of this partitioning are represented by the maximum aqueous solubility and pure saturated vapour concentration of the chemical. The CLEA model estimates saturated soil concentrations where these limits are reached[9]. The CLEA software uses a traffic light system to identify when individual and/or combined assessment criteria exceed the lower of either the aqueous- or vapour-based soil saturation limits. Model output cells are flagged red where the saturated soil concentration has been exceeded and the contribution of the indoor and outdoor vapour pathway to total exposure is greater than 10%. In this case, further consideration of the following is required[9]:

- Free phase contamination may be present.
- Exposure from the vapour pathways will be over-predicted by the model, as in reality the vapour phase concentration will not increase at concentrations above saturation limits
- Where the vapour pathway contribution is greater than 90%, it is unlikely the relevant health criteria value (HCV) will be exceeded at soil concentrations at least a factor of ten higher than the relevant HCV.

Where the vapour pathway is the predominant pathway (contributes greater than 90% of exposure) or the only exposure route considered and the cell is highlighted red (SAC exceeds saturation limit), the risk based on the assumed conceptual model is likely to be negligible as the vapour risk is assumed to be tolerable at maximum possible soil concentrations. In such circumstances, the vapour pathway exposure should be considered based on the presence of free phase or non-aqueous phase liquid sources and the measured concentrations of volatile organic compounds (VOC) in the vapour phase. Screening could be considered based on setting the SAC as the modelled soil saturation limits. However, as stated within the CLEA handbook[9], this is likely to not be practical in many cases because of the very low saturation limits and, in any case, is highly conservative.

It should also be noted that for mixtures of compounds, free phase may be present where soil (or groundwater) concentrations are well below saturation limits for individual compounds.

Where the vapour pathway is only one of the exposure pathways considered, an additional approach can then be utilised as detailed within Section 4.12 of the CLEA model handbook[9], which explains how to calculate an effective assessment criterion manually.

SR3[5] states that, as a general rule of thumb, it is recognised that estimating vapour phase concentrations from dissolved and sorbed phase contamination by petroleum hydrocarbons are at least a factor of ten higher than those likely to be measured on-site. RSK has therefore applied an empirical subsurface to indoor air correction factor of 10 into the CLEA model chemical database for all petroleum hydrocarbon fractions (including BTEX, trimethylbenzenes and the

polycyclic aromatic hydrocarbons (PAH) naphthalene, acenaphthene and acenaphthylene) to reduce this conservatism.

Input selection

The most up-to-date published chemical and toxicological data was obtained from EA Report SC050021/SR7[10], the EA TOX[1] reports, the C4SL SP1010 project report and associated appendices[3,6], the 2015 LQM/CIEH report[7] or the USEPA IRIS database[14]. Where a C4SL has been published, the RSK GAC have duplicated the C4SL published values using all input parameters within the SP1010 final project report[3] and associated appendices[6], and has adopted them as GAC for these six substances. Toxicological and specific chemical parameters for 1,2,4-trimethylbenzene and methyl tertiary-butyl ether (MTBE) were obtained from the CL:AIRE Soil Generic Assessment Criteria report[11].

For TPH, aromatic hydrocarbons C_5–C_8 were not modelled, as this range comprises benzene (>EC5-EC7) and toluene (>EC7-EC8), which are modelled separately.

Physical parameters

For the residential without home-grown produce scenario, the CLEA default building is a small, two-storey terrace house with a concrete ground-bearing slab. SR3[5] notes this residential building type to be the most conservative in terms of potential for vapour intrusion. The building parameters used in the production of the RSK GACs are the default CLEA v1.06 inputs presented in Table 3.3 of SR3[3], with a dust loading factor detailed in Section 9.3 of SR3[5]. The parameters for a sandy loam soil type were used in line with Table 4.4 of SR3[5]. This includes a value of 6% for the percentage of soil organic matter (SOM) within the soil. In RSK's experience, this is rather high for many sites. To avoid undertaking site-specific risk assessments for this SOM, RSK has produced an additional set of GAC for SOM of 1% and 2.5% for all substances using the CLEA tool.

Summary of modifications to the default CLEA SR3[5] input parameters for residential without home-grown produce

In summary, the RSK GAC were produced using the default input parameters for soil properties, the air dispersion model, building properties and the vapour model detailed in SR3[5]. Modifications to the default SR3[5] exposure scenarios based on the C4SL exposure scenarios[3] are presented in Table 2 below.

The final selected GAC are presented by pathway in Table 3 and the combined GAC in Table 4.

Figure 1: Conceptual model for CLEA residential scenario without home-grown produce

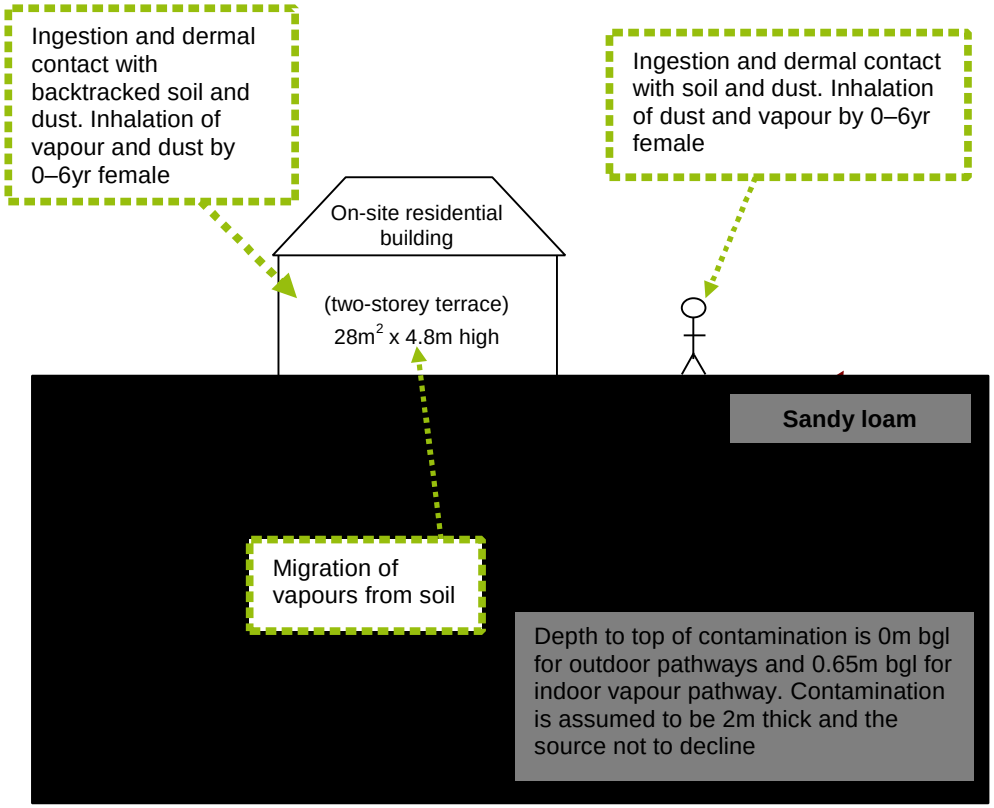


Table 1: Exposure assessment parameters for residential scenario without home-grown produce – inputs for CLEA model

Parameter	Value	Justification
Land use	Residential without home-grown produce	Chosen land use
Receptor	Female child	Key generic assumption given in Box 3.1, SR3[5]
Building	Small terraced house	Key generic assumption given in Box 3.1, SR3[5]. Small, two-storey terraced house chosen, as it is the most conservative residential building type in terms of protection from vapor intrusion (Section 3.4.6, SR3)[5]
Soil type	Sandy loam	Most common UK soil type (Section 4.3.1, from Table 3.1, SR3)[5]
Start age class (AC)	1	Range of age classes corresponding to key generic assumption that the critical receptor is a young female child aged 0–6. From Box 3.1, SR3[5]
End AC	6	
SOM (%)	6	Representative of sandy loamy soil according to EA guidance note dated January 2009 entitled 'Changes We Have Made to the CLEA Framework Documents'[13]
	1	To provide SAC for sites where SOM <6% as often observed by RSK
	2.5	
pH	7	Model default

Table 2: Residential without home-grown produce – modified receptor data

Parameter	Unit	Age class					
		1	2	3	4	5	6
Soil to skin adherence factor – (outdoor)	mg soil/cm^2 skin	0.1	0.1	0.1	0.1	0.1	0.1
Justification		Table 3.5, SP1010[3]					
Inhalation rate	m^3 day^{-1}	5.4	8.0	8.9	10.1	10.1	10.1
Justification		Mean value USEPA, 2011[12]; Table 3.2, SP1010[3]					
Notes: For **cadmium**, the exposure assessment for a residential land use is based on estimates representative of lifetime exposure AC1-18. This is because the TDI_{oral} and TDI_{inh} are based on considerations of the kidney burden accumulated over 50 years. It is therefore reasonable to consider exposure not just in childhood but averaged over a longer period. See the Environment Agency Science Report SC05002/ TOX 3[1], Science Report SC050021/Cadmium SGV[1] and the project report SP1010[3] for more information.							

References

1. Environment Agency (2009), 'Science Reports SC050021 - SGV and TOX reports for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin-like PCBs'; 'Supplementary information for the derivation of SGV for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin-like PCBs', and 'Contaminants in soil: updated collation of toxicological data and intake values for humans: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin-like PCBs'. Available at: https://www.gov.uk/government/publications/contaminants-in-soil-updated-collation-of-toxicological-data-and-intake-values-for-humans and https://www.gov.uk/government/publications/land-contamination-soil-guideline-values-sgvs (accessed 4 February 2015)

2. Nathanial, C. P., McCaffrey, C., Ashmore, M., Cheng, Y., Gillet, A. G., Ogden, R. C. and Scott, D. (2009), *LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment*, second edition (Nottingham: Land Quality Press).

3. Contaminated Land: Applications in Real Environment (CL:AIRE) (2014). 'Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination', Revision 2, DEFRA research project SP1010.

4. Department for Environment, Food and Rural Affairs (Defra) (2014), 'SP1010: Development of Category 4 Screening Levels for assessment of land affected by contamination – Policy Companion Document', Revision 2.

5. Environment Agency (2009), *Science Report – SC050021/SR3. Updated technical background to the CLEA model* (Bristol: Environment Agency).

6. Contaminated Land: Applications in Real Environment (CL:AIRE) (2014). 'Appendices C to H). DEFRA research project SP1010'.

7. Nathanial, C. P., McCaffrey, C., Gillet, A. G., Ogden, R. C. and Nathanial, J. F. (2015), *The LQM/CIEH S4ULs for Human Health Risk Assessment* (Nottingham: Land Quality Press).

8. Environment Agency (2009), *Human health toxicological assessment of contaminants in soil. Science Report – Final SC050021/SR2* (Bristol: Environment Agency).

9. Environment Agency (2009), *Science Report – SC050021/SR4 CLEA Software (version 1.05) Handbook* (Bristol: Environment Agency).

10. Environment Agency (2008), *Science Report SC050021/SR7. Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values* (Bristol: Environment Agency).

11. CL:AIRE (2009), *Soil Generic Assessment Criteria for Human Health Risk Assessment* (London: CL:AIRE).

12. USEPA (2011), *Exposure factors handbook*, EPA/600/R-090/052F (Washington, DC: Office of Research and Development).

13. Environment Agency (2009), 'Changes made to the CLEA framework documents after the three-month evaluation period in 2008', released January 2009.

14. USEPA (2010). Hydrogen cyanide and cyanide salts. Integrated Risk Information Systems (IRIS) Chemical Assessment Summary. September 2010. https://www.epa.gov/iris (accessed 9 December 2015)

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITHOUT HOME-GROWN PRODUCE

Table 3

Human Health Generic Assessment Criteria by Pathway for Residential Scenario Without Home-Grown Produce

Compound		SAC Appropriate to Pathway SOM 1% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 2.5% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 6% (mg/kg)			Soil Saturation Limit (mg/kg)
		Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	

APPENDIX G
HUMAN HEALTH SOIL VAPOUR GENERIC ASSESSMENT CRITERIA

Generic assessment criteria (vGAC) for indoor human health exposure

Background

RSK's vapour generic assessment criteria (vGAC) were initially prepared in 2012. The RSK vGAC are periodically revised when updated information on toxicological, land use or receptor parameters is published.

The potential for volatile organic compounds (VOC) present in the ground to cause significant human health risks *via* inhalation exposure is well documented and UK guidance on investigating, assessing and managing risks of inhalation of VOC on land affected by contamination has been published in CIRIA C682[1]. CIRIA C682[1] is consistent with existing UK regulatory guidance on land contamination (e.g. the CLEA model and supporting documents[2,3,4] and complements BS8576[5] - Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds (VOCs).

A detailed framework for the assessment of VOC is provided in CIRIA C682[1], which describes the development and use of screening criteria for VOC present in soil, groundwater and soil gas (vapour).

For soil it is recognised that for VOC, published Soil Guideline Values (SGV) or calculated generic assessment criteria (GAC) that include, or are specific to, indoor inhalation exposure pathways may be used as conservative screening criteria[1]. RSK has calculated GAC for VOC in soils for a variety of end-uses using CLEA v1.06, where SGV are not available. RSK also uses data from the Suitable for Use Levels published in 2015 by Nathanial et al.,[6] and CL:AIRE[7]. For groundwater, RSK has calculated GAC using the RBCA model (version 1.3b) updated to reflect UK guidance.

It is recognised within CIRIA C682[1] that SGV/GAC for VOC in soil and groundwater calculated using published coefficients to estimate the partitioning from the sorbed or dissolved phase into the gas phase (e.g. Henry's constant) may be conservative by up to several orders of magnitude. Additional conservatism of inhalation exposure may also occur through estimation of soil gas intrusion into building *via* the foundation using models such as Johnson & Ettinger (J&E)[8], although there are recognisable differences between chlorinated and non-chlorinated compounds. The J&E model is known to typically overestimate the intrusion of non-chlorinated VOC into buildings, whilst chlorinated VOC may be underestimated, with the consequence that the J&E model is no longer recommended for predicting vapour intrusion of chlorinated VOC in many of the states in the USA[1]. This difference is in part due to the often rapid biodegradation of non-chlorinated VOC and very slow degradation of chlorinated in aerobic environments such as those typically found in shallow soils and beneath buildings.

Notwithstanding the above, it should be recognised that comparison of laboratory data for VOC in soils with SGV/GAC may also underestimate inhalation risk, due to the potential loss of VOC during soil sampling, which may be significant. Many states in the USA disregard reliance on soil results for vapour intrusion assessment for this reason.

The conservatism associated with estimating the indoor intrusion of VOC in soils has been recognised in guidance for the use of the CLEA model[3], where calculated indoor VOC concentrations may be amended using a sub-surface soil to indoor air correction factor for petroleum hydrocarbons.

In general, multiple lines of evidence are recommended for vapour intrusion risk assessment[1]. However, **it is not necessary to undertake soil gas VOC monitoring at all sites**, particularly those where VOC are not anticipated or identified in soil and groundwater. In deciding when it is appropriate to undertake soil gas VOC monitoring the following situations should be considered, <u>based on a detailed understanding of the conceptual model and possible limitations in your data</u>:

- Reliance on VOC in <u>soil data alone</u> - acceptable only where shallow groundwater is absent and where:
    - VOC sources are not anticipated;
    - VOC are not identified during drilling/sampling (i.e. no olfactory evidence); and
    - VOC concentrations in soil samples are representative and well below SGV/GAC; potential significant losses of VOC during soil sampling must be recognised.

- Reliance on VOC in <u>soil and groundwater data alone</u> (i.e. no soil gas VOC data) - acceptable only where:
    - VOC sources are not anticipated;
    - VOC are not identified during drilling/sampling (i.e. no olfactory evidence); and
    - VOC concentrations in soil and groundwater samples are representative and below SGV/GAC; potential significant losses of VOC during soil sampling must be recognised.

Where VOC are either anticipated or present in soil and/or groundwater in concentrations near to or exceeding SGV/GAC then direct measurement of VOC in soil gas is recommended to assess potential inhalation exposure. Soil gas VOC data should initially be compared with generic soil gas VOC assessment criteria (vGAC).

Remediation measures should not be recommended, or remediation criteria calculated, to mitigate inhalation exposure risks in the absence of soil gas VOC data, except in specific circumstances, e.g. where acute risk is possible or emergency response work is being undertaken.

Generic Soil Gas VOC Assessment Criteria (vGAC)

As part of a multiple lines of evidence approach, recommended in CIRIA C682, RSK details herein the calculation of vGAC to be used for screening soil gas VOC concentrations for the protection of human health inhalation exposure within residential and commercial buildings. vGAC are relevant to soil gas VOC concentrations measured in the following scenarios:

- Open spaces, with planned future development;
- Near slab – i.e. close to, but outside, the building footprint; and
- Sub slab – i.e. directly beneath the building footprint.

It is important to note that vGAC relate to soil gas concentrations only and are not for use when assessing the results of indoor air sampling. Indoor air sampling data must be compared directly with relevant published or adjusted inhalation health criteria value (HCV) such as those in Table 3 or with occupational exposure limits depending upon the purpose of the assessment.

Model Selection

In line with recommendations[9] and the approach taken within the CLEA model, RSK has used the J&E model[10] as the basis to estimate the vGAC. Limitations of the J&E model for chlorinated compounds are noted. The following components of vapour intrusion are incorporated within the model:

1. Partitioning of contaminants between groundwater, soil and vapour-phase.
2. Movement of contaminants in the soil vapour-phase through the unsaturated zone – **diffusion** controlled.
3. Movement of contaminants in the soil vapour-phase through the unsaturated zone – **advection** controlled for shallow soils beneath a building.
4. Movement of contaminants through the building foundation (dust-filled joints and cracks) - **advection** controlled.
5. Dilution of soil gas vapours within indoor air.

Movement of soil gas vapours through advection forces (pressure differential) is recognised to be more rapid than *via* diffusion, particularly in close proximity to building foundations.

The following components of vapour intrusion are not included in the model:

1. Preferential flow paths through foundations (e.g. *via* large cracks or service entries);
2. Biodegradation/bioattenuation during unsaturated zone transport, during intrusion via the foundation or whilst in indoor air.

The output of the J&E model is the calculation of an attenuation factor (α) by the following equation (Equation 10.4 in SR3[3]):

$$\alpha = \frac{\left[\left(\frac{D_{eff} A_B}{Q_b L_T}\right) \exp\left(\frac{Q_s L_{crack}}{D_{crack} A_{crack}}\right)\right]}{\left[\exp\left(\frac{Q_s L_{crack}}{D_{crack} A_{crack}}\right) + \left(\frac{D_{eff} A_B}{Q_b L_T}\right) + \left(\frac{D_{eff} A_B}{Q_s L_T}\right)\left[\exp\left(\frac{Q_s L_{crack}}{D_{crack} A_{crack}}\right) - 1\right]\right]}$$

Where: α is the steady-state attenuation coefficient between soil and indoor air, dimensionless
D_{eff} is the effective diffusion coefficient for unsaturated soils, $cm^2\ s^{-1}$
A_B is the area of enclosed floor and walls below ground, cm^2
Q_b is the building ventilation rate, $cm^3\ s^{-1}$
L_T is the source-building separation, cm
Q_s is the volumetric flow rate of soil gas into the enclosed space, $cm^3\ s^{-1}$ [25 to 150]
L_{crack} is the foundation slab thickness, cm
A_{crack} is the floor crack area, cm^2
D_{crack} is the effective diffusion coefficient through the cracks, $cm^2\ s^{-1}$ [= D_{eff}]
Note: Appendix 1, Equation A10 where the Peclet number approaches infinity

The attenuation factor (α) is the ratio of the indoor concentration to the concentration in the soil gas for a particular chemical (Equation 10.6 in SR3[3]) and is a measure of the degree of **reduction** in concentration as VOC migrate into buildings:

$$A = \left[\frac{D_T^{eff}}{E_B \left(\frac{V_B}{A_B}\right) L_T}\right], \quad B = \left[\frac{\left(\frac{Q_{soil}}{Q_B}\right) E_B \left(\frac{V_B}{A_B}\right) L_{crack}}{D_{crack}^{eff}\ \eta}\right], \quad C = \left[\frac{Q_{soil}}{Q_B}\right]$$

Identification of critical parameters for the J&E model (1991) was undertaken by Johnson in 2002[11]. Johnson[11] identified three multi-component parameters (termed A, B and C), required to achieve the required J&E model output:

$$C_{air} = \alpha\ C_{vap} \times 1000000\, cm^3 m^{-3}$$

Where: C_{air} is the indoor air concentration, mg m^{-3}
α is steady-state attenuation coefficient between soil and indoor air, dimensionless
C_{vap} is the soil vapour concentration, mg cm^{-3}

Where additional parameters:

E_B is the enclosed space air exchange rate (d^{-1})

V_B is the enclosed space volume (m^3)

(Note – subscript B is not related to multi-component parameter B)

Depending on a variety of situations where movement of soil gas is controlled by either diffusion (slow) or advection (fast), Johnson identified solutions to the J&E model for the calculation of α based solely on the three multi-component parameters *A, B and C*.

The most **conservative** assumption is where movement of soil gas across the building foundation *via* advection is rate limiting, then:

$$\alpha \approx C \approx Q_{soil}/Q_B$$

Where: α = attenuation factor

Q_{soil} = soil gas flow into building

Q_B = building ventilation rate ($cm^3\ s^{-1}$)

For other situations where diffusion is assumed to be either dominant, or occurs in addition to advection (e.g. for a deeper source), then the solutions for α *via* parameters A and B are less conservative.

Assuming that the contaminant source in the soil gas is directly beneath the building foundation and that movement is controlled by advection (i.e. the most conservative assumption), then the attenuation factor α is the ratio of the flux of soil gas migration into the building (Q_{soil}) and the flux of air out of the building (building ventilation rate Q_B).

Guidance in SR3[3] provides recommendations for the calculation of the ventilation rate Q_B as follows:

$$C = (H \times A_{foot} \times E_x) \times 1{,}000{,}000\ cm^3\ m^{-3} \times 1/3600\ s\ hr^{-1}$$

Where: H = height of living space (m)

A_{foot} = building footprint (m^2)

E_x = building air exchange rate (hr^{-1})

Approach to Calculation of vGAC

The building ventilation rate Q_B can be calculated for various building types (residential and commercial) using building parameters provided in Tables 3.3 and 4.21 in SR3[3], and based on building air exchange rates (E_X) recommended in SR3[3] for residential properties (0.5 h^{-1}) and commercial properties (1.0 h^{-1}).

Values for the volumetric flow rate into the building (Q_{soil}) are stated in SR3[3], based on a combination of worst-case building parameters and soil type (crack/joint infill), and calculations

provided in Appendix 1 of SR3[3], as 25 cm^3 s^{-1} and 150 cm^3 s^{-1} for the residential and commercial land uses, respectively.

The approach to calculating vGAC taken by RSK therefore bypasses direct use of the full J&E model algorithm and uses a simple dilution relationship (Q_{soil}/ Q_B), which is more conservative and suitable for screening purposes. This approach also negates the requirement to measure (or assume) a variety of soil and other physical characteristics (e.g. soil volumetric moisture content, total porosity, molecular diffusion in air).

Attenuation factors (α) have been calculated on the basis of the above and are presented in Table 2.

This method of calculating attenuation factors from reasonably conservative vapour entry rates and indoor air exchange rates has been suggested in a recent (2014) paper[11] to offer a more technically defensible approach for the development of site specific attenuation factors, compared with a method that uses a comparison between paired, indoor air and sub-slab soil gas data in empirical databases.

As expected, attenuation is typically greater (α is a smaller value) for commercial properties than for residential properties. Calculation of vGAC, specific to both chemical and building type, has been undertaken through division of the HCV, specific to the critical receptor for a given end-use (e.g. residential or commercial), and the corresponding building-specific attenuation factor.

$$\textbf{vGAC} = \textbf{HCV} / \alpha$$

Health Criteria Values (HCV)

The HCV and background inhalation has been taken from the relevant SGV report[12], published by Nathanial et al.,[6] or the CL:AIRE report[7], as appropriate. The HCV have been amended for commercial, petrol (retail) and residential scenarios as follows:

- Commercial
  - An adult weighing 70kg and breathing 15.7m^3 air per day in accordance with the revised exposure parameters used in the SP1010 final project report for the Category 4 Screening Levels (C4SL) (Table 3.2[13]) and USEPA data[14]
  - Background inhalation (mean daily intake(MDI)) for an adult (Age Class 17).
  - Background inhalation (mean daily intake (MDI)) for an adult (Age Class 17).
- Residential
  - A child weighing 13.3kg (average of 0-6 year old female in accordance with Table 4.6 of SR3[3]) and breathing 8.77m^3 (average daily inhalation rate for a 0-6yr old female in accordance with SP1010 final project report for the C4SL (Table 3.2[13]) and USEPA data[14]
  - Background inhalation (mean daily intake (MDI)) for a child (Age Classes 1-6)

- Residential amendments to the MDI for younger age groups following Table 3.4 and Section 3.4.1 of SR2[2]; amended to reflect average daily inhalation rates in accordance with SP1010 final project report for the C4SL (Table 3.2[13]) and USEPA data[15]. Correction factors are presented in Table 1.

Amended HCV are shown in Table 3.

Note on Trimethylbenzenes

For trimethylbenzenes the CL:AIRE report[7] based background inhalation from non-soil sources (MDI) on a Dutch study from 1985, which is reported to have identified an average daily dose of 1,2,4-trimethylbenzene of 86 ug d^{-1} (1,3,5-trimethylbenzene was 20.5 ug d^{-1}). This dose value was based on the upper end of the identified concentration range of 1,2,4-trimethylbenzene (2.46 – 5.66 ug m^{-3}) and was used to calculate an a MDI of 1.23 ug kg^{-1} bw d^{-1} for a 70 kg adult breathing 20 m^3 of air daily.

The approach recommended in SR2[2], and also adopted for the C4SLs[13], for non-carcinogenic (threshold) compounds such as trimethylbenzenes is to subtract the MDI from the tolerable daily intake (TDI) to obtain a tolerable daily intake from soil (TDSI) in units of ug kg^{-1} bw d^{-1}. For 1,2,4-trimethylbenzene, the adult MDI from the Dutch study used in the CL:AIRE report[7] (1.23 ug kg^{-1} bw d^{-1}) is a significant proportion of the TDI (2.0 ug kg^{-1} bw d^{-1}), resulting in a low TDSI (1.0 ug kg^{-1} bw d^{-1}) when the 50% rule is applied (i.e. TDSI = TDI * 0.5 when MDI is high relative to TDI). This TDSI equates to an Inhalation Reference Concentration (or modified Health Criteria Value) for adults of 3.4 ug m^{-3} (70 kg adult breathing 15.7 m^3 d^{-1}).

By comparison the adult inhalation modified HCV for benzene is 6.2 ug m^{-3}, which is proven human carcinogen (non-threshold compound).

The MDI for 1,2,4-trimethylbenzene is considered by RSK to be overly conservative for the following reasons:

- The Dutch 1985 study is dated and air quality has improved since this time
- The maximum value in the range (5.66 ug m^{-3}) was used in calculating the MDI
- Experience has shown that trimethylbenzenes often appear to drive inhalation risks to a greater extent than benzene, even though the latter is carcinogenic and more volatile.

As an alternative to the 1985 Dutch study, RSK have obtained automated roadside air quality monitoring data for the UK from www.uk-air.defra.gov.uk/. The average concentration of 1,2,4-trimethylbenzene measured during 2015 at Eltham, south-east London (urban) was 0.309 ug m^{-3}, significantly lower than that identified in the Dutch study and used by CL:AIRE[7] for calculation of a MDI. Whilst an average concentration of 1,2,4-trimethylbenzene in UK urban and rural areas is likely to be significantly below 0.0.309 ug m^{-3}, this value is considered to be suitably conservative for the calculation of a modified HCV for trimethylbenzenes in the UK.

On this basis, the HCV for 1,2,4-trimethylbenzene for adults and children was calculated as 8.5 ug m^{-3} (0.0085 mg m^{-3}) and 2.6 ug m^{-3} (0.0026 mg m^{-3}), respectively (see Table 3). Due to the paucity of toxicological data for 1,2,3-trimethylbenzene and 1,3,5-trimethylbenzene the modified HCV for 1,2,4-trimethylbenzene is considered suitable for assessing total trimethylbenzenes.

RSK vGAC

RSK vGAC are presented in Table 4 for residential and commercial end-uses for common VOC and have also been calculated for common semi-volatile organic chemicals (sVOC), which may also have the potential to pose inhalation exposure risks.

RSK vGAC are simple screening criteria, in line with the principles of the CLEA model and the derivation of GAC, and are considered to be suitably conservative for use in a GQRA for the following reasons:

- Calculation of attenuation factors is based on the conservation assumption that the source lies directly beneath the foundation and that no additional depletion *via* diffusion occurs, i.e. attenuation is attributed solely to the dilution of soil gas as it moves through the foundation into indoor air
- The vGAC are applicable to the most conservative soil type
- Volumetric flow rate into buildings (Q_{soil}) is based on a combination of a sandy loam soil and parameters for a worst-case building type
- Biodegradation of VOC is not taken into account. Biodegradation of petroleum hydrocarbons can potentially attenuate soil gas concentrations and vapour intrusion by several orders of magnitude[15].

RSK vGAC listed in Table 4 have been calculated for the most conservative residential (small terraced house) and commercial buildings (pre-1970 office). vGAC may be calculated for other residential and commercial buildings *via* attenuation factors listed in Table 1 and modified HCV listed in Table 3.

Uncertainties/Limitations

The use of the J&E model[10] is considered to be inappropriate for site conditions where NAPL is present and potentially for use with modelling chlorinated hydrocarbons. The simplified RSK approach described negates these limitations provided representative soil gas concentrations are measured.

Use of the vGAC should only be undertaken with **detailed knowledge of the conceptual model and an understanding of the potential limitations in data** for the site and should be used as part of a multiple lines of evidence approach to assessing vapour intrusion. Note that the compounds listed in tables are not exhaustive and VOC not listed may have the potential to pose an indoor inhalation risk.

vGAC listed in Table 4 may not be relevant or suitably protective where VOC migration is dominated by ground gas (carbon dioxide and methane) pressure driven flow or where other mechanisms leading to VOC exposure from soils (e.g. ingestion, dermal, dust inhalation) are active. vGAC may also not be relevant where the direct impact of foundation structures with impacted groundwater or NAPL occurs.

vGAC are not to be used for screening indoor or outdoor air quality results, where direct inhalation exposure is possible. In this scenario relevant inhalation HCV are suitable for use as screening criteria (for acceptable exposure) such as those in Table 3.

The conceptual model associated with the vGAC does not consider vapour intrusion along drainage pipes/backfill and migration into a building.

Table 1: Correction factors used to adjust adult MDI to younger age groups

Age Class	Body weight (kg)[1]	Inhalation rate (m^3/day)[2]	Correction factor for inhalation MDI[3]
1	5.6	5.4	0.34
2	9.8	8	0.51
3	12.7	8.9	0.57
4	15.1	10.1	0.64
5	16.9	10.1	0.64
6	19.7	10.1	0.64
17	70	15.7	-
Mean (AC1-6)	**13.3**	**8.8**	**0.56**

Notes
[1] Body weight from CLEA v1.06
[2] Inhalation rate from Table 3.2 of the SP1010 final project report for the C4SL[(13)]
[3] Inhalation correction factors are the ratio of the average male and female inhalation rates for each age class to the adult rate at age class 17 (age 16–59 years) and are based on the rates used by the Category 4 Screening Levels to derive the C4SLs[(13)],following the methodology in SR2[(2)].

Table 2: α Attenuation Factors for a Variety of Residential and Commercial Buildings.

Receptor	Building Living Space Height - H (m) [a]	Building Footprint A_{foot} (m^2) [a]	Building Air Exchange Rate (hr^{-1}) [a]	Building Ventilation Rate Q_B ($cm^3\ s^{-1}$) [b]	Soil Gas Flow Rate into Building Q_{soil} ($cm^3\ s^{-1}$) [c]	Attenuation Factor - Alpha = Q_{soil}/Q_B [d]	Degree of Attenuation
Residential - Bungalow	2.4	78	0.5	22472	25	0.00096	1040
Residential - Small Terrace House	**4.8**	**28**	**0.5**	**9250**	**25**	**0.00134**	**747**
Residential - Medium/Large Terrace House	4.8	44	0.5	13694	25	0.00085	1173
Residential - Semi-Detached House	4.8	43	0.5	13417	25	0.00087	1147
Residential - Detached House	4.8	68	0.5	20361	25	0.00055	1813
Commercial - Warehouse (pre-1970)	**5.2**	**1089**	**1**	**304222**	**150**	**0.00008**	**12584**
Commercial - Warehouse (post-1970)	5.9	1914	1	533583	150	0.00004	25095
Commercial - Office (pre-1970)	10.2	424	1	120889	150	0.00010	9611
Commercial - Office (post-1970)	13	610	1	173333	150	0.00006	17622

Notes:

[a] From Table 3.3 and 4.21, SR3[3]

[b] Equation 10.5, SR3[3]

[c] Generic flow rate, Section 10.3, SR3[3]

[d] Most conservative assumption where advection across foundation is rate limiting[8]

Table 3: Amended Health Criteria Values

	Modified HCV (mg/m^3)[1]	
VOC / SVOC	**Child (Residential)**	**Adult (Commercial)**
MTBE	1.0803	3.2064
Benzene	0.0021	0.0062
Toluene	2.1164	6.2362
Ethylbenzene	0.1113	0.3301
Xylenes	0.0808	0.2586
Trimethybenzenes	0.0026	0.0085
TPH_Aliph EC5-EC6	3.7913	11.1465
TPH_Aliph >EC6-EC8	3.7913	11.1465
TPH_Aliph >EC8-EC10	0.2199	0.6465
TPH_Aliph >EC10-EC12	0.2199	0.6465
TPH_Aliph >EC12-EC16	0.2199	0.6465
TPH_Arom >EC8-EC10	0.0455	0.1338
TPH_Arom >EC10-EC12	0.0455	0.1338
TPH_Arom >EC12-EC16	0.0455	0.1338
Acenaphthene	0.0910	0.2675
Acenaphthylene	0.0910	0.2675
Naphthalene	0.0011	0.0037
Vinyl chloride	0.0005	0.0013
Dichloroethane-1,2	0.0002	0.0005
Tetrachloroethene	0.0083	0.0363
Carbon tetrachloride	0.0025	0.0114
Trichloroethane-1,1,1	0.9099	2.6752
Trichloroethene	0.0009	0.0025
Tetrachloroethane 1,1,2,2 & 1,1,1,2	0.0086	0.0257
1,1,2-Trichloroethane	0.0073	0.0216
1,1-dichloroethane	0.3030	0.8915
1,1-dichloroethene	0.0864	0.2541
Chloroethane	4.3318	12.7374
Chloromethane	0.0039	0.0115
cis-1,2-dichloroethene	0.0087	0.0264
Dichloromethane	0.1781	0.5765
trans-1,2-dichloroethene	0.0253	0.0754
Trichloromethane (chloroform)	0.0570	0.1752

[1] Inhalation HCV has taken account of background inhalation for threshold compounds only

Table 4: RSK vGAC – Single Exposure Route

	vGAC (mg/m^3)	
Volatile Organic Compound	**Residential (Small Terrace House)**	**Commercial (Office pre-1970)**
Attenuation factor (α)	**0.00134**	**0.00010**
MTBE	807	25679
Benzene	1.59	49.99
Toluene	1580	49945
Ethylbenzene	83.1	2644
Xylenes	62.3	2089
Trimethybenzenes	1.9	68.3
TPH_Aliph EC5-EC6	2831	89271
TPH_Aliph >EC6-EC8	2831	89271
TPH_Aliph >EC8-EC10	164	5178
TPH_Aliph >EC10-EC12	164	5178
TPH_Aliph >EC12-EC16	164	5178
TPH_Arom >EC8-EC10	34	1071
TPH_Arom >EC10-EC12	34	1071
TPH_Arom >EC12-EC16	34	1071
Acenaphthene	68	2142
Acenaphthylene	68	2142
Naphthalene	0.82	29.3
Vinyl chloride	0.34	10.7
Dichloroethane-1,2	0.14	4.3
Tetrachloroethene	6.23	291
Carbon tetrachloride	1.8457	91
Trichloroethane-1,1,1	679	21425
Trichloroethene	0.6	20
Tetrachloroethane 1,1,2,2 & 1,1,1,2	6.5	206
1,1,2-Trichloroethane	5.4	173
1,1-dichloroethane	226	7140
1,1-dichloroethene	65	2035
Chloroethane	3234	102012
Chloromethane	2.9	91.8
cis-1,2-dichloroethene	6.5	211
Dichloromethane	133	4617
trans-1,2-dichloroethene	18.9	604
Trichloromethane (chloroform)	42.6	1403

References

1. Baker, K, Hayward, H, Potter, L, Bradley, D, MacLeod, C. (2009). Investigating, assessing and managing risks of inhalation of VOC on land affected by contamination. CIRIA C682 (London).
2. Environment Agency (2009), *Human health toxicological assessment of contaminants in soil. Science Report – Final SC050021/SR2* (Bristol: Environment Agency).
3. Environment Agency (2009), *Science Report – SC050021/SR3. Updated technical background to the CLEA model* (Bristol: Environment Agency).
4. Environment Agency (2009), *Science Report – SC050021/SR4 CLEA Software (version 1.05) Handbook* (Bristol: Environment Agency).
5. BSI (2013). British Standard 8576:2013 - Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds (VOCs).
6. Nathanial, C. P., McCaffrey, C., Gillet, A. G., Ogden, R. C. and Nathanial, J. F. (2015), The LQM/CIEH S4ULs for Human Health Risk Assessment (Nottingham: Land Quality Press).
7. CL:AIRE (2009). *Soil Generic Assessment Criteria for Human Health Risk Assessment* (London: CL:AIRE).
8. Johnson P.C. & Ettinger R.A. (1991). Heuristic model for the intrusion rate of contaminant vapors into buildings. Environmental Science & Technology, 25(8); 1445–1452.
9. Environment Agency. 2002. Vapour transfer of soil contaminants, R&D Technical Report P5-018/TR.
10. Johnson P.C. (2002). Identification of critical parameters for the Johnson & Ettinger (1991) vapour intrusion model. American Petroleum Institute.
11. Brewer R, Nagashima, J, Rigby, M, Schmidt, M, O'Neill, H. (2014). Estimation of Generic Subslab Attenuation Factors for Vapour Intrusion Investigations. Groundwater Monitoring & Remediation 34 (4); 79-82.
12. Environment Agency (2009), 'Science Reports SC050021 - SGV and TOX reports for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin-like PCBs'; 'Supplementary information for the derivation of SGV for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin-like PCBs', and 'Contaminants in soil: updated collation of toxicological data and intake values for humans: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin-like PCBs'. Available at: https://www.gov.uk/government/publications/contaminants-in-soil-updated-collation-of-toxicological-data-and-intake-values-for-humans

    and https://www.gov.uk/government/publications/land-contamination-soil-guideline-values-sgvs (accessed 4 February 2015)
13. Contaminated Land: Applications in Real Environment (CL:AIRE) (2014). 'Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination', Revision 2, DEFRA research project SP1010
14. USEPA (2011), *Exposure factors handbook*, EPA/600/R-090/052F (Washington, DC: Office of Research and Development).
15. Interstate Technology Regulatory Council (ITRC). Vapour intrusion pathway: a practical guideline. January 2007.

APPENDIX H
GENERIC ASSESSMENT CRITERIA FOR PHYTOTOXIC EFFECTS

Several compounds can inhibit plant growth; hence it is important to have generic assessment criteria (GAC) to promote healthy plant growth. In the absence of other published GAC, the GAC have been obtained from legislation (UK and European) and guidance related to the use of sewage sludge on agricultural fields.

The Council of European Communities Sewage Sludge Directive (86/278/EEC) dated 1986, has been transposed into UK law by Statutory Instrument No. 1263, The Sludge (use in Agriculture) Regulations 1989 (Public Health England, Wales and Scotland), as ammended in 1990 and The Sludge (use in Agriculture) Regulations (Northern Ireland) SR No, 245, 1990. In addition the Department of Environment (DoE) produced a Code of Practice (CoP) (Updated 2nd Edition) in 2006 which provided guidance on the application of sewage sludge on agricultural land (however the status of this document is unclear as it is on the archive section of the Defra website).

The directive seeks to encourage the use of sewage sludge in agriculture and to regulate its use in such a way as to "***prevent harmful effects on soil, vegetation, animals and man".*** To this end, it prohibits the use of untreated sludge on agricultural land unless it is injected or incorporated into the soil. Treated sludge is defined as having undergone "biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use". To provide protection against potential health risks from residual pathogens, sludge must not be applied to soil in which fruit and vegetable crops are growing, or less than ten months before fruit and vegetable crops are to be harvested. Grazing animals must not be allowed access to grassland or forage land less than three weeks after the application of sludge.

The specified limits of concentrations of selected elements in soil are presented in Table 4 of the updated 2nd Edition of the DoE Code of Practice and are designed to protect plant growth. It is noted that these values are more stringent than the values set in current UK regulations. However since they were ammended following recommendations from the Independent Scientific Committee in 1993. (MAFF/DOE 1993). The GAC are presented in Table 1.

Table 1: Generic assessment criteria

Determinant	Generic assessment criteria (mg/kg)			
	pH 5.0 < 5.5	pH 5.5 < 6.0	pH 6.0 < 7.0	pH >7.0
Zinc	200	200	200	300
Copper	80	100	135	200
Nickel	50	60	75	110
Lead	300	300	300	300
Cadmium	3	3	3	3
Mercury	1	1	1	1
Note: Only compounds with assessment criteria documented within the Directive 86/278/EEC have been included, although criteria for 5 additional compounds have been presented within the 2006 CoP.				

APPENDIX I
GENERIC ASSESSMENT CRITERIA FOR POTABLE WATER SUPPLY PIPES

A range of pipe materials is available and careful selection, design and installation is required to ensure that water supply pipes are satisfactorily installed and meet the requirements of the Water Supply (Water Fittings) Regulations 1999 in England and Wales, the Byelaws 2000 in Scotland and the Northern Ireland Water Regulations. The regulations include a requirement to use only suitable materials when laying water pipes and laying water pipes without protection is not permitted at contaminated sites. The water supply company has a statutory duty to enforce the regulations.

Contaminants in the ground can pose a risk to human health by permeating potable water supply pipes. To fulfil their statutory obligation, UK water supply companies require robust evidence from developers to demonstrate either that the ground in which new plastic supply pipes will be laid is free from specific contaminants, or that the proposed remedial strategy will mitigate any existing risk. If these requirements cannot be demonstrated to the satisfaction of the relevant water company, it becomes necessary to specify an alternative pipe material on the whole development or in specific zones.

In 2010, UK Water Industry Research (UKWIR) published *Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (Report Ref. No. 10/WM/03/21). This report reviewed previously published industry guidelines and threshold concentrations adopted by individual water supply companies.

The focus of the UKWIR research project was to develop clear and concise procedures, which provide consistency in the pipe selection decision process. It was intended to provide guidance that can be used to ensure compliance with current regulations and to prevent water supply pipe failing prematurely due to the presence of contamination.

The report concluded that in most circumstances only organic contaminants pose a potential risk to plastic pipe materials and Table 3.1 of the report provides threshold concentrations for polyethylene (PE) and polyvinyl chloride (PVC) pipes for the organic contaminants of concern. The report also makes recommendations for the procedures to be adopted in the design of site investigations and sampling strategies, and the assessment of data, to ensure that the ground through which water supply pipes will be laid is adequately characterised.

Risks to water supply pipes have therefore been assessed against the threshold concentrations for PE and PVC pipe specified in Table 3.1 of Report 10/WM/03/21, which have been adopted as the GAC for this linkage and are reproduced in Table A3 below.

Since water supply pipes are typically laid at a minimum depth of 0.75 m below finished ground levels, sample results from depths between 0.5 m and 1.5 m below finished level are generally considered suitable for assessing risks to water supply. Samples outside these depths can be used, providing the stratum is the same as that in which water supply pipes are likely to be located. The report specifies that sampling should characterise the ground conditions to a minimum of 0.5 m below the proposed depth of the pipe.

It should be noted that the assessment provided in this report is a guide and the method of assessment and recommendations should be checked with the relevant water supply company.

Table A3: Generic assessment criteria for water supply pipes

		Pipe material	
		GAC (mg/kg)	
	Parameter group	PE	PVC
1	Extended VOC suite by purge and trap or head space and GC-MS with TIC (Not including compounds within group 1a)	0.5	0.125
1a	• BTEX + MTBE	0.1	0.03
2	SVOCs TIC by purge and trap or head space and GC-MS with TIC (aliphatic and aromatic C_5–C_{10}) (Not including compounds within group 2e and 2f)	2	1.4
2e	• Phenols	2	0.4
2f	• Cresols and chlorinated phenols	2	0.04
3	Mineral oil C_{11}–C_{20}	10	Suitable
4	Mineral oil C_{21}–C_{40}	500	Suitable
5	Corrosive (conductivity, redox and pH)	Suitable	Suitable
Specific suite identified as relevant following site investigation			
2a	Ethers	0.5	1
2b	Nitrobenzene	0.5	0.4
2c	Ketones	0.5	0.02
2d	Aldehydes	0.5	0.02
6	Amines	Not suitable	Suitable
Notes: where indicated as 'suitable', the material is considered resistant to permeation or degradation and no threshold concentration has been specified by UKWIR.			

APPENDIX J
COMPARISON OF MEASURED CONCENTRATIONS OF CONTAMINANTS TO GAC

Table A
Comparision of measured concentrations in soil to GAC derived for the protection of residential end use without plant uptake

Lab Sample ID	Units	Method	GAC 2.5% SOM	18/06954/1	18/06954/2	18/06954/3	18/06954/5	18/06954/6	18/06954/8	18/06954/9	18/06954/10	18/06954/12	18/06954/13
Borehole ID				WS1-ES1	WS1-ES2	WS1-ES3	WS2-ES2	WS2-ES3	WS3-ES1	WS3-ES2	WS3-ES3	WS4-ES1	WS4-ES3
Sample Depth				0.2	0.5	0.8	0.5	0.8	0.2	0.5	0.8	0.3	0.8
Date Sampled				29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018
Sample Type				Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
% Stones >10mm	% w/w	A-T044	-	<0.1	18.7	41.5	20.9	17	29.6	25.2	<0.1	26.3	12.2
pH	pH	A-T-031s	-	11.14	8.1	7.91	8.2	8.3	10.54	8.75	7.93	9.03	8.28
Sulphate (water sol 2:1)	g/l	A-T-026s	-	0.06	0.04	0.04	0.02	0.02	0.11	0.04	<0.01	0.06	0.03
Sulphate (acid soluble)	mg/kg	A-T-028s	-	2000	830	460	720	600	2500	820	580	550	360
Total Organic Carbon	% w/w	A-T-032s	-			0.91		2.63	3.79				
Metals													
Arsenic	mg/kg	A-T-024s	40	19	17	5	9	7	16	12	8	2	6
Cadmium	mg/kg	A-T-024s	149	0.8	0.7	<0.5	0.6	0.6	1.3	0.5	0.6	<0.5	0.7
Copper	mg/kg	A-T-024s	910	17	24	17	18	21	18	11	28	21	42
Chromium	mg/kg	A-T-024s	7100	43	38	10	114	45	218	58	39	22	12
Lead	mg/kg	A-T-024s	310	190	210	48	411	251	1800	519	62	52	14
Mercury	mg/kg	A-T-024s	56	0.81	0.54	0.2	1.03	0.91	3.86	1.66	<0.17	<0.17	0.32
Nickel	mg/kg	A-T-024s	180	25	28	10	19	19	21	14	28	17	38
Selenium	mg/kg	A-T-024s	430	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Zinc	mg/kg	A-T-024s	40000	164	124	36	127	107	796	171	78	60	49
Asbestos in Soil (inc. matrix)													
Asbestos in soil		A-T-045	-	Chrysotile	NAD	N/A	NAD	N/A	N/A	NAD	N/A	NAD	N/A
Asbestos Matrix (visual)		Gravimetry	-	-	-	N/A	-	N/A	N/A	-	N/A	-	N/A
Asbestos Matrix (microscope)			-	Fibre Bundles	-	N/A	-	N/A	N/A	-	N/A	-	N/A
Asbestos ACM - Suitable for Water Absorption Test?			-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Asbestos in Soil Quantification % (Hand Picking & Weighing)													
Asbestos in soil % composition (hand picking and weighing)	% w/w			<0.001									
Bulk Fibre ID (inc. matrix)													
Bulk Fibre Identification													
Bulk Fibre Identification Matrix (visual)													
Bulk Fibre Identification - Suitable for Water Absorption Test?													
PAH 16													
Acenaphthene	mg/kg	A-T-019s	7200	0.03	0.02	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	mg/kg	A-T-019s	7200	0.27	0.06	<0.01	0.05	<0.01	0.13	0.04	<0.01	<0.01	<0.01
Anthracene	mg/kg	A-T-019s	35000	0.44	1.03	<0.02	0.08	<0.02	0.17	0.06	<0.02	<0.02	<0.02
Benzo(a)anthracene	mg/kg	A-T-019s	13.6	7.3	2.48	<0.04	0.72	<0.04	1.06	0.51	<0.04	0.09	<0.04
Benzo(a)pyrene	mg/kg	A-T-019s	5.3	5.53	1.18	<0.04	0.62	<0.04	1.11	0.46	<0.04	0.11	<0.04
Benzo(b)fluoranthene	mg/kg	A-T-019s	4	6.81	1.47	<0.05	0.78	<0.05	1.34	0.57	<0.05	0.11	<0.05
Benzo(ghi)perylene	mg/kg	A-T-019s	358	1.9	0.36	<0.05	0.3	<0.05	0.81	0.27	<0.05	0.08	<0.05
Benzo(k)fluoranthene	mg/kg	A-T-019s	107	2.8	0.57	<0.07	0.27	<0.07	0.45	0.2	<0.07	<0.07	<0.07
Chrysene	mg/kg	A-T-019s	31	6.79	1.8	<0.06	0.88	<0.06	1.27	0.62	<0.06	0.11	<0.06
Dibenzo(ah)anthracene	mg/kg	A-T-019s	0.32	0.87	0.17	<0.04	0.11	<0.04	0.2	0.09	<0.04	<0.04	<0.04
Fluoranthene	mg/kg	A-T-019s	1600	9.87	4.31	<0.08	1.2	<0.08	2.2	0.95	<0.08	0.13	<0.08
Fluorene	mg/kg	A-T-019s	3800	0.09	0.14	<0.01	0.02	<0.01	0.05	0.02	<0.01	<0.01	<0.01
Indeno(123-cd)pyrene	mg/kg	A-T-019s	46	2.95	0.62	<0.03	0.48	<0.03	1.05	0.4	<0.03	0.11	<0.03
Naphthalene	mg/kg	A-T-019s	55	0.05	<0.03	<0.03	<0.03	<0.03	0.04	<0.03	<0.03	<0.03	<0.03
Phenanthrene	mg/kg	A-T-019s	1450	2.38	1.36	<0.03	0.41	<0.03	0.94	0.43	<0.03	0.04	<0.03
Pyrene	mg/kg	A-T-019s	3800	8.38	3.25	<0.07	1.02	<0.07	1.89	0.77	<0.07	0.12	<0.07
PAH (total 16)	mg/kg	A-T-019s	na										
TPH CWG													
Ali >C5-C6	mg/kg	A-T-022s	78	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Ali >C6-C8	mg/kg	A-T-022s	230	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ali >C8-C10	mg/kg	A-T-022s	65	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ali >C10-C12	mg/kg	A-T-023s	330	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ali >C12-C16	mg/kg	A-T-023s	*2400*	<1	<1	<1	<1	<1	2	<1	<1	<1	<1
Ali >C16-C21	mg/kg	A-T-023s	*92000 (21)*	6	<1	1	<1	<1	3	<1	<1	<1	<1
Ali >C21-C35	mg/kg	A-T-023s	*92000 (21)*	78	13	9	4	1	26	5	3	3	<1
Total Aliphatics	mg/kg	A-T-022+23s	na	84	13	10	4	1	29	5	3	3	<1
Aro >C5-C7	mg/kg	A-T-022s	-	83	15	11	5	1	31	8	3	3	<1
Aro >C7-C8	mg/kg	A-T-022s	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aro >C8-C9	mg/kg	A-T-022s	115	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aro >C9-C10	mg/kg	A-T-022s	600	3	2	1	2	<1	2	2	1	2	<1
Aro >C10-C12	mg/kg	A-T-023s	2300	2	<1	<1	<1	<1	2	<1	<1	<1	<1
Aro >C12-C16	mg/kg	A-T-023s	1900	6	3	1	5	1	7	3	1	2	<1
Aro >C16-C21	mg/kg	A-T-023s	1900	17	9	2	26	<1	27	6	<1	3	<1
Aro >C21-C35	mg/kg	A-T-023s	1900	113	44	7	155	3	194	44	4	19	1
Total Aromatics	mg/kg	A-T-022+23s	na	141	59	11	189	4	231	56	7	27	1
TPH (Ali & Aro)	mg/kg	A-T-022+23s	na	225	74	22	194	6	262	63	9	30	1
BTEX - Benzene	mg/kg	A-T-022s	1.6	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
BTEX - Toluene	mg/kg	A-T-022s	1900	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
BTEX - Ethyl Benzene	mg/kg	A-T-022s	190	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
BTEX - m & p Xylene	mg/kg	A-T-022s	210	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
BTEX - o Xylene	mg/kg	A-T-022s	180	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MTBE	mg/kg	A-T-022s	170	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

123	The GAC derived is in excess of the theoretical soil saturation limit, therefore unless free product is observed an exceedance in the GAC is not considered to pose a significant risk to human health. The saturation limit is shown in brackets.
	Measured concentration in excess of the GAC and required further consideration
123	Measured concentration in excess if the GAC not considered to pose unacceptable risks to human health as no free phase product identified.
na	Not applicable multiple compounds
-	No GAC available and/or not applicable
<	Concentration below the laboratory method detection limit

Table B

Comparision on measured concentrations of contaminants in soil to GAC associated with phytotoxic effects

Lab Sample ID	Units	GAC	18/06954/1	18/06954/2	18/06954/3	18/06954/5	18/06954/6	18/06954/8	18/06954/9	18/06954/10	18/06954/12	18/06954/13
Borehole ID			WS1-ES1	WS1-ES2	WS1-ES3	WS2-ES2	WS2-ES3	WS3-ES1	WS3-ES2	WS3-ES3	WS4-ES1	WS4-ES3
Sample Depth			0.2	0.5	0.8	0.5	0.8	0.2	0.5	0.8	0.3	0.8
Date Sampled			29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018
Sample Type			Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Cadmium	mg/kg	3	0.8	0.7	<0.5	0.6	0.6	1.3	0.5	0.6	<0.5	0.7
Copper	mg/kg	200	17	24	17	18	21	18	11	28	21	42
Lead	mg/kg	300	190	210	48	411	251	1800	519	62	52	14
Mercury	mg/kg	1	0.81	0.54	0.2	1.03	0.91	3.86	1.66	<0.17	<0.17	0.32
Nickel	mg/kg	110	25	28	10	19	19	21	14	28	17	38

Notes:

< Concentration below the laboratory method detection limit

Measured concentration in excess of the GAC and requires further consideration.

Table C

Comparision on measured concentrations of contaminants in soil to GAC associated with potable water supply pipes

Lab Sample ID	Units	GAC PE Pipes	GAC PVC Pipes		18/06954/1	18/06954/2	18/06954/3	18/06954/5	18/06954/6	18/06954/8	18/06954/9	18/06954/10	18/06954/12	18/06954/13
Borehole ID					WS1-ES1	WS1-ES2	WS1-ES3	WS2-ES2	WS2-ES3	WS3-ES1	WS3-ES2	WS3-ES3	WS4-ES1	WS4-ES3
Sample Depth					0.2	0.5	0.8	0.5	0.8	0.2	0.5	0.8	0.3	0.8
Date Sampled					29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018
Sample Type				Max	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sum Aromatic + Aliphatics C5-C10	mg/kg	2*	1.4*	3	**3**	**2**	1	**2**	<1	**2**	**2**	1.01	**2**	<1
Mineral Oil C11-C20	mg/kg	10	500	41	31	12	4	31	1	41	9	1	5	<1
Mineral Oil C21-C40	mg/kg	500	suitable	220	191	57	16	159	4	220	49	7	22	1
Sum MTBE and BTEX	mg/kg	0.1	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sum VOC (excluding BTEX & MTBE)	µg/kg	0.5	0.125	0	-	-	-	-	-	-	-	-	-	-
Phenol	µg/kg	2	0.4	0	-	-	-	-	-	-	-	-	-	-
Sum SVOC	µg/kg	2000	1400	262	225	74	22	194	6	262	63	9	30	1

Notes:

Notes:

	Measured concentration in excess of the PE GAC and requires further consideration.
123	Measured concentration in excess of the PVC GAC and required further consideration.
<	Concentration below the laboratory method detection limit
<MDL	All compounds contained in suite below their respective labortatory method detection limits
*	Full SVOC analysis not conducted in all locations therefore where not analysed sum PAH and aliphatic and aromatic C_5–C_{10} compared to the GAC for SVOCs

APPENDIX K
CERTIFICATES OF GEOTECHNICAL ANALYSIS

STRUCTURAL SOILS LTD

TEST REPORT

Report No. 583916-01 (00) 1774

Date	14-September-2018	Contract	Land at 31A North Street, Emsworth

Client RSK
Address 18 Frogmore Rd
Apsley
Hemel Hempstead
Hertfordshire
HP3 9RT
For the Attention of Andy Denton

Samples submitted by client	30-August-2018	Client Reference	305019
Testing Started	05-September-2018	Client Order No.	n/a
Testing Completed	13-September-2018	Instruction Type	Written

Tests marked 'Not UKAS Accredited' in this report are not included in the UKAS Accreditation Schedule for our Laboratory.

UKAS Accredited Tests

1.01	Moisture Content (oven drying method) BS1377:Part 2:1990:clause 3.2 (superseded)*
1.03	Liquid Limit (one point method) & Plastic Limit BS1377:Part 2:1990,clause 4.4/5.3

* This clause of BS1377 is no longer the most up to date method due to the publication of ISO17892

Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of .
Test were undertaken on samples 'as received' unless otherwise stated.
Opinions and interpretations expressed in this report are outside the scope of accreditation for this laboratory.

Structural Soils Ltd 18 Frogmore Rd Hemel Hempstead HP3 9RT Tel.01442 416661 e-mail dimitris.xirouchakis@soils.co.uk

TESTING VERIFICATION CERTIFICATE

UKAS TESTING
1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

In accordance with the Structural Soils Ltd Laboratory Quality Management System, results sheets and summaries of results issued by the laboratory are checked by an approved signatory. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **14/09/2018 10:37:29**.

Testing reported after this date is not covered by this Verification Certificate.

[redacted]

Approved Signatory
Sharon Cairns (Laboratory Manager)

(Head Office)
Bristol Laboratory
Unit 1A, Princess Street
Bedminster
Bristol
BS3 4AG

Castleford Laboratory
The Potteries, Pottery Street
Castleford
West Yorkshire
WF10 1NJ

Hemel Laboratory
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Tonbridge Laboratory
Anerley Court, Half Moon Lane
Hildenborough
Tonbridge
TN11 9HU

	Contract:	Job No:
STRUCTURAL SOILS LTD	**Land at 31A North Street Emsworth**	**583916**

AGS

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_018 PrjVersion: v8_06 - Core+Geotech Lab-Hemel - 009 | GrfcText L - LAB VERIFICATION REPORT - V02 - A4P | 583916 LAND AT 31A NORTH STREET EMSWORTH.GPJ - v8_06.
Structural Soils Ltd, Branch Office - Hemel Hempstead: 18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT. Tel: 01442 262323, Fax: 01442 262683, Web: www.soils.co.uk, Email: ask@soils.co.uk. | 14/09/18 - 10:38 | SC1 |

$ . .) . . * 2 22 2'2 2! 2 # 3 ; 3

7/1 ; $	(1 6	(1 %1	1 4(5	+ * ,	-*) (,	; . (,	; . $/	, 0 '*(	. 1 (1
!	"	!							# $ %
									&
'		!	" "						&
'	"	!	'	!					# ( )*(
	'								
	"		"						# ( ) ( )*(

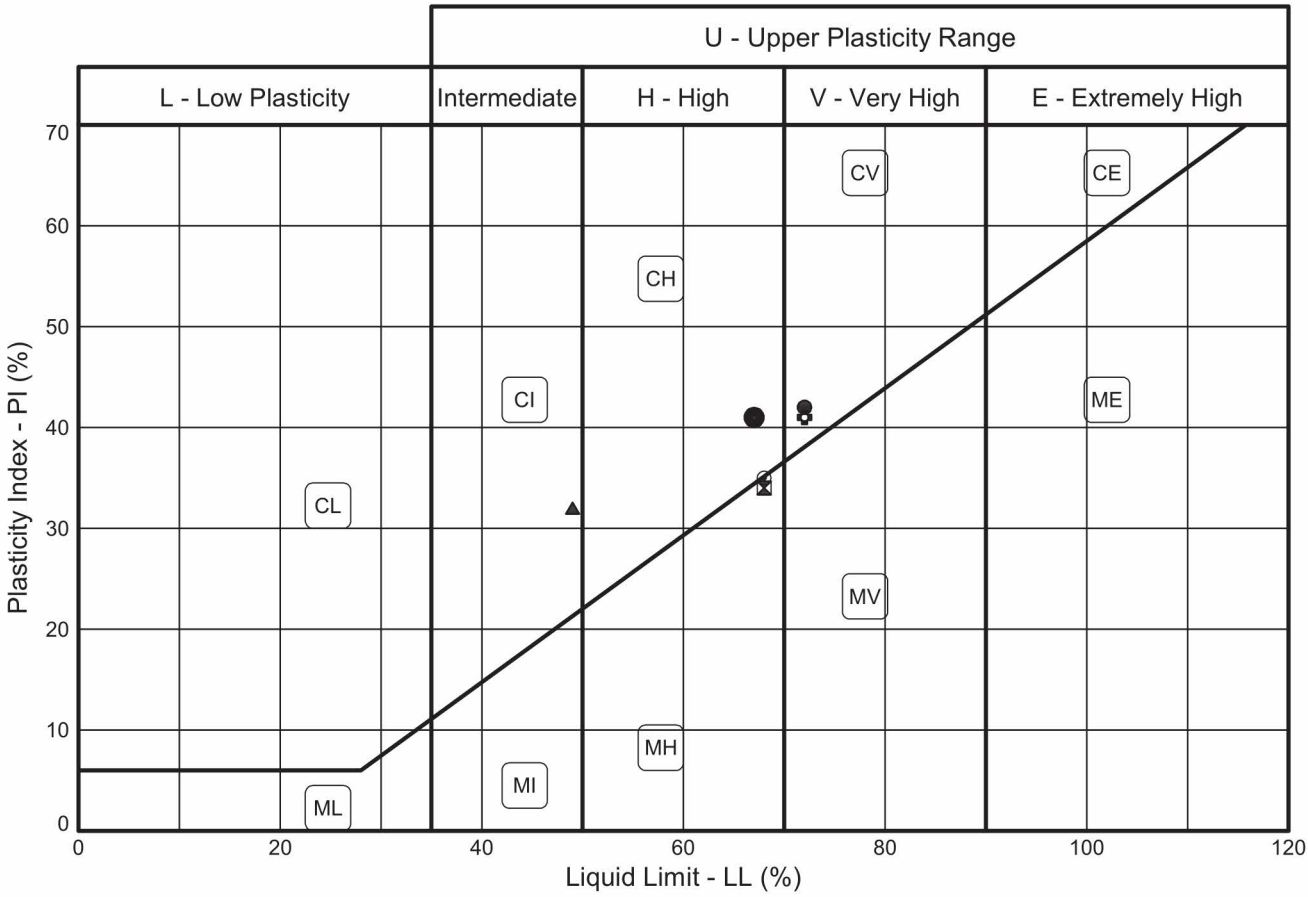
.3

. 6 3

$ 8% G $#6 6 G9! G' # 3 : ; + + 6 &< $<$%$&8 : 3' ! " 8 % 8 &6 %= %67 7 % 7+ &6 %= ; > 3??! 3 ! 3 3

PLASTICITY CHART - PI Vs LL

In accordance with BS5930:2015
Testing in accordance with BS1377-2:1990



Sample Identification				BS Test Method #	Preparation Method +	MC %	LL %	PL %	PI %	<425um %	Lab location
	Exploratory Position ID	Sample	Depth (m)								
●	WS1	1D	1.40	3.2/4.4/5.3/5.4	4.2.4	32	72	30	42	93	H
⊠	WS1	2D	1.80	3.2/4.4/5.3/5.4	4.2.4	27	68	34	34	97	H
▲	WS2	1D	1.00	3.2/4.4/5.3/5.4	4.2.4	34	49	17	32	97	H
★	WS2	4D	2.50	3.2/4.4/5.3/5.4	4.2.4	28	67	26	41	100	H
⊙	WS3	1D	1.50	3.2/4.4/5.3/5.4	4.2.4	30	68	33	35	87	H
✿	WS3	3D	2.50	3.2/4.4/5.3/5.4	4.2.4	29	72	31	41	99	H
◉	WS4	3D	2.00	3.2/4.4/5.3/5.4	4.2.4	27	67	26	41	93	H

Tested in accordance with the following clauses of BS1377-2:1990.

3.2 - Moisture Content
4.3 - Cone Penetrometer Method
4.4 - One Point Cone Penetrometer Method
4.6 - One Point Casagrande Method
5.3 - Plastic Limit Method
5.4 - Plasticity Index

+ Tested in accordance with the following clauses of BS1377-2:1990.

4.2.3 - Natural State
4.2.4 - Wet Sieved

Key: * = Non-standard test, NP = Non plastic.

Lab location: B = Bristol (BS3 4AG), C = Castleford (WF10 1NJ), H = Hemel Hempstead (HP3 9RT), T = Tonbridge (TN11 9HU)

STRUCTURAL SOILS
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By		Date
[redacted]	NIKITA JACOBSEN	13/9/18

Contract	Contract Ref:
Land at 31A North Street Emsworth	**583916**

AGS

GINT_LIBRARY_V8_06.GLB LibVersion: v8_06_018 PrjVersion: v8_06 - Core+Geotech Lab-Hemel - 009 | Graph L - ALINE STANDARD - A4P | 583916 LAND AT 31A NORTH STREET EMSWORTH.GPJ - v8_06.
Structural Soils Ltd, Branch Office - Hemel Hempstead: 18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT. Tel: 01442 262323, Fax: 01442 262683, Web: www.soils.co.uk, Email: ask@soils.co.uk. | 13/9/18 - 16:38 | NJ1 |

APPENDIX L
HAZWASTE ASSESSMENT

envirolab

Haswaste, developed by Dr. Iain Haslock.

Please enter available data in the rows associated with the test (grey) cells. Calculation cells initially display either "0.0000" or "#DIV/0!".
If any calculation cells below state "0.00000", testing has NOT been undertaken that contributes to that Hazardous Property.

31A North Street, Emsworth

TP/WS/BH		WS1-ES1	WS1-ES2	WS1-ES3	WS2-ES2	WS2-ES3	WS3-ES1	WS3-ES2	WS3-ES3	
Depth (m)		0.20	0.50	0.80	0.50	0.80	0.20	0.50	0.80	
Envirolab reference										
% Moisture	%									
pH (soil)		11.14	8.10	7.91	8.20	8.30	10.54	8.75	7.93	
pH (leachate)										
Arsenic	mg/kg	19	17	5	9	7	16	12	8	
Cadmium	mg/kg	0.8	0.7	<0.5	0.6	0.6	1.3	0.5	0.6	
Copper	mg/kg	43	38	10	114	45	218	58	39	
CrVI or Chromium	mg/kg	17	24	17	18	21	18	11	28	
Lead	mg/kg	190	210	48	411	251	1,800	519	62	
Mercury	mg/kg	0.81	0.54	0.20	1.03	0.91	3.86	1.66	<0.17	
Nickel	mg/kg	25	28	10	19	19	21	14	28	
Selenium	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	
Zinc	mg/kg	164	124	36	127	107	796	171	78	
Barium	mg/kg									
Beryllium	mg/kg									
Vanadium	mg/kg									
Cobalt	mg/kg									
Manganese	mg/kg									
Molybdenum	mg/kg									
Antimony	mg/kg									
Aluminium	mg/kg									
Bismuth	mg/kg									
CrIII	mg/kg									
Iron	mg/kg									
Strontium	mg/kg									
Tellurium	mg/kg									
Thallium	mg/kg									
Titanium	mg/kg									
Tungsten	mg/kg									
Ammoniacal N	mg/kg									
ws Boron	mg/kg									
PAH (Input Total PAH **OR** individual PAH results)										
Acenaphthene	mg/kg	0.03	0.02	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	
Acenaphthylene	mg/kg	0.27	0.06	<0.01	0.05	<0.01	0.13	0.04	<0.01	
Anthracene	mg/kg	0.44	1.03	<0.02	0.08	<0.02	0.17	0.06	<0.02	
Benzo(a)anthracene	mg/kg	7.30	2.48	<0.04	0.72	<0.04	1.06	0.51	<0.04	
Benzo(a)pyrene	mg/kg	5.53	1.18	<0.04	0.62	<0.04	1.11	0.46	<0.04	
Benzo(b)fluoranthene	mg/kg	6.81	1.47	<0.05	0.78	<0.05	1.34	0.57	<0.05	
Benzo(ghi)perylene	mg/kg	1.90	0.36	<0.05	0.30	<0.05	0.81	0.27	<0.05	
Benzo(k)fluoranthene	mg/kg	2.80	0.57	<0.07	0.27	<0.07	0.45	0.20	<0.07	
Chrysene	mg/kg	6.79	1.80	<0.06	0.88	<0.06	1.27	0.62	<0.06	
Dibenzo(ah)anthracene	mg/kg	0.87	0.17	<0.04	0.11	<0.04	0.20	0.09	<0.04	
Fluoranthene	mg/kg	9.87	4.31	<0.08	1.20	<0.08	2.20	0.95	<0.08	
Fluorene	mg/kg	0.09	0.14	<0.01	0.02	<0.01	0.05	0.02	<0.01	
Indeno(123cd)pyrene	mg/kg	2.95	0.62	<0.03	0.48	<0.03	1.05	0.40	<0.03	
Naphthalene	mg/kg	0.05	<0.03	<0.03	<0.03	<0.03	0.04	<0.03	<0.03	
Phenanthrene	mg/kg	2.38	1.36	<0.03	0.41	<0.03	0.94	0.43	<0.03	
Pyrene	mg/kg	8.38	3.25	<0.07	1.02	<0.07	1.89	0.77	<0.07	
Coronene	mg/kg									
Total PAHs (16 or 17)	mg/kg	56.50	18.80	<0.08	6.94	<0.08	12.70	5.39	<0.08	
TPH										
Petrol	mg/kg									
Diesel	mg/kg									
Lube Oil	mg/kg									
Crude Oil										
White Spirit / Kerosene	mg/kg									
Creosote	mg/kg									
Unknown TPH with ID	mg/kg									
Unknown TPHCWG	mg/kg	225.0	74.0	22.0	194.0	6.0	262.0	63.0	9.0	
Total Sulphide	mg/kg									
Complex Cyanide	mg/kg									
Free (or Total) Cyanide	mg/kg									
Thiocyanate	mg/kg									
Elemental/Free Sulphur	mg/kg									
Phenols Input Total Phenols HPLC **OR** individual Phenol results.										
Phenol	mg/kg									
Cresols	mg/kg									
Xylenols	mg/kg									
Resourcinol	mg/kg									
Phenols Total by HPLC	mg/kg									
BTEX Input Total BTEX **OR** individual BTEX results.										
Benzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Toluene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Ethylbenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Xylenes	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Total BTEX	mg/kg									
PCBs (POPs)										
PCBs Total (eg EC7/WHO12)	mg/kg									
PBBs (POPs)										
Hexabromobiphenyl (Total or PBB153; 2,2',4,4',5,5'- if only available)	mg/kg									

envirolab

Please enter available data in the rows associated with the test (grey) cells. Calculation cells initially display either "0.0000" or "#DIV/0!".
If any calculation cells below state "0.00000", testing has NOT been undertaken that contributes to that Hazardous Property.

Haswaste, developed by Dr. Iain Haslock.

31A North Street, Emsworth

TP/WS/BH	WS1-ES1	WS1-ES2	WS1-ES3	WS2-ES2	WS2-ES3	WS3-ES1	WS3-ES2	WS3-ES3	
Depth (m)	0.20	0.50	0.80	0.50	0.80	0.20	0.50	0.80	
Envirolab reference									

POPs Dioxins and Furans Input Total Dioxins and Furans **OR** individual Dioxin and Furan results.

2,3,7,8-TeCDD	mg/kg									
1,2,3,7,8-PeCDD	mg/kg									
1,2,3,4,7,8-HxCDD	mg/kg									
1,2,3,6,7,8-HxCDD	mg/kg									
1,2,3,7,8,9-HxCDD	mg/kg									
1,2,3,4,6,7,8-HpCDD	mg/kg									
OCDD	mg/kg									
2,3,7,8-TeCDF	mg/kg									
1,2,3,7,8-PeCDF	mg/kg									
2,3,4,7,8-PeCDF	mg/kg									
1,2,3,4,7,8-HxCDF	mg/kg									
1,2,3,6,7,8-HxCDF	mg/kg									
2,3,4,6,7,8-HxCDF	mg/kg									
1,2,3,7,8,9-HxCDF	mg/kg									
1,2,3,4,6,7,8-HpCDF	mg/kg									
1,2,3,4,7,8,9-HpCDF	mg/kg									
OCDF	mg/kg									
Total Dioxins and Furans	mg/kg									

Some Pesticides (POPs unless otherwise stated)

Aldrin	mg/kg									
α Hexachlorocyclohexane (alpha-HCH) *(leave empty if total HCH results used)*	mg/kg									
β Hexachlorocyclohexane (beta-HCH) *(leave empty if total HCH results used)*	mg/kg									
α Cis-Chlordane (alpha) ***OR*** *Total Chlordane*	mg/kg									
δ Hexachlorocyclohexane (delta-HCH) *(leave empty if total HCH results used)*	mg/kg									
Dieldrin	mg/kg									
Endrin	mg/kg									
χ Hexachlorocyclohexane (gamma-HCH) (lindane) ***OR*** *Total HCH*	mg/kg									
Heptachlor	mg/kg									
Hexachlorobenzene	mg/kg									
o,p'-DDT *(leave empty if total DDT results used)*	mg/kg									
p,p'-DDT ***OR*** *Total DDT*	mg/kg									
χ Trans-Chlordane (gamma) *(leave empty if total Chlordane results used)*	mg/kg									
Chlordecone (kepone)	mg/kg									
Pentachlorobenzene	mg/kg									
Mirex	mg/kg									
Toxaphene (camphechlor)	mg/kg									

Tin

Tin *(leave empty if Organotin and Tin excl Organotin results used)*	mg/kg									

Organotin

Dibutyltin; DiBT	mg/kg									
Tributyltin; TriBT	mg/kg									
Triphenyltin; TriPT	mg/kg									
Tetrabutyltin; TeBT	mg/kg									

Tin excluding Organotin

Tin excl Organotin	mg/kg									

envirolab

Haswaste, developed by Dr. Iain Haslock.

Please enter available data in the rows associated with the test (grey) cells. Calculation cells initially display either "0.0000" or "#DIV/0!".
If any calculation cells below state "0.00000", testing has NOT been undertaken that contributes to that Hazardous Property.

31A North Street, Emsworth

TP/WS/BH	WS1-ES1	WS1-ES2	WS1-ES3	WS2-ES2	WS2-ES3	WS3-ES1	WS3-ES2	WS3-ES3	
Depth (m)	0.20	0.50	0.80	0.50	0.80	0.20	0.50	0.80	
Envirolab reference									

Asbestos in Soil	Thresholds									
Asbestos detected in Soil (enter Y or N)	Y		Y	N		N			N		
			If Asbestos in Soil above is "Y", the soil is Hazardous Waste HP5 and HP7								
Asbestos % Composition in Soil (Matrix Loose Fibres or Microscopic Identifiable Pieces only)	see "Carc HP7 % Asbestos in Soil (Fibres)" below	%	0.00100								
Carcinogenic HP7 % Asbestos in Soil (fibres or micro pieces) *Please be advised, if the calculation cell is "0.00000" DOES NOT MEAN asbestos testing has been undertaken and the result is zero.*	≥0.1%		0.00100	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
			If Asbestos in Soil above is "Y", but Asbestos % above is "<0.1%", the soil is Non Hazardous Waste. You can only use Asbestos % results where loose fibres or micro pieces are only present. You cannot use Asbestos % results when visual identifiable pieces are present.								
Asbestos Identifiable Pieces visible with the naked eye detected in the Soil (enter Y or N)	Y									

If visual identifiable pieces of asbestos are present, you cannot use Asbestos % results and the whole soil sample is Hazardous Waste HP5 and HP7 Construction material containing Asbestos 17 06 05.
Therefore, if Asbestos in Soil above is "Y", the Asbestos % above is "<0.1%", but the Asbestos Identifiable Pieces visible with the naked eye is "Y", the soil is Hazardous Waste.

Identifiable Pieces are Cement, Fragments, Board, Rope etc. ie anything ACM that is not Loose Fibres.
All visual asbestos pieces need to be removed leaving only fibres (or micro pieces) with an Asbestos % Composition in Soil result of <0.1% for the soil to become non-hazardous waste.

Hazardous Property	Thresholds	Cut Off Value	**If cells below turn yellow and the text turns red, the samples should be classified as Hazardous Waste.**								
Corrosive HP8	≥5%	<1%	0.00577	0.00685	0.00392	0.00464	0.00496	0.00557	0.00370	0.00643	0.00000
Irritant HP4	≥10%	<1%	0.00737	0.00654	0.00179	0.01407	0.00601	0.02675	0.00814	0.00546	0.00000
Irritant HP4	≥20%	<1%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.00000
Specifc Target Organ Toxicity HP5	≥1%		0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Specifc Target Organ Toxicity HP5	≥20%		0.00565	0.00188	0.00000	0.00069	0.00000	0.00127	0.00054	0.00000	0.00000
Specifc Target Organ Toxicity HP5	≥1%		0.00505	0.00566	0.00326	0.00384	0.00403	0.00424	0.00283	0.00566	0.00000
Specifc Target Organ Toxicity HP5	≥10%		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.00000
Aspiration Toxicity HP5	≥10%		#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.00000
Acute Toxicity HP6	≥0.1%	<0.1%	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥0.25%	<0.1%	0.00259	0.00230	0.00068	0.00129	0.00102	0.00250	0.00175	#VALUE!	0.00000
Acute Toxicity HP6	≥5%	<0.1%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.00000
Acute Toxicity HP6	≥25%	<1%	0.03590	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.21061	#VALUE!	#VALUE!	0.00000
Acute Toxicity HP6	≥0.25%	<0.1%	0.00008	0.00005	0.00002	0.00010	0.00009	0.00039	0.00017	#VALUE!	0.00000
Acute Toxicity HP6	≥2.5%	<0.1%	0.00326	0.00461	0.00326	0.00346	0.00403	0.00346	0.00211	0.00538	0.00000
Acute Toxicity HP6	≥15%	<0.1%	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥55%	<1%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.00000
Acute Toxicity HP6	≥0.1%	<0.1%	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥0.5%	<0.1%	0.00343	0.00473	#VALUE!	0.00362	0.00418	0.00397	0.00233	#VALUE!	0.00000
Acute Toxicity HP6	≥3.5%	<0.1%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.00000
Acute Toxicity HP6	≥22.5%	<1%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.00000
Carcinogenic HP7	≥0.1%		0.02250	0.02100	0.00480	0.04110	0.02510	**0.18000**	0.05190	0.00620	0.00000
Carcinogenic HP7	≥0.1%		0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000
Carcinogenic HP7	≥1%		0.00565	0.00188	0.00000	0.00069	0.00000	0.00127	0.00054	0.00000	0.00000
Carcinogenic HP7 Unknown TPH with ID	≥1,000mg/kg		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carcinogenic HP7 b(a)p marker test (Unknown TPH with ID only) Cell only applicable if TPH >1,000mg/kg	≥0.01%		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
pH Corrosive HP8 pH (soil or leachate)	H8 ≥11.5		11.14	8.10	7.91	8.20	8.30	10.54	8.75	7.93	0.00
pH Corrosive HP8 pH (soil or leachate)	H8 ≤2		11.14	8.10	7.91	8.20	8.30	10.54	8.75	7.93	0.00
Toxic for Reproduction HP10	≥0.3%		0.01900	0.02100	0.00480	0.04110	0.02510	0.18000	0.05190	0.00620	0.00000
Toxic for Reproduction HP10	≥3%		0.02250	0.00740	0.00326	0.01940	0.00403	0.02620	0.00630	0.00538	0.00000
Mutagenic HP11	≥0.1%		0.02250	0.00740	0.00326	0.01940	0.00403	0.02620	0.00630	0.00538	0.00000
Mutagenic HP11 Unknown TPH with ID	≥1,000mg/kg		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mutagenic HP11 b(a)p marker test (Unknown TPH with ID only) Cell only applicable if TPH >1,000mg/kg	≥0.01%		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Mutagenic HP11	≥1%		0.00565	0.00566	0.00202	0.00384	0.00384	0.00424	0.00283	0.00566	0.00000
Produces Toxic Gases HP12 Sulphide	≥1,400mg/kg		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Produces Toxic Gases HP12 Cyanide	≥1,200mg/kg		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Produces Toxic Gases HP12 Thiocyanate	≥2,600mg/kg		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HP13 Sensitising	≥10%		0.00565	0.00566	0.00326	0.00384	0.00403	0.00424	0.00283	0.00566	0.00000
Ecotoxic HP14 amended v6	≥25%	<0.1%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.00000

Table 3 of the CLP, CL Inventory, ATPs, IARC, Concawe, MSDSs, REACH + Pesticide Properties databases. Worst case REACH + MSDS's used for "*" STOT + Acute Toxicity.

Please enter available data in the rows associated with the test (grey) cells. Calculation cells initially display either "0.0000" or "#DIV/0!".
If any calculation cells below state "0.00000", testing has NOT been undertaken that contributes to that Hazardous Property.

Haswaste, developed by Dr. Iain Haslock.

31A North Street, Emsworth

TP/WS/BH			WS1-ES1	WS1-ES2	WS1-ES3	WS2-ES2	WS2-ES3	WS3-ES1	WS3-ES2	WS3-ES3	
Depth (m)			0.20	0.50	0.80	0.50	0.80	0.20	0.50	0.80	
Envirolab reference											
Ecotoxic HP14 amended v6	≥25%	<0.1% (except Be, V, Te, Tl, Petrol, Diesel, Crude Oil, Kerosene, White Spirit, Crosote, TPH, TPHCWG, Phenol, Cresols, Xylenols, T-Phenols, CompCN, Thiocyanate, Toluene, Ethylbenzene, Xylene + BTEX 1%).	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.00000
Ecotoxic HP14 amended v6	≥25%	<0.1% (except Be, V, Te, Tl, Petrol, Diesel, Crude Oil, Kerosene, White Spirit, Crosote, TPH, TPHCWG, Phenol, Cresols, Xylenols, T-Phenols, CompCN, Thiocyanate, Toluene, Ethylbenzene, Xylene + BTEX 1%).	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.00000
Persistent Organic Pollutant (PCB, PBB or POP Pesticides)	>0.005%		0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
Persistent Organic Pollutant (Total Dioxins+Furans)	>0.0000015%		0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000
Persistent Organic Pollutant (Individual Dioxins+Furans)	>0.0000015%		0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000

If other contaminants need adding to Haswaste, please contact Envirolab.

envirolab

Please enter available data in the rows associated with the test (grey) cells. Calculation cells initially display either "0.0000" or "#DIV/0!".
If any calculation cells below state "0.00000", testing has NOT been undertaken that contributes to that Hazardous Property.

Haswaste, developed by Dr. Iain Haslock.

31A North Street, Emsworth

TP/WS/BH		WS4-ES1	WS4-ES3							
Depth (m)		0.30	0.80							
Envirolab reference										
% Moisture	%									
pH (soil)		9.03	8.28							
pH (leachate)										
Arsenic	mg/kg	2	6							
Cadmium	mg/kg	<0.5	0.7							
Copper	mg/kg	22	12							
CrVI or Chromium	mg/kg	21	42							
Lead	mg/kg	52	14							
Mercury	mg/kg	<0.17	0.32							
Nickel	mg/kg	17	38							
Selenium	mg/kg	<1	<1							
Zinc	mg/kg	60	49							
Barium	mg/kg									
Beryllium	mg/kg									
Vanadium	mg/kg									
Cobalt	mg/kg									
Manganese	mg/kg									
Molybdenum	mg/kg									
Antimony	mg/kg									
Aluminium	mg/kg									
Bismuth	mg/kg									
CrIII	mg/kg									
Iron	mg/kg									
Strontium	mg/kg									
Tellurium	mg/kg									
Thallium	mg/kg									
Titanium	mg/kg									
Tungsten	mg/kg									
Ammoniacal N	mg/kg									
ws Boron	mg/kg									
PAH (Input Total PAH **OR** individual PAH results)										
Acenaphthene	mg/kg	<0.01	<0.01							
Acenaphthylene	mg/kg	<0.01	<0.01							
Anthracene	mg/kg	<0.02	<0.02							
Benzo(a)anthracene	mg/kg	0.09	<0.04							
Benzo(a)pyrene	mg/kg	0.11	<0.04							
Benzo(b)fluoranthene	mg/kg	0.11	<0.05							
Benzo(ghi)perylene	mg/kg	0.08	<0.05							
Benzo(k)fluoranthene	mg/kg	<0.07	<0.07							
Chrysene	mg/kg	0.11	<0.06							
Dibenzo(ah)anthracene	mg/kg	<0.04	<0.04							
Fluoranthene	mg/kg	0.13	<0.08							
Fluorene	mg/kg	<0.01	<0.01							
Indeno(123cd)pyrene	mg/kg	0.11	<0.03							
Naphthalene	mg/kg	<0.03	<0.03							
Phenanthrene	mg/kg	0.04	<0.03							
Pyrene	mg/kg	0.12	<0.07							
Coronene	mg/kg									
Total PAHs (16 or 17)	mg/kg	0.90	<0.08							
TPH										
Petrol	mg/kg									
Diesel	mg/kg									
Lube Oil	mg/kg									
Crude Oil										
White Spirit / Kerosene	mg/kg									
Creosote	mg/kg									
Unknown TPH with ID	mg/kg									
Unknown TPHCWG	mg/kg	30.0	1.0							
Total Sulphide	mg/kg									
Complex Cyanide	mg/kg									
Free (or Total) Cyanide	mg/kg									
Thiocyanate	mg/kg									
Elemental/Free Sulphur	mg/kg									
Phenols Input Total Phenols HPLC **OR** individual Phenol results.										
Phenol	mg/kg									
Cresols	mg/kg									
Xylenols	mg/kg									
Resourcinol	mg/kg									
Phenols Total by HPLC	mg/kg									
BTEX Input Total BTEX **OR** individual BTEX results.										
Benzene	mg/kg	<0.01	<0.01							
Toluene	mg/kg	<0.01	<0.01							
Ethylbenzene	mg/kg	<0.01	<0.01							
Xylenes	mg/kg	<0.01	<0.01							
Total BTEX	mg/kg									
PCBs (POPs)										
PCBs Total (eg EC7/WHO12)	mg/kg									
PBBs (POPs)										
Hexabromobiphenyl (Total or PBB153; 2,2',4,4',5,5'- if only available)	mg/kg									

Please enter available data in the rows associated with the test (grey) cells. Calculation cells initially display either "0.0000" or "#DIV/0!".
If any calculation cells below state "0.00000", testing has NOT been undertaken that contributes to that Hazardous Property.

Haswaste, developed by Dr. Iain Haslock.

31A North Street, Emsworth

TP/WS/BH	WS4-ES1	WS4-ES3							
Depth (m)	0.30	0.80							
Envirolab reference									

POPs Dioxins and Furans Input Total Dioxins and Furans **OR** individual Dioxin and Furan results.

2,3,7,8-TeCDD	mg/kg									
1,2,3,7,8-PeCDD	mg/kg									
1,2,3,4,7,8-HxCDD	mg/kg									
1,2,3,6,7,8-HxCDD	mg/kg									
1,2,3,7,8,9-HxCDD	mg/kg									
1,2,3,4,6,7,8-HpCDD	mg/kg									
OCDD	mg/kg									
2,3,7,8-TeCDF	mg/kg									
1,2,3,7,8-PeCDF	mg/kg									
2,3,4,7,8-PeCDF	mg/kg									
1,2,3,4,7,8-HxCDF	mg/kg									
1,2,3,6,7,8-HxCDF	mg/kg									
2,3,4,6,7,8-HxCDF	mg/kg									
1,2,3,7,8,9-HxCDF	mg/kg									
1,2,3,4,6,7,8-HpCDF	mg/kg									
1,2,3,4,7,8,9-HpCDF	mg/kg									
OCDF	mg/kg									
Total Dioxins and Furans	mg/kg									

Some Pesticides (POPs unless otherwise stated)

Aldrin	mg/kg									
α Hexachlorocyclohexane (alpha-HCH) *(leave empty if total HCH results used)*	mg/kg									
β Hexachlorocyclohexane (beta-HCH) *(leave empty if total HCH results used)*	mg/kg									
α Cis-Chlordane (alpha) ***OR*** *Total Chlordane*	mg/kg									
δ Hexachlorocyclohexane (delta-HCH) *(leave empty if total HCH results used)*	mg/kg									
Dieldrin	mg/kg									
Endrin	mg/kg									
χ Hexachlorocyclohexane (gamma-HCH) (lindane) ***OR*** *Total HCH*	mg/kg									
Heptachlor	mg/kg									
Hexachlorobenzene	mg/kg									
o,p'-DDT *(leave empty if total DDT results used)*	mg/kg									
p,p'-DDT ***OR*** *Total DDT*	mg/kg									
χ Trans-Chlordane (gamma) *(leave empty if total Chlordane results used)*	mg/kg									
Chlordecone (kepone)	mg/kg									
Pentachlorobenzene	mg/kg									
Mirex	mg/kg									
Toxaphene (camphechlor)	mg/kg									

Tin

Tin *(leave empty if Organotin and Tin excl Organotin results used)*	mg/kg									

Organotin

Dibutyltin; DiBT	mg/kg									
Tributyltin; TriBT	mg/kg									
Triphenyltin; TriPT	mg/kg									
Tetrabutyltin; TeBT	mg/kg									

Tin excluding Organotin

Tin excl Organotin	mg/kg									

envirolab

Haswaste, developed by Dr. Iain Haslock.

Please enter available data in the rows associated with the test (grey) cells. Calculation cells initially display either "0.0000" or "#DIV/0!".
If any calculation cells below state "0.00000", testing has NOT been undertaken that contributes to that Hazardous Property.

31A North Street, Emsworth

TP/WS/BH	WS4-ES1	WS4-ES3							
Depth (m)	0.30	0.80							
Envirolab reference									

Asbestos in Soil	Thresholds									
Asbestos detected in Soil (enter Y or N)	Y		N							
			If Asbestos in Soil above is "Y", the soil is Hazardous Waste HP5 and HP7							
Asbestos % Composition in Soil (Matrix Loose Fibres or Microscopic Identifiable Pieces only)	see "Carc HP7 % Asbestos in Soil (Fibres)" below	%								
Carcinogenic HP7 % Asbestos in Soil (fibres or micro pieces) *Please be advised, if the calculation cell is "0.00000" DOES NOT MEAN asbestos testing has been undertaken and the result is zero.*	≥0.1%		0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
			If Asbestos in Soil above is "Y", but Asbestos % above is "<0.1%", the soil is Non Hazardous Waste. You can only use Asbestos % results where loose fibres or micro pieces are only present. You cannot use Asbestos % results when visual identifiable pieces are present.							
Asbestos Identifiable Pieces visible with the naked eye detected in the Soil (enter Y or N)	Y									

If visual identifiable pieces of asbestos are present, you cannot use Asbestos % results and the whole soil sample is Hazardous Waste HP5 and HP7 Construction material containing Asbestos 17 06 05.
Therefore, if Asbestos in Soil above is "Y", the Asbestos % above is "<0.1%", but the Asbestos Identifiable Pieces visible with the naked eye is "Y", the soil is Hazardous Waste.

Identifiable Pieces are Cement, Fragments, Board, Rope etc. ie anything ACM that is not Loose Fibres.
All visual asbestos pieces need to be removed leaving only fibres (or micro pieces) with an Asbestos % Composition in Soil result of <0.1% for the soil to become non-hazardous waste.

Hazardous Property	Thresholds	Cut Off Value	**If cells below turn yellow and the text turns red, the samples should be classified as Hazardous Waste.**								
Corrosive HP8	≥5%	<1%	0.00430	0.00886	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Irritant HP4	≥10%	<1%	0.00275	0.00215	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Irritant HP4	≥20%	<1%	#VALUE!	#VALUE!	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Specifc Target Organ Toxicity HP5	≥1%		0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Specifc Target Organ Toxicity HP5	≥20%		0.00009	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Specifc Target Organ Toxicity HP5	≥1%		0.00403	0.00806	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Specifc Target Organ Toxicity HP5	≥10%		#VALUE!	#VALUE!	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Aspiration Toxicity HP5	≥10%		#VALUE!	#VALUE!	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥0.1%	<0.1%	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥0.25%	<0.1%	#VALUE!	0.00082	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥5%	<0.1%	#VALUE!	#VALUE!	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥25%	<1%	#VALUE!	#VALUE!	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥0.25%	<0.1%	#VALUE!	0.00003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥2.5%	<0.1%	0.00403	0.00806	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥15%	<0.1%	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥55%	<1%	#VALUE!	#VALUE!	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥0.1%	<0.1%	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥0.5%	<0.1%	#VALUE!	0.00817	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥3.5%	<0.1%	#VALUE!	#VALUE!	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Acute Toxicity HP6	≥22.5%	<1%	#VALUE!	#VALUE!	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Carcinogenic HP7	≥0.1%		0.00520	0.00806	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Carcinogenic HP7	≥0.1%		0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000
Carcinogenic HP7	≥1%		0.00009	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Carcinogenic HP7 Unknown TPH with ID	≥1,000mg/kg		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carcinogenic HP7 b(a)p marker test (Unknown TPH with ID only) Cell only applicable if TPH >1,000mg/kg	≥0.01%		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
pH Corrosive HP8 pH (soil or leachate)	H8 ≥11.5		9.03	8.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pH Corrosive HP8 pH (soil or leachate)	H8 ≤2		9.03	8.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Toxic for Reproduction HP10	≥0.3%		0.00520	0.00768	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Toxic for Reproduction HP10	≥3%		0.00403	0.00806	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Mutagenic HP11	≥0.1%		0.00403	0.00806	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Mutagenic HP11 Unknown TPH with ID	≥1,000mg/kg		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mutagenic HP11 b(a)p marker test (Unknown TPH with ID only) Cell only applicable if TPH >1,000mg/kg	≥0.01%		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Mutagenic HP11	≥1%		0.00343	0.00768	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Produces Toxic Gases HP12 Sulphide	≥1,400mg/kg		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Produces Toxic Gases HP12 Cyanide	≥1,200mg/kg		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Produces Toxic Gases HP12 Thiocyanate	≥2,600mg/kg		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HP13 Sensitising	≥10%		0.00403	0.00806	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Ecotoxic HP14 amended v6	≥25%	<0.1%	#VALUE!	#VALUE!	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Table 3 of the CLP, CL Inventory, ATPs, IARC, Concawe, MSDSs, REACH + Pesticide Properties databases. Worst case REACH + MSDS's used for "*" STOT + Acute Toxicity.

Please enter available data in the rows associated with the test (grey) cells. Calculation cells initially display either "0.0000" or "#DIV/0!".
If any calculation cells below state "0.00000", testing has NOT been undertaken that contributes to that Hazardous Property.

Haswaste, developed by Dr. Iain Haslock.

31A North Street, Emsworth

TP/WS/BH			WS4-ES1	WS4-ES3							
Depth (m)			0.30	0.80							
Envirolab reference											
Ecotoxic HP14 amended v6	≥25%	<0.1% (except Be, V, Te, Tl, Petrol, Diesel, Crude Oil, Kerosene, White Spirit, Crosote, TPH, TPHCWG, Phenol, Cresols, Xylenols, T-Phenols, CompCN, Thiocyanate, Toluene, Ethylbenzene, Xylene + BTEX 1%).	#VALUE!	#VALUE!	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Ecotoxic HP14 amended v6	≥25%	<0.1% (except Be, V, Te, Tl, Petrol, Diesel, Crude Oil, Kerosene, White Spirit, Crosote, TPH, TPHCWG, Phenol, Cresols, Xylenols, T-Phenols, CompCN, Thiocyanate, Toluene, Ethylbenzene, Xylene + BTEX 1%).	#VALUE!	#VALUE!	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Persistent Organic Pollutant (PCB, PBB or POP Pesticides)	>0.005%		0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
Persistent Organic Pollutant (Total Dioxins+Furans)	>0.0000015%		0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000
Persistent Organic Pollutant (Individual Dioxins+Furans)	>0.0000015%		0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.0000000000

If other contaminants need adding to Haswaste, please contact Envirolab.

APPENDIX M
DISCOVERY STRATEGY

Managing Unexpected Contamination

This Discovery Strategy sets out in principle the proposed methods for identifying and managing site specific risks in the event that suspected or potential land contamination is uncovered during redevelopment.

The Contractor appointed to carry out the works will be responsible for implementing the procedures outlined in this document. However, before taking investigative or remedial action the Contractor will prepare a method statement to the satisfaction of the Client's Consultant, who in turn will also consult the Environmental Quality Officer at the Local Authority.

This Discovery Strategy is a working document. The Contractor should consult the Environmental Consultant in the event that suspicious ground conditions or/and unexpected contamination are uncovered. There may be a requirement to review the procedures and consult with the Local Authority in the event that unforeseen conditions are encountered.

Revised or new procedures to deal with suspicious ground conditions or/and unexpected contamination may require approval from the Local Authority before works can proceed. The materials observed and tested during the ground investigation represent only a small proportion of the materials present onsite. There may be other conditions prevailing at the site that have not been revealed by these investigations and which have therefore not been taken into account. The Discovery Strategy is designed to address this issue.

Identification of potential contaminated material

All operatives and ground workers should remain vigilant for unforeseen or suspicious ground conditions. Initial identification will be based on visual and or olfactory assessment. General indicators of possible contamination could be arisings that quickly change appearance or appear inconsistent with the general soil profile outlined within this RSK report. Potential unexpected contamination and/or suspicious ground conditions may include the following examples (although this is not an exclusive list):

- Hydrocarbons in the form of oily (or free phase) pockets;
- Strong odours or/and discolouration associated with the underlying soils itself;
- Cement bound debris suspected of containing asbestos;
- Fibrous materials; and
- Unexploded ordnance (UXOs).

Managing Suspicious Ground Conditions

On the discovery of the suspicious material/unexpected contamination (including any visible signs of elemental mercury) during excavation works, the following sequence should be adopted:

1. Contractor should assess the requirement for any additional health and safety or environmental management control measures;

2. Contractor's suitably experienced person should take note of the nature and extent of 'contamination' and immediately inform the Environmental Consultant and the Local Authority;
3. Working area will be cordoned off and works will cease in the vicinity;
4. Environmental Consultant will attend site to undertake sampling regime with subsequent laboratory testing as deemed necessary;
5. Findings will be discussed with the Local Authority along with the provision of the test records;
6. Remedial action, if necessary, and programming of the works are to be agreed with the Environmental Quality Officer at Local Authority;
7. Contractor is informed of the remedial action required;
8. Contractor prepares a Method Statement that details how the agreed remedial action will be carried out;
9. Method Statement is agreed by Environmental Consultant; and
10. Evidence of work carried out is collated for inclusion in the verification report.

Asbestos Containing Materials (ACMs)

In addition to the above sequence of procedures, should any non-licensable asbestos containing materials (ACMs) be encountered, a watching brief should be maintained and a programme of handpicking should be undertaken by competent persons and be disposed off site in line with 'Duty of Care', Waste Management Legislation. Any areas where asbestos is suspected in soils the Principal Contractor will obtain a sample and submit for quantified asbestos analysis.

Should sampling and analysis of any suspect materials reveal the presence of significant notifiable asbestos containing materials, such as lagging or fibreboard, then the continuation of works may require the use of licensed asbestos contactors to handle the materials. In this instance the HSE would need to be notified of the works via the submission of an ASB5 notification.