

14. Ground Conditions

Introduction

1. This chapter has been prepared by Lithos Consulting Ltd and assesses the impact of the Proposed Development on soil and groundwater. In particular it considers potential impacts of the Proposed Development on baseline soil and groundwater conditions and the effects of any existing contamination within the soils.
2. This chapter (and its associated figures and appendices) is not intended to be read as a stand-alone assessment and reference should be made to the Front End of this ES (Chapters 1-4), as well as Chapter 17 Summary of Predicted Impacts / cumulative impacts.
3. Lithos have issued the following reports in support of the planning application for the Proposed Development (see Appendices 14.1 and 14.2):
 - A desk study of the wider HS11 area (Lithos Report Ref. 2311/1A, dated February 2016) issued to O'Neil Associates who were working on behalf of Kirklees Council. This is a large area (c. 76 ha (including Bradley Villa Farm & Bradley Park golf course).
 - A full site investigation (Lithos Report Ref. 3319/1, dated March 2019), commissioned via Savills, issued to PS & SP Kershaw. This covers Bradley Villa Farm (c.12ha) in the west of the wider site; essentially the Redrow red line area, but also including the adjacent farmyard (not currently being considered by Redrow)
4. This chapter summarises the main findings of the two investigations in relation to soil, groundwater and contamination and considers the existing and likely future impact on sensitive receptors.
5. With respect to professional competencies, Lithos are members of the following:
 - Member Association of Geotechnical & Geo-environmental Specialists (AGS).
 - Member British Drilling Association (BDA).
 - Member Contaminated Land: Applications in Real Environments (CL:AIRE)
 - All our engineers are Fellows (or above) of the Geological Society or an equivalent Body.
6. The allocated site (HS11) is in two ownerships. The majority of the site is in Council ownership, while Bradley Villa Farm in the west is in private ownership. The proposed development comprises c. 1460 residential dwellings with additional capacity for a further 498 dwellings post plan period.

Legislation and Planning Policy Context

Legislative Framework

7. The applicable legislative framework is summarised as follows:

Environmental Protection Act (EPA) 1990

8. Part IIA of the EPA 1990 (**Ref. **.1**) describes the regulatory role for local authorities in dealing with land contaminated from historical use which is not undergoing development. The provisions are set out in Section 57 of the Environment Act 1995, which inserts Part IIA into the EPA 1990.

Contaminated Land Regulations (England) 2000

9. The Contaminated Land (England) Regulations 2000 (**Ref. **.2**) provide a definition of what constitutes Contaminated Land and sets out the responsibilities of the local authority and the Environment Agency in the identification and management of Contaminated Land.
10. Under the Regulations, Contaminated Land is defined as, "land which in the opinion of the Local Authority to be in such a condition by reason of substances in on or under the land that:
- Significant harm is being caused or there is a significant possibility of such harm being caused; or
 - Pollution of controlled waters is being, or is likely to be caused.

Groundwater (Water Framework Directive) (England) Direction 2016

11. The Groundwater (Water Framework Directive) (England) Direction 2016 (**Ref. **.3**) sets out the obligations to protect groundwater (water found below the surface) nationally, regionally and at a local level.
12. It updates requirements including:
- the monitoring and setting of thresholds for pollutants in groundwater
 - adding new pollutants to the list of pollutants to be monitored
 - changing the information to be reported to the European Commission
 - The Groundwater (Water Framework Directive) (England) Direction 2016 revokes and replaces the Groundwater (Water Framework Directive) (England) Direction 2014.

Environmental Permitting Regulations 2010

13. Environmental Permitting Regulations 2010 (**Ref. **.4**) established a regime for the identification, regulation and enforcement of waste, water and flood risk activities. The EPR also include provision to permit and restrict groundwater activities, including discharge of hazardous and non-hazardous substance to groundwater and surface water.

Model Procedures for the Management of Land Contamination

14. The Environment Agency guidance document CLR11, Model Procedures for the Management of Land Contamination (**Ref. **.5**) sets out a tiered framework for the assessment of potential risks to human health and controlled waters from land

contamination. This document forms the basis of contaminated land risk assessment in the UK and establishes the requirement for an appropriate conceptual site model which is followed through the assessment process.

Planning Policy

National Planning Policy Framework (NPPF)

15. The National Planning Policy Framework (**Ref. **.6**) was published on 27 March 2012, coming into immediate effect and replacing the majority of previous Planning Policy Guidance notes (PPGs) and Planning Policy Statements (PPSs). As such the relevant paragraphs from the NPPF are set out below. Set out below is a summary of the relevant NPPF guidance relating to contamination.

16. NPPF paragraph 120 states that: “To prevent unacceptable risks from pollution and land instability, planning policies and decisions should ensure that new development is appropriate for its location. The effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution, should be taken into account. Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner”.

17. NPPF paragraph 121 states that: “Planning policies and decisions should also ensure that:

- the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or effects on the natural environment arising from that remediation;
- after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and
- adequate site investigation information, prepared by a competent person, is presented”.

Local Planning Policy

18. The local planning policies relevant to the Proposed Development are set out in the UDP for Kirklees Council (dated 28th September 2007). The UDP pre-dates NPPF, and therefore with regard to land, air and water quality makes reference to PPS 23, most notably paragraph 2 which states: – “any consideration of the quality of land, air or water and potential effects arising from development, possibly leading to effects on health, is capable of being a material planning consideration, in so far as it arises or may arise from or may affect any land use”.

19. Chapter 6 of the Kirklees UDP deals with Minerals. With respect to coal, it states: “the only deep coal mine which operates in the District has sufficient permitted reserves for the next

10 years. In West Yorkshire opencast coal mining is concentrated in Leeds and Wakefield Districts. There has not been an operational opencast coal mine in Kirklees since 1984 perhaps because the local geology is more difficult and because of the extent of previous extraction in the exposed coalfield within Kirklees during the 1950's and 1960's. Unlike aggregates there is no national or regional guidance on the level of production required or where it should be met; MPG3 leaves that to market forces. For these reasons no allocations for opencast coal mining are considered necessary”.

Methodology

Scope of the Assessment

20. This assessment considers significant effects relating to soils, groundwater and contamination during the site construction and operational phases of the Proposed Development.

Extent of Study Area

21. The site comprises a single parcel of land of approximately 76 hectares. The majority of the site (about 64 hectares) is owned by Kirklees Council; land to the west (Bradley Villa Farm) is owned privately. The site is located just south of the M62 motorway, between the A641 in the west and Tithe House Way in the east.

Assessment Methodology

22. Lithos have completed a desk study of the 76 ha wider area (Lithos Report Ref. 2311/1A, dated February 2016), including Bradley Villa Farm & Bradley Park golf course. In addition, intrusive ground investigation has been undertaken in the west of the wider site (c.12ha), within the curtilage of Bradley Villa Farm (Lithos Report Ref. 3319/1, dated March 2019).

23. Primary aims of Lithos' investigation were to identify salient geo-environmental issues affecting the site in order to support the submission of a planning application, and also to enable Redrow to obtain budget costs for: foundations; gas protection measures; and site preparatory works.

24. It has been assumed in the production of this chapter that the Site will be developed for a residential end use and consequently, future residents of the Site and the built development will form potential receptors within the Proposed Development.

25. Lithos completed the investigation in accordance with current UK guidance including:

- BS5930:2015 “Code of practice for site investigation”
- BS10175:2013 "Code of practice for the identification of potentially contaminated sites".
- BRE Digest 348 (1989) – Walkovers

- YALPAG (March 2018) Development on Land Affected by Contamination – Technical Guidance for Developers, Landowners & Consultants.
- “Technical Aspects of Site Investigation” – EA R&D Technical Report P5-065/TR (2000)
- CIRIA C665 (2007) – Assessing risks posed by hazardous ground gases to buildings
- BS 8485:2015+A1:2019 – Code of Practice for the characterisation design of protective measures for methane and carbon dioxide ground gases for new buildings.

26.Lithos' Preliminary Investigation ('Phase 1 or Desk Study') of the wider site, comprised the following works:

- an assessment of the land use history
- determination of the site's environmental setting (by reference to geology, mining/quarrying, risks associated with hazardous gas (including radon, landfill gas, mines gas etc), proximity to landfilled ground, hydrology, flood risk, and hydrogeology).
- a site walkover and inspection
- assessment of anticipated ground conditions, including potential contaminants
- assessment of anticipated foundation and engineering issues associated with redevelopment
- preparation of a Conceptual Site Model and design of an appropriate ground investigation

27.Information used in the compilation of the Preliminary Investigation was sourced from the following:

- British Geological Survey published mapping:
- 1:50,000 scale Sheet 77 Huddersfield.
- 1:10,000 scale Sheet SE12SE and SE12SW.
- Envirocheck report Ref.76826195_1_1, dated December 2015
- Kirklees Civic Council search dated December 2015
- Coal Authority mining report Ref 51001054942001 dated 11th January 2015.

28.Lithos subsequently completed an intrusive ('Phase 2') ground investigation within the fields surrounding Bradley Villa Farm sub-area in the west of the wider site, the scope of works for which was determined by the Preliminary Investigation, and included:

- an intrusive ground investigation comprising 41 trial pits, including soakaway tests in 5 trial pits excavated in February 2019.
- retrieval of appropriate soil and groundwater samples
- laboratory analysis of soil samples (geotechnical & chemical)

29.Further information sourced for the Desk Study section of this Phase 2 investigation included:

- Envirocheck report Ref. 192531415_1_1, dated 30th January 2019
- Coal Authority mining report Ref 51002003374001 dated 30th January 2019.

- The Coal Authority Planning Advice Team Response – dated 14th March 2019
- 30.Exploratory hole locations were selected to provide a representative view of the strata beneath the site, and to target areas of interest identified during the Preliminary Investigation.
- 31.Representative soil/fill samples were taken at regular intervals from the exploratory holes to assist in description of the ground and to allow selected laboratory testing to be performed. The soils encountered during the ground investigation were described (logged) in general accordance with BS 5930:2015.
- 32.Where encountered during the fieldwork, groundwater was recorded on exploratory hole logs. Groundwater levels were recorded after completion of the fieldwork in the monitoring wells installed.
- 33.An assessment of potential contaminants associated with current and former usages of the site was undertaken with reference to CLR 8 “Potential contaminants for the assessment of land”.
- 34.Lithos adopted a tiered approach to risk assessment, consistent with UK guidance and best practice. The initial step of such a risk assessment (or Tier 1) is the comparison of site data with appropriate guidance levels (CLEA SGVs where available), intervention levels or remedial targets.
- 35.The potential risk to building materials was completed via reference to the relevant BRE Digests, with particular emphasis on BRE Special Digest 1, ‘Concrete in Aggressive Ground’, 2005.
- 36.The Geo-Environmental Appraisal Report 3319/3 and 2311/1A can be regarded as a baseline survey. The study areas are defined on Drawing 3319/3 in Report 3319/1 and on Drawing 2311/3 in Report 2311/1A.

Methodology

- 37.The above sources of information were used to establish a Preliminary Conceptual Site Model in accordance with current best practice guidance set out in CLR11 (Model Procedures for the Management of Land Contamination) (**Ref 10.5**). Information was used to identify:
- Potential sources of contamination;
 - Potential pathways linking contaminant sources with identified receptors;
 - Potential environmental receptors including controlled waters and ecological receptors
- 38.It has been assumed in the production of this chapter that the site will be developed for a residential end use and consequently, future residents of the site and the built development will also form potential receptors within the Proposed Development.

39. Reference is also made to the Environment Agency's approach to groundwater protection (Ref. **7), and the relevant Groundwater Vulnerability Map.

40. Bedrock and any overlying granular Drift deposits are classified by the EA using Water Framework Directive classifications:-

- **Principal Aquifers:** "These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic".
- **Secondary A Aquifers:** "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".
- **Secondary B Aquifers:** "predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localized features such as fissures, thin permeable horizons and weathering".
- **Unproductive Strata:** "These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow".

41. Groundwater vulnerability is determined by 4 variables:

- The presence and nature of overlying soil (the weathered zone affected by living organisms; soil in the UK can extend up to 2m in depth). Physical properties of the soil affect the downward passage of water and its ability to attenuate pollutants. The EA make reference to a three-fold classification of soil types:-
- Soils of **low** leaching potential are defined as "soils in which the pollutants are unlikely to penetrate the soil layer because either water movement is largely horizontal, or they have the ability to attenuate diffuse pollutants".
- Soils of **intermediate** leaching potential are defined as "soils which have a moderate ability to attenuate diffuse source pollutants or in which it is possible that some non-adsorbed diffuse source pollutants and liquid discharges could penetrate the soil layer".
- Soils of **high** leaching potential are defined as "soils with little ability to attenuate diffuse source pollutants and in which non-adsorbed diffuse source pollutants and liquid discharges have the potential to move rapidly to underlying strata or to shallow groundwater".

42. The presence and nature of Drift, which often overlies bedrock. Where Drift is of substantial thickness and low permeability, it can provide an effective barrier to surface pollutant migration. Permeable Drift is classified as a Minor Aquifer except where it is in probable hydraulic continuity with a Major Aquifer, where it is regarded as part of the Major Aquifer unless proven otherwise by site investigation.

43. The nature of the geological strata (bedrock). Rocks that contain groundwater in exploitable quantities are called aquifers.

44. The depth of the unsaturated zone; i.e. that part of the aquifer which lies above the water table.

45. The EA have also designated groundwater Source Protection Zones, which are based on proximity to a groundwater source (springs, wells and abstraction boreholes). The size of a Source Protection Zone is a function of the aquifer, volume of groundwater abstracted and the effective rainfall, and may vary from tens to several thousand hectares.
46. Reference has been made to publicly available Government held digital data via QGIS (an Open Source Geographic Information System) and the Envirocheck report with respect to:
- surface water quality
 - recorded pollution incidents
 - licensed abstractions (groundwater & surface waters)
 - licensed discharge consents
 - site susceptibility to flooding

Impact Assessment and Significance Criteria

47. The Site's environmental setting (and proposed end use) is used to assess the significance of any contamination encountered during the subsequent ground investigation.
48. Assessment of contaminated land is based on an evaluation of pollutant linkages (source-pathway-receptor). Contaminants within the near surface strata represent a potential source of pollution. The environment (most notably groundwater), site workers and end users are potential receptors.
49. Potential pollutant linkages are described within the context of a preliminary conceptual site model. The preliminary model is revised in light of data arising from the subsequent ground investigation.
50. The assessment of potential impacts from the Proposed Development takes into account both the construction and operational phases. The significance level attributed to each impact is based on the magnitude of change due to the development and the sensitivity of the receiving environment and/or receptor. The significance of the impacts are defined in terms of Major, Moderate, Minor or Negligible as set out in **Table 2.2 (Chapter 2)**.

Impact prediction

51. The desk study helps to define the environmental setting of a site which in turn defines the site's sensitivity, mainly to contamination issues, via the presence or otherwise of any of the following site-specific features:
- Surface water
 - Underlying drift or bedrock aquifer
52. Reference to historical maps of the Site and a site walkover will establish whether any historical or current land uses have, or have had, the potential to cause significant contamination of the Site.

53. In addition, risks assigned to the Site from any potential sources of contamination would be increased by any ground or surface water extraction schemes, which could have Source Protection Zones assigned to them.

54. The above findings are presented within a Preliminary Conceptual Site Model (CSM) illustrating the potential sources of contamination, the relevant and realistic pathways and the targets or receptors, usually end users of the Site.

Mitigation

55. On sites where significant contamination is encountered, mitigation measures can be varied and complex. Generally, such measures vary from excavation or treatment of any gross organic contamination to a simple cover system in garden areas over any inorganic contamination. Mitigation measures would protect both the environment and end users of the Site.

56. In the case of gas risk, from either nearby landfill sites, underground coal workings or radon, gas measures could be installed, the extent of which would be determined by the severity of the risk.

57. Geotechnical risks can be addressed by specific concrete design to combat high sulphate/ low pH conditions and/or specialised foundations and hardstanding designs in areas of deep made ground or soft/loose natural ground conditions.

Assumptions and Limitations

58. Assessment of the wider development is limited to desk study data on a large area with a varied land-use and history. Only the Bradley Villa Farm sub-area in the far west has been subject to intrusive investigation to confirm ground conditions.

Baseline Conditions

59. The following sub-sections set out the current understanding of baseline conditions at the site which have been used to generate a preliminary conceptual site model.

The Site

60. The Site is located approximately 4km northeast of Huddersfield town centre, just south of the M62 motorway, between the A641 in the west and Tithe House Way in the east. The Site is predominantly occupied by Bradley Park Golf Course, with areas of arable farmland in the east and west.

61. There is a farmyard (Bradley Villa Farm) in the west, which has been subjected to an intrusive investigation by Lithos.

62. A former landfill is present beneath an area of about 6 hectares (c. 8% of the total site area) in the far east.

Geology

63. Geological maps suggest the Site is directly underlain by bedrock including: Pennine Lower Coal Measures; Thick Stone Sandstone; un-named sandstone leaves & members; and Clifton Rock Sandstone. Elland Flags sandstone is also anticipated at c. 45m depth.
64. No drift deposits are shown to underlie the Site. However, a veneer of residual soils (c. 1m to 2m thick) is likely to be present above bedrock. Furthermore, investigation within Bradley Villa Farm sub-area recorded Cohesive Residual Soil beneath topsoil to depths between 0.6m and 1.9m. Granular Residual Soil was also typically encountered beneath Cohesive Residual Soils to depths between 0.5m and 3.0m. Bedrock was encountered from depths of between 0.5m and 3.1m (average 1.8m).
65. Given the history of the Site, made ground is likely to be present within the vicinity of Bradley Villa farmyard, the Golf Clubhouse & car park, and an area of historical coke ovens. Deep made ground comprising landfill waste (household, commercial & industrial) is anticipated in the far east.
66. Two faults are conjectured to cross the site. The first crosses the west of the site oriented roughly 330° north to south, downthrowing to the east. The second crosses the northeast of the site, oriented roughly 180° east to west; downthrowing 8m to the south.
67. The site is predominantly located within a Coal Mining Development Low Risk Area, but parts lie within High Risk Areas.
68. Geological maps and BGS Technical Report suggest that 4 coal seams underlie the Site at shallow depth. These are the:
- Crow coal: 0.5m thick, outcropping in the east, and underlying about 16ha (c. 20%) of land in the east.
 - Black Bed Coal: 0.8m thick, outcropping across the centre of the site, and underlying about 35ha (c. 45%; eastern half of the site). Lies about 10m below the Crow Coal.
 - Better Bed Band Coal: a thin seam; about 35m below the Crow Coal.
 - Better Bed Coal: 0.5m thick, outcropping just beyond the site's northern boundary, and underlying the entire site. Lies about 45m below the Crow Coal.
69. About half of the site (central, south & far-east) lies within a Low Risk Area, but land close to the conjectured outcrops of the Crow and Black Bed coals is shown to lie within High Risk Areas – areas with specific mining legacy risks to the surface, including mine entries; shallow coal workings etc.
70. In order to determine risks posed by recorded coal mining, a mining report was commissioned and obtained from the Coal Authority (CA). A copy of the mining report is included in **Appendix 14.1**. Salient points pertinent to the Site is summarised below:

“The property is within the likely zone of influence from workings in 2 seams of coal at shallow to 100m depth, and last worked in 1917”. “Within, or within 20m of the boundary of the property there are 15 mine entries.”

71. The site is underlain by known workings from 3 collieries: the Anchor Pit Colliery (working the Better Bed Coal) ; the Bradley Park Colliery (working the Better Bed Coal); and the Cookson Colliery (working the Black Bed Coal).
72. Abandonment Plans show that the Better Bed Coal Seam has been worked extensively beneath approximately 40% of the site in the east. The plans also show workings within the Black Bed Coal Seam (approximately 10% of the site area beneath the centre of the site), but with old workings shown east of the recorded workings. Abandonment plans also show dayholes associated with historic mining within the Anchor Pit.
73. The Site has 15 known mine entries within, or within 20m of its boundary. Five are located close to the Site's northern boundary, likely targeting the Better Bed coal. Eight are located close to the outcrop of the Black Bed seam; 6 of these lie within about 250m of the golf clubhouse to the east and 2 are located to the site's eastern boundary.
74. Based on recorded geology and the CA report, mineworking in the Crow, Black Bed and Better Bed coals, which could affect surface stability are present beneath almost half of the total Site area. Coal is likely to have been extracted by pillar & stall methods.
75. In addition, there may also have been earlier, unrecorded mineworkings via bell pits and/or pillar and stall methods, and if present these could result in unpredictable subsidence.

Hydrology (Surface Water)

76. Three tertiary rivers cross north and south of the site. These watercourses are not classified under the Environment Agency's general quality assessment (GQA) scheme and no data on surface water quality is currently available for the immediate vicinity of the Site. The surface watercourses should be considered as potential receptors for contamination impacts arising from the Proposed Development.
77. According to the Envirocheck report there are no significant pollution incidents recorded by the EA within 250m of the site.
78. There are no surface water abstractions of significance to the site.
79. There is a discharge consent 30m south east for the “discharge of storm water overflow into freshwater stream/river”.

Hydrogeology (Groundwater)

80. Superficial strata are recorded on groundwater vulnerability mapping (included in the Envirocheck report) as being of high leaching potential. Based on the site geology established for the area from BGS borehole records, it is considered that drift cover is likely

to be absent. Consequently, it is assumed, for the purposes of this assessment, that Site soils do not afford significant protection to the underlying aquifer.

- 81. Lower Coal Measures bedrock is classified as a Secondary A Aquifer by the Environment Agency.
- 82. The Envirocheck Report indicates that there is a groundwater abstraction well 36m west for Kirklees Active Leisure (Kirklees Council) for spray irrigation at Bradley Park Golf Course.
- 83. According to QGIS and the Envirocheck Report the Site does not lie within 500m of a groundwater Source Protection Zone.

Historic Land Uses/Contamination

- 84. The Site has a long history of coal mining; the 1854 historical map shows a coal pit & coke ovens in the centre of site and two further coal pits in the north. The far east of the site was also occupied by Parkhill sandstone quarry at this time. These features were no longer shown on the 1893 – 1894 historical map, but associated activities may have resulted in significant ground contamination.
- 85. Bradley Villa Farm has been present in the west of Site since pre-1854 and has expanded over the years. No contamination was encountered during the ground investigation undertaken by Lithos in 2019, but no exploratory holes were excavated within the farmyard itself due to ongoing operations.
- 86. Electricity pylons crossed the site, oriented east to west, in 1966. These are no longer present and are unlikely to have resulted in significant ground contamination.
- 87. It is understood Bradley Park Golf Club was constructed in 1977, and is shown on the 1982 historical map. Made ground associated with the clubhouse and car park may yield some localised ground contamination.
- 88. Two landfills are present within or within 50m of the site boundary. Bradley Golf Course is underlain by a landfill, with industrial and household waste tipped from 1955 to c. 1975. Gas and leachate controls are considered unlikely to have been installed as landfilling pre-dates the Control of Pollution Act 1974.
- 89. Bradley Park Tip lies adjacent to the north-eastern boundary; filling commenced in 1945 and is still ongoing. The fill comprises industrial, commercial and household waste. An area of the tip bounding the adjacent golf course is lined and capped and the site is recorded as the first in the country to use asphaltic concrete as a cover layer. A leachate lagoon has been in operation since 1993.
- 90. An assessment of potential contaminants associated with the former uses has been undertaken with reference to CLR8 and the following DETR profiles: Gas works, coke works and other coal carbonisation plants; and waste recycling, treatment and disposal

sites. As a consequence of this assessment, anticipated potential contaminants within soil and/or groundwater include:

- Coke Ovens:
- Metals, arsenic, cadmium, lead, manganese, magnesium etc.
- PAH's
- Sulphates, sulphides, cyanides, ammoniacal compounds
- Ash, clinker & coal dust/waste
- Landfill:
- Contaminants too varied to list comprehensively

Ground Gas

91. Given the presence of landfilled ground in the far-east and the proximity of the Site to the currently operational Bradley Park Tip, a robust ground gas investigation will be required.
92. Protective gas measures will almost certainly be required for new buildings across this Site.
93. The Site is also underlain by shallow mineworkings, although it is not in an area known to be susceptible to mine gas emissions.
94. The intrusive ground investigation undertaken at Bradley Villa Farm in the far west (Report 3319/1) recommended CS2 protective measures due to the very low risk of hazardous gas from mineworkings at depth. The landfills of concern across the wider site are >1km east of this sub-area.

Assessment of Impacts, Mitigation and Residual Effects

95. Site Preparation/Construction Phase

a) Contact with contaminated soils leading to adverse health impacts

96. Much of the site is essentially greenfield, but localised areas of made ground are likely in the vicinity of Bradley Villa farmyard, the Golf Clubhouse & car park, and an area of historical coke ovens. Deep made ground comprising landfill waste (household, commercial & industrial) is anticipated in the far east, but no development is anticipated within this sub-area
97. The sensitivity of the human receptor (Site worker and adjacent residents) is high but the magnitude of change, prior to mitigation is low. Therefore, the impact on human health is potentially direct although temporary and of **minor negative** significance, prior to implementation of mitigation measures.

Mitigation

98. It is considered that the potential risk of exposure to contaminated soils (beyond any earthworks within the area of known landfill, but none anticipated) during the construction

phase will be sufficiently mitigated by the adoption of normal site health and safety procedures. Potential risks must be specifically assessed as part of the health and safety evaluation for the works to be performed in accordance with prevailing legislation. Site practices must conform to the specific legislative requirements and follow appropriate guidance (e.g., HSE, 1991; CIRIA, 1996).

Residual Effect

99.The residual effect on human health is **negligible** following implementation of mitigation measures.

b) Contamination of surface soils and surface waters due to construction works

100.The sensitivity of the existing Site soils and adjacent surface water is moderate and the magnitude of change, prior to mitigation is high. Therefore, the impact on soil condition is likely to be direct, permanent, long-term and of **moderate negative** significance, prior to implementation of mitigation measures.

Mitigation

101.During the construction phase of the development, appropriate measures will be required to store and contain any fuels and building materials stored on Site. Reference should be made to the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) and the Control of Pollution (Oil Storage) (England) Regulations 2001 when storing fuel on Site. Recommendations include: Leak detection systems, suitable provision of bunded storage for fuel, drip trays for use in a designated fueling area and provision of a spill kit on Site.

Residual Effect

102.The residual effect on soil contamination is **negligible** following implementation of mitigation measures.

c) Migration of hazardous gas and build up within Site excavations leading to explosion or asphyxiation

103.There are potential sources of hazardous gas associated with: landfilled ground in the far-east; the adjacent, currently operational Bradley Park Tip; and shallow mineworkings.

104.The sensitivity of the human receptor (Site worker and adjacent residents) is high, but the magnitude of change is low. The impact on human health may be direct, permanent, long-term and of **major negative** significance, prior to implementation of mitigation measures.

Mitigation

105.Access into all excavations must be controlled with use appropriate personal protection equipment implemented to avoid risks to construction workers. The atmosphere in shored trenches should be monitored for oxygen, methane and carbon dioxide, prior to personnel

entering such excavations. Monitoring should be continuous whilst personnel are working in deep excavation.

Residual Effect

106. The residual effect on human health is **negligible** following implementation of mitigation measures.

Operational Phase

d) Sterilisation of Coal Resources

107. Approximately half of the site is located in a Coal Mining Development High Risk area - land close to the conjectured outcrops of the Crow and Black Bed coals.

108. Geological maps and a BGS Technical report suggest that 4 coal seams underlie the site at shallow depth.

109. Based on statements in Chapter 6 of Kirklees UDP (see 2.2.5 above), effect on the coal resource is considered to be **minor negative**.

Mitigation

110. No mitigation is proposed (unless shallow mineworkings are encountered during the ground investigation, in which case drilling & grouting may be required).

Residual Effects

111. The residual effect will be **negligible**.

e) Surface instability due to historic shallow coal workings beneath the Site

112. Mineworking in the Crow, Black Bed and Better Bed coals, which could affect surface stability are present beneath almost half of the total Site area. Coal is likely to have been extracted by pillar & stall methods.

113. In addition, there are 15 known mine entries within, or within 20m of its boundary and there may also be earlier, unrecorded bell pits.

114. The sensitivity of the proposed end users (residents) and built development (Proposed dwellings) at the site is high, but the magnitude of potential change, prior to mitigation is potentially high. Therefore, the impact on safety has the potential to be direct, permanent, long-term and of **major negative** significance, prior to implementation of mitigation measures. is low.

Mitigation

115. An intrusive investigation will be required before mitigation measures can be recommended. However, at this stage it is considered likely that at least some drilling and grout stabilisation of workings will be required.

116. Building over the top of, or in close proximity to, entries should be avoided wherever possible (even after they have been capped), in line with Coal Authority policy.

Residual Effects

117. The residual impact following the aforementioned mitigation would be **negligible**.

f) Contact with contaminated soils leading to adverse health impacts

118. Much of the site is essentially greenfield, but localised areas of made ground are likely in the vicinity of Bradley Villa farmyard, the Golf Clubhouse & car park, and an area of historical coke ovens. Deep made ground comprising landfill waste (household, commercial & industrial) is anticipated in the far east, but no development is anticipated within this sub-area.

119. The sensitivity of the proposed end users (residents) at the Site is high but the magnitude of change, is low. Therefore, the impact on human health has the potential to be direct, permanent, long-term and of **minor to moderate negative** significance, prior to implementation of mitigation measures.

Mitigation

120. An intrusive investigation will be required before mitigation measures can be recommended. However, at this stage it is considered likely that some excavation/treatment of contaminated soils and placement of soil cover in garden areas will be required.

Residual Effects

121. The residual impact following the aforementioned mitigation would be **negligible**.

g) Migration of hazardous gas and build up within buildings leading to explosion, toxic effects and asphyxiation

122. There are potential sources of hazardous gas associated with: landfilled ground in the far-east; the adjacent, currently operational Bradley Park Tip; and shallow mineworkings.

123. The sensitivity of the proposed end users (residents) and buildings (residential properties) at the Site is high and the magnitude of change, prior to mitigation is potentially high. Therefore, the impact on human health has the potential to be direct, permanent, long-term and of **major negative** significance, prior to implementation of mitigation measures.

Mitigation

124. Gas monitoring and risk assessment will be required before mitigation measures can be recommended. However, at this stage it is considered likely that protective gas measures will be required in all new buildings across this Site.

Residual Effects

125. The residual impact following the aforementioned mitigation would be **negligible**.

h) Groundwater

126. No potential adverse impacts to groundwater are considered likely to arise as a result of the Proposed Development. Consequently, no additional specific mitigation measures with regard to potential groundwater impacts are considered necessary. The impact of the development on groundwater is considered to be **negligible**.

Mitigation

127. No mitigation is proposed.

Residual Effects

128. The residual impact will be **negligible**.

Cumulative Effects

129. The site is located within the Garden Community Corridor and lies in an area expected to undergo significant changes in the coming years as a result of developments at allocated sites within Calderdale and Kirklees. These include the following allocated sites within Kirklees:

- HS12 – Land north and west of Gernhill Avenue, Fixby. Housing allocation (indicative capacity: 377 units). Planning permission granted for 252 units under application ref: 2018/92055
- ES1 – Land at Bradley Business Park (Aflex Hose site), Dyson Wood Way, Bradley. Employment allocation (indicative capacity: 15,155sqm floorspace). Planning permission granted for 19,202sqm B1(a), B1(b), B2 and B8 floorspace under application ref: 2018/91432.
- HS13 – Land to the east of Netheroyd Hill, Cowcliffe. Housing allocation (indicative capacity: 68 units).
- HS14 – Land north of Ashbrow Road, Brackenhallf. Housing allocation (indicative capacity: 162 units). Planning permission granted for 161 units under application ref: 2019/92940.
- ES9 – Former Cooper Bridge Waste Water Treatment Works, Leeds Road. Employment allocation (indicative capacity: 14,910sqm floorspace).

- MXS6 – Land at Slipper Lane and Leeds Road, Mirfield. Mixed use allocation (indicative capacities: 166 residential units and 17,234sqm employment floorspace). Various permissions granted for residential and employment development.

130. The site (HS11) lies adjacent to Calderdale's Indicative Spatial Priority Area. The sites below are within the Garden Community Corridor and Indicative Spatial Priority Area for Calderdale based on the Calderdale Local Plan Publication Draft 2018 and Calderdale Local Plan Housing Requirement Update and Potential Supply:

- LP1463 – Land between, Highmoor Lane and Bradford Road, Brighouse. Housing allocation (Garden Suburb. Indicative capacity: 1,998).
- LP1451 – Land between, Bradley Wood and Woodhouse Lane, Rastrick, Brighouse. Housing allocation (Garden Suburb. Indicative capacity: 1,257).
- LP0338 – Land adjacent to Whinney Hill Park, Whinney Hill, Brighouse. Housing allocation (indicative capacity: 22).
- LP0571 – Site to the rear of 9A, Birds Royd Lane, Brighouse. Housing allocation (indicative capacity: 100)
- LP1000 - Land off Woodhouse Lane, Rastrick, Brighouse. Housing allocation (indicative capacity: 24).
- Land off, Toothill Bank, Rastrick, Brighouse, HD7. Housing allocation (indicative capacity: 64).
- LP0568 – Land south of Clough Lane, Rear of New Hey Road, Rastrick, Brighouse, HD7. Housing allocation (indicative capacity: 83). Planning permission granted for 78 units under application: 18/01333/FUL.
- LP0578 – 126-128, Bradford Road, Brighouse. Mixed use allocation (indicative capacity: 60 units and 2000sqm of B1 floorspace).
- LP0573 – Land adjacent Mill Royd street, Mill Royd Street, Brighouse, HD6. Mixed use allocation (indicative capacity: 200 units and 6,000sqm of B floorspace).
- LP1232 – Land at, Wakefield Road/Clifton Common, Clifton, Brighouse, HD7. Employment allocation (indicative capacity: 49,177sqm of B floorspace under application: 19/00612/LAA.
- LP0585 – Land west of, Anchor Place, Brighouse, HD6 3RT. Employment allocation (indicative capacity: 24,430sqm of B floorspace).
- LP1078 – Land between Dewsbury Road and New Hey Road, Rastrick, Brighouse, HD7. Housing allocation (indicative capacity: 149). Planning permission granted for 267 units under application: 19/00628/FUL.
- LP1032 – Southgates Quarry, Ogden Lane & Toothill Bank, Rastrick, Brighouse. Housing allocation (indicative capacity: 42).

131. With respect to ground conditions, it is considered that the potential cumulative impacts are **negligible**.

Summary and Conclusions

132. The subject Site (Bradley Park Golf Course and Bradley Villa Farm, Huddersfield) is located approximately 4km northeast of Huddersfield town centre, and occupies an area of approximately 76Ha. The Site is predominantly occupied by Bradley Park Golf Course with areas of arable farmland in the east and west. There is a farmyard (Bradley Villa Farm) in the far west. A former landfill is present beneath an area of about 6 hectares (c.8% of the total site area) in the far-east of the site.

133. Lithos have completed a desk study of the 76 ha wider area, including Bradley Villa Farm & Bradley Park golf course. In addition, intrusive ground investigation has been undertaken in the west of the wider site (c. 12ha), within the curtilage of Bradley Villa Farm.

134. Lithos' Preliminary Investigation (Desk Study) of the wider site, comprised the following works:

- review of publicly available Government held digital data via QGIS and an Envirocheck report
- an assessment of the land use history
- determination of the site's environmental setting.
- a site walkover and inspection
- assessment of anticipated ground conditions, including potential contaminants
- assessment of anticipated foundation and engineering issues associated with redevelopment
- preparation of a Conceptual Site Model and design of an appropriate ground investigation

135. Lithos subsequently completed an intrusive ('Phase 2') ground investigation within the Bradley Villa Farm sub-area in the west of the wider site, the scope of works for which was determined by the Preliminary Investigation, and included:

- 41 trial pits, including soakaway tests in 5 trial pits.
- retrieval of appropriate soil and groundwater samples
- laboratory analysis of soil samples (geotechnical & chemical)

136. Findings of the above have been incorporated into this Environmental Statement in the Appendices.

Baseline Conditions

137. The Site has not been previously developed. Geological maps suggest the Site is directly underlain by bedrock. No drift deposits are shown to underlie the Site but residual soils (c. 1m to 2m thick) are likely to be present above bedrock. A veneer of made ground is anticipated within the vicinity of Bradley Villa Farm, the golf clubhouse & car park and historical coke ovens. Deep made ground is anticipated within the former landfill in the far east.

138. Lithos' ground investigation within the fields surrounding Bradley Villa Farm in the far west encountered topsoil underlain by Residual Soils. Coal Measures bedrock (sandstone,

mudstone and siltstone) was encountered from an average depth of 1.8m (notably shallower in the northwest and south east).

139. Approximately half of the site is located in a Coal Mining Development High Risk area - land close to the conjectured outcrops of the Crow and Black Bed coals. Any unrecorded mineworking associated with these coal seams could affect surface stability. In addition, there are 15 known mine entries within, or within 20m of its boundary and there may also be earlier, unrecorded bell pits.

140. Coal Measures bedrock is classified as a Secondary A Aquifer. Drift cover is likely to be absent and it is therefore likely that site soils do not afford significant protection to the underlying aquifer.

141. Three tertiary rivers cross north and south of the site.

142. There are potential sources of hazardous gas associated with: landfilled ground in the far-east; the adjacent, currently operational Bradley Park Tip; and shallow mineworkings.

Likely Effects – Construction phase

143. There is a low likelihood that adverse impacts to construction operatives and adjacent residents will occur during the construction phase. Adverse environmental effects could occur due to the inappropriate use and storage of construction materials and fuels during construction.

Mitigation and Residual Effects

144. Mitigation of impacts can be satisfactorily achieved through the adoption of safe working practices and compliance with the relevant statutory and advisory guidance.

Likely Effects – Operational phase

145. There is a low likelihood that adverse impacts to Site end users and the built development will occur during the operational phase of the Proposed Development due to the potential presence of contaminants and hazardous ground gas at the Site.

Mitigation and Residual Effects

146. An intrusive investigation (with gas monitoring and risk assessment) will be required before mitigation measures can be recommended. However, at this stage it is considered likely that the following will be required:

- some excavation/treatment of contaminated soils and placement of soil cover in garden areas;
- some drilling and grout stabilisation of mineworkings;
- protective gas measures in all new buildings.

References

- .1 Environmental Protection Act (1990)
- 2 Contaminated Land (England) Regulations (2000)
- 3 Groundwater (Water Framework Directive) (England) Directive (2016)
- 4 Environmental Permitting Regulations (England) 2010
- 5 Model Procedures for the Management of Land Contamination (CLR11) 2004; Defra and Environment Agency
- 6 Department for Communities and Local Government (2012); National Planning Policy Framework.
- 7 Approach to groundwater protection (2018 Version 1.2), Environment Agency.