

CONTAMINATED LAND INTRUSIVE INVESTIGATION

Deer View Lodge
Copse Lane
Hayling Island
Hampshire
PO11 0QB



February 2020

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1 Introduction and scope of work

Apple Environmental has been appointed to undertake an intrusive soil contamination investigation and internal volatile and ground gas monitoring exercise at Deer View Lodge, Copse Lane, Hayling Island, Hampshire PO11 0QB. This report has been prepared in support of a prior notification for the change of use of the existing building from office to residential use.

An environmental desk study and preliminary risk assessment previously undertaken by Apple Environmental for the site (Report Ref. CL/2746/DV) had identified a potential land contamination concern, due principally to the use of the heavy machinery on the site, along with general storage and the expectation that historically structures may have been demolished.

Due to the proposal to introduce soft landscaped garden areas, the conceptual model within the aforementioned desk study had highlighted a perceived risk from the above sources, with potentially significant pathway linkages enabling contamination to reach receptors. In considering this, the contaminants deemed to be potentially present included general inorganics, hydrocarbons (petroleum and poly-aromatic) and ground gases. An intrusive investigation was subsequently recommended in order to determine the presence and extent of any such contamination, and to assess the overall risk more fully. The investigation has focussed on the proposed garden areas associated with the dwelling, although an internal investigation had also been recommended in order to determine the possible presence of any ground gas or vapour ingress.

The principal aims of this work therefore have been to devise and implement an appropriate strategy such that it has been possible to:

- determine the nature of the sub-surface material on-site;
- determine the presence of unacceptable ground contamination in specified areas, along with its nature and extent;
- assess the degree to which the site itself could be contributing to the contamination of environmental media off-site;
- determine the presence, extent and nature of any ground gases or volatiles within the building;
- observe or presume contaminant-pathway-receptor relationships on site; and
- assess the risk to future users of the site, as well as building structures services.

This type of assessment relies upon visual examination of the area and sub-surface material, as well as the laboratory analysis of material samples.

As such, the specific objectives were:

- to excavate trial pits at three separate locations at the site to a minimum depth of 1000mm;
- to characterise the nature of the sub-surface material at each of these locations;
- to collect two soil samples from each of the of the pits for laboratory analysis representing the direct contact zone (100-200mm) and the indirect contact zone (500-600mm);
- to collect additional soil samples from where there may be any other specific or noticeable contamination concern;
- to analyse the soil samples for a range of contamination indicators;
- to record the levels of volatiles, methane, carbon dioxide, carbon monoxide, and hydrogen sulphide within all internal ground floor areas of the building;
- to ascertain the significance of all chemical or physical data obtained;
- to determine the risk to future users based upon residential usage; and
- to make appropriate recommendations in order to reduce and/or eliminate any risks, as identified.

2 Methodology

2.1 Soil investigation

As stated above, the main aim of this investigation has been to assess the sub-surface of the site in order to determine any risk that may be present as a result of ground contamination.

For this purpose, three trial pits were excavated to a minimum depth of 1000mm, at the approximate locations shown below in Figure 1.

Figure 1 Plan showing the approximate sampling locations



● Borehole locations

The soil profile from each investigated location has been logged within Section 3 below, along with photographs showing the material excavated.

As stated, soil samples were collected from the three trial pits, representing soil depths of 100 - 200mm and 500 - 600mm.

All of these soil samples were placed immediately into sterilised containers and transferred into refrigerated cold-boxes until removed for analysis.

Chemical analysis was undertaken for the following determinands:

- arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc;
- sulphate, sulphide, chloride, cyanide, ammonia and asbestos;
- benzene, toluene, ethylbenzene and xylene (all isomers);
- polycyclic aromatic hydrocarbons (speciated), petroleum hydrocarbons (banded TPHCWG);
- phenols and non-speciated VOCs*.

* Photo-ionisation detection was undertaken in-situ on the removed soil material in order to detect vapours originating from any VOC residue (fuels/solvents etc.) that may be present in each excavated area. This was performed by means of an externally calibrated Phocheck Tiger PID. Calibration certification has been appended to this report.

All chemical analyses were undertaken by a UKAS accredited laboratory. Laboratory certification has been appended to this report.

2.2 Ground gas and vapour monitoring

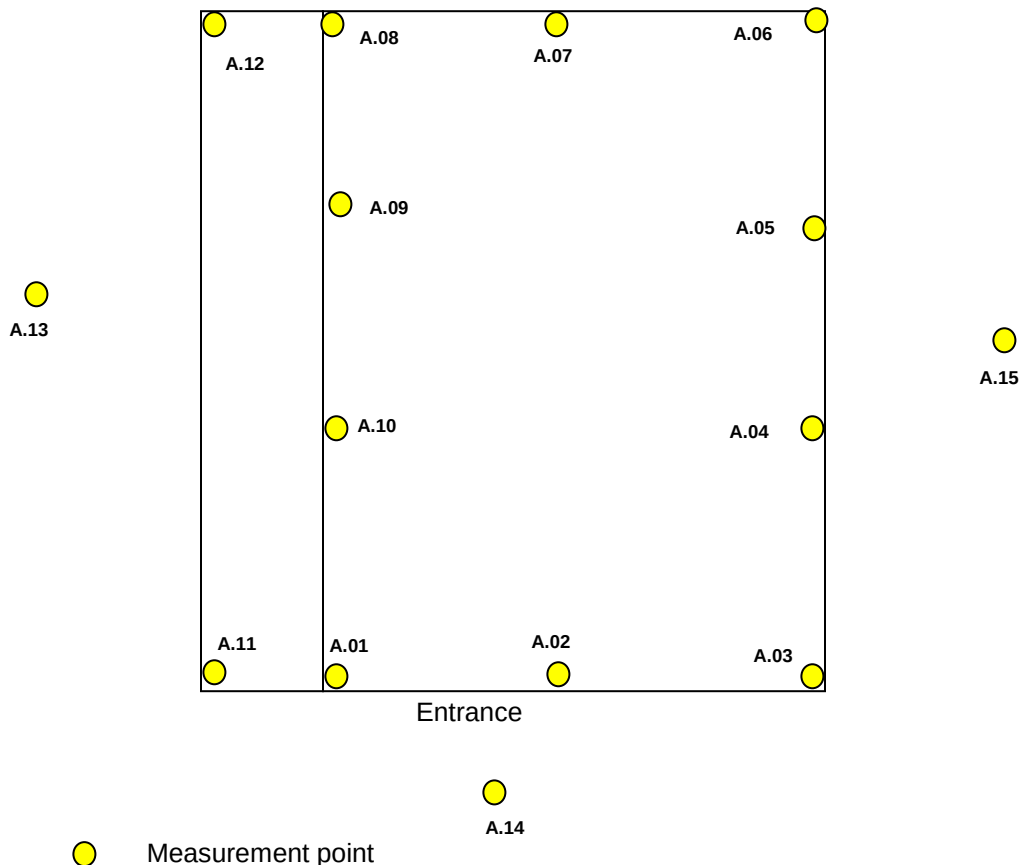
An additional aim of this work has been to assess any risk from ground gas or volatiles presence at the site due to the former use of the site, or from possible underlying made-ground deposits.

For this purpose, appropriate detection instruments were placed at floor level within 12 internal areas of the building (measurement points A.01 - A.12) during the afternoon of the 13th February 2020. The instruments were left in place until the readings stabilised.

In most instances locations were selected where it was suspected that there may have been a path of low resistance, through which volatiles or gases could find a pathway into the building; namely, where services entered (or exited) the building through the concrete floor slab, or where the walls joined the floor slab, or where there may have been joins in the floor slab. In other instances readings were obtained randomly, and specifically within enclosed areas. In addition to the internal measurements, 3 external readings were also obtained (measurement points A.13 - A.15) in order to assess the internal findings against the perceived ambient ground gas and volatile concentration for this area. A plan showing the location of each measurement point has been reproduced below in Figure 2.

The instrument used for measuring the concentration of volatiles was a Phocheck Tiger detector with the capability of reporting down to 0.1ppm. The instrument used for measuring methane, carbon dioxide, carbon monoxide and hydrogen sulphide concentration was a Geotechnics GA2000 gas detector, which has the capability to report down to 0.1% (v/v). Calibration certification for both instruments has been appended to this report.

Figure 2 Methane and volatiles measurement locations



The atmospheric pressure conditions immediately prior to the assessment being undertaken on the 13th February 2020 have been reproduced below in Table 1.

Table 1 Atmospheric pressure prior to the gas and volatile measurement

Date	Time	Pressure
12/02/2020	06:00	1015
12/02/2020	12:00	1017
12/02/2020	18:00	1015
13/02/2020	00:00	1008
13/02/2020	06:00	995
13/02/2020	12:00	992

As shown above, the atmospheric pressure decreased rapidly on the day of monitoring.

3 On-site observations

The ground surface across the site is variable with areas of soft-landscaping and compressed soil and scalpings.

It is understood that the bedrock at the site is characterised by the Lambeth Group Formation (clay). This is believed to have been observed in all of the trial pit locations.

The bedrock in this area is expected to be overlain by superficial River Terrace Deposits. These deposits were also observed within each of the trial pit locations, albeit extending to a shallow depth only of around 400mm.

In general, the extracted material profiles were characterised by a surface layer of grass or compressed soil and scalpings, underlain by gravelly made-ground containing hardcore, and silty sandy clay.

The sub-surface material strata logs have been reproduced below in Tables 2 to 4 along with any detailed observations.

Photographs showing the removed material have been appended to each strata log (Photographs 1 to 3).

Table 2 Strata log - Location **TP.01**

Location ID	Depth (mm)	Notes
TP.01	0 - 220	Gravelly made-ground comprising brick, pottery and rounded stones (5-15mm diameter).
	220 - 550	Mid-brown soft silty clay.
	550 - 1050	Light-brown soft, silty sandy clay.
Groundwater	-	Groundwater was not reached

Photograph 1 Trial pit and removed soil material - Location TP.01



Table 3 Strata log - Location **TP.02**

Location ID	Depth (mm)	Notes
TP.02	0 - 120	Made-ground within a clayey matrix, comprising bricks, tarmacadam and concrete.
	120 - 330	Dark-brown soft silty clay with rounded stones (5-15mm diameter).
	330 - 1050	Light-brown soft, silty sandy clay.
Groundwater	-	Groundwater was not reached

Photograph 2 Trial pit and removed soil material - Location TP.02



Table 4 Strata log - Location **TP.03**

Location ID	Depth (mm)	Notes
TP.03	0 - 20	Grass
	20 - 270	Made-ground in a clayey matrix comprising brick fragments and small rounded stones (10-20mm diameter).
	270 - 410	Made-ground comprising brick and block.
	410 - 1100	Light-brown soft, silty sandy clay.
Groundwater	-	Groundwater was not reached

Photograph 3 Trial pit and removed soil material - Location TP.03



4 Results

4.1 Soil analyses

The results from the soil analyses are displayed in Tables 5 to 11 below. Any determinand detected has been highlighted in **bold** type.

Table 5 Results for specified inorganics in soil - metals

Determinand (mg/kg)	TP.01		TP.02		TP.03	
	Depth 100-200mm	Depth 500-600mm	Depth 100-200mm	Depth 500-600mm	Depth 100-200mm	Depth 500-600mm
Arsenic	8	7	8	6	9	8
Boron	< 1	< 1	< 1	< 1	1	< 1
Cadmium	< 0.2	< 0.2	2.6	< 0.2	0.4	< 0.2
Chromium	11	17	13	15	17	17
Hexavalent chromium	< 2	< 2	< 2	< 2	< 2	< 2
Copper	11	7	149	9	21	15
Lead	79	16	163	31	91	42
Mercury (total)	< 0.05	< 0.05	0.05	< 0.05	0.07	0.05
Nickel	7	9	8	8	11	9
Selenium	< 3	< 3	< 3	< 3	< 3	< 3
Zinc	69	41	560	58	289	44

Table 6 Results for specified inorganics in soil - non-metals

Determinand (mg/kg)	TP.01		TP.02		TP.03	
	Depth 100-200mm	Depth 500-600mm	Depth 100-200mm	Depth 500-600mm	Depth 100-200mm	Depth 500-600mm
Cyanide (total)	<2	<2	<2	<2	<2	<2
Sulphate (total)	12790	459	1010	266	491	210
Sulphide	<5	<5	<5	<5	<5	<5
Chloride	100	95	31	31	34	39
Asbestos	None detected	None detected	None detected	None detected	None detected	None detected

Table 7 Results for specified hydrocarbons in soil

Determinand (mg/kg)	TP.01		TP.02		TP.03	
	Depth 100-200mm	Depth 500-600mm	Depth 500-600mm	Depth 500-600mm	Depth 500-600mm	Depth 500-600mm
Benzene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Toluene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ethylbenzene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
p & m-Xylene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
o-Xylene	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
MTBE	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Phenols	< 2	< 2	< 2	< 2	< 2	< 2

Table 8 Results for poly-aromatic hydrocarbons in soil

Determinand (mg/kg)	TP.01		TP.02		TP.03	
	Depth 100-200mm	Depth 500-600mm	Depth 100-200mm	Depth 500-600mm	Depth 100-200mm	Depth 500-600mm
Naphthalene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	< 0.1	< 0.1	1.40	< 0.1	0.12	< 0.1
Anthracene	< 0.1	< 0.1	0.27	< 0.1	< 0.1	< 0.1
Fluoranthene	0.27	< 0.1	3.54	< 0.1	0.34	< 0.1
Pyrene	0.25	< 0.1	3.03	< 0.1	0.30	< 0.1
Benzo(a)anthracene	0.20	< 0.1	1.98	< 0.1	0.17	< 0.1
Chrysene	0.21	< 0.1	1.89	< 0.1	0.19	< 0.1
Benzo(b)fluoranthene	0.34	< 0.1	2.92	< 0.1	0.28	< 0.1
Benzo(k)fluoranthene	0.13	< 0.1	1.06	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	0.22	< 0.1	2.22	< 0.1	0.18	< 0.1
Indeno(123-cd)pyrene	0.14	< 0.1	1.97	< 0.1	0.14	< 0.1
Dibenzo(ah)anthracene	< 0.1	< 0.1	0.28	< 0.1	< 0.1	< 0.1
Benzo(ghi)perylene	0.13	< 0.1	1.78	< 0.1	0.13	< 0.1
Coronene	< 0.1	< 0.1	0.74	< 0.1	< 0.1	< 0.1
Total PAHs	1.9	<1.6	22.3	<1.6	1.8	<1.6

Table 9 Results for petroleum hydrocarbons in soil

Determinand (mg/kg)	TP.01		TP.02		TP.03	
	Depth 100-200mm	Depth 500-600mm	Depth 100-200mm	Depth 500-600mm	Depth 100-200mm	Depth 500-600mm
Aliphatic C5 - C6	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C6 - C8	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Aliphatic C8 - C10	< 2	< 2	< 2	< 2	24	< 2
Aliphatic C10 - C12	< 2	< 2	< 2	< 2	34	< 2
Aliphatic C12 - C16	< 3	< 3	< 3	< 3	21	< 3
Aliphatic C16 - C21	< 3	< 3	5	< 3	< 3	< 3
Aliphatic C21 - C34	< 10	< 10	41	< 10	< 10	< 10
Total Aliphatic (C5 - 34)	< 21	< 21	46	< 21	79	< 21
Aromatic C5 - C7	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C7 - C8	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Aromatic C8 - C10	< 2	< 2	< 2	< 2	< 2	< 2
Aromatic C10 - C12	< 2	< 2	< 2	< 2	< 2	< 2
Aromatic C12 - C16	< 2	< 2	< 2	< 2	< 2	< 2
Aromatic C16 - C21	< 3	< 3	8	< 3	< 3	< 3
Aromatic C21 - C35	< 10	< 10	40	< 10	< 10	< 10
Total Aromatic (C5 -35)	< 21	< 21	48	< 21	< 21	< 21
Total (C5 - 35)	< 42	< 42	94	< 42	79	< 42

Table 10 Non-specified VOCs - measured by means of photo-ionisation detection in-situ

TP.01	TP.02	TP.03
Depth 100-200mm	Depth 100-200mm	Depth 100-200mm
<0.1 ppm	<0.1 ppm	<0.1 ppm
TP.01	TP.02	TP.03
Depth 500-600mm	Depth 500-600mm	Depth 500-600mm
<0.1 ppm	<0.1 ppm	<0.1 ppm

4.1 Ground gas and volatiles monitoring

The results from the ground gas and volatiles monitoring are displayed in Table 11. Locations A.01 to A.12 refer to internal readings whereas locations A.13 and A.15 were external readings.

Table 11 Readings obtained

Location	Volatiles	Methane	Carbon dioxide	Carbon monoxide	Hydrogen sulphide
A.01	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.02	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.03	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.04	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.05	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.06	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.07	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.08	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.09	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.10	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.11	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.12	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.13	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.14	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm
A.15	<0.1ppm	<0.1%	<0.1%	<0.1ppm	<0.1ppm

5 Interpretation

Tables 12 to 14 below show the soil guideline concentrations used as part of this assessment.

Where Environment Agency guideline values are unavailable, soil guideline concentrations derived using CLEA software packages and other published guidelines have been consulted. In all instances guideline values for residential end-use with home-grown produce have been considered.

For the purposes of this assessment therefore, the following guideline criteria have been referred to:

- Environment Agency Category 4 Screening Levels (2014);
- CIEH (LQM) GAC 3rd Edition (residential end-use);
- Atkins ATRISK SSVs (residential end-use with home-grown produce);
- GAC CLEA generated value for residential end-use with home-grown produce; and
- others, as available.

Note that for some guideline values a choice of soil organic matter (SOM) concentration is provided whereby different guideline concentrations exist for SOM values of between 1% and 6%.

In this instance the guideline value for 1% SOM was referred to, as the mean organic content was determined as 1.41%; which approximates to 2.4% SOM.

Table 12 Soil guideline concentrations referred to for this assessment

Determinand (mg/kg)	Guideline concentration for 1% SOM	Origin
Arsenic	37	Atkins ATRISK Category 4 Screening Level
Boron	290	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce
Cadmium	22.1	Atkins ATRISK Category 4 Screening Level
Chromium	14300	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Chromium VI	20.5	Atkins ATRISK Category 4 Screening Level
Copper	4730	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Lead	200	Category 4 Screening Level ^(a)
Mercury (elemental)	0.0863	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Mercury (inorganic Hg ²⁺)	180	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Nickel	136	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Selenium	375	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Zinc	20000	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Free Cyanide	34	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Sulphate	10000	ICRCL Action Value domestic gardens ^(b)
Sulphide	1000	ICRCL Action Value all uses ^(b)
Phenols (SOM 1%)	267	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Benzene (SOM 1%)	0.137	Atkins ATRISK (C4SL) for residential with home-grown produce
Toluene (SOM 1%)	113	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Ethylbenzene (SOM 1%)	50.7	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
o-Xylene (SOM 1%)	26.4	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
m-Xylene (SOM 1%)	25	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
p-Xylene (SOM 1%)	24	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce

(a) Quoted for residential land-use 0-7 year-old child taking into account bioavailability, with exposure parameters as detailed in report SR3.

(b) This 'withdrawn' value has been quoted in the absence of any other available published guideline.

Table 13 Soil guideline concentrations for PAHs referred to for this assessment

Determinand (mg/kg)	Guideline concentration for 1% SOM	Origin
Naphthalene	2.3	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce
Acenaphthylene	608	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Acenaphthene	210	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce
Fluorene	735	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Phenanthrene	95	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce
Anthracene	10200	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Fluoranthene	983	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Pyrene	668	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Benzo(a)anthracene	7.2	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce
Chrysene	15	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce
Benzo(b)fluoranthene	2.6	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce
Benzo(k)fluoranthene	77	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce
Benzo(a)pyrene	2.2	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce
Indeno(123-cd)pyrene	27	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce
Dibenzo(ah)anthracene	0.24	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce
Benzo(ghi)perylene	320	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce

Table 14 Soil guideline concentrations for TPHs referred to for this assessment

Determinand (mg/kg)	Guideline concentration for 1% SOM	Origin
Aliphatic TPH C5-C6	42.7	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aliphatic TPH C6-C8	99.3	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aliphatic TPH C8-C10	13.9	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aliphatic TPH C10-C12	81.7	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aliphatic TPH C12-C16	385	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aliphatic TPH C16-C35	210000	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aliphatic TPH C35-C44	65000	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce
Aromatic TPH C5-C7	0.137	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aromatic TPH C7-C8	113	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aromatic TPH C8-C10	20.5	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aromatic TPH C10-C12	70	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aromatic TPH C12-C16	165	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aromatic TPH C16-C21	319	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aromatic TPH C21-C35	1120	Atkins ATRISK (CLEA 1.07) for residential with home-grown produce
Aromatic TPH C5-C35	1100	LQM/CIEH S4ULs (CLEA 1.06) for residential with home-grown produce

6 Summary of soil analyses

As detailed above, three trial pits were excavated at the site to a minimum depth of 1000mm, whereupon two soil samples were collected from each; representing the direct contact zone at a depth of 100 - 200mm below the surface, and the indirect contact zone at a depth of 500 - 600mm, for the laboratory analysis of a broad range of contamination indicators.

Through reference to Tables 7 to 14 above, it has been shown that some chemical substances were present above guideline criteria for residential use; namely specified poly-aromatic hydrocarbons (PAHs), and light hydrocarbons.

Of these, an elevated concentration of PAHs was detected within the upper soil horizon (100 - 200mm) in just one location (TP.02), whereas light hydrocarbons (C8-C10) were detected within the upper soil horizon in trial pit TP.03 only. These exceedences have been summarised below in Table 15.

It is also noted that there was an elevated concentration of sulphates within one location (TP.01), however in the absence of any direct guideline criteria for residential development this has been considered separately below

Table 15 Soil guideline criteria exceedences

Trial pit/ and sample depth	Benzo-(b) fluoranthrene	Benzo-(a) pyrene	Dibenzo-(ah) anthracene	Petroleum hydrocarbons C8-C10
TP.02 100-200mm				
TP.03 100-200mm				

Guideline exceedence



.

The source of this identified PAH and petroleum hydrocarbon presence is quite possibly associated with the storage or use of machinery or vehicles. Although the source of the hydrocarbon contamination within trial pit TP.03 could also be due to the use of, or discarding of, other solvents, such as white spirit outside of the existing building.

As stated above, a high concentration of sulphates was also noted within trial pit TP.01; the source of which is expected to be the made-ground. Through reference to the analytical results it is apparent that this is not affecting the pH of the ground by means of acidification in this area; however it may be prudent to use sulphate resistant materials below ground level.

On the basis of these reported analyses the possible extent of ground contamination across the site has been indicated in Figure 2 below.

Figure 2 Plan showing the possible extent of ground contamination



 PAH contamination  Hydrocarbon contamination

7 Summary from ground gas and volatiles monitoring

As detailed above, ground gas and volatiles monitoring was undertaken at both internal and external locations in order to determine whether there has been any ingress of either into the existing building.

The findings from this exercise were that there was nothing detectable, internally or externally.

As a consequence a worst case concentration of 0.1ppm has been reported for all volatiles, carbon monoxide and hydrogen sulphide, and a worst case concentration of 0.1% has been reported for methane and carbon dioxide.

8 Review of conceptual model and risk assessment

Using the sampling results and observations made, the conceptual site model (CSM) from the Phase 1 desk study can now be reviewed and updated. In doing so any uncertainties highlighted within that report can now be readdressed and the corresponding risk reassessed.

In reviewing this conceptual model, Table 16 below highlights any perceived pollutant pathway linkages that may be present.

It should be noted that the following re-assessment of the risk, has been made on the basis that there will be soft landscaped recreational areas created with the proposed dwelling, as well as the presumption that groundworks may be undertaken for the installation of footings and new services etc.

The original CSM within the desk study report did not identify groundwater or other off-site receptors as being at any significant risk from ground contamination, and the findings from this site investigation have not altered this belief. These are therefore not being considered as either pathways or receptors in this instance.

The risk matrix used for assessment is reproduced below in Figure 3.

Figure 3 Risk assessment algorithm

Potential severity	Risk rating						Severity of hazard	Probability of hazard	Overall risk
	5	5	10	15	20	25	5 = Fatality	1 = Improbable	1 - 6 Low
	4	4	8	12	16	20	4 = Major	2 = Remote	8 - 12 Medium
	3	3	6	9	12	15	3 = Minor	3 = Possible	15 - 25 High
	2	2	4	6	8	10	2 = Negligible	4 = Probable	
	1	1	2	3	4	5	1 = None	5 = Certainty	
		1	2	3	4	5			
	Probability						Severity of hazard x probability = risk rating		

Table 16 Reviewed comments relating to perceived risk

Contaminants identified	Potential pathways	Perceived level of risk	Comments and reasoning
Specified PAHs and petroleum hydrocarbons	Direct ingestion of soil and soil-dust	12	The likelihood of ingesting soil during construction work, gardening or recreation is low. Ingestion is most likely to be limited to trace quantities through unwashed hands or ingesting airborne dusts etc. However as elevated concentrations of petroleum hydrocarbons and PAHs have been identified, the corresponding risk level must at least be considered moderate.
	Dermal contact with soil and soil-dust	12	The potential for touching soil during construction work, gardening or recreation is high. It is also possible that the PAH and petroleum hydrocarbon contamination could exert a biological effect from absorption through the epidermis, or alternatively be transferred to the mouth. In either instance the extent of uptake is expected to be low, although as they have the potential to be harmful, the corresponding risk level must at least be considered moderate.
	Ingestion soil attached to vegetables	8	Considering the presence of elevated concentrations of PAHs and petroleum hydrocarbons in the soil, there is some potential for ingestion from either home-grown vegetables or from soil attached to these vegetables. Despite this, the extent of uptake is expected to be fairly low. As such the corresponding risk level is considered to be low-moderate at worst.

Table 16 (Cont.)

Reviewed comments relating to perceived risk

Contaminants identified	Potential pathways	Perceived level of risk	Comments and reasoning
Specified PAHs and petroleum hydrocarbons	Inhalation of soil or soil-derived dust	8	Uptake from the inhalation of PAHs and hydrocarbons during the disturbance of soil is expected to be limited to trace quantities only. Overall the corresponding risk from inhalation is deemed to be low-moderate at worst.
	Inhalation and/or ignition of gases and/or vapours	6	Despite the presence of made-ground as well as elevated concentrations of PAHs and petroleum hydrocarbons, it is not expected for the soil to be producing significant amounts of vapours or ground gases. This is concluded on the basis that the soil has a low organic carbon content, and the made-ground was largely composed of construction hardcore, along with internal air sampling which failed to detect either. The overall risk from gases and vapours therefore is believed to be low.
	Direct contact with underground building fabric and services	8	Both hydrocarbons, and sulphates, can potentially present a risk to building fabric and underground services. If either of these are to be located in the area where an concentration of either is present then appropriate materials resistant to chemical attack may need to be considered. The corresponding risk in those areas must be deemed to be potentially moderate.

9 Overall summary and remediation proposal

9.1 Summary

This report has been prepared in support of the proposed redevelopment of an existing office building for residential use with associated garden areas.

The report has noted that specified poly-aromatic hydrocarbons (PAHs) exceeded guideline criteria within the soil in the location of trial pit TP.02, whilst petroleum hydrocarbons (aliphatic C8-C10) exceeded guideline criteria in the vicinity of trial pit TP.03. An elevated concentration of sulphates was also noted within the vicinity of trial pit TP.01.

It is quite possible that the source of the PAH and light hydrocarbon contamination may well be due the storage and use of machinery or vehicles, arising from possible oil/fuel spillages and spillages. It has also been suggested that the light hydrocarbons may have resulted from the discarding of solvents to the ground in this area; i.e. white spirit or similar.

The elevated presence of sulphates may well be a characteristic of the made-ground, which was noted to contain construction wastes, or similar

The existing building has a concrete slab base at ground level, which is to be retained. It was therefore recommended that monitoring was carried out for volatiles and ground gas detection internally within the building in order to determine whether or not there had been any ingress of either. In addition to this, external areas were similarly assessed also in order to provide any baseline data. The findings were that no ground gases or volatile species were detected, either internally and externally; hence no actual pathway linkage has been identified.

Based on the overall findings of the investigation, the conceptual site model (CSM) has therefore concluded that in its current state the site presents an unacceptable degree of risk to future receptors, on the basis of residential use.

9.2 Recommendations

In view of the soil sampling findings it would be necessary to undertake a programme of remediation in order to bring the risk down to an acceptable level.

On the basis of the information known to-date, remediation would need to be considered for the majority of the site in order to ensure that the risk has been fully minimised.

Alternatively however, delineation sampling may wish to be undertaken in order to attempt to determine more precisely the actual extent of PAH and hydrocarbon contamination within the garden areas; thereby potentially focussing remediation more effectively (and sustainably).

In the absence of undertaking any delineation sampling, the recommended areas where ground remediation would be required has been highlighted in Figure 4 below.

Figure 4 Plan showing the recommended area requiring remediation



 Areas requiring remediation to eliminate the highlighted soil contamination

More specifically, it is suggested that in the first instance the soil in these highlighted areas (above) should initially be excavated to a depth of at least 300mm below the existing ground level, and removed off-site for appropriate disposal or treatment.

Once this has been undertaken, it is suggested that soil samples are obtained from the base and sides of the excavated area, and analysed for the presence of PAHs, hydrocarbons and sulphates.

In any area where the concentration of PAHs and/or hydrocarbons in the soil still exceeds guideline criteria then the excavation should extend deeper to a maximum depth of 600mm.

In any area where the excavation has been extended to 600mm, the soil at the base and sides of that excavation will once again need to be sampled and analysed, depending upon the specific concern in that area.

If either of these contaminants is still present above guideline criteria at this depth then the excavated area would need to be lined with an appropriate barrier membrane to the base and sides, and protected with at least 100mm of clean crushed concrete, prior to being backfilled with 'clean' soil.

Conversely, if either of these contaminants are no longer present above guideline criteria at this 600mm depth then each excavated area can be directly backfilled with 'clean' soil.

Note that any soil brought onto the site for the purposes of backfilling these excavated areas should arrive 'fit for purpose', and comply with the British Standard BS3882:2015; although this will still need to undergo independent confirmatory laboratory analyses to show that it is free from contamination.

Photographic evidence of all remedial work undertaken should be collated and presented to the planning authority in the form of a post-remediation verification report, along with any waste transfer documentation relating to the off-site disposal of soil, and any receipts or other documentation relating to the importation of 'clean' soil.

With regards to underground service runs, if any services are expected to be emplaced at a depth of greater than 600mm (below surface level) in any of the areas where such contamination is known to exist, it should be ensured that all materials used are safe from chemical or physical attack.

In view of the findings from internal gas and volatiles monitoring, there would appear to be no requirement to introduce any protective measures into the proposed development in order to eliminate any risk from ground gas or volatiles ingress.

10 Limitations

This work has been undertaken in accordance with Apple Environmental Limited's standard terms and conditions.

The findings represent the professional opinion of the report author. All work carried out is based upon Apple Environmental Limited's current professional knowledge and understanding. It is therefore stated that the conclusions of this report have been based upon information gathered from a number of sources and it can only be assumed that this information provided was accurate and correct.

Intrusive investigation undertaken as part of this work has been restricted to a level of detail required to achieve the stated objectives of this work. The results of any measurements taken may vary spatially or with time, and further confirmatory measurements may wish to be considered, as necessary.

It is also pointed out that soil sampling, may only provide a general indication of contamination present. There is always the possibility that other undetected contaminants exist, or, that detected contaminants may exist at a greater concentration than that specified in areas of the site that have not been intrusively investigated.

11 References and specific sources of information

1. Investigation of potentially contaminated sites - code of practice (BSI 10175:2011+A2:2017)
2. Using Soil Guideline Values - Environment Agency Science Report SC050021/SGV (March 2009)
3. The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment CIEH 3rd Ed. - Land Quality Management Ltd. (2015)
4. Atkins ATRISK SSCs (July 2017)
5. CLEA Software (Version 1.05) Handbook - Environment Agency Science Report SC050021/SR4 (January 2014)
6. ICRCL 59/83 Trigger Concentrations - Department of the Environment (1983)
7. Land Affected by Contamination - Planning Practice Guidance - The Department for Communities and Local Government (June 2014)
8. The National Planning Policy Framework (Revised) - July 2018
9. Model procedures for the management of contaminated land (CLR-11) – Environment Agency (September 2004)
10. Contaminated Land Risk Assessment: A Guide to Good Practice (C552) - CIRIA (2001)
11. SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination - CL:AIRE (September 2014)
12. British Geological Survey. Geology of Britain:
<http://mapapps.bgs.ac.uk/geologyofbritain/home.html?>

APPENDICES

Laboratory data
Calibration certification



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DETS Report No: 20-01984

Site Reference: None Supplied

Project / Job Ref: CL/2939/DV

Order No: None Supplied

Sample Receipt Date: 17/02/2020

Sample Scheduled Date: 17/02/2020

Report Issue Number: 1

Reporting Date: 24/02/2020

Authorised by:

Dave Ashworth
Technical Manager

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Soil Analysis Certificate						
DETS Report No: 20-01984	Date Sampled	13/02/20	13/02/20	13/02/20	13/02/20	13/02/20
Apple Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: None Supplied	TP / BH No	TP.01/01/2939	TP.01/02/2939	TP.02/01/2939	TP.02/02/2939	TP.03/01/2939
Project / Job Ref: CL/2939/DV	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Reporting Date: 24/02/2020	DETS Sample No	463131	463132	463133	463134	463135

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
pH	pH Units	N/a	MCERTS	9.4	8.1	8.2	8.5	7.4
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Total Sulphate as SO ₄	mg/kg	< 200	NONE	12790	459	1010	266	491
Total Sulphate as SO ₄	%	< 0.02	NONE	1.28	0.05	0.10	0.03	0.05
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	1990	166	82	27	19
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	1.99	0.17	0.08	0.03	0.02
Sulphide	mg/kg	< 5	NONE	< 5	< 5	< 5	< 5	< 5
Total Organic Carbon (TOC)	%	< 0.1	MCERTS	0.6	0.6	2.6	0.8	3.3
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	100	95	31	31	34
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	50.2	47.5	15.5	15.3	17
Arsenic (As)	mg/kg	< 2	MCERTS	8	7	8	6	9
W/S Boron	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	1
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2	< 0.2	2.6	< 0.2	0.4
Chromium (Cr)	mg/kg	< 2	MCERTS	11	17	13	15	17
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	11	7	149	9	21
Lead (Pb)	mg/kg	< 3	MCERTS	79	16	163	31	91
Mercury (Hg) ^(S)	mg/kg	< 0.05	MCERTS	< 0.05	< 0.05	0.05	< 0.05	0.07
Nickel (Ni)	mg/kg	< 3	MCERTS	7	9	8	8	11
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3	< 3	< 3
Zinc (Zn)	mg/kg	< 3	MCERTS	69	41	560	58	289
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C
Subcontracted analysis (S)



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Soil Analysis Certificate						
DETS Report No: 20-01984	Date Sampled	13/02/20				
Apple Environmental Ltd	Time Sampled	None Supplied				
Site Reference: None Supplied	TP / BH No	TP.03/02/2939				
Project / Job Ref: CL/2939/DV	Additional Refs	None Supplied				
Order No: None Supplied	Depth (m)	None Supplied				
Reporting Date: 24/02/2020	DETS Sample No	463136				

Determinand	Unit	RL	Accreditation				
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected			
pH	pH Units	N/a	MCERTS	8.0			
Total Cyanide	mg/kg	< 2	NONE	< 2			
Total Sulphate as SO ₄	mg/kg	< 200	NONE	210			
Total Sulphate as SO ₄	%	< 0.02	NONE	0.02			
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	23			
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.02			
Sulphide	mg/kg	< 5	NONE	< 5			
Total Organic Carbon (TOC)	%	< 0.1	MCERTS	0.6			
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	39			
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	19.7			
Arsenic (As)	mg/kg	< 2	MCERTS	8			
W/S Boron	mg/kg	< 1	NONE	< 1			
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2			
Chromium (Cr)	mg/kg	< 2	MCERTS	17			
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2			
Copper (Cu)	mg/kg	< 4	MCERTS	15			
Lead (Pb)	mg/kg	< 3	MCERTS	42			
Mercury (Hg) ^(S)	mg/kg	< 0.05	MCERTS	0.05			
Nickel (Ni)	mg/kg	< 3	MCERTS	9			
Selenium (Se)	mg/kg	< 3	NONE	< 3			
Zinc (Zn)	mg/kg	< 3	MCERTS	44			
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C
 Subcontracted analysis (S)



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Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 20-01984	Date Sampled	13/02/20	13/02/20	13/02/20	13/02/20	13/02/20
Apple Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: None Supplied	TP / BH No	TP.01/01/2939	TP.01/02/2939	TP.02/01/2939	TP.02/02/2939	TP.03/01/2939
Project / Job Ref: CL/2939/DV	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Reporting Date: 24/02/2020	DETS Sample No	463131	463132	463133	463134	463135

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.40	< 0.1	0.12
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.27	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	0.27	< 0.1	3.54	< 0.1	0.34
Pyrene	mg/kg	< 0.1	MCERTS	0.25	< 0.1	3.03	< 0.1	0.30
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	0.20	< 0.1	1.98	< 0.1	0.17
Chrysene	mg/kg	< 0.1	MCERTS	0.21	< 0.1	1.89	< 0.1	0.19
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.34	< 0.1	2.92	< 0.1	0.28
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	0.13	< 0.1	1.06	< 0.1	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	0.22	< 0.1	2.22	< 0.1	0.18
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	0.14	< 0.1	1.97	< 0.1	0.14
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.28	< 0.1	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	0.13	< 0.1	1.78	< 0.1	0.13
Coronene	mg/kg	< 0.1	NONE	< 0.1	< 0.1	0.74	< 0.1	< 0.1
Total Oily Waste PAHs	mg/kg	< 1	MCERTS	1.2	< 1	12.3	< 1	< 1
Total Dutch 10 PAHs	mg/kg	< 1	MCERTS	1.3	< 1	16.1	< 1	1.3
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	1.9	< 1.6	22.3	< 1.6	1.8
Total WAC-17 PAHs	mg/kg	< 1.7	NONE	1.9	< 1.7	23.1	< 1.7	1.8

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 20-01984	Date Sampled	13/02/20				
Apple Environmental Ltd	Time Sampled	None Supplied				
Site Reference: None Supplied	TP / BH No	TP.03/02/2939				
Project / Job Ref: CL/2939/DV	Additional Refs	None Supplied				
Order No: None Supplied	Depth (m)	None Supplied				
Reporting Date: 24/02/2020	DETS Sample No	463136				

Determinand	Unit	RL	Accreditation				
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1			
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1			
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1			
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1			
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1			
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1			
Fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1			
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1			
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1			
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1			
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1			
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1			
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1			
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1			
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1			
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1			
Coronene	mg/kg	< 0.1	NONE	< 0.1			
Total Oily Waste PAHs	mg/kg	< 1	MCERTS	< 1			
Total Dutch 10 PAHs	mg/kg	< 1	MCERTS	< 1			
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6			
Total WAC-17 PAHs	mg/kg	< 1.7	NONE	< 1.7			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - TPH CWG Banded

DETS Report No: 20-01984	Date Sampled	13/02/20	13/02/20	13/02/20	13/02/20	13/02/20
Apple Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: None Supplied	TP / BH No	TP.01/01/2939	TP.01/02/2939	TP.02/01/2939	TP.02/02/2939	TP.03/01/2939
Project / Job Ref: CL/2939/DV	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Reporting Date: 24/02/2020	DETS Sample No	463131	463132	463133	463134	463135

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	24
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	34
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3	< 3	< 3	< 3	21
Aliphatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3	5	< 3	< 3
Aliphatic >C21 - C34	mg/kg	< 10	MCERTS	< 10	< 10	41	< 10	< 10
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	< 21	< 21	46	< 21	79
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3	8	< 3	< 3
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	< 10	< 10	40	< 10	< 10
Aromatic (C5 - C35)	mg/kg	< 21	NONE	< 21	< 21	48	< 21	< 21
Total >C5 - C35	mg/kg	< 42	NONE	< 42	< 42	94	< 42	79

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Tel : 01622 850410



Soil Analysis Certificate - TPH CWG Banded

DETS Report No: 20-01984	Date Sampled	13/02/20				
Apple Environmental Ltd	Time Sampled	None Supplied				
Site Reference: None Supplied	TP / BH No	TP.03/02/2939				
Project / Job Ref: CL/2939/DV	Additional Refs	None Supplied				
Order No: None Supplied	Depth (m)	None Supplied				
Reporting Date: 24/02/2020	DETS Sample No	463136				

Determinand	Unit	RL	Accreditation				
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01			
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05			
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2			
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2			
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3			
Aliphatic >C16 - C21	mg/kg	< 3	MCERTS	< 3			
Aliphatic >C21 - C34	mg/kg	< 10	MCERTS	< 10			
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	< 21			
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01			
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05			
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2			
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2			
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	< 2			
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	< 3			
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	< 10			
Aromatic (C5 - C35)	mg/kg	< 21	NONE	< 21			
Total >C5 - C35	mg/kg	< 42	NONE	< 42			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - BTEX / MTBE						
DETS Report No: 20-01984	Date Sampled	13/02/20	13/02/20	13/02/20	13/02/20	13/02/20
Apple Environmental Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: None Supplied	TP / BH No	TP.01/01/2939	TP.01/02/2939	TP.02/01/2939	TP.02/02/2939	TP.03/01/2939
Project / Job Ref: CL/2939/DV	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	Depth (m)	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Reporting Date: 24/02/2020	DETS Sample No	463131	463132	463133	463134	463135

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Toluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Ethylbenzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
p & m-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
o-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
MTBE	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - BTEX / MTBE						
DETS Report No: 20-01984	Date Sampled	13/02/20				
Apple Environmental Ltd	Time Sampled	None Supplied				
Site Reference: None Supplied	TP / BH No	TP.03/02/2939				
Project / Job Ref: CL/2939/DV	Additional Refs	None Supplied				
Order No: None Supplied	Depth (m)	None Supplied				
Reporting Date: 24/02/2020	DETS Sample No	463136				

Determinand	Unit	RL	Accreditation				
Benzene	ug/kg	< 2	MCERTS	< 2			
Toluene	ug/kg	< 5	MCERTS	< 5			
Ethylbenzene	ug/kg	< 2	MCERTS	< 2			
p & m-xylene	ug/kg	< 2	MCERTS	< 2			
o-xylene	ug/kg	< 2	MCERTS	< 2			
MTBE	ug/kg	< 5	MCERTS	< 5			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - Sample Descriptions

DETS Report No: 20-01984	
Apple Environmental Ltd	
Site Reference: None Supplied	
Project / Job Ref: CL/2939/DV	
Order No: None Supplied	
Reporting Date: 24/02/2020	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
463131	TP.01/01/2939	None Supplied	None Supplied	8.9	Brown sandy gravel with stones and concrete
463132	TP.01/02/2939	None Supplied	None Supplied	16.6	Brown loamy clay
463133	TP.02/01/2939	None Supplied	None Supplied	11.3	Black loamy sand with stones and concrete
463134	TP.02/02/2939	None Supplied	None Supplied	16.1	Brown loamy clay
463135	TP.03/01/2939	None Supplied	None Supplied	16.7	Black loamy sand with stones and concrete
463136	TP.03/02/2939	None Supplied	None Supplied	14.9	Brown loamy clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample ^{1/5}

Unsuitable Sample ^{u/s}



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-01984

Apple Environmental Ltd

Site Reference: None Supplied

Project / Job Ref: CL/2939/DV

Order No: None Supplied

Reporting Date: 24/02/2020

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 dphenylcarbazine followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 - C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450°C	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

CALIBRATION CERTIFICATE NO: 65685

ISSUED BY: SHAWCITY LIMITED
DATE: 03-Apr-19
APPROVED SIGNATORY: 
NAME: David Godfrey
CUSTOMER: Apple Environmental Ltd
INSTRUMENT: Phocheck Tiger
SERIAL NUMBER: T-113211
CALIBRATION METHOD: CM03
AMBIENT CONDITIONS: 20°C ± 2°C and 50% (± 20%) RH

Prior to calibration the instrument was allowed to stabilise in the laboratory for at least 30 minutes.
The instrument was calibrated by exposing the sensor to known values of gas concentrations.
All gases were sampled through the complete probe and in line filter, where applicable.
The reference value is that generated by the certified source and the indicated value is that measured by the instrument.

CALIBRATION RESULTS

GAS	LOT No	REF. VALUE	INDICATED VALUE
Isobutylene	WO132063-5	100 ppm	100 ppm
Isobutylene	WO130990-3	1000 ppm	1000 ppm
Benzene	WO184558-5	5 ppm	5.1 ppm

COMMENTS:

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of $k=2$.
This provides a level of confidence of uncertainty of approximately 95%.
The uncertainty of measurement is $\pm 2\%$
The results indicate that the instrument conforms to the applicable parts of the published specification.

HEALTH & SAFETY, OCCUPATIONAL HYGIENE AND ENVIRONMENTAL MONITORING INSTRUMENTS

Tel: 01793 780622
www.shawcity.co.uk

Instrument House, 91-92 Shrivenham Hundred Business Park
Watchfield, Oxfordshire, SN6 8TY

Fax: 01793 784466
service@shawcity.co.uk

CERTIFICATION OF CALIBRATION



Date Of Calibration: 02-Aug-2019

Certificate Number: GA11347_2/23678

Issued by: QED Environmental Systems Ltd.

Customer: Apple Environmental
Unit 3 Estevan Farm Stoney Lane Medstead
Alton Hampshire GU34 5EL UNITED KINGDOM

Description: Gas Analyser

Model: GA2000

Serial Number: GA11347

UKAS Accredited results:

Results after adjustment :

Methane (CH ₄)		
Certified Gas (%)	Instrument Reading (%)	Uncertainty (%)
5.0	5.1	0.41
15.0	15.2	0.64
50.0	49.7	0.94

Carbon Dioxide (CO ₂)		
Certified Gas (%)	Instrument Reading (%)	Uncertainty (%)
5.0	4.9	0.43
15.0	15.0	0.70
50.0	50.4	1.1

Oxygen (O ₂)		
Certified Gas (%)	Instrument Reading (%)	Uncertainty (%)
21.1	21.1	0.31

The inwards assessment was carried out 18-Jul-2019.

The maximum adjustment was less than the inwards assessment uncertainty.

Inwards assessment data is available if requested.

All concentrations are molar.

CH₄, CO₂ readings recorded at : 32.6 °C ± 2.5 °C

O₂ readings recorded at : 22.8 °C ± 2.5 °C

Barometric Pressure : 1010 mbar ± 4 mbar

Method of Test : The analyser is calibrated in a temperature controlled chamber using a series of reference gases, in compliance with procedure LP004.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Calibration Instance:104 IGC Instance:103

Page 1 of 2 | LP015GIUKAS-2.4

www.qedenv.com +44 (0) 333 800 0088 sales@qedenv.co.uk

QED Environmental Systems Ltd. Cyan Park - Unit 3, Jimmy Hill Way, Coventry, CV2 4QP, UNITED KINGDOM

Registered in England and Wales 1898734

CERTIFICATION OF CALIBRATION



Date Of Calibration: 02-Aug-2019

Certificate Number: GA11347_2/23678

Issued by: QED Environmental Systems Ltd.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Calibrations marked 'Non-UKAS Accredited results' on this certificate have been included for completeness.

Non-UKAS accredited results after adjustment:

Barometer (mbar)	
Reference	Instrument Reading
1010	1010

Additional Gas Cells		
Gas	Certified Gas (ppm)	Instrument Reading (ppm)
CO	519	519
H ₂ S	251	251

Internal Flow	
Applied (l/hr)	Instrument Reading (l/hr)
5.00	4.97
10.00	9.91

Date of Issue : 05-Aug-2019

Approved by Signatory

Graham Ingles

Laboratory Inspection

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Calibration Instance:104 IGC Instance:103

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