# Land to the Rear of 26 Cross Lane, Royston

# Phase 1 Site Investigation Report

# GMF Commercial & Domestic Property Services Ltd

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**September 2016**

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Report Title: **Land to the Rear of 26 Cross Lane, Royston**
**Phase 1 Site Investigation Report**

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# Executive Summary

| | | |
|---|---|---|
| **Site Location** | The site is located off Cross Lane, Royston, Barnsley and covers an area of 0.5 hectares. The National Grid Reference is 437300, 411570. | |
| **Current Site Use** | The site is grassed with several areas of trees and bushes. There are a small number of stables / barns on the site. The site is currently used to keep chickens and ducks. | |
| **Previous Site Uses** | The site was used as allotments from approximately 1917 to 1962, with the western part being an orchard from 1962 until approximately 1994. | |
| **Proposed Site Use** | The proposed site use is for residential housing with gardens. | |
| **Geology** | Drift: | None. |
| | Solid: | Carboniferous Pennine Middle Coal Measures. |
| | Faults: | One shown immediately north of site. |
| **Environmental Consideration** | Landfills: | Several historical landfills within 250m of the site, including one adjoining the site boundary. |
| | Radon: | No radon protection measures required. |
| | Pollution: | No pollution incidents recorded that could affect the site. |
| | Groundwater: | Underlying solid strata are a Secondary A Aquifer. Not within a groundwater Source Protection Zone. No abstraction points for potable water within 1km. |
| | Surface Water: | A small un-named water course is located in proximity to the site. |
| **Preliminary Contamination Assessment** | There is a potential for soil contamination to be present as a result of previous uses of the site. There is therefore a risk for potential contaminant linkages to human health to exist following residential redevelopment.<br><br>Landfills located in proximity to the site could act as a source of ground gas migration to the development.<br><br>Sulphates could be present in sub-soils, which would pose a risk to sub-surface concrete for proposed structures.<br><br>There is a low risk from pollution of controlled waters from the site. | |
| **Recommendations** | A Phase 2 site investigation is recommended in order to determine the actual risks from the potential contamination linkages identified.<br><br>Window sampling should be carried out in order to allow sampling of site soils for laboratory testing, the installation of gas monitoring wells and to provide information for a geotechnical assessment.<br><br>A programme of ground gas monitoring should be undertaken to determine whether gas protection measures are required. | |

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# 1 Introduction

## 1.1 Terms of Reference

1.1.1 Ecus Ltd (hereafter Ecus) was commissioned by GMF Commercial & Domestic Property Services Ltd to undertake a Phase 1 Site Investigation for a site to the rear of 26 Cross Lane, Royston, Barnsley, hereafter referred to as 'the site'.

1.1.2 To complete the Phase 1 Site Investigation, a site walkover and assessment of current activities has been undertaken, together with an investigation into land use history and a review of local environmental conditions.

1.1.3 The results of the investigation are presented in Section 2 of this report and Section 3 draws together a preliminary conceptual model and risk assessment. Section 4 presents conclusions and recommendations. Appendices A - D provide supporting information.

## 1.2 Objectives of the Phase 1 Site Investigation

1.2.1 The assessment has been carried out in general accordance with the requirements of British Standard BS10175 (2011) – Code of Practice for the Investigation of Potentially Contaminated Sites.

1.2.2 The general objectives of the assessment are as follows:

- To provide information on past and current uses of the site and surrounding area, and the nature of hazards and physical constraints;
- To identify receptors, potential sources of contamination, likely pathways and any features of immediate concern;
- To provide information on the geology, hydrogeology and hydrology of the site to assist in establishing the conceptual model;
- To provide an initial conceptual model of the nature and extent of potential contamination;
- To provide recommendations for the development of the site based on the information obtained.

## 1.3 Future Site Use

1.3.1 It is understood that it is proposed to redevelop the site for residential use, comprising 18no. houses with private gardens, as shown on SBP Architect Drawing No. 16-025-SSP01 Rev A.

1.3.2 This report has been produced with that end use in mind; any proposed change in use may result in a need for revision of this assessment.

## 1.4 Sources of Information

1.4.1 Table 1 presents sources of information that have been consulted during this assessment.

**Table 1: Sources of Information**

| Source | Details |
|---|---|
| Client | The client provided information regarding the proposed use of the site. |
| Site Walkover | Information about the site was gained from visual inspection during a site walkover. |
| Landmark Envirocheck Report | Presented in Appendices C and D and containing historical mapping and records of environmental information for the surrounding area. |
| British Geological Survey (BGS) | BGS 1:50,000 scale Geological Map No. 87, Barnsley (Bedrock & Superficial Deposits edition) was consulted for geological information relating to the site and surrounding area. |

# 2 Findings of the Phase 1 Investigation

## 2.1 Site Location and Current Condition

2.1.1 The site is approximately 0.53 hectares in area, and is situated off Cross Lane, Royston, Barnsley. Figure A1, Appendix A shows the location of the site which centres on National Grid Reference 437300, 411570.

2.1.2 A site walkover was carried out on 27th September 2016. Figure A2, Appendix A shows the current layout of the site. Photographs of the site are presented in Appendix B.

## 2.2 Site Description

2.2.1 The site is an approximately square plot of land lying to the rear (east) of 26 Cross Lane. The site is currently accessed via a track beside 26 Cross Lane.

2.2.2 The site appears to be largely unused, except for keeping chickens and ducks and possibly stabling of horses, although none were present at the time of the walkover survey.

2.2.3 The western part of the site comprises an open field with several mature and semi-mature trees, mainly around the site boundaries. The eastern part of the site comprises an open field, with a horse paddock enclosure in the south-eastern quadrant of the site.

2.2.4 There is a stable in the north-eastern corner of the site, of wooden frame and corrugated steel cladding and roof. The access track from Cross Lane continues across the north of the site to the entrance of this building.

2.2.5 There is a pile of general waste including a mattress, tarpaulin, old garden hoses and green waste in front of the stable.

2.2.6 There is a wooden-frame and tiled roof barn in the central-northern part of the site, with stables with a suspected asbestos cement roof adjoining to the east. To the south-east of these buildings is a small brick-built building with tiled roof, currently housing ducks. There is a low circular brick-built structure to the east of these buildings, with a paving slab base. The purpose of this is not known, although it may have been a drinking trough for horses.

## 2.3 Topography and Ground Cover

2.3.1 There is a gentle gradient from the north-west (approximately 51m AOD) down to the south-east (approximately 48m AOD). The horse paddock in the south-eastern corner is a flat area created by cutting down into the slope at the northern end.

2.3.2 The majority of the site is covered with grass, with trees and shrubs along the boundaries. There is an asphalt-surfaced track along the north of the site to the stable, and a small block-paved area in front of the stables.

## 2.4 Underground Structures and Services

2.4.1 There is evidence of a possible drain outside the stables in the central-northern part of the site, and electricity and water supplies were noted to these buildings.

## 2.5 Potential Contaminant Sources Noted During the Site Walkover

2.5.1 Three suspected asbestos cement panels were noted against the southern wall of the largest stable building.

## 2.6 Visual Evidence of Contamination Noted During the Site Walkover

2.6.1 No visual evidence of gross soil contamination was noted during the site walkover survey.

## 2.7 Current Surrounding Land Use

2.7.1 Current land use directly surrounding the site is outlined in Table 2.

**Table 2: Current Surrounding Land Use**

| Direction | Land Use |
|---|---|
| North | Residential housing and gardens. |
| East | A small field for horse grazing with railway beyond. |
| South | New development of residential housing. |
| West | Residential housing and gardens on Cross Lane. |

## 2.8 Historical Land Use

2.8.1 Historical Ordnance Survey mapping was obtained by commissioning a Landmark Envirocheck report for the site.

2.8.2 The historical maps are presented in Appendix C. A description of the historical use of the site is presented in Table 3. Table 3 also describes surrounding land uses where it is considered that these may influence the contamination potential of the site.

**Table 3: Historical Use of the Site and Surrounding Land (all distances are approximate)**

| Map Date | Land Use within the Site Boundary | Potentially significant surrounding Land Use |
|---|---|---|
| 1854 | The site is an undeveloped field. | The surrounding land is undeveloped. |
| 1893-5 | No changes. | No significant changes. |
| 1906-8 | No changes. | There is a Sewage Works to the south of the site. There is a railway embankment and Goods Shed close to the north-eastern corner of the site. |
| 1917-8 | The site is labelled as Allotment Gardens. | There are Filter Beds associated with the Sewage Works, adjacent to the south-eastern corner of the site. |
| 1932-8 | No changes visible. | No significant changes visible. |
| 1948 | No changes visible. | No significant changes visible. |
| 1956 | No changes visible. | No significant changes visible. |
| 1962-6 | The site is no longer shown as Allotment Gardens. The western half of the site is shown as an orchard. | The Sewage Works are no longer labelled to the south of the site; there are small buildings in its place, possibly lock-up garages. |
| 1975-7 | No changes visible. | No significant changes visible. |
| 1987 | No changes visible. | No significant changes visible. |
| 1990-3 | No changes visible. | The Goods Shed is no longer shown. |
| 1994 | The stable building is shown in the north-eastern corner of the site, with the track leading to it off Cross Lane. | No significant changes visible. |
| 1999 (aerial photo) | The paddock in the eastern part of the site is visible. | No significant changes visible. |
| 2000 | No changes visible. | No significant changes visible. |
| 2006 | No changes visible. | No significant changes visible. |
| 2016 | No changes visible. | There is residential development to the south of the site, on Lineside Lane. |

***Summary of Site History***

2.8.3 The earliest available maps show that the site was undeveloped, comprising part of a field. The site was in use as allotment gardens by 1917 and part of the site as an orchard by 1962. By 1994 the stable in the north-eastern corner of the site is shown.

## 2.9 Geology, Hydrogeology and Hydrology

***Geology***

2.9.1 The geological map for the area has been studied to infer the likely geology of the site and surrounding area.

2.9.2 The site is shown to be underlain by solid strata of the Carboniferous Pennine Middle Coal Measures Formation, comprising mudstone, siltstone and sandstone. No drift deposits are shown to affect the site.

2.9.3 No coal seams are shown in the immediate vicinity of the site. The Sharlston Top seam is shown approximately 500m south of the site, dipping towards the north,

beneath the site. An assessment of the likely dip of the coal seam has indicated that the coal is likely to lie at a depth of over 100m below ground level (bgl) in the vicinity of the site.

2.9.4 One fault is shown in the vicinity, lying to the north of the site. This trends east-west in this area, with the northern side being downthrown.

***Hydrogeology***

2.9.5 The solid strata underlying the site are classified by the Environment Agency (EA) as a Secondary A Aquifer (formerly a Minor Aquifer). The EA describe these aquifers as 'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers'.

2.9.6 The site is not located within a groundwater Source Protection Zone, set by the Environment Agency for the protection of potable groundwater resources.

2.9.7 The Envirocheck report indicates that there are no currently licensed groundwater abstractions within 1km of the site.

2.9.8 The Envirocheck report does not list any licensed discharge consents to groundwater located within 500m of the site.

***Hydrology***

2.9.9 The Envirocheck report indicates that the nearest surface water course to the site is an un-named Tertiary River, located 6m to the east of the site. This appears to pass below the railway to the east of the site via a culvert, to enter Sandybridge Dyke approximately 400m to the south-east of the site.

2.9.10 The Envirocheck report indicates that there are no currently licensed surface water abstractions within 500m of the site.

2.9.11 The Envirocheck shows that there was a discharge consent for discharge of Process Water from the Monckton Coke & Chemicals Company into the small water course that passes close to the site's eastern boundary, issued in 1968 and revoked in 1993. There are no other discharge consents listed within the Envirocheck report that are related to the site or are considered likely to have affected the site.

## 2.10 Pollution Incidents

2.10.1 There are no recorded instances of pollution of controlled waters recorded within the Envirocheck report which relate to the site or are considered likely to have affected the site.

## 2.11 Landfill Sites and Waste Management Licences

2.11.1 There are several historical landfill sites within 250m of the site recorded within the Envirocheck report, as detailed below:

- Adjoining north-eastern boundary of site; waste input between 1992 and 1994; waste included household waste;
- 89m to the north-west (no further details given, but position corresponds to the Barnsley Canal);
- 141m to the north-west; waste input between 1984 and 1997, waste included inert and commercial waste. Authorised waste included non-hazardous building / demolition waste and non-hazardous excavation waste, soil and subsoil;
- 103m to the south-east; no further details given.

2.11.2 There is one registered waste treatment site in the vicinity, located 95m to the north. This relates to the storage of spent iron oxide from the desulphurisation of coke oven gas at Monckton Coke and & Chemical Co. Ltd. However, the record is inaccurate,

as the Monckton Coke Works are located approximately 300m to the north-west and are understood to have closed.

2.11.3 There are no currently registered waste transfer sites located in the vicinity of the site.

## 2.12 Sensitive Land Uses

2.12.1 The Envirocheck report indicates that the site is not located within 1,000m of a sensitive land use, such as a local nature reserve or site of special scientific interest.

## 2.13 Radon

2.13.1 The Envirocheck report states that the site is located within an area where no radon protective measures are required for new dwellings.

## 2.14 Flood Risk

2.14.1 According to the Envirocheck report, the site is located within Flood Zone 1, the lowest risk category in the Environment Agency's classification system.

## 2.15 Coal Mining

2.15.1 Reference to the Coal Authority's online Interactive Map Viewer[1] confirms that the site is not located within a coal mining Development High Risk Area.

[1] http://mapapps2.bgs.ac.uk/coalauthority/home.html Accessed 26th September 2016.

# 3 Preliminary Conceptual Model and Risk Assessment

## 3.1 Potential Contaminants and Sources

3.1.1 The following sections provide an indication of the potentially contaminative activities that have been carried out throughout the historical use of the site and the surrounding land. Likely associated contaminants are also identified. It should be noted that the activities identified may not necessarily have resulted in contamination of the ground.

***On-Site***

3.1.2 The site is known to have been used as allotment gardens since before 1917 and as an orchard from sometime between 1917 and 1962. It is known that allotment soils can contain a range of potential contaminants due to either atmospheric deposition from industrial sources, or from substances introduced by the allotment holder such as wood ash, chimney soot or inorganic pesticides[2]. In addition, orchard soils can contain various contaminants, such as lead and arsenic, from their use in pesticides[3]. The use of lead-arsenate pesticides was diminishing by the 1960s[4], but it is possible that these or other potentially contaminating pesticides were used at the site.

3.1.3 Suspected asbestos cement sheets were noted adjacent to the larger stable building. The smaller stable building was also noted to have a suspected asbestos cement roof. It is therefore possible that localised contamination by asbestos could have occurred previously.

***Off-Site***

3.1.4 The site is within 250m of several historical landfill sites, including one adjoining the site boundary, which accepted household waste. Migration of landfill gases onto the site, including methane and carbon dioxide from the landfills is possible[5].

## 3.2 Potential Pathways and Receptors

3.2.1 Table 4 details and discusses the potential pathways and receptors identified during the Phase 1 investigation for any contaminants that may be present in the ground at the site.

3.2.2 Some pathway-receptor linkages highlighted in the table are not considered likely to be active for the reasons specified in the comments section.

[2] Alloway, B.J., 2004. *Contamination in Soils in Domestic Gardens and Allotments: A Brief Overview*. Land Contamination & Reclamation, 12 (3), 2004. EPP Publications Ltd. Available from: http://s3.amazonaws.com/zanran_storage/epppublications.com/ContentPages/2476110023.pdf [Accessed 29th September 2016].
[3] Martin, I., De Burca, R., Morgan, H., 2009. *Soil Guideline Values for Arsenic in Soil. Science Report SC050021 / arsenic SGV*. Environment Agency, Bristol.
[4] ATSDR, 2007. *Toxicological profile for arsenic*. Atlanta, GA: US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. Available from: http://www.atsdr.cdc.gov/toxprofiles/tp2.pdf [Accessed 29th September 2016].
[5] The Building Regulations 2000. *Approved Document C: Site Preparation and Resistance to Contaminants and Moisture*.

**Table 4: Potential Pathways and Receptors**

| Potential Pathway | Potential Receptor | Comment |
|---|---|---|
| Dermal contact with soil. | Future residents. | Future residents and site users could come into contact with contaminated soils in garden and soft landscaped areas. |
| Intake via direct ingestion of soil and contaminated dusts indoors and outdoors. | Future residents. | See above. Contaminated soils can be tracked indoors to form dusts which are inhaled and ingested. |
| Intake via consumption of fruit and vegetables grown on the site, and attached soils. | Future residents. | Exposure to contaminated soils may occur via consumption of home-grown produce and any attached soils. |
| Intake via inhalation of soil vapours and ground gases indoors and outdoors / methane explosion. | Future residents. | Ground gases can also be generated by landfill waste. These can migrate through the sub-surface and accumulate within confined spaces, e.g. buildings. |
| Direct contact with site soils. | Foundations of proposed buildings. | Some contaminants, including sulphates and acids, may adversely affect building foundations. |
| Migration through soil / groundwater. | Controlled waters: groundwater. | The underlying strata are classified as a Secondary Aquifer, likely to be overlain by clay soils of low to moderate leaching potential.<br>The site is not located within a Source Protection Zone. |
| | Controlled waters: surface water. | There is a small un-named surface water course in proximity to the site. |
| | Off-site residents. | Residential properties are located to the north, west and south of the current development site, which could be affected if contamination migrates from the site. |

## 3.3 Preliminary Conceptual Model

3.3.1 The conceptual model for the site identifies potential pollutant linkages based on the information collated in this Phase 1 Site Investigation, and an understanding of the way that the potential contaminants at the site are likely to behave in the environment. The comments presented in Table 4 have been considered in producing the model and source-pathway-receptor linkages that are not likely to be active have not been included.

3.3.2 For the purpose of the conceptual model, groups of contaminants that (in most circumstances) behave in a similar way in the environment have been grouped and linked to potential pathways and receptors. Table 5 shows the identified potential organic contaminants and Table 6 shows the potential inorganic contaminants that have been identified. Not all potential contaminants have been included in the conceptual model, only those that are considered significant at this stage.

3.3.3 The key for Tables 5 and 6 is as follows:

KEY: LOW – potential risks associated with the presence of the contaminant linkage are low and further assessment or remediation is not considered necessary.

MOD – potential risks associated with the presence of the contaminant linkage are moderate and further assessment or remediation should be considered.

HIGH – potential risks associated with the presence of the contaminant linkage are high and further assessment or remediation is considered necessary.

N/A – The contaminant has no potential to affect the receptor via this exposure pathway.

**Table 5: Summary Conceptual Model and Risk Assessment - Organic Contaminants**

| Receptors and pathways | PAH | Landfill Gases | Notes |
|---|---|---|---|
| **Human Health (On site)** | | | |
| Dermal contact with soil | HIGH | N/A | Topsoil present within allotment gardens and orchards can potentially contain a range of contaminants, including PAHs. |
| Direct ingestion of soil & dusts | HIGH | N/A | It is possible that topsoil present on the site may be re-used within garden areas following redevelopment of the site. |
| Intake via consumption of fruit and vegetables grown on the site, and attached soils. | HIGH | N/A | |
| Intake via inhalation of soil vapours and ground gases indoors and outdoors / methane explosion. | MOD | HIGH | The site is located in proximity to several historical landfills, including one adjacent to the site boundary that accepted household wastes. Migration of landfill gases including methane and carbon dioxide from the landfills is possible. |
| **Human Health (Off site)** | | | |
| Migration of contaminants, gases and vapours off-site through soil / groundwater to neighbouring properties, followed by exposure via pathways described above. | LOW | N/A | Residential properties are located in proximity to the site. Migration of contaminants off site may occur if groundwater pathways are active. However, the site is likely to be underlain by low-permeability clay soils which would prevent or retard off-site migration of contaminants via groundwater flow. |
| **Buildings** | | | |
| Concrete foundations | LOW | N/A | High concentrations of organic contaminants can prevent concrete curing correctly, although this is considered unlikely to be present. |
| **Controlled Waters** | | | |
| Migration to groundwater within Minor Aquifer | LOW | N/A | It is unlikely that significant mobile contamination (e.g., free phase petroleum hydrocarbons) is present on the site. Groundwater below the site is considered to have relatively low sensitivity due to being a secondary aquifer and distant from any groundwater abstractions. |
| Migration to surface water via groundwater | MOD | N/A | There is a small watercourse located in proximity to the site. However, the probability of significant concentrations of contaminants migrating from the site is considered to be low, due to the presence of low-permeability clay soils and likely lack of mobile contamination. |

**Table 6: Summary Conceptual Model - Inorganic Contaminants**

| Receptors and Pathways | Heavy Metals | Sulphates | pH | Asbestos | Notes |
|---|---|---|---|---|---|
| **Human Health (On Site)** | | | | | |
| Dermal contact with soil | HIGH | N/A | N/A | N/A | Topsoil present within allotment gardens and/or orchards can potentially contain a range of inorganic contaminants, including heavy metals and asbestos. |
| Direct ingestion of soil & dusts | HIGH | N/A | N/A | HIGH | It is possible that topsoil present on the site may be re-used within garden areas following redevelopment of the site and that residents are exposed to soil contamination via these pathways. |
| Intake via consumption of fruit and vegetables grown on the site, and attached soils. | HIGH | N/A | N/A | N/A | |
| Intake via inhalation of soil vapours indoors and outdoors. | LOW | N/A | N/A | N/A | The inorganic contaminants potentially present on site do not have the potential to release hazardous vapours. |
| **Human Health (Off Site)** | | | | | |
| Migration of contaminants, gases and vapours off-site through soil / groundwater to neighbouring properties, followed by exposure via pathways described above. | LOW | N/A | N/A | LOW | Residential properties are located in proximity to the site. Migration of contaminants off site may occur if groundwater pathways are active. However, the site is likely to be underlain by low-permeability clay soils which would be expected to prevent or retard off-site migration of contaminants via groundwater flow. |
| **Buildings** | | | | | |
| Concrete foundations | N/A | HIGH | HIGH | N/A | Sulphates and acidic soil can damage sub-surface concrete. |
| **Controlled Waters** | | | | | |
| Migration to groundwater within Minor Aquifer. | LOW | LOW | LOW | N/A | It is unlikely that significant mobile contamination is present on the site. Groundwater below the site is considered to have relatively low sensitivity |
| Migration to surface water via groundwater flow. | LOW | LOW | LOW | N/A | There is a small watercourse located in proximity to the site. However, the probability of significant concentrations of contaminants migrating from the site is considered to be low, due to the presence of low-permeability clay soils and likely lack of mobile contamination. |

## 3.4 Risk Assessment Summary

***Human Health – Exposure to Soil Contamination***

3.4.1 It is considered possible that the historical uses of the site may have introduced some potential organic and inorganic contaminants into shallow soils at the site.

3.4.2 Should topsoil currently present on the site be re-used in garden areas of the development, residents could be exposed to soil contamination via a number of pathways.

***Ground Gases***

3.4.3 There are several historical landfill sites located within 250m of the site, including one adjacent to the site boundary that accepted household waste. Accordingly, the risk to the proposed development from landfill gases is considered to be high at this stage.

3.4.4 Radon protection measures are not required for the site.

***Controlled Waters***

3.4.5 The strata underlying the site are classified as being a Secondary A Aquifer (formerly Minor Aquifer). The site is not within a groundwater source protection zone. No gross mobile contamination is considered to be likely to be present at the site, and groundwater resources at the site are not considered to be a sensitive environmental receptor. Therefore the risk from groundwater pollution associated with the site is considered low.

3.4.6 The Envirocheck report shows a small un-named surface water course in proximity to the site. It is considered unlikely that there are significant volumes of mobile contamination that could migrate from the site to the water course and that the presence of low permeability clay soils would prevent or retard migration of any soluble contaminants from the site.

***Building Materials***

3.4.7 Coal Measures strata are known to potentially contain high concentrations of sulphates with the potential to adversely affect sub-surface concrete, including foundations[6]. It is therefore recommended that samples of the likely founding strata are taken and submitted for chemical analysis for sulphates and pH, in line with BRE Special Digest 1, in order to specify a suitable concrete type.

[6] BRE (2005) Special Digest 1 – Concrete in Aggressive Ground.

# 4 Conclusions and Recommendations

## 4.1 Conclusions

4.1.1 The Phase 1 Site Investigation has identified that:

- In 1854 the site was undeveloped, comprising part of a field. The site was in use as allotment gardens by 1917 and the western part of the site as an orchard by 1962. The current barn / stable buildings were constructed in the 1990s.
- The site currently comprises a plot of grassed land with several areas of trees and bushes used for keeping chickens and ducks and possibly as pasture for horses
- The topsoil present on site has been identified as a potential source of contamination, due to the site's past uses as allotment gardens and an orchard. Localised contamination by asbestos fibres and fragments of asbestos cement may have been caused during construction of the buildings.
- There is considered to be a potential risk of long-term damage to sub-surface concrete (foundations etc.) from sulphates in subsoils derived from Coal Measures strata at the site.
- The risk of pollution of controlled waters is considered to be low.
- There are several historical landfill sites located in proximity to the site, including one adjoining the site boundary. There is therefore considered to be a high risk to the proposed development from landfill gas migration at this stage.

## 4.2 Recommendations

4.2.1 A Phase 2 intrusive site investigation is recommended in order to determine the actual risks from the potential contaminant linkages identified in this report, and to provide sufficient geotechnical information for the safe and economical design of foundations and ground floor slabs, etc. for the proposed development.

4.2.2 It is recommended that the site investigation comprises a number of small diameter, window sample boreholes to allow sampling of site soils for laboratory analysis and to install ground gas monitoring wells. Standard penetration tests (SPTs) and hand shear vane readings should be undertaken in clay soils.

4.2.3 Sampling of site soils should be undertaken with analysis of a range of chemical parameters and potential contaminants. These should include heavy metals, polycyclic aromatic hydrocarbons (PAH) and asbestos.

4.2.4 Should visual or olfactory evidence of other contaminants (e.g., petroleum hydrocarbons) be identified, additional analysis for these should be undertaken).

4.2.5 Soil testing for pH, water soluble sulphate, acid soluble sulphate and total sulphur should be undertaken during construction in order to specify a suitable concrete mix for the sulphate concentration within site soils, in accordance with BRE SD-1.

4.2.6 In accordance with CIRIA guidance on hazardous ground gases[7], the potential source of ground gases is of Moderate generation potential (old landfill), with the sensitivity of development being classified as High (residential with gardens).

4.2.7 Therefore, gas monitoring should ideally be undertaken on twelve occasions over a six-month period in order to determine the extent of gas protection measures required. However, it is possible that the monitoring period could be modified should initial gas monitoring visits prove an absence of landfill gas under ideal atmospheric conditions (i.e. low and falling pressure) on several occasions.

[7] CIRIA Report C665. 2007. Assessing risks posed by hazardous ground gas to buildings.

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# Appendix A: Site Location and Layout Plans

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