

Unilateral Undertaking

under section 106 of the Town and Country Planning Act 1990

relating to development at Peterborough Road, Crowland, Peterborough

THIS UNILATERAL UNDERTAKING AND DEED is given on the 20th of [APRIL] 2020 by:

PARTIES

- (1) CALDIC (UK) LIMITED incorporated in England and Wales with Company
Registration Number 2084881 whose registered office is at Stainsby close,
Holmewood Industrial Estate, Holmewood, Chesterfield, Derbyshire, S42
5UG (the **Owner**)

TO SOUTH HOLLAND DISTRICT COUNCIL of Council Offices Priory Road Spalding PE11
2XE (the **Council**)

BACKGROUND

- A The Council is the local planning authority for the purposes of s 106 of the 1990 Act for the area in which the Land and the Property is situated.
- B The Owner is the current registered proprietor of the Property.
- C The Application has been submitted to the Council and the Council has resolved to grant the Permission subject to completion of this Undertaking.

IT IS AGREED THAT:

1 Interpretation

- 1.1 In this Undertaking unless the context otherwise requires the following terms (arranged in alphabetical order) shall have the following meanings:

the 1990 Act means the Town and Country Planning Act 1990 (as amended);

Application means the application for planning permission for the Construction of residential units at the Property submitted to the Council to which the Council has allocated reference number H02-0901-18;

Permission means full planning permission (subject to conditions) to be granted by the Council for the development of the Property in accordance with the Application.

Planning Obligations means those planning obligations listed at Schedule 2 being planning obligations for the purposes of section 106 of the

Act.

Property	Land on the West side of Peterborough Road Crowland Peterborough as comprised in title number LL340219.
Remediation Implementation Plan	means the document headed "Off-site works Penwald Close Crowland Remediation Implementation Plan" a copy of which is attached to this undertaking at Schedule 1.
Working Day	means any day which is not a Saturday, Sunday, Christmas Day, Good Friday or a statutory bank holiday.

2 Interpretation

- 2.1 Words importing one gender shall be construed as meaning any other gender;
- 2.2 Words in the singular include the plural and vice versa;
- 2.3 References to clauses and schedules are reference to clauses and schedules within this Undertaking only;
- 2.4 A reference to a person includes a company or any legal entity.

3 Obligations and statutory powers

- 3.1 This Undertaking is entered into as a unilateral undertaking and is a planning obligation for the purposes of s 106 of the 1990 Act and it is acknowledged by the parties that the obligations contained within it are enforceable by the Council as local planning authority against the Owner.
- 3.2 The Owner hereby covenants to observe and perform the Planning Obligations;

4 Conditionality

- 4.1 The obligations in this Undertaking are unless otherwise specified conditional on the grant of the Permission by the Council

5 Miscellaneous

- 5.1 This Undertaking can be registered as a local land charge by the Council;
- 5.2 Notwithstanding the provisions of the Contracts (Rights of Third Parties) Act 1999 nothing in this Undertaking confers or purports to confer any right to enforce any of the terms of this Undertaking on any person who is not a party hereto;
- 5.3 Any notice served pursuant to this Undertaking shall be deemed to be served correctly if served to the above addresses by registered post;
- 5.4 This Undertaking is governed by the laws of England and Wales.
- 5.5 The development of the Property can commence in accordance with the Permission (once granted) notwithstanding that any of the Planning Obligations remain to be completed.

This Undertaking has been executed as a deed and delivered on the date stated at the beginning of this Undertaking.

SCHEDULE 1
REMEDIATION IMPLEMENTATION PLAN

SCHEDULE 2

- 1 The Owner hereby undertakes to complete the works as set out in Paragraph 2, Paragraph 3 and Paragraph 4 of the Remediation Implementation Plan within 15 months of the date of this Agreement.

Executed as a deed by CALDIC (UK) LIMITED
acting by a director, in the presence of a
witness.


.....
(R.A. COLLIS).

In the presence of:

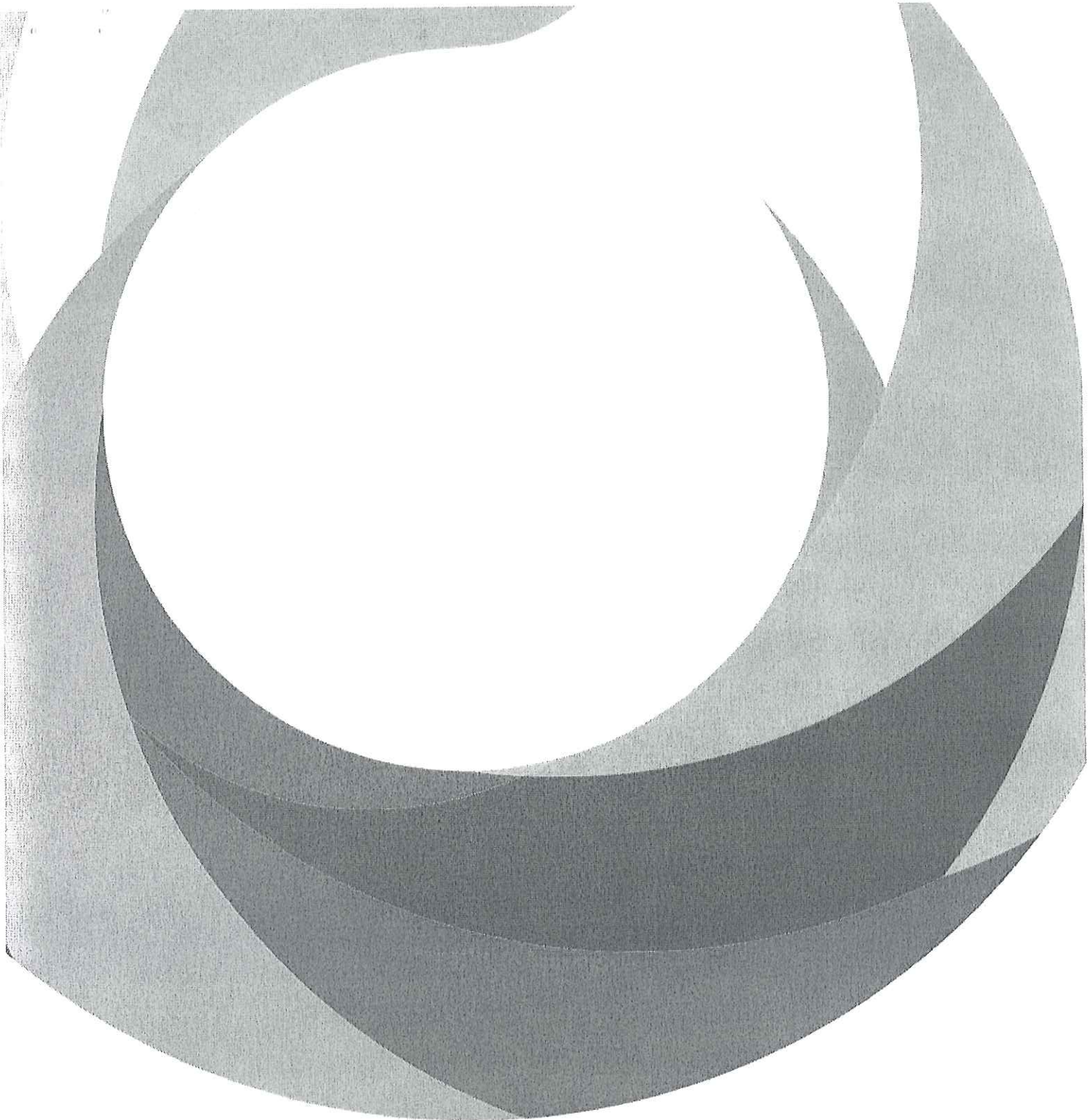
Signature of witness


.....

Name (in BLOCK CAPITALS)

DANIELLE AUTON

Address MEADOW VIEW, STRETTON ROAD, CHESTERFIELD,
S45 9AQ.



CALDIC UK Ltd

Off-site Works, Penwald Close, Crowland
Remediation Implementation Plan

14 May 2019

DOCUMENT CONTROL SHEET

Issued by	FLI QDS Remediation 18 The Pines Broad Street Guildford Surrey GU3 3BH	Tel: +44 (0) 1483 303070 www.fli-qds.co.uk
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Checked by	Rob Timson BSc, MCIWEM C.WEM, CEnv	
Approved by	Simon Curwen	

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FLI QDS Remediation Limited has prepared this report in accordance with the instructions of the above named client for their sole and specific use. Any third parties who may use the information contained herein do so at their own risk.

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1. INTRODUCTION

1.1 Background

FLI QDS Remediation Ltd (QDS) have been appointed by CALDIC (UK) Ltd (the Client) to complete voluntary remediation works on land adjacent to the west of its Peterborough Road, Crowland site. The land is located just to the north of Penwald Close (refer to drawing Q-05483-13 within Appendix A). The extents of the Peterborough Road site are shown on this drawing.

QDS completed soil source removal works on behalf of the Client at the Peterborough Road site between November and December 2018. The Verification Report details the works undertaken in order to deliver the Enabling Phase Remediation Works (ref: 3716-WM-01 FLI QDS, May 2019).

Historic groundwater monitoring has indicated a dissolved phase chlorinated solvent plume below an area of open ground to the west of the main site. Given the nature of the contaminants it has been assumed that this has emanated from the site, i.e. there is no off-site contaminant source.

Groundwater sampling from both on-site and off-site would indicate that natural attenuation of the chlorinated solvents is occurring. This plume is therefore not considered to present a significant risk to either Groundwater or Human Health. Risk based assessments also show that current concentrations do not present an unacceptable risk. However, the Client is keen to target this plume for remediation for two reasons:

1. Address potential long-term liability relating to their site; and
2. Minimise the potential for re-impacting the site once the on-site remediation works have been completed.

QDS have therefore been instructed to design and implement remediation to target this plume. Due to the plume migrating off-site there is limited space for active remediation. This is due to significant constraints such as; public rights of way, public highways, presence of services and garden areas. The area for active remediation is circa 200m².

1.2 Regulatory Position

It is understood that the remediation works and long-term monitoring will be secured under a Section 106 Unilateral Agreement between South Holland District Council (SHDC) and the Client.

1.3 Reference Documents

Information from the following documents has been reviewed in the preparation of this Remediation Implementation Plan:

- Hydrock Consultants Limited, April 2019, Human Health Risk Assessment, Hydrock, Ref: CRO-HYD-XX-ZZ-CO-GE-0002-S2-P1;
- QDS Remediation, October 2017. *Letter Report* Re: Peterborough Road, Crowland – July 2017 Site Investigation, Ref: Q-05483/RT/01; and
- Hydrock Consultants Limited, July 2017. Desk Study, Quantitative Risk Assessment and Remedial Strategy, Hydrock, Ref: CRO-HYD-XX-RS-RP-GE-0001.

2. REMEDIATION STRATEGY

2.1 The Site

The land is located at the end of Penwald Close, postcode PE6 0AQ and is shown on drawing Q-05483-13 (refer to Appendix A). The land is vegetated by a mixture of low lying grass, scrub and trees. A public footpath forms the northern boundary; Peterborough Road to the east being accessed by the path.

The ownership of the land has been investigated by SHDC and QDS. The land was previously owned by the Penwald Close property developer whose business has ceased trading. It is therefore thought that the land will return to the Crown. However, no confirmation has been obtained.

It is understood that the residents of the cul-de-sac once paid a maintenance rate for the upkeep of the land, however the exact details remain unclear. Speaking to the local residents they now undertake upkeep of this strip of land themselves on a voluntary basis.

2.2 Summary of Conceptual Site Model

A Conceptual Model was developed for the main Peterborough Road site in the Hydrock Remedial Strategy document. The document should be referred to for further information.

Elements of the Conceptual Model continue apply to the Penwald Close site including the geology and hydrogeology which are summarised in the table below.

Geology	Hydrogeology	Source	Pathway	Receptor
Made Ground over Peat and or/Tidal Flat Deposits comprised of organic rich sandy clay or silty clay loam over Abbey Sand and Gravel and Oxford Clay	Groundwater has been recorded in MW408 at a depth of approximately 1.3 to 1.5m bgl. Groundwater flow is considered to be to the west. Where groundwater was encountered during the 2018 remedial works, it was considered to be perched above the underlying clay	The presence of chlorinated solvents in the shallow groundwater is consistent with the contamination that was identified on the main Peterborough Road site.	It is considered that there has been shallow groundwater migration to the west through the granular lenses within the Abbey Sand and Gravel. Therefore there is an active inhalation pathway present for the VOC Chemicals of Concern.	Whilst the target area is unoccupied open space, there is potential for further migration to the west towards residential properties. Potential recontamination of the remediated Peterborough Road site.

Table 1: Summary of Conceptual Model

Degradation has been observed at the Peterborough Road site and field monitoring has shown that subsurface conditions are favourable for reductive dechlorination.

2.3 Additional Vapour Human Health Risk Assessment and Site Specific Acceptability Criteria

QDS appointed Hydrock to complete a further Human Health Risk Assessment for chlorinated vapours associated with the groundwater plume and their risk to off-site properties (refer to Appendix B).

Site Specific Acceptability Criteria (SSAC) were derived by Hydrock for soil vapours that are protective of human health for the off-site properties.

3. REMEDIATION METHODOLOGY

Under anaerobic conditions, reductive dechlorination mechanisms can effectively biodegrade chlorinated hydrocarbons. Reductive dechlorination generally involves the sequential replacement of a chlorine atom with a hydrogen atom (that is, converting PCE to TCE to DCE to VC and finally ethene) and has been observed to occur both directly and cometabolically. In anaerobic reductive dechlorination (direct), the mediating bacteria use the contaminant directly as an electron acceptor in energy-producing redox reactions.

Anaerobic reductive dechlorination (cometabolic) occurs when bacteria incidentally dechlorinate the hydrocarbons in the process of using another electron acceptor to generate energy.

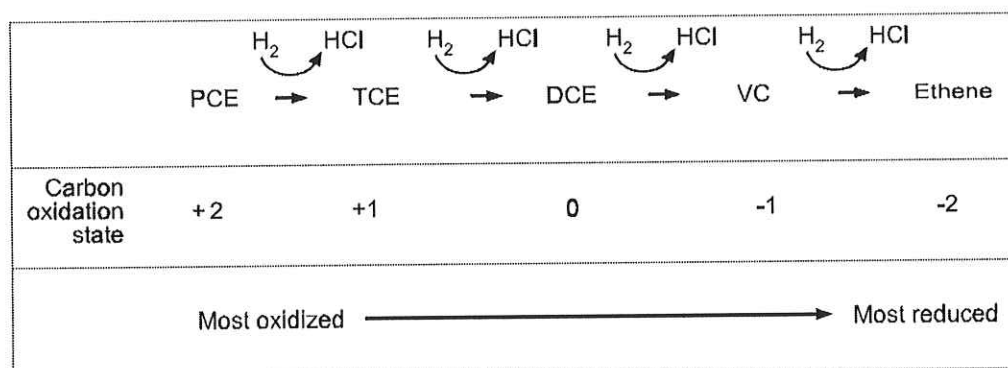


Figure 1: Anaerobic reductive dechlorination of chlorinated hydrocarbons

3.1 Remediation Design

The remediation works will consist of the injection of an Enhanced Reductive Dechlorination (ERD) substrate into the subsurface. The substrate is designed to provide a feed source for anaerobic bacteria, promoting colony growth resulting in enhanced natural degradation of the residual contaminant plume.

Approximately 15 probe points will be installed to circa 4m bgl to create and maintain optimal conditions for reductive dechlorination within the shallow groundwater profile.

3.2 Remediation Implementation

The addition of the ERD will be via direct push injection rods using a small tracked drilling rig. It is anticipated that the works will take up to a week to complete. The area will be subject to a utility clearance scan prior to the enablement works.

Heras fencing will be used to segregate the injection area from the general public. A secure storage container will be housed on the main Peterborough site for the storage of the ERD substrate.

Injection volumes of the reagent will be based on baseline sampling from borehole BH408. Drawing Q-05483-13 (Appendix A) shows the indicative extents of the off-site remediation area. The injection points will be subject to service clearance.

It is anticipated that 15 injection points will be used across the area on a circa 3.5m spacing. The overall required injection volume will be split evenly over the locations.

Should an injection point struggle to take the required volume, initially the point will be raised between 0.5 and 1m and a second attempt made. Should it still not be possible to inject the required volume then the remaining will be split between the nearby points.

Due to the nature of the area and potential access issue due to heavy vegetation/ tree roots etc., the overall injection programme will need to adapt to the practicalities of the site. This will be driven by the experienced Remediation Engineer overseeing the works.

Records of locations and volume injected will be maintained on-site. Works will continue until the required volume of ERD has been injected into the subsurface.

3.3 Remediation Criteria

3.3.1 Groundwater and Human Health (Outdoor Air)

Hydrock Consultants Remedial Strategy (ref: CRO-HYD-XX-RS-RP-GE-0001 S2 p4) identified targets for protection of Human Health (Outdoor Air) and Controlled Waters. Targets are included within Table 4.6 of the report (Controlled Waters) and Appendix H (Human Health).

Table 2 below summarises the SSACs derived for the site and compares them to current off-site groundwater concentrations.

Chemical of Concern	Human Health SSAC (µg/l)	Controlled Waters SSAC (µg/l)	Maximum Concentration (MW408) (µg/l)
VC	1,710,000	5,480	693
Benzene	>solubility*	8,070	<1
TCE	>solubility*	32,200	107
PCE	>solubility*	1,890,000	13.7
1,1,2-TCA	>solubility*	345,000	6.25
1,1,1-TCA	>solubility*	230,000	31.5
1,2-DCA	>solubility*	104	1.63
Dichloromethane	>solubility*	117	7.1

* based on Human Health risk assessments these chemicals must be present in free phase form before they present a risk.

Table 2: Groundwater SSACs compared to off-site concentrations

The data shows that the contaminant concentrations do not present an unacceptable risk to either Controlled Waters or Human Health (via outdoor pathway vapour ingress).

Though there is no significant risk presented by the existing conditions, remediation works are proposed to further reduce the contaminant loading and create conditions for accelerated attenuation of the residual plume.

3.4 Soil Vapours and Human Health (Indoor Air)

The above remediation criteria was derived using a model where indoor air quality was removed as a pathway. This model was based on the redevelopment of the Peterborough Road site where the new residential properties would be constructed with a vapour membrane. Following discussions with SHDC it was agreed that the indoor air pathways needed to be considered for off-site properties, as these were unlikely to have been constructed with vapour membranes.

A theoretical risk to the off-site properties was identified due to the dissolved phase plume known to be present. Therefore, QDS engaged Hydrock Consultants to undertake supplementary modelling to derive Site Specific Acceptability Criteria groundwater targets (SSAC_{gwvap}) assuming the indoor and outdoor vapour pathways were open. The output of

this additional modelling was to derive soil vapour criteria that are protective of Human Health for off-site properties. The Hydrock model (ref: CRO-HYD-XX-ZZ-CO-GE-0002-S2-P1) is contained within Appendix B.

Based on this document the Scenario B SSAC generated for vapours in the April 2019 Hydrock Human Health Risk Assessment will be used as Remediation Criteria for the remediation works.

In conjunction with the additional modelling QDS completed baseline vapour sampling in February 2019 from four points surrounding monitoring well BH408 (see drawing Q-05483-13 within Appendix A).

Sample probes were inserted to a depth of 0.7m bgl and attached to 1400ml Silonite vacuum gas canisters at the surface. After sampling, the canisters were sent to ALS, an accredited laboratory for analysis.

The results of the baseline vapour sampling are compared against the Scenario B SSAC_{vap} in Table 3. Laboratory certificates are contained within Appendix C.

Chemical of Concern	SSAC _{vap} (µg/m ³) Scenario B	Sample 001	Sample 002	Sample 003	Sample 004
Approximated distance from Peterborough Road Site Boundary		5m	9m	18m	30m
1,2-Dichloroethane	2,310	<189	<170	<157	<189
Vinyl chloride	5,730	<119	<106	<98.3	<118
Trichloroethene	133,000	3,780	1,100	278	<250
1,1,1-Trichloroethene	15,400,000	341	869	335	<254
Tetrachloroethene	1,300,000	4,300	435	<263	<317
Toluene	350,000,000	787	727	934	864
Ethylbenzene	60,300,000	<203	<182	<168	<203
Xylene, m-	14,500,000	<203	<182	271	266
Xylene, p-	14,400,000				
Xylene, o-	14,400,000	<203	<182	<168	<203
Benzene	320,000	<129	<116	<107	<129
Dichloromethane	2,160,000				

Table 3: Baseline vapour sampling results

The results of the baseline monitoring indicate that the concentrations within the soil vapour phase are compliant with the derived criteria and therefore current conditions do not present an unacceptable risk to off-site properties.

The vapour results would also be supportive of an environment where degradation of the contaminants is occurring. The recorded vapour concentrations of the main contaminants (PCE and TCE) are seen to reduce by over an order of magnitude between 5m and 30m from the site (source area).

4. VERIFICATION PLAN

4.1.1 Groundwater Monitoring

QDS will undertake four monitoring rounds post injection works to assess the groundwater conditions and the effectiveness of the reductive dechlorination. These will be undertaken at quarterly intervals following the completion of the works, with samples collected from the two existing off-site monitoring wells, BH406 and BH408.

The proposed monitoring suite is presented below in Table 4.

Monitoring Locations	Frequency of testing	Proposed monitoring suite
Boreholes BH408 and BH406	Quarterly following completion of injection works. Four rounds in total.	Dissolved Oxygen, Redox Potential, pH, Nitrate, Sulphate, Fe(II), Mn (II), Hydrogen Sulphide, Alkalinity, Electrical Conductivity, COD, TOC, PCE, TCE, cis-1,2-DCE, VC.

Table 4: Proposed monitoring suite

Due to the degradation dynamics involved with chlorinated solvents there remains a risk that the process could stall at vinyl chloride. While baseline concentrations indicate that the plume dose not currently present an unacceptable risk, to provide reassurance that attenuation is being fully achieved, QDS will commit to ensuring that dissolved phase VC concentrations will not be higher at the end of the 12-month monitoring period than at the start. Due to the nature of ethene, our experience on similar projects has identified that obtaining representative samples is very difficult and therefore it is not proposed to include this within the verification suite.

4.1.2 Vapour Monitoring

Vapour monitoring will also be completed on a quarterly basis, gas samples being obtained using the same methodology as the baseline event in February 2019. Where possible, the same four probe locations will be utilised. The results will be compared directly against the SSAC_{gwvap} values in Table 3 above to demonstrate than no unacceptable risk exists to the off-site properties.

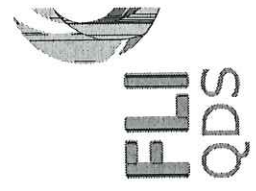
4.2 Verification Report

On completion of the 12-month monitoring period QDS will issue a report detailing the works completed, including the trends in groundwater and vapour conditions and an assessment of contaminant mass reductions.

Appendix A Drawings



Rev.	Description	FIRST ISSUE DRAFT ISSUE
		A



■ Guild
□ Roth

Site Address:
Peterborough
Crowland
PE6 0BB

Appendix B Human Health Risk Assessment – Vapours

Document ref: CRO-HYD-XX-ZZ-CO-GE-0002-S2-P1

Rob Timson
FLI QDS Remediation Limited

17 April 2019

Re: Peterborough Road, Crowland

Dear Rob

Introduction

Please find below a Human Health Risk Assessment with respect the risk posed by chlorinated vapours emanating from the groundwater plume to off-site properties at Peterborough Road, Crowland. Details of the works completed to date are presented in the following:

- Hydrock letter CRO-HYD-XX-ZZ-CO-GE-0001-S2-P1; and
- Hydrock report CRO-HYD-XX-RS-RP-GE-0001-S2-P4.

Background

The existing Site Specific Acceptability Criteria groundwater targets ($SSAC_{gw vap}$) were derived using a site-specific CLEA v7.01 model (SoBRA approach for vapours), assuming the indoor and outdoor only vapour pathways were active.

The existing CLEA v7.01 model calculates an equilibrium between the soil, vapour and pore-water phases that are protective of the human health receptors. Previously (reference Hydrock report CRO-HYD-XX-RS-RP-GE-0001-S2-P4 above), the pore-water concentrations have been extracted from the model and presented as the $SSAC_{gw vap}$ that are protective of human health.

It is recognised that the current modelling approach assumes a very conservative approach to vapour risk assessment, with no allowances being made for potential biodegradation of vapours in the aerobic zone. Accordingly, to remove an element of uncertainty and conservatism the models have been re-run to enable a direct comparison of measured soil vapour concentrations against calculated vapour $SSAC_{vap}$.

Model

The existing CLEA v.7.01 represents the standard SOBRA v1.0 approach for a residential land-use, with the following site-specific parameters based on site conditions:

- » Indoor and outdoor vapour pathways only;
- » Silty clay loam soil type;

» Depth to groundwater 1.5m bgl.

Two different models have been presented below, namely:

- Scenario A - as above with the vapour SSAC presented;
- Scenario B - as above except the CLEA v7.01 defaults for depth for source outside and beneath buildings, as it is accepted that any soil vapour samples that are collected may be taken at a shallower depth than scenario A would assume.

These differences are summarised below in Table 1, with model input sheets included at Annex A:

Table 1: Model scenarios

Input Parameters	Scenario A	Scenario B
Receptor	Female (res C4SL) [default]	Female (res C4SL) [default]
Building Type	Small terraced house [default]	Small terraced house [default]
Pathways	Indoor vapour / outdoor vapour	Indoor vapour / outdoor vapour
Soil type	Silty clay loam [site-specific]	Silty clay loam [site-specific]
Depth to top of source (beneath buildings)	150cm [site specific]	65cm [default]
Depth to top of source (no buildings)	150cm [site specific]	0cm [default]

The Chemicals of Concern (CoC) that have been assessed are detailed below, this is based on the CoC presented in previous reports.

- 1,2 dichloroethane;
- Vinyl chloride (key CoC);
- trichloroethene, 1,1 trichloroethane,
- tetrachloroethene,
- dichloromethane;
- Benzene,
- toluene,
- Ethylbenzene; and
- xylene, (m, p, o species).

Results

Model results are included at Annex B, with the soil vapour concentrations extracted from the "Media Calculations" tab of the CLEA v7.01 spreadsheet. A summary of the results is included below as Table 2. $SSAC_{vap}$ in $\mu\text{g}/\text{m}^3$ have been calculated by multiplying the $SSAC_{vap}$ in mg/cm^3 (direct output in the media calculations sheet) by a factor of 1×10^9 .

Table 2: Derived $SSAC_{vap}$

Scenario	$SSAC_{vap}$ (mg/cm^3)		$SSAC_{vap}$ ($\mu\text{g}/\text{m}^3$)	
	Scenario A	Scenario B	Scenario A	Scenario B
1,2 dichloroethane;	6.01E-06	2.31E-06	6,010	2,310
Vinyl chloride (key CoC);	1.49E-05	5.73E-06	14,900	5,730
trichloroethene	3.50E-04	1.33E-04	350,000	133,000
1,1,1 trichloroethene	4.05E-02	1.54E-02	40,500,000	15,400,000
tetrachloroethene	3.41E-03	1.30E-03	3,410,000	1,300,000

Scenario	SSAC _{vap} (mg/cm ³)		SSAC _{vap} (µg/m ³)	
	Scenario A	Scenario B	Scenario A	Scenario B
toluene	9.19E-01	3.50E-01	919,000,000	350,000,000
ethylbenzene	1.59E-01	6.03E-02	159,000,000	60,300,000
xylene, m-	3.81E-02	1.45E-02	38,100,000	14,500,000
xylene, p-	3.80E-02	1.44E-02	38,000,000	14,400,000
xylene, o-	3.78E-02	1.44E-02	37,800,000	14,400,000
benzene	8.36E-04	3.20E-04	836,000	320,000
dichloromethane	5.61E-03	2.16E-03	5,610,000	2,160,000

Summary and conclusions

Hydrock have derived Site Specific Acceptability Criteria for soil vapours that are protective of human health for the off-site properties. These have been derived for both the original groundwater model and a revised model which have the CLEA defaults enabled for soil sources (i.e. a reduced pathway length for vapours).

As a conservative approach, the SSAC_{vap} for Scenario B should be compared to samples of soil vapours acquired from the site, in order to enable an updated human health risk assessment of the risk posed by chlorinated vapours emanating from the groundwater plume to off-site properties.

Regards

Leon Warrington
Principal Hydrogeologist

M: 07825 399237
E: leonwarrington@hydrock.com

Enc:

- Annex A1 - Hydrock custom SSAC: CLEA v1.07 settings for Scenario A
- Annex A2 - Hydrock custom SSAC: CLEA v1.07 settings for Scenario B
- Annex B1 - Hydrock custom SSAC: CLEA v1.07 results and media calculations sheet for Scenario A
- Annex B2 - Hydrock custom SSAC: CLEA v1.07 results and media calculations sheet for Scenario B

Annex A-1

Hydrock custom SSAC: CLEA v1.07 settings for Scenario A

CLEA Software Version 1.071

Report generated 15/04/2019

Report title

Created by

Page 1 of 5

Environment Agency

BASIC SETTINGS

Land Use	Residential without produce (C4SL)			
Building	Small terraced house			
Receptor	Female (res C4SL)	Start age class	1	
Soil	Silty clay loam	End age class	6	
		Exposure Duration	6	years
Exposure Pathways	Direct soil and dust ingestion			☒
	Consumption of homegrown produce			☒
	Soil attached to homegrown produce			☒
		Dermal contact with indoor dust		☒
		Dermal contact with soil		☒
		Inhalation of indoor dust		☒
		Inhalation of soil dust		☒
		Inhalation of indoor vapour		☒
		Inhalation of outdoor vapour		☒



Land Use Residential without produce (C4SL)

Receptor Female (res C4SL)

Age Class	Exposure Frequencies (days yr ⁻¹)						Occupation Periods (hr day ⁻¹)		Soil to skin adherence factors (mg cm ²)		Direct soil ingestion rate (g day ⁻¹)	Body weight (kg)	Body height (m)	Inhalation rate (m ³ day ⁻¹)	Max exposed skin factor		Total skin area (m ²)
	Direct soil ingestion	Consumption of homegrown produce	Dermal contact with indoor dust	Dermal contact with soil	Inhalation of dust and vapour, indoor	Inhalation of dust and vapour, outdoor	Indoors	Outdoors	Indoor	Outdoor							
1	180	0	180	170	365	365	23.0	1.0	0.06	0.10	0.10	5.60	0.7	5.4	0.32	0.26	3.43E-01
2	365	0	365	170	365	365	23.0	1.0	0.06	0.10	0.10	9.80	0.8	8.0	0.33	0.26	4.84E-01
3	365	0	365	170	365	365	23.0	1.0	0.06	0.10	0.10	12.70	0.9	8.9	0.32	0.25	5.82E-01
4	365	0	365	170	365	365	23.0	1.0	0.06	0.10	0.10	15.10	0.9	10.1	0.35	0.28	6.36E-01
5	365	0	365	170	365	365	19.0	1.0	0.06	0.10	0.10	16.90	1.0	10.1	0.35	0.28	7.04E-01
6	365	0	365	170	365	365	19.0	1.0	0.06	0.10	0.10	19.70	1.1	10.1	0.33	0.26	7.94E-01
7	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	22.10	1.2	12.0	0.22	0.15	8.73E-01
8	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	25.30	1.2	12.0	0.22	0.15	9.36E-01
9	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	27.50	1.3	12.0	0.22	0.15	1.01E+00
10	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	31.40	1.3	12.0	0.22	0.15	1.08E+00
11	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	35.70	1.4	12.0	0.22	0.14	1.19E+00
12	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	41.30	1.4	15.2	0.22	0.14	1.29E+00
13	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	47.20	1.5	15.2	0.22	0.14	1.42E+00
14	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	51.20	1.6	15.2	0.22	0.14	1.52E+00
15	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	56.70	1.6	15.2	0.21	0.14	1.60E+00
16	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	59.00	1.6	15.2	0.21	0.14	1.63E+00
17	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	70.00	1.6	15.7	0.33	0.27	1.78E+00
18	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	70.90	1.6	13.6	0.33	0.27	1.80E+00

Consumption Rates



Age Class	MEAN RATES										90TH PERCENTILE RATES					
	Green veg	Root veg	Tuber veg	Herb. Fruit	Shrub fruit	Tree fruit	Green veg	Root veg	Tuber veg	Herb. Fruit	Shrub fruit	Tree fruit				
1	3.47E+00	5.22E+00	9.22E+00	8.90E-01	1.07E+00	1.87E+00	7.12E+00	1.07E+01	1.60E+01	1.83E+00	2.23E+00	3.82E+00				
2	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01				
3	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01				
4	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01				
5	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00				
6	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00				
7	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00				
8	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00				
9	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00				
10	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00				
11	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00				
12	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00				
13	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00				
14	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00				
15	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00				
16	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00				
17	1.26E+00	6.00E-01	1.18E+00	6.90E-01	9.00E-02	1.27E+00	2.36E+00	1.12E+00	2.35E+00	1.29E+00	1.80E-01	2.38E+00				
18	1.35E+00	6.40E-01	1.25E+00	7.40E-01	1.00E-01	1.36E+00	2.34E+00	1.12E+00	2.36E+00	1.28E+00	1.80E-01	2.37E+00				

Consumption rates (α FW kg^{-1} bodyweight day^{-1}) by Produce Group

Top 2 applied? Yes

Where top 2 method is applied, two produce categories use 90th percentile rates, while the remainder use the mean. Produce categories vary on a chemical-by-chemical basis. Where top 2 method is not used, all produce categories for all chemicals assume 90th percentile rates.

Building Small terraced house

Soil Silty clay loam



Building footprint (m ²)	2.80E+01	Porosity, Total (cm ³ cm ⁻³)	5.80E-01
Living space air exchange rate (hr ⁻¹)	5.00E-01	Porosity, Air-Filled (cm ³ cm ⁻³)	1.20E-01
Living space height (above ground, m)	4.80E+00	Porosity, Water-Filled (cm ³ cm ⁻³)	4.60E-01
Living space height (below ground, m)	0.00E+00	Residual soil water content (cm ³ cm ⁻³)	2.10E-01
Pressure difference (soil to enclosed space, Pa)	3.10E+00	Saturated hydraulic conductivity (cm s ⁻¹)	1.17E-03
Foundation thickness (m)	1.50E-01	van Genuchten shape parameter <i>m</i> (dimensionless)	3.07E-01
Floor crack area (cm ²)	4.23E+02	Bulk density (g cm ⁻³)	1.07E+00
Dust loading factor (µg m ⁻³)	5.00E+01	Threshold value of wind speed at 10m (m s ⁻¹)	7.20E+00
		Empirical function (F _d) for dust model (dimensionless)	1.22E+00
		Ambient soil temperature (K)	2.83E+02
		Soil pH	7.00E+00
		Soil Organic Matter content (%)	2.50E+00
		Fraction of organic carbon (g g ⁻¹)	1.45E-02
		Effective total fluid saturation (unitless)	6.76E-01
		Intrinsic soil permeability (cm ²)	1.56E-08
		Relative soil air permeability (unitless)	4.66E-01
		Effective air permeability (cm ²)	7.28E-09



Soil - Vapour Model

Air Dispersion Model

Depth to top of source (no building) (cm)	150	Mean annual windspeed at 10m (m s ⁻¹)	5.00
Depth to top of source (beneath building) (cm)	150	Air dispersion factor at height of 0.8m *	2400.00
Default soil gas ingress rate?	Yes	Air dispersion factor at height of 1.6m *	0.00
Soil gas ingress rate (cm ³ s ⁻¹)	2.50E+01	Fraction of site cover (m ² m ⁻²)	0.75
Building ventilation rate (cm ³ s ⁻¹)	1.87E+04	* Air dispersion factor in g m ⁻² s ⁻¹ per kg m ⁻³	
Averaging time surface emissions (yr)	6		
Finite vapour source model?	No		
Thickness of contaminated layer (cm)	200		

Dry weight conversion factor

Soil - Plant Model

	g DW g ⁻¹ FW	Homegrown fraction Average	High	Soil loading factor	Preparation correction factor
Green vegetables	0.096	dimensionless	0.05	g g ⁻¹ DW	dimensionless
Root vegetables	0.103	0.33	0.33	1.00E-03	2.00E-01
Tuber vegetables	0.210	0.06	0.40	1.00E-03	1.00E+00
Herbaceous fruit	0.058	0.02	0.13	1.00E-03	1.00E+00
Shrub fruit	0.166	0.06	0.40	1.00E-03	6.00E-01
Tree fruit	0.157	0.09	0.60	1.00E-03	6.00E-01
		0.04	0.27	1.00E-03	6.00E-01

Gardener type None

Annex A-2

Hydrock custom SSAC: CLEA v1.07 settings for Scenario B

CLEA Software Version 1.071

Report generated 15/04/2019

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Created by

Environment Agency

BASIC SETTINGS

Land Use	Residential without produce (C4SL)			
Building	Small terraced house			
Receptor	Female (res C4SL)	Start age class	1	
Soil	Silty clay loam	End age class	6	
		Exposure Duration	6	years
Exposure Pathways				
	Direct soil and dust ingestion			
	Consumption of homegrown produce			
	Soil attached to homegrown produce			
		Dermal contact with indoor dust		
		Dermal contact with soil		
		Inhalation of indoor dust		
		Inhalation of soil dust		
		Inhalation of indoor vapour		
		Inhalation of outdoor vapour		



Land Use Residential without produce (C4SL)

Receptor

Female (res C4SL)

Age Class	Exposure Frequencies (days yr ⁻¹)						Occupation Periods (hr day ⁻¹)		Soil to skin adherence factors (mg cm ⁻²)		Direct soil ingestion rate (g day ⁻¹)	Receptor			Max exposed skin factor		Total skin area (m ²)
	Direct soil ingestion	Consumption of homegrown produce	Dermal contact with indoor dust	Dermal contact with soil	Inhalation of dust and vapour, indoor	Inhalation of dust and vapour, outdoor	Indoors	Outdoors	Indoor	Outdoor		Body weight (kg)	Body height (m)	Inhalation rate (m ³ day ⁻¹)	Indoor (m ² m ⁻²)	Outdoor (m ² m ⁻²)	
1	180	0	180	170	365	365	23.0	1.0	0.06	0.10	0.10	5.60	0.7	5.4	0.32	0.26	3.43E-01
2	365	0	365	170	365	365	23.0	1.0	0.06	0.10	0.10	9.80	0.8	8.0	0.33	0.26	4.84E-01
3	365	0	365	170	365	365	23.0	1.0	0.06	0.10	0.10	12.70	0.9	8.9	0.32	0.25	5.82E-01
4	365	0	365	170	365	365	23.0	1.0	0.06	0.10	0.10	15.10	0.9	10.1	0.35	0.28	6.36E-01
5	365	0	365	170	365	365	19.0	1.0	0.06	0.10	0.10	16.90	1.0	10.1	0.35	0.28	7.04E-01
6	365	0	365	170	365	365	19.0	1.0	0.06	0.10	0.10	19.70	1.1	10.1	0.33	0.26	7.94E-01
7	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	22.10	1.2	12.0	0.22	0.15	8.73E-01
8	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	25.30	1.2	12.0	0.22	0.15	9.36E-01
9	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	27.50	1.3	12.0	0.22	0.15	1.01E+00
10	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	31.40	1.3	12.0	0.22	0.15	1.08E+00
11	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	35.70	1.4	12.0	0.22	0.14	1.19E+00
12	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	41.30	1.4	15.2	0.22	0.14	1.29E+00
13	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	47.20	1.5	15.2	0.22	0.14	1.42E+00
14	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	51.20	1.6	15.2	0.22	0.14	1.52E+00
15	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	56.70	1.6	15.2	0.21	0.14	1.60E+00
16	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	59.00	1.6	15.2	0.21	0.14	1.63E+00
17	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	70.00	1.6	15.7	0.33	0.27	1.78E+00
18	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	70.90	1.6	13.6	0.33	0.27	1.80E+00



Consumption Rates

Consumption rates (a FW kg^{-1} bodyweight day^{-1}) by Produce Group

Age Class	MEAN RATES					90TH PERCENTILE RATES						
	Green veg	Root veg	Tuber veg	Herb. Fruit	Shrub fruit	Tree fruit	Green veg	Root veg	Tuber veg	Herb. Fruit	Shrub fruit	Tree fruit
1	3.47E+00	5.22E+00	9.22E+00	8.90E-01	1.07E+00	1.87E+00	7.12E+00	1.07E+01	1.60E+01	1.83E+00	2.23E+00	3.82E+00
2	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
3	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
4	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
5	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
6	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
7	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
8	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
9	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
10	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
11	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
12	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
13	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
14	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
15	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
16	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
17	1.26E+00	6.00E-01	1.18E+00	6.90E-01	9.00E-02	1.27E+00	2.36E+00	1.12E+00	2.35E+00	1.29E+00	1.80E-01	2.38E+00
18	1.35E+00	6.40E-01	1.25E+00	7.40E-01	1.00E-01	1.36E+00	2.34E+00	1.12E+00	2.36E+00	1.28E+00	1.80E-01	2.37E+00

Top 2 applied? Yes

Where top 2 method is applied, two produce categories use 90th percentile rates, while the remainder use the mean. Produce categories vary on a chemical-by-chemical basis. Where top 2 method is not used, all produce categories for all chemicals assume 90th percentile rates.

Building Small terraced house

Soil Silty clay loam



Building footprint (m ²)	2.80E+01	Porosity, Total (cm ³ cm ⁻³)	5.80E-01
Living space air exchange rate (hr ⁻¹)	5.00E-01	Porosity, Air-Filled (cm ³ cm ⁻³)	1.20E-01
Living space height (above ground, m)	4.80E+00	Porosity, Water-Filled (cm ³ cm ⁻³)	4.60E-01
Living space height (below ground, m)	0.00E+00	Residual soil water content (cm ³ cm ⁻³)	2.10E-01
Pressure difference (soil to enclosed space, Pa)	3.10E+00	Saturated hydraulic conductivity (cm s ⁻¹)	1.17E-03
Foundation thickness (m)	1.50E-01	van Genuchten shape parameter <i>m</i> (dimensionless)	3.07E-01
Floor crack area (cm ²)	4.23E+02	Bulk density (g cm ⁻³)	1.07E+00
Dust loading factor (µg m ⁻³)	5.00E+01	Threshold value of wind speed at 10m (m s ⁻¹)	7.20E+00
		Empirical function (F _d) for dust model (dimensionless)	1.22E+00
		Ambient soil temperature (K)	2.83E+02
		Soil pH	7.00E+00
		Soil Organic Matter content (%)	2.50E+00
		Fraction of organic carbon (g g ⁻¹)	1.45E-02
		Effective total fluid saturation (unitless)	6.76E-01
		Intrinsic soil permeability (cm ²)	1.56E-08
		Relative soil air permeability (unitless)	4.66E-01
		Effective air permeability (cm ²)	7.28E-09



Soil - Vapour Model

Air Dispersion Model

Depth to top of source (no building) (cm)	0	Mean annual windspeed at 10m (m s ⁻¹)	5.00
Depth to top of source (beneath building) (cm)	65	Air dispersion factor at height of 0.8m *	2400.00
Default soil gas ingress rate?	Yes	Air dispersion factor at height of 1.6m *	0.00
Soil gas ingress rate (cm ³ s ⁻¹)	2.50E+01	Fraction of site cover (m ² m ⁻²)	0.75
Building ventilation rate (cm ³ s ⁻¹)	1.87E+04	* Air dispersion factor in g m ⁻² s ⁻¹ per kg m ⁻³	
Averaging time surface emissions (yr)	6		
Finite vapour source model?	No		
Thickness of contaminated layer (cm)	200		

Dry weight conversion factor

Soil - Plant Model

	g DW g ⁻¹ FW	Homegrown fraction Average	High	Soil loading factor	Preparation correction factor
Green vegetables	0.096	dimensionless	0.05	g g ⁻¹ DW	dimensionless
Root vegetables	0.103	0.33	0.06	1.00E-03	2.00E-01
Tuber vegetables	0.210	0.40	0.02	1.00E-03	1.00E+00
Herbaceous fruit	0.058	0.13	0.06	1.00E-03	1.00E+00
Shrub fruit	0.166	0.40	0.06	1.00E-03	6.00E-01
Tree fruit	0.157	0.60	0.09	1.00E-03	6.00E-01
		0.04	0.27	1.00E-03	6.00E-01

Gardener type None

Annex B-1

*Hydrock custom SSAC: CLEA v1.07 results and media calculations
sheet for Scenario A*

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Environment
Agency

Soil-to-water partition coefficient (cm ³ g ⁻¹)	Vapour pressure (Pa)	Water solubility (mg L ⁻¹)	Soil-to-plant concentration factor for green vegetables (mg g ⁻¹ plant DW or FW basis over mg g ⁻¹ DW soil)	Soil-to-plant concentration factor for root vegetables (mg g ⁻¹ plant DW or FW basis over mg g ⁻¹ DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g ⁻¹ plant DW or FW basis over mg g ⁻¹ DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g ⁻¹ plant DW or FW basis over mg g ⁻¹ DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g ⁻¹ plant DW or FW basis over mg g ⁻¹ DW soil)	Soil-to-plant concentration factor for tree fruit (mg g ⁻¹ plant DW or FW basis over mg g ⁻¹ DW soil)
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[illegible]

[illegible]

Outdoor Air Concentration of Vapours

[illegible]

[illegible]

[illegible]

Annex B-2

*Hydrock custom SSAC: CLEA v1.07 results and media calculations
sheet for Scenario B*

[illegible]

Outdoor Air Concentration of Vapours

[illegible]

[illegible]

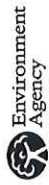
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CLEA Software Version 1.071		Page 1 of 11
Report generated	15-Apr-19	
Report title		
Created by		
RESULTS		



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[illegible]

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CLEA Software Version 1.071		Report generated 15-Apr-19		Page 9 of 11	
	Oral Health Criteria Value	($\mu\text{g kg}^{-1}\text{ BW day}^{-1}$)			
	Inhalation Health Criteria Value	($\mu\text{g kg}^{-1}\text{ BW day}^{-1}$)			
	Inhalation Mean Daily Intake	($\mu\text{g day}^{-1}$)			
	Air-water partition coefficient	(K_{aw}) ($\text{cm}^3\text{ cm}^{-3}$)			
	Coefficient of Diffusion in Air	($\text{m}^2\text{ s}^{-1}$)			
	Coefficient of Diffusion in Water	($\text{m}^2\text{ s}^{-1}$)			
	$\log K_{oc}$ ($\text{cm}^3\text{ g}^{-1}$)				
	$\log K_{ow}$ (dimensionless)				
	Dermal Absorption Fraction (dimensionless)				
	Soil-to-dust transport factor	($\text{g g}^{-1}\text{ DW}$)			
	Sub-surface soil to indoor air correction factor (dimensionless)				
	Relative bioavailability via soil ingestion (unitless)				
	Relative bioavailability via dust inhalation (unitless)				
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29					
30					

[illegible]



Soil-to-water partition coefficient (cm ³ g ⁻¹)	Vapour pressure (Pa)	Water solubility (mg L ⁻¹)	Soil-to-plant concentration factor for green vegetables (mg g ⁻¹ plant DW or FW basis over mg g ⁻¹ DW soil)	Soil-to-plant concentration factor for root vegetables (mg g ⁻¹ plant DW or FW basis over mg g ⁻¹ DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g ⁻¹ plant DW or FW basis over mg g ⁻¹ DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g ⁻¹ plant DW or FW basis over mg g ⁻¹ DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g ⁻¹ plant DW or FW basis over mg g ⁻¹ DW soil)	Soil-to-plant concentration factor for tree fruit (mg g ⁻¹ plant DW or FW basis over mg g ⁻¹ DW soil)
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Appendix C Laboratory Certificates



Unit 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
Deeside
CH5 3US
Tel: (01244) 528700
Fax: (01244) 528701
email: hawardencustomerservices@alsglobal.com
Website: www.alsenvironmental.co.uk

FLI QDS
18 The Pines Business Park
Broad Street
GU3 3BH

Attention: Ellie Cotterill

CERTIFICATE OF ANALYSIS

Date of report Generation:	11 March 2019
Customer:	H_FLIQDS_GUI
Sample Delivery Group (SDG):	190302-32
Your Reference:	Crowland
Location:	Crowland
Report No:	496181

We received 4 samples on Saturday March 02, 2019 and 4 of these samples were scheduled for analysis which was completed on Monday March 11, 2019. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

All sample data is provided by the customer. The reported results relate to the sample supplied, and on the basis that this data is correct.

Incorrect sampling dates and/or sample information will affect the validity of results.

The customer is not permitted to reproduce this report except in full without the approval of the laboratory.

Approved By:

Sonia McWhan

Operations Manager



CERTIFICATE OF ANALYSIS

Validated

SDG: 190302-32
Location: Crowland

Client Reference: Crowland
Order Number: PO-0000434

Report Number: 496181
Superseded Report:

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
19468139	001		0.70 - 0.70	28/02/2019
19468140	002		0.70 - 0.70	28/02/2019
19468141	003		0.70 - 0.70	28/02/2019
19468142	004		0.70 - 0.70	28/02/2019

Maximum Sample/Coolbox Temperature (°C) :

6.8

ISO 5667-3 Water quality - Sampling - Part 3 -
during Transportation samples shall be stored in a cooling device capable of maintaining
temperature of (5±3)°C.

ALS have data which show that a cool box with 4 frozen icepacks is capable of
maintaining pre-chilled samples at a temperature of (5±3)°C for a period of up to 24hrs.

Only received samples which have had analysis scheduled will be shown on the following pages.



Validated

CERTIFICATE OF ANALYSIS

SDG: 190302-32
Location: CrowlandClient Reference: Crowland
Order Number: PO-0000434Report Number: 496181
Superseded Report:

Results Legend



Test

No Determination
Possible

Sample Types -

S - Soil/Solid
UNS - Unspecified Solid
GW - Ground Water
SW - Surface Water
LE - Land Leachate
PL - Prepared Leachate
PR - Process Water
SA - Saline Water
TE - Trade Effluent
TS - Treated Sewage
US - Untreated Sewage
RE - Recreational Water
DW - Drinking Water Non-regulatory
UNL - Unspecified Liquid
SL - Sludge
G - Gas
OTH - Other

/OC's

Lab Sample No(s)	19468142	19468141	19468140	19468139
Customer Sample Reference	004	003	002	001
AGS Reference				
Depth (m)	0.70 - 0.70	0.70 - 0.70	0.70 - 0.70	0.70 - 0.70
Container	Gas Canister	Gas Canister	Gas Canister	Gas Canister
Sample Type	G	G	G	G
All	NDPs: 0			
	Tests: 4			
	X	X	X	X



CERTIFICATE OF ANALYSIS

Validated

SDG: 190302-32
Location: CrowlandClient Reference: Crowland
Order Number: PO-0000434Report Number: 496181
Superseded Report:

Sample Number 19468139

Sample ID 001

Depth 0.70 - 0.70

Sampled Date 28/02/2019 00:00:00

Method TM330 Determination of VOC's in atmospheric, sub-slab and soil gas samples

Canister No. 10252

Sample Volume (ml) 5 Dispatch pressure (psia) -0.13 Initial pressure (psia) 12.84 Final pressure (psia) 20.03 Dilution 1.5599688474

CAS Number	Compound	LOD	Result	Units	LOD	Result	Units
71-55-6	1,1,1-Trichloroethane	<46.8	62.7	ppbv	<255	341	ug/m ³
79-34-5	1,1,2,2-Tetrachloroethane	<46.8	<46.8	ppbv	<322	<322	ug/m ³
79-00-5	1,1,2-Trichloroethane	<46.8	<46.8	ppbv	<255	<255	ug/m ³
75-34-3	1,1-Dichloroethane	<46.8	404	ppbv	<189	1640	ug/m ³
75-35-4	1,1-Dichloroethene	<46.8	<46.8	ppbv	<186	<186	ug/m ³
526-73-8	1,2,3-Trimethylbenzene	<46.8	<46.8	ppbv	<230	<230	ug/m ³
120-82-1	1,2,4-Trichlorobenzene	<46.8	<46.8	ppbv	<346	<346	ug/m ³
95-63-6	1,2,4-Trimethylbenzene	<46.8	<46.8	ppbv	<230	<230	ug/m ³
106-93-4	1,2-Dibromoethane	<46.8	<46.8	ppbv	<360	<360	ug/m ³
95-50-1	1,2-Dichlorobenzene	<46.8	<46.8	ppbv	<281	<281	ug/m ³
107-06-2	1,2-Dichloroethane	<46.8	<46.8	ppbv	<189	<189	ug/m ³
78-87-5	1,2-Dichloropropane	<46.8	<46.8	ppbv	<216	<216	ug/m ³
76-14-2	1,2-Dichlorotetrafluoroethane	<46.8	<46.8	ppbv	<327	<327	ug/m ³
108-67-8	1,3,5-Trimethylbenzene	<46.8	<46.8	ppbv	<230	<230	ug/m ³
106-99-0	1,3-Butadiene	<46.8	<46.8	ppbv	<103	<103	ug/m ³
106-46-7	1,4-Dichlorobenzene	<46.8	<46.8	ppbv	<281	<281	ug/m ³
123-91-1	1,4-Dioxane	<46.8	<46.799065422	ppbv	<168	<168	ug/m ³
71-23-8	1-Propanol	<46.8	<46.8	ppbv	<115	<115	ug/m ³
78-93-3	2-Butanone (MEK)	<46.8	<46.8	ppbv	<138	<138	ug/m ³
591-78-6	2-Hexanone	<46.8	<46.8	ppbv	<191	<191	ug/m ³
107-87-9	2-Pentanone	<46.8	<46.8	ppbv	<165	<165	ug/m ³
589-38-8	3-Hexanone	<46.8	<46.8	ppbv	<191	<191	ug/m ³
96-22-0	3-Pentanone	<46.8	<46.8	ppbv	<165	<165	ug/m ³
108-10-1	4-Methyl-2-pentanone	<46.8	<46.8	ppbv	<191	<191	ug/m ³
67-64-1 & 123-38-6	Acetone + Propanal	<46.8	249	ppbv	<111	591	ug/m ³
75-05-8	Acetonitrile	<46.8	<46.8	ppbv	<78.5	<78.5	ug/m ³
107-02-8	Acrolein	<46.8	<46.8	ppbv	<107	<107	ug/m ³
71-43-2	Benzene	<40.6	<40.6	ppbv	<130	<129	ug/m ³
100-44-7	Benzyl Chloride	<46.8	<46.8	ppbv	<243	<243	ug/m ³
75-27-4	Bromodichloromethane	<46.8	<46.8	ppbv	<314	<314	ug/m ³
75-25-2	Bromoform	<46.8	<46.8	ppbv	<484	<484	ug/m ³
74-83-9	Bromomethane	<46.8	<46.8	ppbv	<182	<182	ug/m ³
123-72-8	Butanal	<46.8	<46.8	ppbv	<138	<138	ug/m ³
75-15-0	Carbon Disulfide	<46.8	<46.8	ppbv	<145	<145	ug/m ³
56-23-5	Carbon Tetrachloride	<46.8	<46.8	ppbv	<295	<295	ug/m ³
108-90-7	Chlorobenzene	<46.8	<46.8	ppbv	<216	<216	ug/m ³
75-00-3	Chloroethane	<46.8	<46.8	ppbv	<124	<124	ug/m ³
67-66-3	Chloroform	<46.8	<46.8	ppbv	<228	<228	ug/m ³
74-87-3	Chloromethane	<46.8	<46.8	ppbv	<95.7	<95.7	ug/m ³
156-59-2	cis-1,2-Dichloroethene	<46.8	569	ppbv	<186	2260	ug/m ³
10061-01-5	cis-1,3-Dichloropropene	<46.8	<46.8	ppbv	<212	<212	ug/m ³
110-82-7	Cyclohexane	<46.8	<46.8	ppbv	<161	<161	ug/m ³
75-71-8	Dichlorodifluoromethane	<46.8	<46.8	ppbv	<232	<232	ug/m ³
75-45-6	Difluorochloromethane	<46.8	<46.8	ppbv	<165	<165	ug/m ³
100-41-4	Ethylbenzene	<46.8	<46.8	ppbv	<203	<203	ug/m ³
87-68-3	Hexachlorobutadiene	<46.8	<46.8	ppbv	<498	<498	ug/m ³
66-25-1	Hexanal	<46.8	<46.8	ppbv	<191	<191	ug/m ³



CERTIFICATE OF ANALYSIS

Validated

SDG: 190302-32
Location: CrowlandClient Reference: Crowland
Order Number: PO-0000434Report Number: 496181
Superseded Report:Sample Number 19468139
Sample ID 001

Depth 0.70 - 0.70

Sampled Date 28/02/2019 00:00:00

Method TM330 Determination of VOC's in atmospheric, sub-slab and soil gas samples

Canister No. 10252

Sample Volume (ml) 5 Dispatch pressure (psia) -0.13 Initial pressure (psia) 12.84 Final pressure (psia) 20.03 Dilution 1.5599688474

CAS Number	Compound	LOD	Result	Units	LOD	Result	Units
110-54-3	Hexane	<46.8	<46.8	ppbv	<165	<165	ug/m ³
74-88-4	Iodomethane	<46.8	<46.8	ppbv	<272	<272	ug/m ³
115-11-7	Isobutene	<46.8	<46.8	ppbv	<107	<107	ug/m ³
78-79-5	Isoprene	<46.8	<46.8	ppbv	<130	<130	ug/m ³
108-38-3 & 106-42-3	m/p-Xylene	<46.8	<46.8	ppbv	<203	<203	ug/m ³
78-85-3	Methylacrolein	<46.8	<46.8	ppbv	<134	<134	ug/m ³
75-09-2	Methylene Chloride	<46.8	<46.8	ppbv	<163	<163	ug/m ³
1634-04-4	MTBE	<46.8	<46.8	ppbv	<168	<168	ug/m ³
	Naphthalene	<46.8	<46.799065422	ppbv	<245	<245	ug/m ³
95-47-6	o-Xylene	<46.8	<46.8	ppbv	<203	<203	ug/m ³
110-62-3	Pentanal	<46.8	<46.8	ppbv	<165	<165	ug/m ³
109-66-0	Pentane	<46.8	<46.8	ppbv	<138	<138	ug/m ³
100-42-5	Styrene	<46.8	<46.8	ppbv	<199	<199	ug/m ³
127-18-4	Tetrachloroethene	<46.8	634	ppbv	<318	4300	ug/m ³
108-88-3	Toluene	<46.8	209	ppbv	<176	787	ug/m ³
156-60-5	trans-1,2-Dichloroethene	<46.8	110	ppbv	<186	435	ug/m ³
1006-02-6	trans-1,3-Dichloropropene	<46.8	<46.8	ppbv	<212	<212	ug/m ³
79-01-6	Trichloroethene	<46.8	705	ppbv	<251	3780	ug/m ³
75-69-4	Trichlorofluoromethane	<46.8	<46.8	ppbv	<262	<262	ug/m ³
26523-64-8	Trichlorotrifluoroethane	<46.8	<46.8	ppbv	<358	<358	ug/m ³
108-05-4	Vinyl Acetate	<46.8	<46.8	ppbv	<165	<165	ug/m ³
75-01-4	Vinyl Chloride	<46.8	<46.8	ppbv	<119	<119	ug/m ³



CERTIFICATE OF ANALYSIS

Validated

SDG: 190302-32
Location: CrowlandClient Reference: Crowland
Order Number: PO-0000434Report Number: 496181
Superseded Report:Sample Number 19468140
Sample ID 002

Depth 0.70 - 0.70

Sampled Date 28/02/2019 00:00:00

Method TM330 Determination of VOC's in atmospheric, sub-slab and soil gas samples

Canister No. 10255

Sample Volume (ml) 5 Dispatch pressure (psia) -0.13 Initial pressure (psia) 13.99 Final pressure (psia) 19.56 Dilution 1.3981415297

CAS Number	Compound	LOD	Result	Units	LOD	Result	Units
71-55-6	1,1,1-Trichloroethane	<41.9	160	ppbv	<228	869	ug/m ³
79-34-5	1,1,2,2-Tetrachloroethane	<41.9	<41.9	ppbv	<288	<288	ug/m ³
79-00-5	1,1,2-Trichloroethane	<41.9	<41.9	ppbv	<228	<228	ug/m ³
75-34-3	1,1-Dichloroethane	<41.9	1160	ppbv	<170	4700	ug/m ³
75-35-4	1,1-Dichloroethene	<41.9	<41.9	ppbv	<166	<166	ug/m ³
526-73-8	1,2,3-Trimethylbenzene	<41.9	<41.9	ppbv	<206	<206	ug/m ³
120-82-1	1,2,4-Trichlorobenzene	<41.9	<41.9	ppbv	<310	<311	ug/m ³
95-63-6	1,2,4-Trimethylbenzene	<41.9	<41.9	ppbv	<206	<206	ug/m ³
106-93-4	1,2-Dibromoethane	<41.9	<41.9	ppbv	<322	<323	ug/m ³
95-50-1	1,2-Dichlorobenzene	<41.9	<41.9	ppbv	<252	<252	ug/m ³
107-06-2	1,2-Dichloroethane	<41.9	<41.9	ppbv	<170	<170	ug/m ³
78-87-5	1,2-Dichloropropane	<41.9	<41.9	ppbv	<194	<194	ug/m ³
76-14-2	1,2-Dichlorotetrafluoroethane	<41.9	<41.9	ppbv	<293	<293	ug/m ³
108-67-8	1,3,5-Trimethylbenzene	<41.9	<41.9	ppbv	<206	<206	ug/m ³
106-99-0	1,3-Butadiene	<41.9	<41.9	ppbv	<92.5	<92.6	ug/m ³
106-46-7	1,4-Dichlorobenzene	<41.9	<41.9	ppbv	<252	<252	ug/m ³
123-91-1	1,4-Dioxane	<41.9	<41.944245891	ppbv	<151	<151	ug/m ³
71-23-8	1-Propanol	<41.9	<41.9	ppbv	<103	<103	ug/m ³
78-93-3	2-Butanone (MEK)	<41.9	77.3	ppbv	<123	228	ug/m ³
591-78-6	2-Hexanone	<41.9	<41.9	ppbv	<171	<172	ug/m ³
107-87-9	2-Pentanone	<41.9	<41.9	ppbv	<147	<148	ug/m ³
589-38-8	3-Hexanone	<41.9	<41.9	ppbv	<171	<172	ug/m ³
96-22-0	3-Pentanone	<41.9	<41.9	ppbv	<147	<148	ug/m ³
108-10-1	4-Methyl-2-pentanone	<41.9	<41.9	ppbv	<171	<172	ug/m ³
67-64-1 & 123-38-6	Acetone + Propanal	<41.9	242	ppbv	<99.4	575	ug/m ³
75-05-8	Acetonitrile	<41.9	<41.9	ppbv	<70.3	<70.3	ug/m ³
107-02-8	Acrolein	<41.9	<41.9	ppbv	<96.0	<96.1	ug/m ³
71-43-2	Benzene	<36.4	<36.4	ppbv	<116	<116	ug/m ³
100-44-7	Benzyl Chloride	<41.9	<41.9	ppbv	<218	<218	ug/m ³
75-27-4	Bromodichloromethane	<41.9	<41.9	ppbv	<281	<281	ug/m ³
75-25-2	Bromoform	<41.9	<41.9	ppbv	<434	<434	ug/m ³
74-83-9	Bromomethane	<41.9	<41.9	ppbv	<163	<163	ug/m ³
123-72-8	Butanal	<41.9	<41.9	ppbv	<123	<124	ug/m ³
75-15-0	Carbon Disulfide	<41.9	<41.9	ppbv	<130	<130	ug/m ³
56-23-5	Carbon Tetrachloride	<41.9	<41.9	ppbv	<264	<264	ug/m ³
108-90-7	Chlorobenzene	<41.9	<41.9	ppbv	<194	<194	ug/m ³
75-00-3	Chloroethane	<41.9	<41.9	ppbv	<111	<112	ug/m ³
67-66-3	Chloroform	<41.9	<41.9	ppbv	<204	<204	ug/m ³
74-87-3	Chloromethane	<41.9	<41.9	ppbv	<85.7	<85.8	ug/m ³
156-59-2	cis-1,2-Dichloroethene	<41.9	105	ppbv	<166	416	ug/m ³
10061-01-5	cis-1,3-Dichloropropene	<41.9	<41.9	ppbv	<190	<190	ug/m ³
110-82-7	Cyclohexane	<41.9	<41.9	ppbv	<144	<144	ug/m ³
75-71-8	Dichlorodifluoromethane	<41.9	<41.9	ppbv	<207	<208	ug/m ³
75-45-6	Difluorochloromethane	<41.9	<41.9	ppbv	<147	<148	ug/m ³
100-41-4	Ethylbenzene	<41.9	<41.9	ppbv	<182	<182	ug/m ³
87-68-3	Hexachlorobutadiene	<41.9	<41.9	ppbv	<446	<446	ug/m ³
66-25-1	Hexanal	<41.9	<41.9	ppbv	<171	<172	ug/m ³



CERTIFICATE OF ANALYSIS

Validated

SDG: 190302-32
Location: CrowlandClient Reference: Crowland
Order Number: PO-0000434Report Number: 496181
Superseded Report:Sample Number 19468140
Sample ID 002

Depth 0.70 - 0.70

Sampled Date 28/02/2019 00:00:00

Method TM330 Determination of VOC's in atmospheric, sub-slab and soil gas samples

Canister No. 10255

Sample Volume (ml) 5 Dispatch pressure (psia) -0.13 Initial pressure (psia) 13.99 Final pressure (psia) 19.56 Dilution 1.3981415297

CAS Number	Compound	LOD	Result	Units	LOD	Result	Units
110-54-3	Hexane	<41.9	<41.9	ppbv	<147	<148	ug/m ³
74-88-4	Iodomethane	<41.9	<41.9	ppbv	<243	<244	ug/m ³
115-11-7	Isobutene	<41.9	<41.9	ppbv	<96.0	<96.1	ug/m ³
78-79-5	Isoprene	<41.9	<41.9	ppbv	<117	<117	ug/m ³
108-38-3 & 106-42-3	m/p-Xylene	<41.9	<41.9	ppbv	<182	<182	ug/m ³
78-85-3	Methylacrolein	<41.9	<41.9	ppbv	<120	<120	ug/m ³
75-09-2	Methylene Chloride	<41.9	<41.9	ppbv	<146	<146	ug/m ³
1634-04-4	MTBE	<41.9	<41.9	ppbv	<151	<151	ug/m ³
	Naphthalene	<41.9	<41.944245891	ppbv	<219	<220	ug/m ³
95-47-6	o-Xylene	<41.9	<41.9	ppbv	<182	<182	ug/m ³
110-62-3	Pentanal	<41.9	<41.9	ppbv	<147	<148	ug/m ³
109-66-0	Pentane	<41.9	<41.9	ppbv	<123	<124	ug/m ³
100-42-5	Styrene	<41.9	<41.9	ppbv	<178	<178	ug/m ³
127-18-4	Tetrachloroethene	<41.9	64.1	ppbv	<284	435	ug/m ³
108-88-3	Toluene	<41.9	193	ppbv	<158	727	ug/m ³
156-60-5	trans-1,2-Dichloroethene	<41.9	107	ppbv	<166	423	ug/m ³
1006-02-6	trans-1,3-Dichloropropene	<41.9	<41.9	ppbv	<190	<190	ug/m ³
79-01-6	Trichloroethene	<41.9	206	ppbv	<224	1100	ug/m ³
75-69-4	Trichlorofluoromethane	<41.9	<41.9	ppbv	<235	<235	ug/m ³
26523-64-8	Trichlorotrifluoroethane	<41.9	<41.9	ppbv	<320	<321	ug/m ³
108-05-4	Vinyl Acetate	<41.9	<41.9	ppbv	<147	<148	ug/m ³
75-01-4	Vinyl Chloride	<41.9	<41.9	ppbv	<106	<106	ug/m ³



CERTIFICATE OF ANALYSIS

Validated

SDG: 190302-32
Location: CrowlandClient Reference: Crowland
Order Number: PO-0000434Report Number: 496181
Superseded Report:

Sample Number 19468141

Sample ID 003

Depth 0.70 - 0.70

Sampled Date 28/02/2019 00:00:00

Method TM330 Determination of VOC's in atmospheric, sub-slab and soil gas samples

Canister No. 10265

Sample Volume (ml) 5 Dispatch pressure (psia) -0.12 Initial pressure (psia) 15.12 Final pressure (psia) 19.53 Dilution 1.291666667

CAS Number	Compound	LOD	Result	Units	LOD	Result	Units
71-55-6	1,1,1-Trichloroethane	<38.8	61.6	ppbv	<211	335	ug/m ³
79-34-5	1,1,2,2-Tetrachloroethane	<38.8	<38.8	ppbv	<267	<266	ug/m ³
79-00-5	1,1,2-Trichloroethane	<38.8	<38.8	ppbv	<211	<211	ug/m ³
75-34-3	1,1-Dichloroethane	<38.8	337	ppbv	<157	1370	ug/m ³
75-35-4	1,1-Dichloroethene	<38.8	<38.8	ppbv	<154	<154	ug/m ³
526-73-8	1,2,3-Trimethylbenzene	<38.8	<38.8	ppbv	<190	<190	ug/m ³
120-82-1	1,2,4-Trichlorobenzene	<38.8	<38.8	ppbv	<287	<287	ug/m ³
95-63-6	1,2,4-Trimethylbenzene	<38.8	<38.8	ppbv	<190	<190	ug/m ³
106-93-4	1,2-Dibromoethane	<38.8	<38.8	ppbv	<298	<298	ug/m ³
95-50-1	1,2-Dichlorobenzene	<38.8	<38.8	ppbv	<233	<233	ug/m ³
107-06-2	1,2-Dichloroethane	<38.8	<38.8	ppbv	<157	<157	ug/m ³
78-87-5	1,2-Dichloropropane	<38.8	<38.8	ppbv	<179	<179	ug/m ³
76-14-2	1,2-Dichlorotetrafluoroethane	<38.8	<38.8	ppbv	<271	<271	ug/m ³
108-67-8	1,3,5-Trimethylbenzene	<38.8	<38.8	ppbv	<190	<190	ug/m ³
106-99-0	1,3-Butadiene	<38.8	<38.8	ppbv	<85.7	<85.6	ug/m ³
106-46-7	1,4-Dichlorobenzene	<38.8	<38.8	ppbv	<233	<233	ug/m ³
123-91-1	1,4-Dioxane	<38.8	<38.750000001	ppbv	<140	<139	ug/m ³
71-23-8	1-Propanol	<38.8	<38.8	ppbv	<95.2	<95.1	ug/m ³
78-93-3	2-Butanone (MEK)	<38.8	<38.8	ppbv	<114	<114	ug/m ³
591-78-6	2-Hexanone	<38.8	<38.8	ppbv	<159	<158	ug/m ³
107-87-9	2-Pentanone	<38.8	<38.8	ppbv	<136	<136	ug/m ³
589-38-8	3-Hexanone	<38.8	<38.8	ppbv	<159	<158	ug/m ³
96-22-0	3-Pentanone	<38.8	<38.8	ppbv	<136	<136	ug/m ³
108-10-1	4-Methyl-2-pentanone	<38.8	<38.8	ppbv	<159	<158	ug/m ³
67-64-1 & 123-38-6	Acetone + Propanal	<38.8	254	ppbv	<92.0	603	ug/m ³
75-05-8	Acetonitrile	<38.8	<38.8	ppbv	<65.1	<65.0	ug/m ³
107-02-8	Acrolein	<38.8	<38.8	ppbv	<88.9	<88.8	ug/m ³
71-43-2	Benzene	<33.6	<33.6	ppbv	<107	<107	ug/m ³
100-44-7	Benzyl Chloride	<38.8	<38.8	ppbv	<202	<201	ug/m ³
75-27-4	Bromodichloromethane	<38.8	<38.8	ppbv	<260	<260	ug/m ³
75-25-2	Bromoform	<38.8	<38.8	ppbv	<401	<401	ug/m ³
74-83-9	Bromomethane	<38.8	<38.8	ppbv	<151	<151	ug/m ³
123-72-8	Butanal	<38.8	<38.8	ppbv	<114	<114	ug/m ³
75-15-0	Carbon Disulfide	<38.8	<38.8	ppbv	<121	<120	ug/m ³
56-23-5	Carbon Tetrachloride	<38.8	<38.8	ppbv	<244	<244	ug/m ³
108-90-7	Chlorobenzene	<38.8	<38.8	ppbv	<179	<179	ug/m ³
75-00-3	Chloroethane	<38.8	<38.8	ppbv	<103	<103	ug/m ³
67-66-3	Chloroform	<38.8	<38.8	ppbv	<189	<189	ug/m ³
74-87-3	Chloromethane	<38.8	<38.8	ppbv	<79.3	<79.2	ug/m ³
156-59-2	cis-1,2-Dichloroethene	<38.8	<38.8	ppbv	<154	<154	ug/m ³
10061-01-5	cis-1,3-Dichloropropene	<38.8	<38.8	ppbv	<176	<176	ug/m ³
110-82-7	Cyclohexane	<38.8	<38.8	ppbv	<133	<133	ug/m ³
75-71-8	Dichlorodifluoromethane	<38.8	<38.8	ppbv	<192	<192	ug/m ³
75-45-6	Difluorochloromethane	<38.8	<38.8	ppbv	<136	<136	ug/m ³
100-41-4	Ethylbenzene	<38.8	<38.8	ppbv	<168	<168	ug/m ³
87-68-3	Hexachlorobutadiene	<38.8	<38.8	ppbv	<413	<412	ug/m ³
66-25-1	Hexanal	<38.8	<38.8	ppbv	<159	<158	ug/m ³



CERTIFICATE OF ANALYSIS

Validated

SDG: 190302-32
Location: CrowlandClient Reference: Crowland
Order Number: PO-0000434Report Number: 496181
Superseded Report:

Sample Number 19468141

Sample ID 003

Depth 0.70 - 0.70

Sampled Date 28/02/2019 00:00:00

Method TM330 Determination of VOC's in atmospheric, sub-slab and soil gas samples

Canister No. 10265

Sample Volume (ml) 5 Dispatch pressure (psia) -0.12 Initial pressure (psia) 15.12 Final pressure (psia) 19.53 Dilution 1.291666667

CAS Number	Compound	LOD	Result	Units	LOD	Result	Units
110-54-3	Hexane	<38.8	45.9	ppbv	<136	161	ug/m ³
74-88-4	Iodomethane	<38.8	<38.8	ppbv	<225	<225	ug/m ³
115-11-7	Isobutene	<38.8	<38.8	ppbv	<88.9	<88.8	ug/m ³
78-79-5	Isoprene	<38.8	<38.8	ppbv	<108	<108	ug/m ³
108-38-3 & 106-42-3	m/p-Xylene	<38.8	62.6	ppbv	<168	271	ug/m ³
78-85-3	Methylacrolein	<38.8	<38.8	ppbv	<111	<111	ug/m ³
75-09-2	Methylene Chloride	<38.8	<38.8	ppbv	<135	<135	ug/m ³
1634-04-4	MTBE	<38.8	<38.8	ppbv	<140	<139	ug/m ³
	Naphthalene	<38.8	<38.75000001	ppbv	<203	<203	ug/m ³
95-47-6	o-Xylene	<38.8	<38.8	ppbv	<168	<168	ug/m ³
110-62-3	Pentanal	<38.8	<38.8	ppbv	<136	<136	ug/m ³
109-66-0	Pentane	<38.8	62.5	ppbv	<114	184	ug/m ³
100-42-5	Styrene	<38.8	<38.8	ppbv	<165	<165	ug/m ³
127-18-4	Tetrachloroethene	<38.8	<38.8	ppbv	<263	<263	ug/m ³
108-88-3	Toluene	<38.8	248	ppbv	<146	934	ug/m ³
156-60-5	trans-1,2-Dichloroethene	<38.8	90.2	ppbv	<154	358	ug/m ³
1006-02-6	trans-1,3-Dichloropropene	<38.8	<38.8	ppbv	<176	<176	ug/m ³
79-01-6	Trichloroethene	<38.8	51.8	ppbv	<208	278	ug/m ³
75-69-4	Trichlorofluoromethane	<38.8	<38.8	ppbv	<217	<217	ug/m ³
26523-64-8	Trichlorotrifluoroethane	<38.8	<38.8	ppbv	<297	<296	ug/m ³
108-05-4	Vinyl Acetate	<38.8	<38.8	ppbv	<136	<136	ug/m ³
75-01-4	Vinyl Chloride	<38.8	<38.8	ppbv	<98.4	<98.3	ug/m ³



CERTIFICATE OF ANALYSIS

Validated

SDG: 190302-32
Location: CrowlandClient Reference: Crowland
Order Number: PO-0000434Report Number: 496181
Superseded Report:

Sample Number 19468142

Sample ID 004

Depth 0.70 - 0.70

Sampled Date 28/02/2019 00:00:00

Method TM330 Determination of VOC's in atmospheric, sub-slab and soil gas samples

Canister No. 10273

Sample Volume (ml) 5 Dispatch pressure (psia) -0.12 Initial pressure (psia) 12.60 Final pressure (psia) 19.62 Dilution 1.5571428571

CAS Number	Compound	LOD	Result	Units	LOD	Result	Units
71-55-6	1,1,1-Trichloroethane	<46.7	<46.7	ppbv	<254	<254	ug/m ³
79-34-5	1,1,2,2-Tetrachloroethane	<46.7	<46.7	ppbv	<321	<321	ug/m ³
79-00-5	1,1,2-Trichloroethane	<46.7	<46.7	ppbv	<254	<254	ug/m ³
75-34-3	1,1-Dichloroethane	<46.7	81.6	ppbv	<189	331	ug/m ³
75-35-4	1,1-Dichloroethene	<46.7	<46.7	ppbv	<185	<185	ug/m ³
526-73-8	1,2,3-Trimethylbenzene	<46.7	<46.7	ppbv	<229	<229	ug/m ³
120-82-1	1,2,4-Trichlorobenzene	<46.7	<46.7	ppbv	<346	<346	ug/m ³
95-63-6	1,2,4-Trimethylbenzene	<46.7	<46.7	ppbv	<229	<229	ug/m ³
106-93-4	1,2-Dibromoethane	<46.7	<46.7	ppbv	<359	<359	ug/m ³
95-50-1	1,2-Dichlorobenzene	<46.7	<46.7	ppbv	<281	<281	ug/m ³
107-06-2	1,2-Dichloroethane	<46.7	<46.7	ppbv	<189	<189	ug/m ³
78-87-5	1,2-Dichloropropane	<46.7	<46.7	ppbv	<216	<216	ug/m ³
76-14-2	1,2-Dichlorotetrafluoroethane	<46.7	<46.7	ppbv	<327	<327	ug/m ³
108-67-8	1,3,5-Trimethylbenzene	<46.7	<46.7	ppbv	<229	<229	ug/m ³
106-99-0	1,3-Butadiene	<46.7	<46.7	ppbv	<103	<103	ug/m ³
106-46-7	1,4-Dichlorobenzene	<46.7	<46.7	ppbv	<281	<281	ug/m ³
123-91-1	1,4-Dioxane	<46.7	<46.714285713	ppbv	<168	<168	ug/m ³
71-23-8	1-Propanol	<46.7	<46.7	ppbv	<115	<115	ug/m ³
78-93-3	2-Butanone (MEK)	<46.7	54.6	ppbv	<138	161	ug/m ³
591-78-6	2-Hexanone	<46.7	<46.7	ppbv	<191	<191	ug/m ³
107-87-9	2-Pentanone	<46.7	<46.7	ppbv	<164	<164	ug/m ³
589-38-8	3-Hexanone	<46.7	<46.7	ppbv	<191	<191	ug/m ³
96-22-0	3-Pentanone	<46.7	<46.7	ppbv	<164	<164	ug/m ³
108-10-1	4-Methyl-2-pentanone	<46.7	<46.7	ppbv	<191	<191	ug/m ³
67-64-1 & 123-38-6	Acetone + Propanal	<46.7	173	ppbv	<111	410	ug/m ³
75-05-8	Acetonitrile	<46.7	<46.7	ppbv	<78.3	<78.3	ug/m ³
107-02-8	Acrolein	<46.7	<46.7	ppbv	<107	<107	ug/m ³
71-43-2	Benzene	<40.5	<40.5	ppbv	<129	<129	ug/m ³
100-44-7	Benzyl Chloride	<46.7	<46.7	ppbv	<243	<243	ug/m ³
75-27-4	Bromodichloromethane	<46.7	<46.7	ppbv	<313	<313	ug/m ³
75-25-2	Bromoform	<46.7	<46.7	ppbv	<483	<483	ug/m ³
74-83-9	Bromomethane	<46.7	<46.7	ppbv	<181	<182	ug/m ³
123-72-8	Butanal	<46.7	<46.7	ppbv	<138	<138	ug/m ³
75-15-0	Carbon Disulfide	<46.7	<46.7	ppbv	<145	<145	ug/m ³
56-23-5	Carbon Tetrachloride	<46.7	<46.7	ppbv	<294	<294	ug/m ³
108-90-7	Chlorobenzene	<46.7	<46.7	ppbv	<216	<216	ug/m ³
75-00-3	Chloroethane	<46.7	<46.7	ppbv	<124	<124	ug/m ³
67-66-3	Chloroform	<46.7	<46.7	ppbv	<227	<227	ug/m ³
74-87-3	Chloromethane	<46.7	<46.7	ppbv	<95.5	<95.5	ug/m ³
156-59-2	cis-1,2-Dichloroethene	<46.7	<46.7	ppbv	<185	<185	ug/m ³
10061-01-5	cis-1,3-Dichloropropene	<46.7	<46.7	ppbv	<212	<212	ug/m ³
110-82-7	Cyclohexane	<46.7	<46.7	ppbv	<160	<160	ug/m ³
75-71-8	Dichlorodifluoromethane	<46.7	<46.7	ppbv	<231	<231	ug/m ³
75-45-6	Difluorochloromethane	<46.7	<46.7	ppbv	<164	<164	ug/m ³
100-41-4	Ethylbenzene	<46.7	<46.7	ppbv	<202	<203	ug/m ³
87-68-3	Hexachlorobutadiene	<46.7	<46.7	ppbv	<497	<497	ug/m ³
66-25-1	Hexanal	<46.7	<46.7	ppbv	<191	<191	ug/m ³



CERTIFICATE OF ANALYSIS

Validated

SDG: 190302-32
Location: CrowlandClient Reference: Crowland
Order Number: PO-0000434Report Number: 496181
Superseded Report:Sample Number 19468142
Sample ID 004

Depth 0.70 - 0.70

Sampled Date 28/02/2019 00:00:00

Method TM330 Determination of VOC's in atmospheric, sub-slab and soil gas samples

Canister No. 10273

Sample Volume (ml) 5 Dispatch pressure (psia) -0.12 Initial pressure (psia) 12.60 Final pressure (psia) 19.62 Dilution 1.5571428571

CAS Number	Compound	LOD	Result	Units	LOD	Result	Units
110-54-3	Hexane	<46.7	<46.7	ppbv	<164	<164	ug/m ³
74-88-4	Iodomethane	<46.7	<46.7	ppbv	<271	<271	ug/m ³
115-11-7	Isobutene	<46.7	<46.7	ppbv	<107	<107	ug/m ³
78-79-5	Isoprene	<46.7	<46.7	ppbv	<130	<130	ug/m ³
108-38-3 & 106-42-3	m/p-Xylene	<46.7	61.3	ppbv	<202	266	ug/m ³
78-85-3	Methylacrolein	<46.7	<46.7	ppbv	<134	<134	ug/m ³
75-09-2	Methylene Chloride	<46.7	<46.7	ppbv	<162	<162	ug/m ³
1634-04-4	MTBE	<46.7	<46.7	ppbv	<168	<168	ug/m ³
	Naphthalene	<46.7	<46.714285713	ppbv	<244	<245	ug/m ³
95-47-6	o-Xylene	<46.7	<46.7	ppbv	<202	<203	ug/m ³
110-62-3	Pentanal	<46.7	<46.7	ppbv	<164	<164	ug/m ³
109-66-0	Pentane	<46.7	64.0	ppbv	<138	188	ug/m ³
100-42-5	Styrene	<46.7	<46.7	ppbv	<199	<199	ug/m ³
127-18-4	Tetrachloroethene	<46.7	<46.7	ppbv	<317	<317	ug/m ³
108-88-3	Toluene	<46.7	230	ppbv	<176	864	ug/m ³
156-60-5	trans-1,2-Dichloroethene	<46.7	<46.7	ppbv	<185	<185	ug/m ³
1006-02-6	trans-1,3-Dichloropropene	<46.7	<46.7	ppbv	<212	<212	ug/m ³
79-01-6	Trichloroethene	<46.7	<46.7	ppbv	<250	<250	ug/m ³
75-69-4	Trichlorofluoromethane	<46.7	<46.7	ppbv	<262	<262	ug/m ³
26523-64-8	Trichlorotrifluoroethane	<46.7	<46.7	ppbv	<357	<357	ug/m ³
108-05-4	Vinyl Acetate	<46.7	<46.7	ppbv	<164	<164	ug/m ³
75-01-4	Vinyl Chloride	<46.7	<46.7	ppbv	<118	<118	ug/m ³



CERTIFICATE OF ANALYSIS

Validated

SDG:	190302-32	Client Reference:	Crowland	Report Number:	496181
Location:	Crowland	Order Number:	PO-0000434	Superseded Report:	

Table of Results - Appendix

Method No	Reference	Description
TM330	EPA/625/R-96/010b (based on)	Determination Of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters And Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS)

A = not applicable.

hemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).



Validated

CERTIFICATE OF ANALYSIS

SDG: 190302-32
Location: CrowlandClient Reference: Crowland
Order Number: PO-0000434Report Number: 496181
Superseded Report:

Test Completion Dates

Lab Sample No(s)	19468139	19468140	19468141	19468142
Customer Sample Ref.	001	002	003	004
AGS Ref.				
Depth	0.70 - 0.70	0.70 - 0.70	0.70 - 0.70	0.70 - 0.70
Type	Gas (G)	Gas (G)	Gas (G)	Gas (G)
/OC's	11-Mar-2019	11-Mar-2019	11-Mar-2019	11-Mar-2019



CERTIFICATE OF ANALYSIS

SDG: 190302-32
Location: Crowland

Client Reference: Crowland
Order Number: PO-0000434

Report Number: 496181
Superseded Report:

Appendix

Results are expressed on a dry weight basis (dried at 35°C) for all soil analyses except the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH₄ by the RE method, VOC TICs and SVOC TICs.

Samples will be run in duplicate upon request, but an additional charge may be incurred.

If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALS reserve the right to charge for samples received and stored but not analysed.

With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as "Not detected". If no asbestos fibres are found all will be reported as "Not detected" and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible (NDP). The quantity of asbestos present is not determined unless specifically requested.

If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

If appropriate preserved bottles are not received preservation will take place on receipt. However, the integrity of the data may be compromised.

NDP - No determination possible due to insufficient/unsuitable sample.

Metals in water are performed on a filtered sample, and therefore represent dissolved metals - total metals must be requested separately.

Results relate only to the items tested.

LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.

Surrogate recoveries - Surrogates are added to your sample to monitor recovery of the test requested. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-130%. Recoveries in soils are affected by organic rich or clay rich matrices. Waters can be affected by remediation fluids or high amounts of sediment. Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix effect.

Product analyses - Organic analyses on products can only be semi-quantitative due to matrix effects and high dilution factors employed.

Phenols monohydric by HPLC include phenol, cresols (2-Methylphenol, 3-Methylphenol and 4-Methylphenol) and Xylenols (2,3 Dimethylphenol, 2,4 Dimethylphenol, 2,5 Dimethylphenol, 2,6 Dimethylphenol, 3,4 Dimethylphenol, 3,5 Dimethylphenol).

Total of 5 speciated phenols by HPLC includes Phenol, 2,3,5-Trimethyl Phenol, Isopropylphenol, Cresols and Xylenols (as detailed in 15).

Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

General

For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

Tentatively Identified Compounds (TICs) are non-target peaks in VOC and SVOC analysis. All non-target peaks detected with a concentration above the LoD are subjected to a mass spectral library search. Non-target peaks with a library search confidence of >75% are reported based on the best mass spectral library match. When a non-target peak with a library search confidence of <75% is detected it is reported as "mixed hydrocarbons". Non-target compounds identified from the scan data are semi-quantified relative to one of the deuterated internal standards, under the same chromatographic conditions as the target compounds. This result is reported as a semi-quantitative value and reported as Tentatively Identified Compounds (TICs). TICs are outside the scope of UKAS accreditation and are not moisture corrected.

Sample Deviations

If a sample is classed as deviated then the associated results may be compromised.

1	Container with Headspace provided for volatiles analysis
2	Incorrect container received
3	Deviation from method
§	Sampled on date not provided
◆	Sample holding time exceeded in laboratory
@	Sample holding time exceeded due to late arrival of instructions or samples

Asbestos

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: - Trace - Where only one or two asbestos fibres were identified.

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.