Herefordshire Council

Model Farm

Geotechnical Update to Desk Study (2008), Phase 1 Environmental Risk Assessment (2008) and the Ground Investigation Report (2009)

Technical Update Report

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This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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Appendices

Appendix A

Geotechnical Desk Study (Amey, 2008)

Appendix B

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1 Introduction

Ove Arup and Partners Limited (Arup) has been commissioned by Herefordshire Council (the Council) to provide an update to previously prepared planning documentation for the Model Farm site, Ross-on-Wye, in order to enable the resubmission of the planning application for the proposed employment led development. The site location is shown in Figure 1below.



Figure 1 Site Location Plan

As part of the 2017 update works, it has been identified that previous geoenvironmental reports prepared for the site require review in accordance with current guidance and legislation.

This technical note serves to identify these required updates and presents the results of associated assessments undertaken in accordance with such current legislation. It should be noted that this note presents the factual findings of these assessments only. No detailed interpretations and/or risk assessments have been undertaken as part of this commission.

2 Background

The Model Farm site, is approximately 15.4 hectares, and is located on the eastern edge of Ross-on-Wye Town Centre, north of the A40.

The site is owned by Herefordshire Council (HC) and is currently used for agricultural purposes by tenant farmers. The site consists of Model Farm and Spring Farm which are on either side of a farm access track, leading onto Highfield Farm to the north.

The A40 runs along the southern boundary of the site. To the west of the site is a residential area, located beyond a green buffer zone. Further agricultural land is located to the east. The north boundary of the site is formed by a disused railway line. The Hildersley Farm Industrial Estate is located on the opposite side of the A40, to the south of the site.

The proposed development comprises 29,400 square meters (sq.m) Gross Floor Area (GFA) of employment uses, including B1 (Business), B2 (General Industrial) and B8 (Storage and Distribution), a number of areas of landscaping are to be both constructed and retained as part of the development.

2.1 Planning History

The site has a long history of planning permissions for employment uses; specifically B1 (Business / Offices), B2 (General / Industrial Estate) and B8 (Storage and distribution / warehousing).

A previous outline planning application for development of the site (reference: DCSE2007/3140/O), was approved in January 2008.

A subsequent hybrid planning application was submitted for the same site and approved in December 2014 (P133411/CD). This included a larger red line boundary but did not increase the amount of floorspace to be developed on the site.

The current planning application seeks to refresh the 2014 permission and a review of the various technical reports has formed part of this update.

3 Scope & Context

In support of the original planning application, three geotechnical/geoenvironmental reports were prepared; 'Geotechnical Desk Study (2008)', and the 'Phase 1 Environmental Risk Assessment (2008)', both prepared by Amey, and the 'Site Investigation Report (2009)' prepared by Wardell Armstrong.

However since these reports were completed, there has been a number of updates to regulatory/legislative framework and guidance.

On account of the above, this technical note has been prepared to detail changes to the regulatory/legislative framework and guidance relative to the development of the site; and identify any issues or amendment to the conclusions of the previously prepared original planning reports.

3.1 The Proposed Development

Outline planning permission is sought for six development areas at the Model Farm site. The future employment uses that have been identified are:

- B1 Business (16,500 sq.m gross floor area GFA);
- B2 General (8,900sq.m GFA); and
- B8 Storage or Distribution (4,000sq.m GFA)

An indicative masterplan (LA-008) has been prepared for illustrative purposes only; to provide guidance on the potential form and layout of development that could come forward on the site in the future, based on the areas above.

3.2 Report Structure

The remainder of this report presents the technical review and updates as follows:

- Section 4 details the updates to the previously prepared Geotechnical Desk Study (2008) and Phase 1 Environmental Risk Assessment (2008) and its conclusions;
- Section 5 details the updates to the previously prepared Site Investigation Report (2009) and its conclusions; and
- Section 6 provides overall conclusions in support of the current planning application.

4 Geotechnical Desk Study (2008)

4.1 Introduction

Amey Consulting were commissioned by Herefordshire Council (HC) to undertake a Geotechnical Desk Study (see Appendix A) and Phase 1 Environmental Risk Assessment (see Appendix B) for the Model Farm Site, which were issued in October 2008 in support of the original Planning Application.

A review of the documents indicates that the only update to legislative guidance with respect to the desk based information enclosed within the 2008 reports is the way by which aquifers and groundwater vulnerability are now classed. This is discussed further below:-

4.1.1 Hydrogeology, Hydrology and soils

The 2008 Geotechnical Desk Study report and Phase 1 Environmental Risk Assessment concluded the following with respect to hydrogeological and hydrological conditions on and beneath the site area:-

- Bedrock and superficial deposits beneath the site were classed as variably permeable minor aquifers (the former being associated with the Brownstones Formation bedrock).
- The soil vulnerability was classed as high and described as readily transmitting non-adsorbed pollutants and liquid discharges, yet having some ability to attenuate adsorbed pollutants. The soils on the River Wye floodplain were deemed to have low leaching potential.
- The 2008 Environmental Agency (EA) records, as reported in the 2008 report indicated that the majority of the site lies in a Source Protection Zone (outer zone), with the inner protection zone lying to the immediate south west of the site. The flood records of the EA, showed the site to be outside any flood or extreme risk areas. The nearest flood plain was identified to be 500m to the North West of the site.
- The Soil Survey of England and Wales records (1983) indicated the site to be located on Eardiston 1 (541c) soil association soils; described *as well drained reddish coarse loamy soils over sandstone, shallow in places especially on brown. Some reddish fine silty soils over shale and siltstone. Risk of water erosion.*

In line with current regulatory/legislative framework and guidance, (the Environment Agency, 2008, Groundwater Protection Policy (GP3) and the 2015 Water Framework Directive (WFD), based on British Geological Survey mapping), the following updates to groundwater and aquifer classifications, and flood risk classification maps (based on the Flood Risk Regulations 2009, which implements the European Floods Directive, 2007) are discussed below.

• As of April 2010 the EA Groundwater Protection Policy now uses aquifer designations that are consistent with the Water Framework Directive.

Based on this updated guidance, the Alluvium of the River Wye floodplain, which the site is located on, is now classified as a Secondary A aquifer (<u>http://maps.environment-agency.gov.uk/</u>) as shown on Figure 2.

The bedrock geology of the site (Brownstones Sandstone Formation) is also classified as a Secondary A aquifer (http://maps.environment-agency.gov.uk/) as shown on Figure 3.



Figure 2 Superficial Aquifer designation: Secondary A aquifer (<u>http://maps.environment-agency.gov.uk/</u>)



Figure 3 Bedrock Aquifer designation: Secondary A aquifer (<u>http://maps.environment-agency.gov.uk/</u>)

The Environment Agency has also recently updated its groundwater vulnerability maps to reflect improvements in data mapping, modelling

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capability and understanding of the factors affecting vulnerability. Figure 4shows that the site is located within a Major Aquifer Intermediate Groundwater Vulnerability Zone, with soils of intermediate leaching potential.



Figure 4 Groundwater Vulnerability zone; Major Aquifer Intermediate (soil leaching) (<u>http://maps.environment-agency.gov.uk/</u>)

• Review of the Environment Agency's Flood Map for Planning data (Rivers and Sea) (Figure 5) shows the site to be located in 'Flood Zone 1': having a low probability (less than 1 in 1000 annual probability) of river or sea flooding.



Figure 5 Flood Zone 1: Land and property in flood zone 1 have a low probability of flooding (<u>http://maps.environment-agency.gov.uk/</u>).

• Concurrent with the 2008 Desk Study report, the site remains within a Groundwater Source Protection Outer Zone (Zone 2) of the Alton Court aquifer (defined as having a 400 day travel time from a point below the water table) as shown in Figure 6.



Figure 6 The Site (approximate location shown by the pink circle) is located in a Groundwater source protection Outer Zone (Zone 2) (<u>http://maps.environment-agency.gov.uk/</u>).

4.1.2 Conclusions

With respect to the previously prepared Desk Study and Phase 1 Environmental Risk Assessment Report its conclusions pertaining to hydrogeology, hydrology and soils, the Groundwater Source Protection Zone (outer zone) and low risk of flooding at the site (although now referred to as Flood Zone 1 by the EA) remains the same under current regulatory guidance.

The bedrock and superficial aquifer classifications beneath the Model Farm site have however been updated and should now be regarded as Secondary A Aquifers; these were formerly known as minor aquifers.

There is no further information contained within the 2008 Desk Study report or Phase 1 Environmental Risk Assessment that is considered to be out of date with regards to current regulatory/legislative framework and guidance.

With respect to the above, the overall conclusions of the 2008 Desk Study and Phase 1 Environmental Risk Assessment are not considered to have changed, and the reports and its conclusions remain valid.

5 Site Investigation Report (2009)

5.1 Introduction

The 2009 Site Investigation Report (2009) prepared by Wardell Armstrong (see Appendix B) details the findings of a ground investigation undertaken at the Model Farm site between 27th and 30th April 2009 by Exploration Limited and St Clements Plant Limited (under direct supervision of Wardell Armstrong).

The investigation comprised the excavation of 22no light percussion boreholes, 21no trial pits and 5no hand dug pits. The exploratory holes were positioned across the development area to provided general coverage. Areas of potential contamination (fuel storage etc.) were also targeted.

The locations of the exploratory holes are provided on Drawing no.WM10264/02 within the Site Investigation Report (2009).

As part of the ground investigation a series of soil and water samples (groundwater and surface pond water) were obtained and chemically analysed for a variety of potential contaminants. The results of the chemical analyses were reviewed as detailed in the 2009 report in accordance with published guidance, current at the time of writing (2009). In addition, six rounds of gas monitoring were undertaken from 8no.installed standpipes and the results were assessed to determine any requirements for gas protection measures.

Since issue of the 2009 report, the guidance pertaining to how contaminated land risk assessments are undertaken has been updated, which has included publication of updated soil guideline values and generic assessment criteria (for the assessment of risks posed to human health) and updated Water Framework Directive Environmental Quality Standards for the protection of controlled waters. Consequently, the 2009 ground investigation data has been reviewed in accordance with these updated standards and guidance as presented below.

5.1.1 Soils

As discussed in the Site Investigation Report (2009) a total of 49no soil samples were obtained from across the Model Farm site, comprising 24no samples of made ground and 25no samples of natural strata.

As part of the Wardell Armstrong 2009 assessment to determine risks posed to site end users (as reported in the Site Investigation Report), the soil analyses results were screened against available published SGVs for a residential with plant uptake and also commercial land use scenario. In the absence of these SGVs for some contaminants, GACs derived (by Wardell Armstrong) using the CLEA v1.04 model, and published by CIEH/LQMs were applied.

Using the above, Wardell Armstrong concluded that there was no significant or widespread contamination present across the site area. However one area of PAH contamination in the locale of LP2 (adjacent to the existing Spring Farm building), associated with pockets of ash within the made ground was identified. Visual evidence of minor surface hydrocarbon contamination, (staining, associated with oil containers) was also noted within shallow hand dug trial holes

HDP2 and HDP5. Chemical analyses of the samples from these locations identified TPH concentrations of 5,700mg/kg and 940mg/kg.

Since 2009, the previously applied screening criteria has either been updated or withdrawn. On account of this, the chemical data presented in the 2009 Ground Investigation Report has been re-assessed against current published soil screening criteria for both public open space (POS - park) and a commercial end use. Although the proposed buildings on the site comprise commercial premises the current master plan (LA-008) indicates a variety of landscaping features to be either maintained or constructed as part of the development and hence public open space guideline values are also considered appropriate. The current screening criteria used to re-asses the results comprises:

- Category 4 Screening Levels (C4SLs) (2014) [1] available for 6% SOM for Arsenic, Cadmium, Chromium IV, Lead, Nickel and Benzo(a)pyrene,
- Land Quality Management (LQM) / Chartered institute of environmental health (CIEH) 'Suitable 4 Use Levels' (S4ULs) (2014) [2] available for soil organic matter (SOM) values of 1%, 2.5% and 6%.

Where a range of SOM values exist, and in the absence of SOM data for the site, the most conservative SOM of 1% has been used for the purpose of the screening assessment.

Results of Re-Assessment

The results of the re-assessment of the existing data against current published guidance is presented below:

- 36no samples (comprising 18no natural and 18no made ground) were analysed for commonly encountered contaminants including metals, phenol, cyanides and sulphate. All concentrations of these contaminants were recorded below the applied public open space (POS) and commercial screening criteria.
- 2no sample of made ground were analysed for unspeciated total petroleum hydrocarbons (TPH) and 1no sample was analysed for speciated TPHs. Unspeciated TPH was recorded at low concentrations (no guideline value currently exists for TPH, however total concentrations recorded are less than the lowest current guideline values for individual carbon bands). Speciated TPHs were recorded at concentrations less than the applied POS and commercial guideline values.
- 6no samples (comprising 5no made ground and 1no natural) were analysed for 16 PAHs. One sample LP2 at 0.4mbgl, associated with a discrete pocket of ash, recorded benzo(a)anthracene and chrysene at concentrations in excess of the applied public open space (POS) criteria (as shown in blue in Table 1 below) and benzo(a)pyrene and dibenzo(ah)anthracene in excess of both the POS and commercial screening criteria. The remaining 5no samples analysed recorded PAH values below the applied screening criteria for both land uses.

	LQM S4UL 2014 Public Open	LQM S4UL 2014	
	Space	Commercial	
	(Parkland) SOM:1%	SOM:1%	LP2 at 0.4 mbgl
	(mg/kg)	(mg/kg)	(mg/kg)
Benz(a)anthracene	93	170	120
Chrysene	13	350	98
Benzo(a)pyrene	21 (C4SL)	77 (C4SL)	140
Dibenzo(ah)anthracene	1.1	3.5	21
PAH 16 Total	NA	NA	1100

Table 1: Model Farm PAH exceedances

Pesticides / Agrochemicals

5no samples (comprising 4no made ground and 1no natural) were analysed for pesticides and agrochemicals as part of the 2009 GI. Of the 24no individual substances tested for, 4no were detected above the analytical limit of detection; DDE, DDT, Sieldrin and Malathion. Wardell Armstrong derived in house generic assessment criteria using the CLEA 1.04 model for DDE and DDT, which were not exceeded by the concentrations recorded. No GACs have been derived for these contaminants as part of this assessment and no published screening criteria currently exists. Current screening criteria for a public open space and commercial end use exists for Dieldrin and Malathion; both of these contaminants were recorded at concentrations less than the current screening criteria.

Asbestos

5no soil samples were 'screened' for asbestos as part of the 2009 GI. No asbestos was detected in the samples analysed.

However, as detailed in the ALcontrol Laboratories test certificates, (enclosed within the 2009 SI report), the method of asbestos screening was an 'in house' soil fibre screen, undertaken on a wet soil sample.

This method of asbestos analysis was not UKAS accredited and as such, may not be considered reliable or as accurate under current 2017 laboratory test methods. UKAS accreditation for asbestos analysis, now means that samples are typically inspected under a stereomicroscope to determine the presence of potential ACM and fibres, and if detected, analysis can then be performed using gravimetric and fibre dispersion/counting methods as appropriate, to reliably quantify asbestos in the samples.

Soil Conclusions

A review of the results of the re-assessment of the 2009 site investigation data has indicated that PAHs are present at concentrations in excess of current published guideline values in the made ground of LP2 at 0.4mbgl. Benzo(a)anthracene and chrysene were recorded at concentrations in excess of the applied public open space (POS) screening criteria and benzo(a)pyrene and dibenzo(ah)anthracene were recorded in excess of both the POS and commercial screening criteria.

As identified in the 2009 report, it is considered likely that these concentrations are associated with a discrete pocket of ash within the made ground.

Conclusions of the Wardell Armstrong 2009 report also identified evidence of minor surface hydrocarbon contamination, within shallow hand dug trial holes HDP2 and HDP5. Chemical analysis of the samples from this located identified concentrations of TPHs of 5,700 mg/kg and 940mg/kg.

No guideline value currently exists for unspeciated TPHs, however review of the total concentrations recorded indicates that the concentrations are less than the lowest current guideline values for individual carbon bands. In addition samples analysed for speciated TPHs at the site, were recorded at concentrations less than the applied POS and commercial guideline values.

5.1.2 Leachate

The 2009 GI report concluded that all 3no samples of made ground submitted for leachability analyses recorded leachable contaminants at concentrations below the environmental quality standards and UK Drinking Water Standards current at the time of report completion (2009).

However since the 2009 report was issued, new Environmental Quality Standards have been released as part of the 2015 Water Framework Directive. As such, the leachate data has been reviewed in accordance with these updated 2015 EQSs.

Screening of the existing leachability results against current guideline values has identified a number of exceedances not previously highlighted in the original 2009 report. The exceedances are presented in Table 2 below:

Determinand	EQS	Units	LP5 at 0.25mbgl	TP10 at 0.6 mbgl
Zinc Dissolved	14.4 **	ug/l	<5	43
Fluoranthene	0.0063	ug/l	0.081	0.018
Benzo(b)fluoranthene	0.00017	ug/l	< 0.023	< 0.023
Benzo(k)fluoranthene	0.00017	ug/l	< 0.027	< 0.027
Benzo(a)pyrene	0.00017	ug/l	< 0.009	< 0.009
Indeno(123cd)pyrene	0.00017	ug/l	< 0.014	< 0.014
Benzo(ghi)perylene	0.00017	ug/l	< 0.016	< 0.016

Table 2 Leachate exceedances above EQSs

**Bioavailable (12.4ug/l) plus Ambient Background: Concentration Wye River Catchment ambient background concentration of zinc which is 2ug/l (WFD 2015).

As shown in Table 2: Zinc and Fluoranthene have been recorded in two samples in excess of the 2015 EQSs.

In terms of the recorded zinc concentration, "bioavailable" means the fraction of the dissolved concentration of zinc likely to result in toxic effects in the aquatic environment as determined using the UKTAG Metal Bioavailability Assessment Tool (M-BAT). In order to calculate the true bioavailable concentration the DOC and Ca concentration of the samples is required. On account that the DOC and Ca of the samples above are unknown, the bioavailable concentration of zinc cannot be determined, as such, the 'total' recorded zinc concentration have conservatively been used within the screening assessment.

In addition to the above, the laboratory limit of detection is greater than the applied EQS for a number of individual PAHs, and consequently, exceedances (or not) of the EQS for these contaminants cannot be determined.

5.1.3 Groundwater

As part of the 2009 investigation 2no samples of groundwater were obtained and analysed from standpipes LP14 and LP17.

Wardell Armstrong concluded on the basis of 2009 DWS and EQS guideline values that generally concentrations of potential contaminants within the sampled groundwater were recorded below available screening criteria. However this was with the exception of the groundwater sample obtained from LP17 (infilled pond) which recorded slightly elevated concentrations of PAH and TPH within the sample tested.

Wardell Armstrong concluded that the testing method used may have resulted in analysing suspended sediment within the sample from LP17 and that this sampling method would likely be attributable to the elevated results recorded. Wardell Armstrong subsequently stated that the results may not be a true representation of the groundwater quality beneath the site

The results of the 2009 groundwater analyses have been re-screened against current published EQS values (2015). The exceedances are presented in Table 3 below.

Determinand	units	EQS	LP14	LP17
Copper Dissolved (ICP-MS)	ug/l	1 Bioavailable	2.0	13
Nickel Dissolved (ICP-MS)	ug/l	4 Bioavailable	2.9	16
Fluoranthene Aqueous	ug/l	0.0063	0.034	300
Benzo(b)fluoranthene Aqueous	ug/l	0.00017	< 0.023	170
Benzo(k)fluoranthene Aqueous	ug/l	0.00017	< 0.027	94
Benzo(a)pyrene Aqueous	ug/l	0.00017	0.012	160
Indeno(123cd)pyrene Aqueous	ug/l	0.00017	< 0.014	98
Benzo(ghi)perylene Aqueous	ug/l	0.00017	< 0.016	120

Table 3 Groundwater sample exceedances above EQSs

As shown in Table 3 above: Copper has been recorded in two samples in excess of the 2015 bioavailable EQSs.

Nickel was also recorded in sample LP17 in excess of the applied screening criteria. However as discussed above, on account of the DOC and Ca concentrations of the samples being unknown, the bioavailable concentration of both copper and nickel cannot be determined using the M-Bat tool. As such, the recorded 'total' concentrations have conservatively been used within the screening assessment.

PAHs have also been recorded in excess of the applied screening criteria in both samples analysed, with notably elevated concentrations recorded in the groundwater sample from LP17.

As per the leachate analyses, the laboratory test detection limit for a number of PAHs is in excess of the current EQS. Consequently, with respect to the

groundwater sample obtained from LP14, it cannot be confirmed whether the current EQS was exceeded in the sample.

5.1.4 Surface water

As part of the 2009 ground investigation, 2no samples of surface water were obtained from two ponds located on the site (Pond sample 1 and Pond sample 3).

Wardell Armstrong concluded that all contaminants recorded within the surface samples obtained were present at concentrations less than the applied screening criteria (current at the time of report completion).

The surface water data has been reviewed and screened against current 2015 EQS data based on the Water Framework Directive, which has identified the exceedances summarised below.

Determinand	units	EQS	POND1	POND3
Chromium Dissolved (ICP-MS)	ug/l	4.7	8	9
Benzo(b)fluoranthene Aqueous	ug/l	0.00017	< 0.023	< 0.023
Benzo(k)fluoranthene Aqueous	ug/l	0.00017	< 0.027	< 0.027
Benzo(a)pyrene Aqueous	ug/l	0.00017	< 0.009	< 0.009
Indeno(123cd)pyrene Aqueous	ug/l	0.00017	< 0.014	< 0.014
Benzo(ghi)perylene Aqueous	ug/l	0.00017	< 0.016	< 0.016

 Table 4 Surface water sample exceedances above EQSs

As shown in Table 4 above: chromium has been recorded in the two pond samples in excess of the 2015 EQSs screening criteria.

In addition and as highlighted in previous sections, the laboratory test detection limit is greater than the current EQS values for a number of PAHs.

5.1.5 Controlled Water Conclusions

Wardell Armstrong concluded that, on the basis of DWS and EQS values current at the time of writing (2009), contaminant concentrations within groundwater and surface water, and also leachable contaminants within soil samples, were below available screening criteria. However highlighted that this was with the exception of the groundwater sampled from LP17, attributed to incorrect laboratory analyses.

Review of the 2009 data against current screening criteria has identified leachable concentrations of bioavailable zinc and fluoranthene in two sample in excess of the 2015 EQSs. In addition; copper, nickel and fluoranthene are also present within two groundwater samples in excess of the 2015 EQSs. Concentrations of chromium have also been identified to be in excess of the 2015 EQSs within two samples of pond water.

In addition, the laboratory limit of detections for leachable and dissolved PAHs is notably greater than present day EQS values and consequently, exceedances (or not) of the EQS for these contaminants cannot be determined.

5.1.6 Gas

As part of the 2009 ground investigation, standpipes were installed within eight boreholes across the site (the strata in which they were installed is unknown). Six ground gas monitoring visits were undertaken under varying climatic conditions, to measure the concentrations of oxygen, carbon dioxide, methane and gas flow rate. Hydrogen sulphide and carbon monoxide were not measured during the six monitoring rounds.

Wardell Armstrong concluded that in line with CIRIAs C665 traffic light classification system (generally used for low rise housing developments), elevated levels of carbon dioxide (up to 16.4% associated with pond infill materials in LP17), but gas flow rates of zero, would result in the Model Farm site being classified as a "Green" site with a negligible gas regime. On this basis, the site would not require gas protection measures. However Wardell Armstrong identified that on account of the carbon dioxide recorded in LP17 (infilled pond) and dependent on the final site layout, basic gas protection measures may be required in this localised area of the site

The potential risk to the proposed development from ground gas has been assessed as part of this note in accordance with CIRIA 665 (Ref. [3]) and the more recent 2015 British Standard; BS 8485:2015 ([4]) 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'.

At present, it is assumed that the development will be commercial and comprise buildings (single to multiple storeys) with both hardstanding and landscaping at surface level within the site boundary.

In accordance with the current guidance, the proposed development therefore falls within Situation A. This considers all development types except for those in Situation B, (i.e. low rise housing with a ventilated underfloor void).

Under Situation A, gas concentrations and borehole flow rates are used to define the Characteristic Situation (CS) for a site, based on a derived Gas Screening Value (GSV). In line with guidance given in CIRIA C665, the GSV is determined by taking into account the maximum borehole flow rate and the maximum gas concentration recorded. CIRIA C665 outlines the gas protection measures required for a range of Characteristic Situations.

Following BS8485:2015, the GSV in addition to the type and nature of the building proposed is used to determine the level of gas protection measures required. With reference to BS8485:2015 it is considered that the proposed end use of the site falls under a Type C Building on the basis of it being a commercial/public ownership, likely to have full control of structural alterations under a central building management and maintenance body.

An assessment of the 2009 gas monitoring results undertaken onsite, using current guidance, is provided below.

Pressure and flow

The gas monitoring was undertaken over both, steady, falling and rising atmospheric pressure.

Notably no gas flow was recorded in all six monitoring rounds.

No significant trend in gas concentrations or flow rates, in relation to atmospheric pressure, have been observed from the data.

Carbon Dioxide

Concentrations of carbon dioxide were generally recorded between <0.8% vol and 4.9% vol, however maximum concentrations of 9.3% vol and 16.4% vol were measured in LP6 and LP17 (infilled pond) respectively.

The maximum value of 16.4% vol will be used to derive the GSV for carbon dioxide.

Methane

Monitored concentrations of methane were consistently 0% v/v recorded with the exception of one concentration of 0.1 % vol on one occasion recorded in the standpipe in LP3 in round 1.

0.1% value will be used to derive the GSV for methane.

Oxygen

Generally oxygen values of between 16.7% and 18.7% vol were recorded in monitoring installations. However, depleted oxygen (as low at 6.1% vol) was measured predominantly in LP17 and LP6, corresponding to increased CO2 levels.

Gas Screening Value

Gas screening values (GSV) for the site have been calculated for methane and carbon dioxide using the maximum encountered concentrations as reported in Table 5 below:

Ground Gas	Max concentration (% vol)	Max flow rate (l/hr)	Gas Screening Value, GSV (l/hr)	Characteristic Situation (CS) (Situation A development)
Methane	0.1%	0	0	CS 1 – very low risk
Carbon Dioxide	16.4%		0	CS 1 – very low risk

Table 5 Gas Screening Values

On account of no detectable flow rate, the site has been classed a CS1 for which no gas protection measures are necessary, under both CIRIA C665 and BS 8485:2015 (where a point allocation of 0 has been awarded for gas protection measures).

Notwithstanding this however, It is noted that elevated CO2 levels and depleted oxygen have been detected, which may be considered a risk to end site users and confined spaces if flow rates were to increase, (naturally or on account of future development works). As such, in line with Wardell Armstrong's 2009 conclusions, dependent on final site layout, basic gas precaution measures may be required within localised areas of the site.

6 Conclusions

A review of the previous reports submitted as part of the historic planning application for the site has been undertaken in accordance with current guidance. This has identified the following;

- Under the current classification system bedrock and superficial deposits beneath the site are Secondary A aquifers. The site remains to lie within a Groundwater Source Protection Outer Zone.
- The results of the chemical analyses undertaken on soil samples have been rescreened against current published guidance for a public open space and commercial end use (considered relevant to current development proposals). As part of the previous 2009 assessment, the soil analyses results were screened against guideline values for both a residential and commercial end use (current at the time of 2009 report completion).
- The application of current published soil screening criteria for a public open space and commercial end use has identified less exceedances than those identified during the previous 2009 assessment. Notably TPH has not exceeded current published guideline standards for POS or commercial end site use.
- Notwithstanding the above however, concentrations of PAHs within the Made ground from exploratory hole LP2, remain to exceed the applied updated guideline values (both POS and commercial end site use). This is considered to be attributable to the presence of ash within the made ground, as concluded by Wardell Armstrong in 2009.
- Notably the method of asbestos analysis undertaken as part of the 2009 GI, was not UKAS accredited and furthermore the means by which asbestos is analysed for in laboratories has been subject to improvement and updating since the time of the 2009 ground investigation. This is important to consider with respect to the potential presence of asbestos within the subsurface of the site.
- With respect to surface, groundwater and leachate analyses results, it is evident that current EQS values are more stringent than those applied during the 2009 assessment. As a consequence, some samples of subsurface soils have been identified to contain elevated leachable concentrations of metals and PAHs. Similarly, groundwater and surface water samples have also been shown to contain PAHs and metals in excess of present day values. No such exceedances were identified during the 2009 assessment.
- In addition to the above, the 2009 laboratory test detection limits for a number of dissolved contaminants (largely PAHs) are in excess of present day Environmental Quality Standards and therefore exceedances cannot be determined.
- A review of the gas monitoring data has indicated that on the basis of no flow rates, the site is classed as a CS1. However, relatively elevated concentrations of carbon dioxide were recorded, particularly in LP17 (infilled pond) and therefore it may be prudent to consider a potential increase to CS2 for which gas protection measures are required.

7 **References**

- [1] Defra, Development of Category 4 Screening levels for assessment of land affected by contamination, SP1010, Final Project report (Revision 2), September 2014
- [2] The LQM /CIEH S4ULs for Human Health Risk Assessment, Version 1.0, Paul Nathaniel et al. February 2015
- [3] Assessing risks posed by hazardous ground gases to buildings, CIRIA 665, 2007
- [4] BS8485:2015 Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings, 2015

Appendix A

Geotechnical Desk Study (Amey, 2008)

Appendix B

Phase 1 Environmental Risk Assessment (Amey, 2008)

Appendix C

Site Investigation Report (Wardell Armstrong, 2009)