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3rd April 2017

Subject: Supplementary Gas Monitoring.
EPS Ref: UK16.2295

Dear Dean,

Environmental Protection Strategies Ltd (EPS) is pleased to provide this letter report, which presents the findings of supplementary ground gas monitoring undertaken at the Proposed Cheshunt Sports Village, Theobalds Lane, Cheshunt, Hertfordshire, EN8 8RX ('the site').

The objective of this work was to undertake long-term monitoring to supplement the findings of our initial Phase I & II Geo-Environmental Assessment and to further characterise the risks to future site users from ground gas.

Non-Technical Client Summary

- The results of this additional monitoring are consistent with the findings of the initial investigation, which identified low concentrations of methane and slightly elevated concentrations of carbon dioxide.
- On this basis the site is considered to be at low risk from ground gas. However, some basic gas protection measures will be required for incorporation into both the residential and commercial areas of the proposed development.

This document is divided into four main sections which provide a background to the work, a summary of the work itself, the findings, and finally, an interpretation of the current situation with recommendations for any further action.

BACKGROUND & INTRODUCTION

This investigation supplements a Phase I & II Geo-Environmental Assessment undertaken for the site by EPS in September 2016. For background information, it is recommended that the reader review the following document:

- *Phase I & II Geo-Environmental Assessment – Proposed Cheshunt Sports Village, Theobalds Lane, Cheshunt, Hertfordshire, EN8 8RX* (Report Ref: UK16.2295).

As part of this work, eight weekly gas monitoring visits were completed, which included the measurement of oxygen, carbon dioxide, methane, organic vapour and borehole flow rate. Ground Gas Screening Values were calculated for each monitoring visit in accordance with CIRIA guidance C665 'Assessing Risks Posed by Hazardous Ground Gases to Buildings'.

During the initial monitoring programme, worst-case gas screening values for carbon dioxide and methane were calculated at $<0.01571/\text{hr}$ and $<0.00141/\text{hr}$ respectively. Subsequent ground gas risk assessment was completed using Wilson and Card classification system (given the mixed commercial and residential nature of the proposed development), which indicated that the conditions should be classified as 'very low risk'.

However, given the slightly elevated concentrations of carbon dioxide and methane at a single location, basic gas protection measures were recommended. In addition, it was recommended that long-term monitoring should be carried out in order to confirm the appropriate level of gas protection to be incorporated into the buildings.

SUMMARY OF INVESTIGATIONS

An EPS engineer attended the site on nine monthly visits between 29th September 2016 and 23rd March 2017. On each occasion, the presence and concentration of ground gas (including carbon dioxide, oxygen and methane), borehole flow rate and organic volatiles was measured using a GFM 435 gas analyser, flow meter and Photo-Ionisation Detector (PID).

FINDINGS

Concentrations of methane were generally low across the monitoring period, with detectable concentrations only identified at one location, up to a maximum concentration of 1.0% (WS8). Elevated concentrations of carbon dioxide were consistently encountered across the site, up to a maximum of 14.1% within BH8. Positive borehole flow rates were only recorded at two locations during the last visit, with a maximum flow rate of 0.6l/hr. A borehole location plan is included as Figure 1 and the results of the ground gas monitoring are included as Table 1.

CONCLUSIONS & RECOMMENDATIONS

The results from this supplementary period of monitoring are consistent with the data obtained as part of the original Geo-Environmental Assessment.

Worst-case gas screening values for carbon dioxide and methane have been calculated at $0.06721/\text{hr}$ and $<0.0011/\text{hr}$ respectively. Using the Wilson and Card classification system has (in accordance with CIRIA C665), these conditions are considered to fall into the risk category 'low risk' (given that $>5\%$ carbon dioxide has been consistently identified) and characteristic situation 2, for which basic gas protection measures are required.

No ionisable organic vapour was identified above 20ppmV. Although an elevated concentration of 143ppmV was identified during one of the initial eight monitoring visits, this result was considered to be the product of equipment malfunction. Given that no further elevated levels have been identified across an extensive monitoring period, risks associated with ingress of organic vapours to future buildings is not considered to be plausible.

Basic gas protection measures (characteristic situation 2) for incorporation within new residential and commercial development would include provision of a membrane with all joints and penetrations sealed. Selection of an appropriate membrane will depend on the nature of the proposed floor slab as follows:

1. Either, a reinforced concrete, cast in situ floor slab (suspended, non-suspended or raft) with a minimum 1200g DPM
2. Or, a beam and block/pre-cast concrete floor slab with a minimum 2000g DPM/reinforced gas membrane.

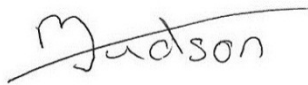
In addition to the above, residential areas of the proposed development should include a ventilated underfloor space.

I trust this information is suitable for your purposes at this time. Please don't hesitate to contact us with any queries or if you require anything further.

Yours Sincerely.

EPS Ltd

Author



Michael Judson
Consultant

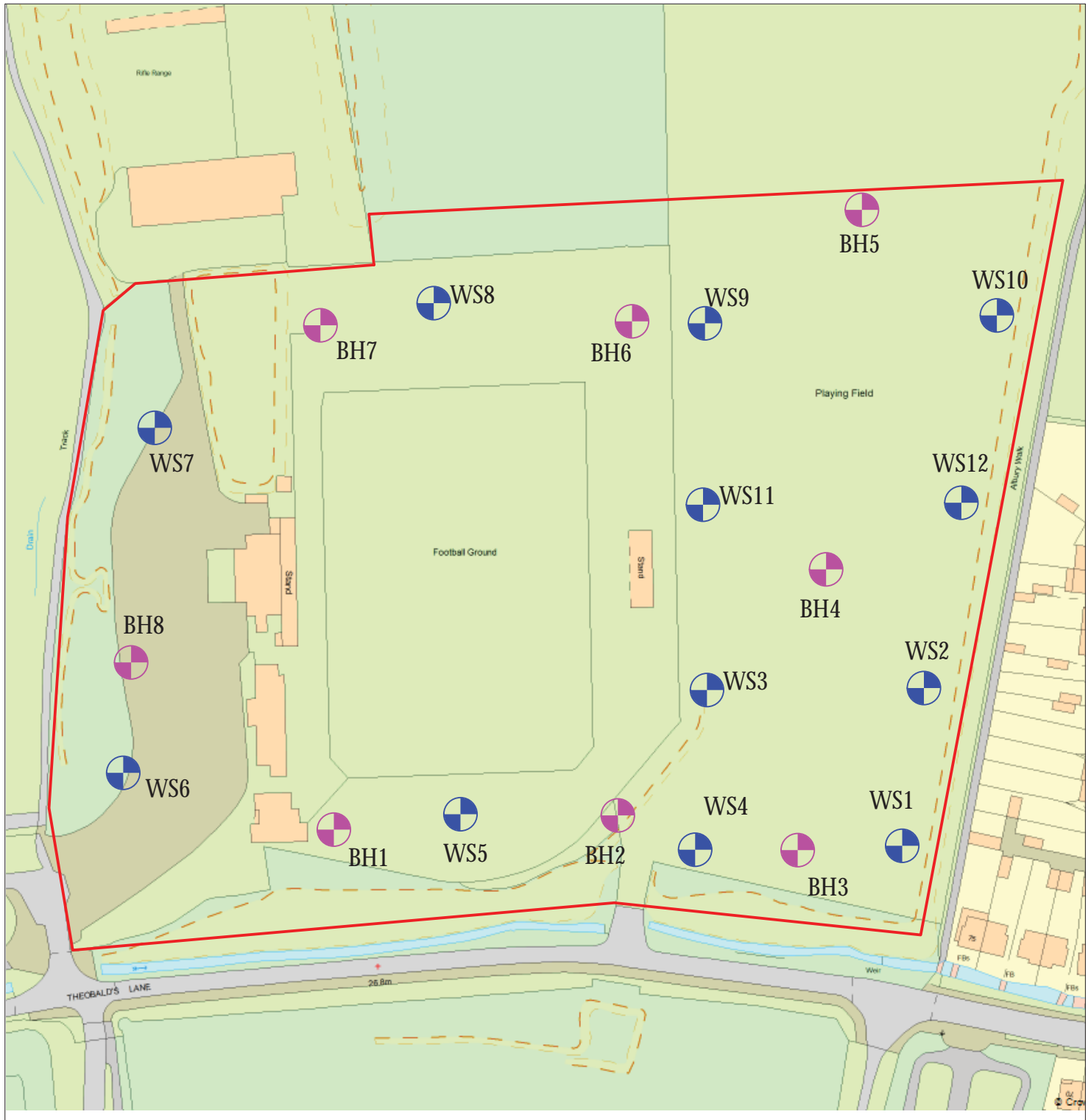
Reviewed / Authorised



Rob Allen
Principal Consultant



FIGURES



EPS Window Sample Location



EPS Shell & Auger Location



Approximate Site Boundary

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Title: Borehole Location Plan

Project: Proposed Cheshunt Sports Village,
Theobalds Lane, Cheshunt,
EN8 8RX

Scale: As Shown

Drawn By: MJ | Approved By: WE

Job No: UK16.2295

Dwg No: Cheshunt/0716/01

Date: June 2016

Fig No: 1

TABLES

Table 1 - Gas Monitoring Well Analysis (29/09/2016)

Sample ID	WS1	WS2	WS4	WS5	WS6	WS7	WS8	WS9	WS10	WS11	BH8
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
CO ₂ (%)	12.2	6.7	9.5	8.0	9.6	3.2	8.9	9.2	1.0	12.7	14.1
O ₂ (%)	9.0	14.3	10.9	12.9	6.7	11.9	2.7	11.2	19.6	8.3	3.1
Flow Rate (l/hr)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Gas Screening Value (l/hr) (CH ₄)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	<0.0001	<0.0001	<0.0001
Gas Screening Value (l/hr) (CO ₂)	<0.0122	<0.0067	<0.0095	<0.0080	<0.0096	<0.0032	<0.0089	<0.0092	<0.001	<0.0127	<0.0141

Readings collected on 29/09/2016 at an atmospheric pressure of 1007mbar (Falling).

Table 1 (continued) - Gas Monitoring Well Analysis (20/10/2016)

Sample ID	WS1	WS2	WS4	WS5	WS6	WS7	WS8	WS9	WS10	WS11	BH8
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CO ₂ (%)	7.3	4.8	1.8	6.3	4.1	10.9	<0.1	2.0	<0.1	<0.1	9.3
O ₂ (%)	13.6	16.7	18.6	14.2	14.2	2.4	20.5	18.3	20.8	20.7	7.4
Flow Rate (l/hr)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Gas Screening Value (l/hr) (CH ₄)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Gas Screening Value (l/hr) (CO ₂)	<0.0073	<0.0048	<0.0018	<0.0063	<0.0041	<0.0109	<0.0001	<0.0020	<0.0001	<0.0001	<0.0093

Readings collected on 20/10/2016 at an atmospheric pressure of 1017mbar (Falling).

Table 1 (continued) - Gas Monitoring Well Analysis (29/11/2016)

Sample ID	WS1	WS2	WS4	WS5	WS6	WS7	WS8	WS9	WS10	WS11	BH8
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CO ₂ (%)	8.5	5.8	8.0	7.2	9.1	10.9	3.5	7.9	1.9	10.8	9.2
O ₂ (%)	11.7	14.0	9.9	11.2	-	-	11.0	12.2	17.5	8.2	-
Flow Rate (l/hr)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Gas Screening Value (l/hr) (CH ₄)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Gas Screening Value (l/hr) (CO ₂)	<0.0085	<0.0058	<0.0080	<0.0072	<0.0091	<0.0109	<0.0035	<0.0079	<0.0019	<0.0108	<0.0092

Readings collected on 29/11/2016 at an atmospheric pressure of 1032-1024mbar (Falling).

Table 1 (continued) - Gas Monitoring Well Analysis (20/12/2016)

Sample ID	WS1	WS2	WS4	WS5	WS6	WS7	WS8	WS9	WS10	WS11	BH8
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.0	<0.1	<0.1	<0.1	<0.1
CO ₂ (%)	9.3	7.1	8.0	4.7	9.0	10.6	8.3	8.0	2.0	13.1	10.1
O ₂ (%)	10.2	12.5	9.5	15.9	9.4	0.8	0.1	10.8	17.3	4.7	2.1
Flow Rate (l/hr)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Gas Screening Value (l/hr) (CH ₄)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0010	<0.0001	<0.0001	<0.0001	<0.0001
Gas Screening Value (l/hr) (CO ₂)	<0.0093	<0.0071	<0.0080	<0.0047	<0.0090	<0.0106	<0.0083	<0.0080	<0.002	<0.0131	<0.0101

Readings collected on 30/12/2016 at an atmospheric pressure of 1020-1019mbar (Falling).

Table 1 (continued) - Gas Monitoring Well Analysis (25/01/2017)

Sample ID	WS1	WS2	WS4	WS5	WS6*	WS7	WS8	WS9	WS10	WS11	BH8*
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	-
CO ₂ (%)	9.0	6.8	7.8	6.5	-	9.4	7.2	8.3	1.7	12.4	-
O ₂ (%)	10.8	12.8	9.5	12.9	-	2.9	0.6	9.8	17.3	6.5	-
Flow Rate (l/hr)	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	-
Gas Screening Value (l/hr) (CH ₄)	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-
Gas Screening Value (l/hr) (CO ₂)	<0.0090	<0.0068	<0.0078	<0.0065	-	<0.0094	<0.0072	<0.0083	<0.0017	<0.0124	-

Readings collected on 25/01/2017 at an atmospheric pressure of 1026-1023mbar (Falling).

* Borehole could not be located.

Table 1 (continued) - Gas Monitoring Well Analysis (22/02/2017)

Sample ID	WS1	WS2	WS4	WS5	WS6	WS7	WS8	WS9	WS10	WS11	BH8
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.7	<0.1	<0.1	<0.1	<0.1
CO ₂ (%)	9.7	6.3	7.2	4.0	3.8	9.5	6.6	6.9	0.1	11.7	8.7
O ₂ (%)	9.3	14.6	9.5	17.2	16.7	1.4	0.6	11.8	21.0	5.9	0.2
Flow Rate (l/hr)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Gas Screening Value (l/hr) (CH ₄)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0007	<0.0001	<0.0001	<0.0001	<0.0001
Gas Screening Value (l/hr) (CO ₂)	<0.0097	<0.0063	<0.0072	<0.004	<0.0038	<0.0095	<0.0066	<0.0069	<0.0001	<0.0117	<0.0087

Readings collected on 22/02/2017 at an atmospheric pressure of 1002-1001 (Falling).



Table 1 (continued) - Gas Monitoring Well Analysis (23/03/2017)

Sample ID	WS1	WS2	WS4	WS5	WS6*	WS7*	WS8	WS9	WS10	WS11	BH8*
CH ₄ (%)	<0.1	<0.1	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	<0.1	-
CO ₂ (%)	9.3	6.7	8.6	5.6	-	-	1.1	8.0	1.4	11.2	-
O ₂ (%)	11.5	15.1	8.7	14.1	-	-	16.9	12.1	19.2	10.2	-
Flow Rate (l/hr)	<0.1	<0.1	0.6	<0.1	-	-	<0.1	<0.1	<0.1	0.6	-
Gas Screening Value (l/hr) (CH ₄)	<0.0001	<0.0001	<0.0006	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0006	-
Gas Screening Value (l/hr) (CO ₂)	<0.0093	<0.0067	0.0516	<0.0056	-	-	<0.0011	<0.0080	<0.0014	0.0672	-

Readings collected on 23/03/2017 at an atmospheric pressure of 1011-1010mbar (Falling).

* Borehole could not be located.

LIMITATIONS & CONSTRAINTS

This report has been prepared for the client(s) listed on the report title page. EPS accepts no liability or responsibility for use of, or reliance upon, this report and / or the information contained within it by third parties.

If third parties have been contracted / consulted during compilation of this report, the validity of any data they may have supplied, and which are included in the report, have been assessed as far as possible by EPS however, EPS cannot guarantee the validity of these data.

No part of this report, or references to it, may be included in published documents of any kind without approval from EPS.

This report and its contents, together with any supporting correspondence or other documentation, remain the property of Environmental Protection Strategies Ltd until paid for in full.

Where ground investigations have been conducted, these have been limited to the level of detail required for the site in order to achieve the objectives of the investigation.

The report has been written, reviewed and authorised by the persons listed above. It has also undergone EPS' in house quality management inspection. Should you require any further assistance regarding the information provided within the report, please do not hesitate to contact us.

No investigation method is capable of completely identifying all ground conditions that might be present in the soil or groundwater under a site. Where outlined in our report, we have examined the ground beneath a site by constructing a number of boreholes and / or trial pits to recover soil and / or groundwater samples. The locations of these excavations and sampling points are considered to be representative of the condition of the whole site subsurface however, ground conditions are naturally variable and it may be possible that the ground conditions may differ to those encountered during the investigation.

Whilst it is recognised that information contained within this report may assist relevant and suitably qualified professionals, this report does not provide a geotechnical appraisal of ground conditions with respect to suitability of foundations or future structures, nor does it intend to identify a need for any associated geotechnical ground improvement works.

No visible evidence of Japanese Knotweed was identified during the site walkover, however this plant can be difficult to identify in the early stages of growth and therefore it is not always possible to identify its presence at certain times of the year. For this reason EPS cannot confirm that Japanese Knotweed rhizomes do not exist and it is recommended that if it is suspected that this species, or other similarly invasive plants are present at the site, a specialist contractor should be commissioned to make a detailed assessment.