Client: **Postland Developments**

Moulton Chapel, Chapel Walk
Gas Protection Measures

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1 Summary

The site is located on Roman Road, Moulton Chapel. This report provides a summary of the Ground Investigation results regarding the soil gas detected. There are also presented below Gas protection measures needed.

The protection measures are based on BS8485:2015+A1:2019 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.

A Ground Investigation report was conducted for the above site. According to this report, whilst the results of gas monitoring would generally suggest a very low risk Characteristic Situation CS1, the elevated carbon dioxide concentrations of up to 12.5% would suggest that the hazard potential should be increased to CS2 as defined by BS8485:2015+A1:2019.

In the Table 1 below a conceptual model relative to Construction and Future Development is presented. The table is an extract from the Ground Investigation report (Report Reference C14951D).

Soil Gas	Inhalation of Soil Gas	Human Health Groundworkers	Low Likelihood	Medium	Moderate /Low Risk
		Human Health Site Users	Low Likelihood	Mild	Low Risk

Table 1: Conceptual model relative to Construction and Future Development

Key	**Definition**
Very High risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, or there is evidence that severe harm to a designated receptor is currently happening. The risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) and remedial works may be necessary in the short term and likely over the long term.
Moderate risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.
Low risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

The below notes were suggested in the Ground Investigation Report:

"Elevated concentrations of up to 12.5% by volume of carbon dioxide were encountered and we believe that the Characteristic Situation CS2 would be applicable for all houses across the proposed development, due to the presence of organic matter within the Tidal Flat Deposits beneath the whole site, in accordance with BS8485:2015+A1:2019 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings."

Table 4 from *BS8485:2015+A1:2019* confirms below the Characteristic situation as described in the Site Investigation Report.

CS	Minimum gas protection score (points)			
	High risk		Medium risk	Low risk
	Type A building	Type B building	Type C building	Type D building
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6.5 [A)]	5.5 [A)]	4.5	3.5
5	— [B)]	[A1] 6 [A1] [A)]	5.5	4.5
6	— [B)]	— [B)]	[A1] — [B)] [A1]	[A1] 6 [A1]

[A)] Residential buildings should not be built on CS4 or higher sites unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.

[B)] The gas hazard is too high for this empirical method to be used to define the gas protection measures.

2 Gas Protection Measures

In respect of the potential for elevated carbon dioxide, and potentially reduced oxygen levels, safe working procedures adopted on this site should follow the principles given by the Health and Safety Executive guidance notes with regards to exposure limits and entry into deep excavations/confined spaces.

Gas detection equipment and an alarm system for personnel working in excavations may be required, together with other safety facilities.

When the minimum gas protection score has been determined for the building as a whole, or for each part of the building, then a combination of two or more of the following three types of protection measures should be used to achieve that score:

- the structural barrier of the floor slab, or of the basement slab and walls if a basement is present
- ventilation measures and
- gas resistant membrane.

Having determined the minimum gas protection score for the building, or each different part of the building, (CS2 for building Type A), an element or combination of elements should be chosen from Table 5, Table 6, and Table 7 from BS8485:2015+A1:2019 with a combined score achieving the minimum recommended gas protection (3.5 points for the proposed development). No more than one element of each type should be combined to achieve the recommended gas protection score.

2.1 Structural barrier of the floor slab

Table 5 — *Gas protection scores for the structural barrier*

Floor and substructure design (see Annex A)	Score [A]
Precast suspended segmental subfloor (i.e. beam and block)	0
Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)	0.5
Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations	1 or 1.5 [B]
Basement floor and walls conforming to BS 8102:2009, Grade 2 waterproofing [C] [D]	2
Basement floor and walls conforming to BS 8102:2009, Grade 3 waterproofing [C] [D]	2.5

[A] The scores are conditional on breaches of floor slabs, etc., being effectively sealed.

[B] To achieve a score of 1.5 the raft or suspended slab should be well reinforced to control cracking and have minimal penetrations cast in (see **A.2.2.2**).

[C] The score is conditional on the waterproofing being provided by a suitable structural barrier with the design and detailing of the walls and floor meeting the requirements for Type B protection. The score cannot be assigned for Type A (waterproof membrane) or Type C (drained cavity wall).

[D] If a membrane is installed beneath and around the basement to provide Type A waterproofing (BS 8102:2009), it can be assigned a gas protection score in accordance with Table 7, if it meets all the criteria for a gas resistant membrane in that table.

The proposed development includes Beam & block floor so no protection measures can be selected by Table 5 **(0 scope points in total)**.

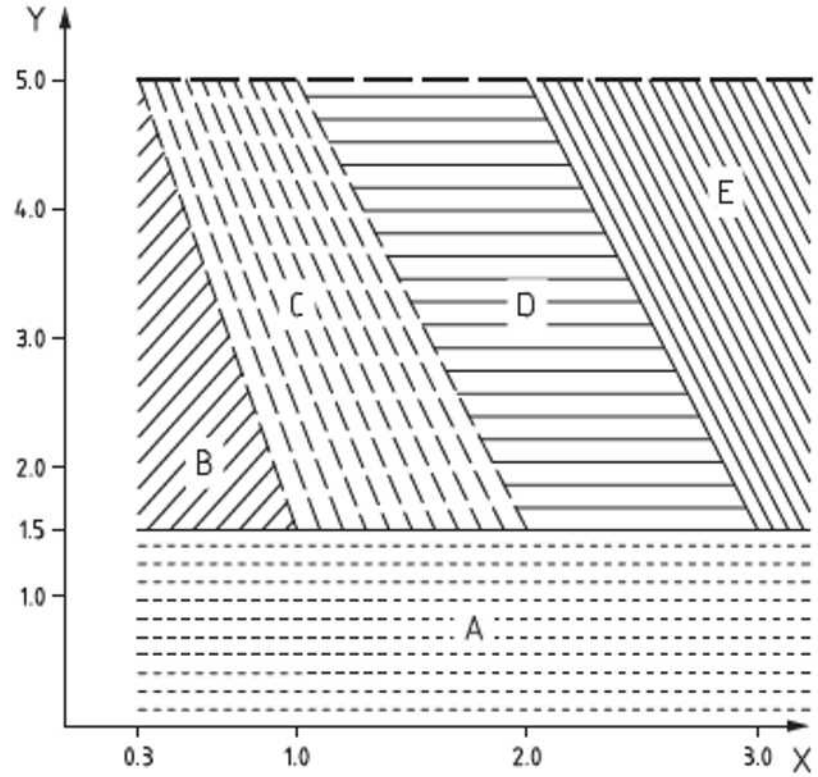
2.2 Ventilation Measures

Table 6 — *Gas protection scores for ventilation protection measures*

Protection element/system	Score	Comments
(a) Pressure relief pathway (usually formed of low fines gravel or with a thin geocomposite blanket or strips terminating in a gravel trench external to the building)	0.5	Whenever possible a pressure relief pathway (as a minimum) should be installed in all gas protection measures systems. If the layer has a low permeability and/or is not terminated in a venting trench (or similar), then the score is zero.
(b) Passive sub floor dispersal layer: Very good performance: Good performance: Media used to provide the dispersal layer are: • Clear void • Polystyrene void former blanket • Geocomposite void former blanket • No-fines gravel layer with gas drains • No-fines gravel layer	2.5 1.5	Performance criteria for methane and carbon dioxide are shown in Figure B.6 and Figure B.7, respectively. The ventilation effectiveness of different media depends on a number of different factors including the transmissivity of the medium, the width of the building, the side ventilation spacing and type and the thickness of the layer. The selected score should be assigned taking into account the recommendations in Annex B. Passive ventilation should be designed to meet at least "good performance", see Annex B.
(c) Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution layer, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers	1.5 to 2.5	This system relies on continued serviceability of the pumps, therefore alarm and response systems should be in place. There should be robust management systems in place to ensure the continued maintenance of the system, including pumps and vents. Active ventilation should always be designed to meet at least "good performance", as described in Annex B.
(d) Active positive pressurization by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket	1.5 to 2.5	This system relies on continued operation of the pumps, therefore alarm and response systems should be in place. The score assigned should be based on the efficient "coverage" of the building footprint and the redundancy of the system. Active ventilation should always be designed to meet at least "good performance".
(e) Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or undercroft car park)	4	Assumes that the car park is vented to deal with car exhaust fumes, designed to *Buildings Regulations 2000, Approved Document F* [9].

From the Ventilation protection measures included in Table 6, a passive sub floor dispersal system with very good performance is selected. Performance criteria for carbon dioxide according to Annex B from BS8485:2015+A1:2019 is presented in the below diagram. In order to achieve Very good performance (A) the maximum hazardous gas concentration in ventilation layer must not exceed 1.5% v/v for any wind speed velocity that might occur. **(1.50 scope points in total)**

Figure B.7 — *Performance criteria for carbon dioxide*



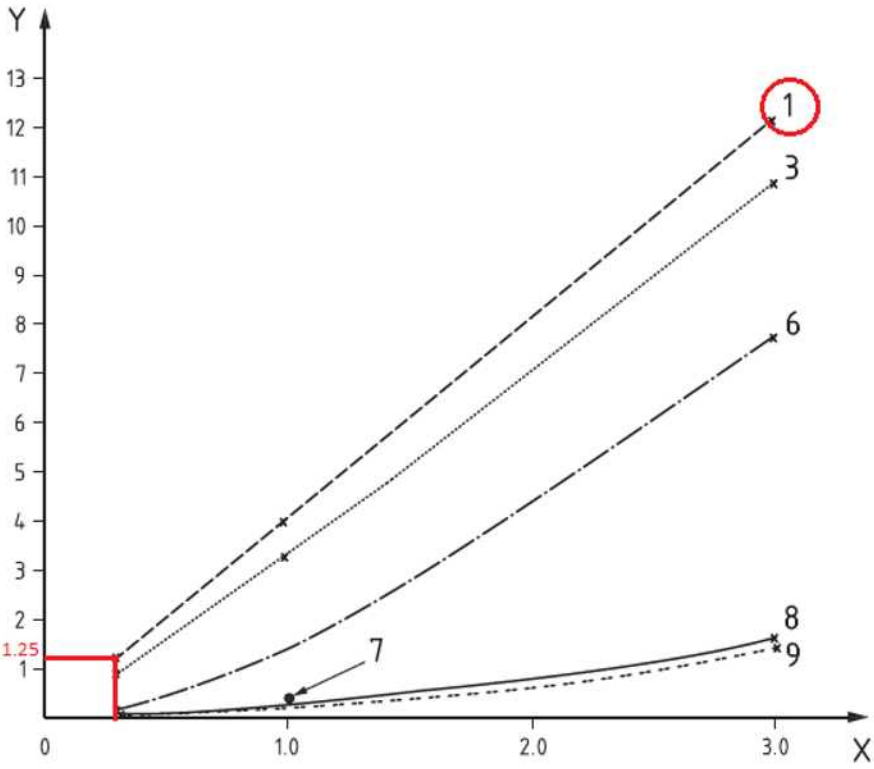
Key

A	Very good	X	Wind speed (m/s)
B	Good	Y	Maximum hazardous gas concentration in ventilation layer (% v/v)
C	Fair		
D	Poor		
E	Unsuitable		

NOTE The information in this figure is based on Passive Venting of Soil Gases Beneath Buildings. Guide for Design [12].

NOTE 4 The DETR/PiT research - Passive Venting of Soil Gases Beneath Buildings. Guide for Design. [12] - and subsequent additional CFD modelling results and interpretation published by two of the DETR/PiT research authors provides the basis of the understanding of the effectiveness of alternative dispersal media and how passive systems can be designed. An illustration of the relative performance of different media for a 30 m wide idealized dispersal layer with no internal discontinuities and similar side ventilation provision is provided in Figure B.8 and for a 5 m by 5 m wide idealized dispersal layer in Figure B.9.

Figure B.9 — *CFD computed volume flow through rates vs wind speed for various media for a 5 m by 5 m wide foundation [12]*



Key

1	Open void 200 mm deep (Model 1)	X	Wind speed (m/s)
3	Polystyrene shutter, 22 mm equivalent clear space (Model 1)	Y	Volume flow rate of air through dispersal layer (m^3/m width/h)
6	40 mm thick cuspated geocomposite void former blanket (Model 1)		
7	20 mm (no fines) gravel blanket. 400 mm thick (Model 1)		
8	20 mm (no fines) gravel blanket. 200 mm thick with pipes (not interleaved) at 2 m centres (Model 3)		
9	20 mm (no fines) gravel blanket, 200 mm thick (Model 3)		

NOTE In the Figure and the Key, 2, 4 and 5 are not used.

Air-bricks shall be installed in the structure (void space in passive ventilation protection system). The number of airbricks should comply with the above performance criteria for carbon dioxide.

According to paragraph B.6 Clear Void dispersal Layer BS8485:2015+A1:2019:

The volume flow-through rate is governed by the size and number of side vents; for small to medium width buildings (up to 15 m wide), the minimum area of side ventilation should be 1 500 mm_2/m run of wall on at least two opposite sides.

This rate of cross section area of Air-bricks for every liner meter of building shall be used for the right amount of airbrick installation for each side of the building.

2.3 Gas resistannt membrane

Table 7 — *Gas protection score for the gas resistant membrane*

Protection element/system	Score	Comments
Gas resistant membrane meeting all of the following criteria: • sufficiently impervious [A1] , both in the sheet material [A)] and in the sealing of sheets and sealing around sheet penetrations, to prevent any significant passage of methane and/or carbon dioxide through the membrane; [A1] • sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; • [A1] *Text deleted* [A1] • sufficiently strong [A1] [B)] [A1] to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc); [A1] and to withstand in-service stresses (e.g. settlement if placed below a floor slab); [A1] • capable, after installation, of providing a complete barrier to the entry of the relevant gas; and • verified in accordance with CIRIA C735 [N1].	2	The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and integrity of joints. [A1] *Text deleted* [A1] If a membrane is installed that does not meet all the criteria in column 1 then the score is zero.

[A)] [A1] A membrane with a methane gas transmission rate <40.0 ml/day/m²/atm (average) for sheets and joints (tested in accordance with BS ISO 15105-1:2007 manometric method) is regarded as sufficiently impervious.

[B)] For example, reinforced LDPE (virgin polymer) membranes having a minimum mass per unit area of 370 g/m² and not significantly less than 0.4 mm thickness between the reinforcement scrim (tested in accordance with Procedure D (2 mm diameter tip) of BS EN ISO 9863-1:2016) installed above floor slabs are considered sufficiently strong to meet the performance criteria (see also C.3). Thicker and more robust membranes or an additional membrane protection layer should be installed directly beneath cast-in-situ floor slabs. [A1]

Gas resistant membrane shall be applied according to the above specification **(3.50 scope points in total).**

An LDPE or LLDPE membrane of 0.5mm thickness, manufactured from virgin polymer and meeting the recommendations set out in Table 7 above is proposed to be installed.