

Crayfern Homes

F.A.O. Kevin Wawman
Our Ref: 16612/SGRA
February 2018

Dear Kevin,

RE: Land adjacent to Orchard Business Park, North End Road, Yapton, West Sussex BN18 0GA

Crayfern Homes commissioned Soils Limited to undertake a Soil Gas Risk Assessment at the site known as Land adjacent to Orchard Business Park, North End Road, Yapton, West Sussex BN18 0GA.

Background

The Phase I Desk Study (Ref: 16612/DS, dated November 2017) identified a low risk of soil gas associated with VOC's from on and offsite tanks and offsite garages located between 5m and 45m to the east and northeast. Recommendations were made to undertake a soil gas risk assessment at the site, given its environs and the proposed residential development. As such, 6No. gas monitoring visits were undertaken over a period of three months to assess the risk posed to the site from the identified sources.

The Phase I Desk Study (Ref: 16612/DS, dated November 2017) and Phase II Ground Investigation Report (ref. 16612/GIR, dated November 2017) undertaken by Soils Limited, must be read in conjunction with this letter report.

This letter report documents the findings of the gas monitoring and makes recommendations for gas protection measures, where required.

Works Undertaken

On 9th November 2017 four windowless sampler boreholes (WS1 – WS4) were drilled, using a Premier Compact 110 windowless and dynamic probe rig to a depth of 5.00m below ground level (bgl) at locations selected by Soils Limited using a development plan provided by the client.

Three standpipes were installed within window sample borehole locations (WS1, WS2 and WS4) to allow for continued monitoring of both groundwater and soils gas, where present. The monitoring well installations comprised 25mm ID HPDE pipework installed in boreholes. The response zone comprised a slotted pipe with non-calcareous gravel pack surround with a bentonite seal above. The headworks comprised a single gas tap fitted into an end cap and

placed on the end of the pipework just below ground level within a metal stopcock cover set in concrete.

Soils described as Made Ground were encountered in one out of the seven trial holes from ground level to a depth of 0.40 (WS/DP1). The Made Ground typically comprised soft dark brown very silty CLAY with very rare fine to medium sub-angular flint and brick gravel and frequent very fine white rootlets. Soils described as Topsoil were encountered in five of the seven trial holes from ground level to depths ranging between 0.20m bgl (WS/DP2) and 0.24m bgl (TPA to TPC). The Topsoil comprised dark brown clayey SILT. Frequent fine roots and rootlets were noted.

Soils described as River Terrace Deposits were encountered in all seven trial holes from directly below the Made Ground / Topsoil (from Ground level in WS/DP 2) and persisted to a depth of 5.60m bgl, as inferred from DP4. The River Terrace Deposits typically comprised firm dark orangey brown slightly sandy silty CLAY. Sand was fine to coarse. Rare fine to medium flint gravels were noted. Frequent black decayed root tracks.

Soils described as Lewis Nodular Chalk Formation were encountered in all seven trial holes from directly below the River Terrace Deposits and persisted to a depth of 6.00m bgl, the final depth of all WS/DP holes. Unweathered chalk is a weak rock and it must be noted that the drilling process can disturb the structure and fabric. The Lewis Nodular Chalk Formation typically comprised yellowish white and off-white weathered structureless CHALK recovered as fine to medium weak intact blocks in a sandy silty matrix. Occasional pockets of fine to medium angular flint were noted.

Soil Gas Monitoring Records

Monitoring was undertaken on six separate occasions over a period of three months. These included targeting periods of low and falling pressure where possible.

The results of the monitoring are provided within Table 1.

Table 1 – Soil Gas Results

Date (Barometric Trend)	TH	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	H ₂ S (ppm)	CO (ppm)	LEL (%)	aP (mb)	Flow (l/h)	Dp	H ₂ O (m bgl)	Base Of Hole (m)	VOC (ppm)
Thursday 23/11/2017 (Rising)	ATM	0.0	0.0	20.7	-	-	-	1005	-	-	-	-	-
	WS1	0.0	4.5	14.7	0.0	0.0	0.0	1005	0.01	0.0	Dry	4.95	0.0
	WS2	0.0	3.2	9.4	0.0	0.0	0.0	1005	0.01	0.0	Dry	4.90	0.0
	WS4	0.0	2.6	17.7	0.0	0.0	0.0	1005	0.01	0.0	Dry	4.95	0.0
Wednesday 06/12/2017 (Falling)	ATM	0.0	0.1	21.2	-	-	-	1028	-	-	-	-	-
	WS1	0.0	4.1	14.2	0.0	0.0	0.0	1028	0.0	0.0	Dry	5.00	1.0
	WS2	0.0	2.8	17.4	0.0	0.0	0.0	1028	0.0	0.0	Dry	5.00	0.0
	WS4	0.0	3.0	12.9	0.0	0.0	0.0	1028	0.0	0.0	Dry	4.95	0.0
Tuesday 19/12/2017 (Steady)	ATM	0.0	0.0	20.1	-	-	-	1037	-	-	-	-	-
	WS1	0.0	1.9	18.1	0.0	0.0	0.0	1037	0.6	1.0	Dry	5.00	0.8
	WS2	0.0	0.6	18.9	0.0	0.0	0.0	1037	0.3	1.0	Dry	4.88	0.3
	WS4	0.0	2.0	19.1	0.0	0.0	0.0	1037	0.3	1.0	Dry	4.92	0.3

Tuesday	ATM	0.0	0.0	20.1	-	-	-	1005	-	-	-	-	-
02/01/2018	WS1	0.0	3.6	17.1	0.0	0.0	0.0	1005	0.0	0.0	4.57	4.93	0.3
(Falling)	WS2	0.0	1.6	15.0	0.0	0.0	0.0	1005	0.0	0.0	4.63	4.88	0.2
	WS4	0.0	1.5	18.6	0.0	0.0	0.0	1005	0.0	0.0	4.89	4.95	0.5
Tuesday	ATM	0.0	0.0	20.5	-	-	-	1030	-	-	-	-	-
30/01/2018	WS1	0.0	2.5	17.6	0.0	0.0	0.0	1030	0.7	3.0	4.35	4.94	1.0
(Falling)	WS2	0.0	0.8	18.1	0.0	0.0	0.0	1029	0.7	3.0	4.44	4.89	1.0
	WS4	0.0	2.0	16.7	0.0	0.0	0.0	1028	0.7	4.0	4.67	4.96	0.0
Wednesday	ATM	0.0	0.0	20.1	-	-	-	1029	-	-	-	-	-
21/02/2018	WS1	0.0	2.0	18.2	0.0	0.0	0.0	1029	0.7	3.0	4.62	4.93	0.6
(Falling)	WS2	0.0	0.5	20.3	0.0	0.0	0.0	1029	0.5	2.0	4.67	4.88	0.4
	WS4	0.0	2.1	16.5	0.0	0.0	0.0	1028	0.6	3.0	4.89	4.95	0.4
Maximum		0.0	4.5	21.2	0.0	0.0	0.0	1037	0.7	4.0	4.89	5.00	1.0
Minimum		0.0	0.0	9.4	0.0	0.0	0.0	1005	0.0	0.0	4.35	4.88	0.0

Note: Zero reading (0.0) = below the equipment detection limit. - = no data obtained

The trend in barometric pressure over the week of the above dates is presented below, respectively.

Figure 1: Weekly Barometric Trend for Week Commencing 19th November 2017

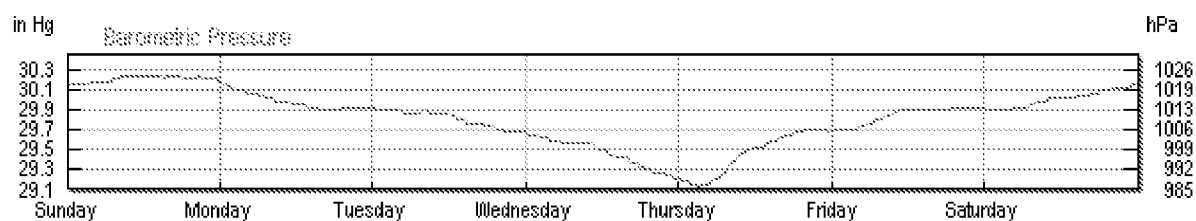


Figure 2: Weekly Barometric Trend for Week Commencing 3rd December 2017

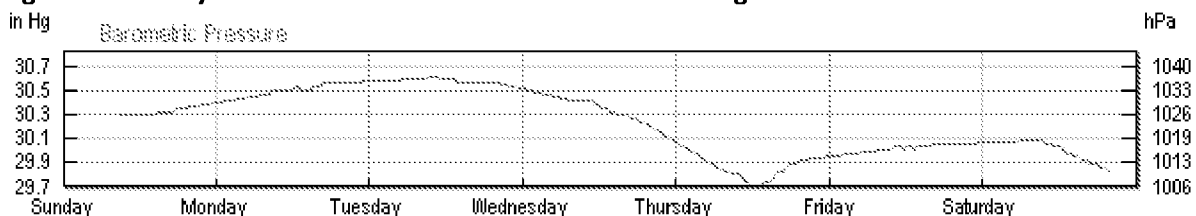


Figure 3: Weekly Barometric Trend for Week Commencing 17th December 2017

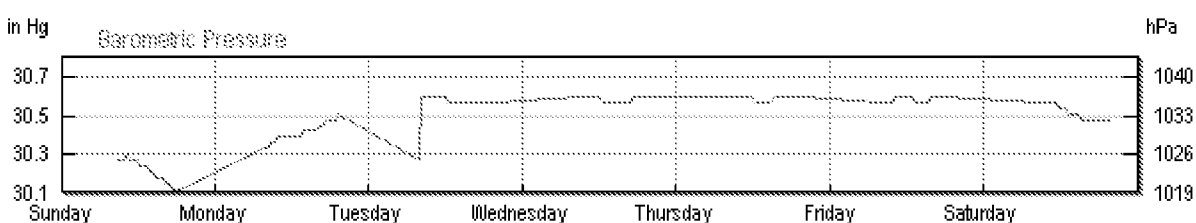
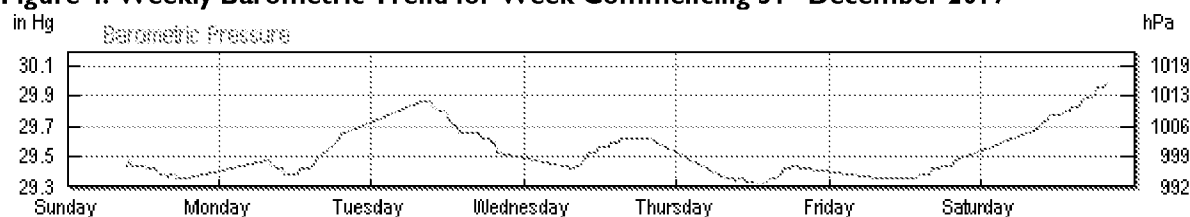
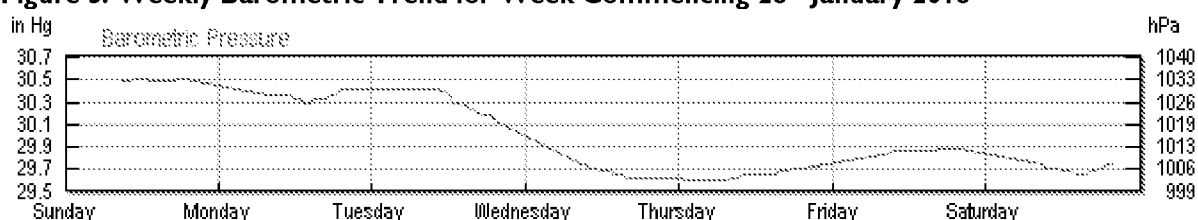
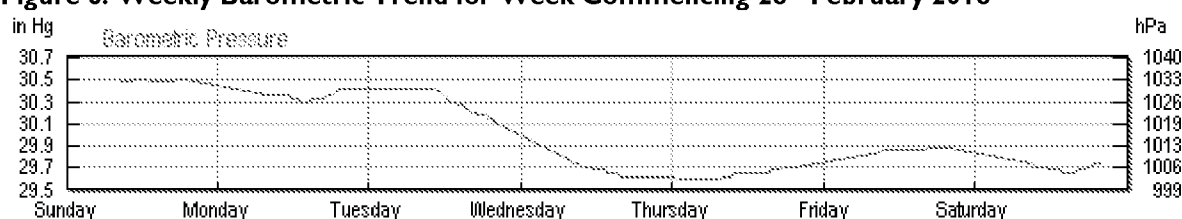


Figure 4: Weekly Barometric Trend for Week Commencing 31st December 2017**Figure 5: Weekly Barometric Trend for Week Commencing 28th January 2018****Figure 6: Weekly Barometric Trend for Week Commencing 28th February 2018**

The **highest concentration of carbon dioxide (CO₂)** was recorded at **4.5% by volume** in WS1 on the 23rd November 2017.

The **lowest concentration of oxygen (O₂)** was recorded at **9.4% by volume** in WS2 on 23rd November 2017.

No concentrations of methane total or LEL (CH₄), Carbon Monoxide (CO) and Hydrogen Sulphide (H₂S) were recorded above instrument detection limit.

The Maximum positive gas of flow was recorded as 0.7l/h during the monitoring period.

Concentrations of Volatile Organic Compounds (VOCs) within the monitoring wells were measured using a Photo-Ionisation Detector (PID). Results showed a **maximum concentration of 1.0ppm**, which is not considered hazardous.

Data Quality

A review was made of the quality of the available data for the site, which can be viewed in Table 2. CIRIA 665 (2007) and BS 8485:2015 stress the need for risk assessments to be based on good quality data and give guidance as to best practice in this respect.

Table 2 – Review of Data Quality

Data Type	Current Situation	UK Practice
Geological and hydro-geological conditions	With regard to soil gas risk assessment the data from Desk Study and logged trial holes was good.	CIRIA 665, Wilson and Card (2007) and BS 8485:2015 recommend that geology and hydrogeology be fully understood.

Monitoring period	The monitoring has been undertaken on a total of six occasions over a three-month period. Monitoring has been undertaken over a range of seasons and weather conditions including falling-rising and low and high atmospheric pressures.	CIRIA 665 recommends approximately 3-month monitoring over a range of weather conditions.
Gas data sets	Borehole flow velocity has been measured on each monitoring occasion.	Borehole flow velocity and borehole gas volume required to define characteristic gas saturation. Modified Wilson and Card, Table 8.5 of CIRIA 665 (2006)/Table 2 of BS 8485:2015.

Data quality was characterised as **good**, covering a range of atmospheric pressure trends. Geological and hydrogeological conditions have been investigated and fully understood.

Risk Assessment

Based on the documentation presented in the “BS 8485:2015, Code of practice for the characterisation and remediation from soil gas in affected developments” the hazardous gas flow rate (Q_{hg}) was calculated using Equation 1:

$$Q_{hg} = (C_{hg}/100) * q \quad \text{Equation 1}$$

Where:

C_{hg} is the measured hazardous gas concentration (in percentage volume-by-volume).

q is the flow rate in litres per hour of combined gases found by direct measurement.

The Q_{hg} for carbon dioxide was calculated using Equation 2a.

$$\begin{aligned} Q_{hg} \text{ (l/hr)} &= \text{gas concentration} * \text{borehole flow rate (l/hr)} \\ &= 4.5/100 * 0.7 = 0.0315 \text{ l/h} \end{aligned} \quad \text{Equation 2a}$$

The maximum carbon dioxide concentration was taken as the gas concentration. The maximum flow during the monitoring period was taken as a rate of 0.7.

Based on a *Site Characteristic hazardous gas flow rate* (Q_{hg}) of 0.0315 l/hr and the maximum carbon dioxide concentration of 4.5% the site fell into a **Characteristic Gas Situation 1 (CS1)**, for which no special precautions are required as given in the “Guidance on methane and carbon dioxide, NHBC 2007” (refer to Tables 11.1 and 11.2).

Should you have any further questions please do not hesitate to contact the undersigned.

Yours Sincerely



John Hills BSc (Hons)

Graduate Geo-Environmental Engineer