13. Ground Conditions, Hydrogeology and Contamination

<table>
<thead>
<tr>
<th>Potential/Predicted Significant Environmental Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Site Preparation and Construction Phase</strong></td>
</tr>
<tr>
<td>• Potential exposure to contamination associated with agricultural and mining historical land uses and effects on human health (e.g. ground workers, earthworks contractors, construction workers and third parties);</td>
</tr>
<tr>
<td>• Potential exposure of ground workers to hazardous ground gases generated from potential sources both on-Site and off-Site (e.g. Made Ground where present, Coal Measures and Alluvium);</td>
</tr>
<tr>
<td>• Potential release/migration of contamination associated with historical land uses and potential spills and leakages during construction to controlled waters (surface water features and underlying Secondary and Principal Aquifers); and</td>
</tr>
<tr>
<td>• Potential effects of ground stability hazards (e.g. mineshafts) on the development and ground workers during the site preparation and construction phase.</td>
</tr>
<tr>
<td><strong>Operational Phase</strong></td>
</tr>
<tr>
<td>• Potential exposure of future populations and third parties to contamination associated with mining and agricultural historical land uses;</td>
</tr>
<tr>
<td>• Potential release/migration of contamination associated with historical land uses and potential future spills and leakages to controlled waters (surface water features and underlying Secondary and Principal Aquifers);</td>
</tr>
<tr>
<td>• Potential effect on groundwater from reduced recharge rates associated with an increased impermeable area due to the Proposed Development;</td>
</tr>
<tr>
<td>• Potential effect of hazardous ground gas ingress into properties and associated effects on human health of future populations and third parties; and</td>
</tr>
<tr>
<td>• Potential effects of ground stability hazards on future Site occupants and third parties.</td>
</tr>
</tbody>
</table>
Introduction

13.1 This Chapter evaluates the likely effects of the Proposed Development on Ground Conditions, Hydrogeology and Contamination. In particular, it considers the potential effects of contamination, ground stability and ground gas and/or vapour emissions based on the underlying geology and historical land uses of the Site, as potential risks to human health and the wider environment as a result of the Proposed Development.

13.2 The Chapter describes the baseline conditions at the Site and considers the potential effects during the site preparation and construction phase and the operational phase.

13.3 Where appropriate, mitigation measures to enhance, prevent, minimise or control the effects are presented, and residual effects following the adoption of those measures are also assessed.

13.4 This Chapter is supported by a Geoenvironmental Desk Study and Terrain Assessment included as Appendix 13.1.

13.5 This Chapter (and its associated Figures and Appendices) is not intended to be read as a standalone assessment and reference should be made to the front end of this Environmental Statement (ES) (Chapters 1 – 5), as well as Chapter 18 Cumulative Effects and Interaction of Factors.

Methodology

Scope of the Assessment

13.6 An EIA Scoping Report (Appendix 1.3) was submitted to Broxtowe Borough Council (BBC) in October 2012. The following potentially significant effects have been identified:

Site Preparation and Construction Phase

- Potential exposure to contamination associated with agricultural and mining historical land uses and effects on human health (e.g. ground workers, earthworks contractors, construction workers and third parties);
Environmental Statement:
Temple Park, Nuthall

Potential exposure of ground workers to hazardous ground gases generated from potential sources both on-site and off-site (e.g. Made Ground where present, Coal Measures and Alluvium);

Potential release/migration of contamination associated with historical land uses and potential spills and leakages during construction to controlled waters (surface water features and underlying Secondary and Principal Aquifers); and

Potential effects of ground stability hazards (e.g. mineshafts) on the development and ground workers during the construction phase.

Operational Phase

Potential exposure of future populations and third parties to contamination associated with mining and agricultural historical land uses;

Potential release/migration of contamination associated with historical land uses and potential future spills and leakages to controlled waters (surface water features and underlying Secondary and Principal Aquifers);

Potential effect on groundwater from reduced recharge rates associated with an increased impermeable area due to the Proposed Development;

Potential effect of hazardous ground gas ingress into properties and associated effects on human health of future populations and third parties; and

Potential effects of ground stability hazards on future Site occupants and third parties.

Extent of the Study Area

The study area for the Geoenvironmental Desk Study and Terrain Assessment (Appendix 13.1) is up to 1km from the planning application Site boundary, or 2km for consideration of groundwater abstractions. A Site Location Plan is presented as Figure 3.1. The proposed layout for the Site is presented on the Parameters Plans attached as Figure 4.1.

Method of Baseline Data Collation

Desk Study and Terrain Assessment

A Desk Study and Terrain Assessment has previously been prepared for the Site by WSP to assess historical land uses, the environment setting, and to obtain initial information about ground conditions and contaminant loadings in shallow soils. It is included as Appendix 13.1 and a summary is presented within this Chapter.
Significance Criteria

Assessment

13.9 Current guidance on the assessment of contamination risk (e.g. Model Procedures for the Management of Contaminated Land: CLR11, Ref. 13.1) advocates the use of a conceptual risk assessment model in an attempt to establish the links between a hazardous source and a sensitive receptor via an exposure pathway. The concept behind this approach is that without each of the three fundamental elements (source, pathway and receptor) there can be no risk of contamination. Thus, the mere presence of a contamination hazard at a particular Site does not necessarily imply the existence of associated risks.

13.10 Assessment of the ground gas regime has been completed with reference to the Construction Industry Research and Information Association (CIRIA) publication C665 ‘Assessing Risks Posed by the Hazardous Ground Gas to Buildings’ 2007 (Ref. 13.2) and the National House Building Council (NHBC) publication ‘Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are present’ 2007 (Ref. 13.3).

13.11 The assessment of potential effects as a result of the Proposed Development has taken into account the site preparation and construction phase (including earthworks) and the operational phase. The significance level attributed to each effect has been assessed based on the magnitude of change due to the Proposed Development and the sensitivity of the affected receptor/receiving environment to change, as well as a number of other factors that are outlined in more detail in Chapter 2 - Methodology. Magnitude of change and the sensitivity of the affected receptor/receiving environment are both assessed on a scale of high, medium, low and negligible (as shown in Chapter 2 - Methodology).

Effect Significance

13.12 The following terms have been used to define the significance of the effects identified:

- **Major Effect** where the Proposed Development could be expected to have a very significant effect (either positive or negative) on ground conditions and associated sensitive receptors;
• **Moderate Effect**: where the Proposed Development could be expected to have a noticeable effect (either positive or negative) on ground conditions and on associated sensitive receptors;

• **Minor Effect**: where the Proposed Development could be expected to result in a small, barely noticeable effect (either positive or negative) on ground conditions and on associated sensitive receptors; and,

• **Negligible**: where no discernible effect is expected as a result of the Proposed Development on ground conditions and on associated sensitive receptors.

**Legislation / Policy Framework**

**Legislative Framework**

13.13 The applicable legislative framework to this Chapter is summarised as follows.

13.14 **Part IIA of the Environmental Protection Act 1990 (Ref. 13.4)** describes a regulatory role for Local Authorities in dealing with contaminated land.

13.15 **Environment Act 1995 (Ref. 13.5)** creates a system whereby Local Authorities must identify and if necessary arrange for the remediation of contaminated sites. The provisions are set out in Section 57, which inserts Part IIA into the Environmental Protection Act 1990. In addition to these requirements, the operation of the regime is subject to regulation and statutory guidance.

13.16 **Contaminated Land (England) Regulations 2006 (Ref. 13.6)** provides a definition of what constitutes ‘contaminated land’ and sets out the responsibilities of the Local Authority and the Environment Agency (EA) in the identification and management of contaminated land. Under the Regulations, contaminated land is defined as “land which is in the opinion of the Local Authority to be in such a condition by reason of substances in or under the land that:

i) Significant harm is being caused or there is significant possibility of significant harm being caused; and,

ii) Significant pollution of controlled waters is being caused or there is a significant possibility of significant pollution of controlled waters being caused”.

13.17 Harm is defined in relation to harm to the health of living organisms or other interference with the ecological systems of which they form a part, and in the case of man includes harm to property.
13.18 The potential for harm to occur requires three conditions to be satisfied:

i) Presence of substances (potential contamination/pollutants) that may cause harm (source of pollution);

ii) The presence of a receptor which may be harmed e.g. the water environment or humans, buildings, fauna and flora (the receptor); and,

iii) The existence of a linkage between the source and receptor (the pathway).

13.19 Therefore the presence of measurable concentrations of contaminants within the ground and subsurface environment does not automatically imply that a contamination problem exists, since contamination must be defined in terms of pollutant linkages and unacceptable risk of harm.

13.20 The nature and importance of both pathways and receptors which are relevant to a particular site will vary according to the intended use of the site, its characteristics and surroundings.

13.21 The Water Environment (Water Framework Directive) (England and Wales) Regulations, 2003 (Ref. 13.7); these Regulations establish a framework for protecting the water environment, with the aim of achieving chemical and ecological water quality targets by 2015.


13.23 Controls of Asbestos Regulations 2012 (Ref. 13.9) prohibit the importation, supply and use of all forms of asbestos. If existing asbestos containing materials are in good condition, they may be left in place; their condition monitored and managed to ensure they are not disturbed. The Asbestos Regulations also include the ‘duty to manage asbestos’ in non-domestic premises.

13.24 Construction (Design & Management) Regulations 2007 (Ref. 13.10) make explicit duties that exist under the Health and Safety at Work Act, 1974 (Ref. 13.11) and the Management of Health and Safety at Work Regulations, 1999 (Ref. 13.12). This requires
clients to use their influence to ensure that the arrangements made by other duty holders are sufficient to ensure the health and safety of those working or those affected by that work.

Planning Policy

13.25 Planning policy at the national, regional, county and local level and its relevance to environmental design and assessment is discussed in Chapter 5 – Assessment of Relevant Policies.

National Planning Policy Framework (NPPF), 2012 (Ref. 13.13)

13.26 This is new national policy (in England) and replaces all previous Planning Policy Statements (PPS) and Policy Planning Guidance (PPG) notes. In relation to ground condition, the NPPF Paragraph 109 states that The planning system should contribute to and enhance the natural and local environment by:

“- Preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water and noise pollution or land instability; and

- remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate contribute to remediating and mitigation contaminated land and re-using land that has previously been developed provided if it is not of high environmental value.”

13.27 The 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.”

13.28 The 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 impacts 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 (Ref. 13.4); and

- adequate site investigation information, prepared by a competent person, is presented.”

**Broxtowe Local Plan, 2004 (Ref. 13.14)**

13.29 The Local Plan provides the framework for protecting and enhancing the districts unique urban, coastal and rural environment. The BBC Local Plan sets out the following “saved” policies which are relevant to the assessment:

**“E26: Pollution:** Planning permission will not be granted for development which would result in a significant deterioration in air quality, significant loss of health or amenity to the occupants of nearby premises due to pollution, or contamination of either surface waters or the site of the development or other land nearby;

**“E27: Protection of Groundwater:** Planning permission will not be granted for development which would be liable to result in the infiltration of contaminants into groundwater resources, particularly in areas of high vulnerability, unless measures would be carried out as part of the development to prevent such contamination taking place; and,

**E29: Contaminated Land:** Development of land which may be contaminated will not be permitted to take place unless and until:

a) A site investigation has been carried out to assess the nature and degree of contamination, using a method of investigation agreed in writing with the Council; and

b) Details of remedial measures required to deal with any contamination have been approved by the local planning authority in consultation with the relevant bodies; and
c) there will be no significant risk to the health and safety of the occupants of the development; and

d) there will be no contamination of any surface water, groundwater or adjacent land.”

Guidance

13.30 The following Pollution Prevention Guidelines (PPGs) have been issued by the EA that are considered to be relevant to this assessment:

- PPG 1 ‘General Guide to the Prevention of Pollution’ (Ref. 13.15) (please note that this document is currently being withdrawn but has been used for reference in lieu of the publication of an amended version);
- PPG 2 ‘Above Ground Oil Storage Tanks’ (Ref. 13.16);
- PPG 6 ‘Working at Construction and Demolition Sites’ (Ref. 13.17);
- PPG 8 ‘Safe Storage and Disposal of Used Oils’ (Ref. 13.18); and,
- PPG 21 ‘Pollution Incident Response Planning’ (Ref. 13.19).

13.31 Other best practice guidance documents considered to be relevant to this assessment include the following:

- British Standards Institution (BS) 8485 (2007) Code of Practice for the Characterisation and Remediation from Ground Gas in Affected Developments (Ref. 13.20);
- BS 10175 (2001) Investigation of Potentially Contaminated Sites – Code of Practice (Ref. 13.21);
- BS 5930 (1999) The Code of Practice for Site Investigations (Ref. 13.22);
- CIRIA 665 (2007), Assessing Risks Posed by Hazardous Gases to Buildings, Wilson, Oliver, Hutchings and Card (Ref. 13.2);
- CIRIA C532 (2001) Control of Pollution from Construction Sites (Ref. 13.23);
- EA and NHBC (2000) Guidance for the safe development of housing on land affected by contamination, EA R&D Publication 66 (Ref. 13.24);
Existing Baseline Conditions

Site Reconnaissance

13.32 A site walkover was completed by Julian Carr of WSP on 7th September 2011. The following pertinent information was obtained.

13.33 The Site is set in an area of mixed land use including residential, agricultural and commercial. The Site topography generally falls to the north-east. For purposes of the site walkover and this Chapter only, the Site was split into four distinct areas (A-D) as shown on Figure 2 in Appendix 13.1.

13.34 Area A is mainly open grassland with a Site access point adjacent to the M1 J26 roundabout. Ragwort was noted to be present on the Site. A spoil heap was noted on the northern boundary of Area A and Area B, which is considered likely to be related to former mining activities undertaken in the area. Some general detritus and debris was noted locally on Area A (gravel sized rubble forming hardstanding areas, concrete cobbles, wood, a gas bottle etc.). This is thought to originate from the previous occupation of the Site by travellers. A grass earthwork and trees form the boundary between the Area A and the Highways Agency land to the west by the M1, with a mature intermittent hedge between Areas A and B. The northern boundary between Areas A and C is marked by a barbed wire fence. Several individual trees were observed within Area A and a woodland area is present between Areas A and D containing mature trees and shrubs.
13.35 **Area B** lies in the centre and south-east of the Site. It had recently been ploughed and was therefore observed to be bare soil during the walkover. An access way into the field from the A6002 Woodhouse Way was noted, with a further access through the hotel to the south of Area B. The boundaries of Area B are formed by hedgerows and mature trees.

13.36 **Area C** lies to the north of the Site and is currently arable farmland, which had recently been harvested. A natural drop in ground elevation was observed towards the northern end of Area C. This is understood to be the location of a former pond/lake known as ‘Ox Watering’. Anecdotal evidence from the farmer, John Blant, indicated that, prior to the M1 being built, water from the west of the Site used to shed into this area forming a pond. Since the construction of the M1, the water pathway has been cut off and the area has become dry.

13.37 **Area D** lies to the south-west of the Site and is arable farmland. The boundary with the M1 is mainly open grass verge with woodland to the northern boundary between Area D and Area A and hedgerow to the south and east.

13.38 With the exception of the suspected spoil heap, no potential current sources of contamination were observed during the walkover.

**Site History**

13.39 A study of historical Ordnance Survey maps provided as part of an Envirocheck Report (a database of environmental information) obtained for the Site (Ref. 13.30) has been undertaken to identify any potential contaminative former land uses.

13.40 The available map information, extracts of which are included within Appendix 13.0, indicates that the Site has remained undeveloped open land since prior to 1881. A well is shown to the west of the wooded area on the western boundary of the Site from pre 1881 to pre 1915. A pond and trees are located in the north of the Site labelled “Ox Watering” from pre 1887 to 1968, the label remains on mapping from this date but the woodland and pond are not shown.

13.41 Pertinant surrounding land uses have included the following:
### Table 13.1: Summary of the History of Land Surrounding the Site

<table>
<thead>
<tr>
<th>Date</th>
<th>Land Use</th>
<th>Distance</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre 1881 – 1966</td>
<td>Agricultural land</td>
<td>Adjacent</td>
<td>North and West</td>
</tr>
<tr>
<td>Pre 1881 – 1955</td>
<td>Old Tramway</td>
<td>Adjacent</td>
<td>South</td>
</tr>
<tr>
<td>Pre 1881 – Pre 2000</td>
<td>Engine Wood and Engine Wood Colliery (with shaft and tank)</td>
<td>31m</td>
<td>East</td>
</tr>
<tr>
<td>Pre 1881 – Pre 2006</td>
<td>Agricultural land</td>
<td>Adjacent</td>
<td>South</td>
</tr>
<tr>
<td>1966 – Present</td>
<td>M1</td>
<td>Adjacent</td>
<td>West</td>
</tr>
<tr>
<td>1966 – Present</td>
<td>A610</td>
<td>Adjacent</td>
<td>North</td>
</tr>
<tr>
<td>2000 – Present</td>
<td>Residential development</td>
<td>30m</td>
<td>East</td>
</tr>
<tr>
<td>2006 – Present</td>
<td>Hotel, Business Park</td>
<td>20m</td>
<td>South</td>
</tr>
</tbody>
</table>

### Environmental Database Information

13.42 A summary of information from publicly available sources is provided below:
Table 13.2: Summary of Environmental Database Information

<table>
<thead>
<tr>
<th>Item</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historic and Local Authority Recorded Landfill Sites</td>
<td>Broxtowe Tip 593m east, active 1972 - 1975 accepting inert, commercial, industrial and domestic waste.</td>
</tr>
<tr>
<td>Fuel station entries</td>
<td>A fuel filling station is located 54m to the east of the Site.</td>
</tr>
<tr>
<td>Contemporary trade directory entries</td>
<td>Trade directory entries include packing and wrapping, fire fighting equipment within 250m of the Site.</td>
</tr>
<tr>
<td></td>
<td>An asphalt and coated macadam laying contractor is located 258m south-east of the Site.</td>
</tr>
<tr>
<td>Land Classifications</td>
<td>The Site is located within an area designated as Greenbelt and a Nitrate Vulnerable Zone</td>
</tr>
</tbody>
</table>

Information from Ref. 13.30 Envirocheck Report; Ref. 13.31 Multi-Agency geographic Information for the Countryside (MAGIC) web Site accessed on 22nd September 2011; and Ref. 13.32 Environment Agency Web Site accessed on 22nd September 2011.

Consultation

13.43 The following consultation was undertaken in 2011 as part of the Geoenvironmental Desk Study and Terrain Assessment.

13.44 The Contaminated Land Officers (CLO) at Nottinghamshire County Council and BBC were contacted by telephone and email on the 22nd September 2011. Nottinghamshire County Council CLO (Andy Bryan) confirmed the Site was not of concern regarding contaminated land other the designations listed in Table 3.2 and Table 3.3 of Appendix 13.1. He did note a mineral route passed to the south of the Site through the present Business Park area. Therefore, the only potentially significant contaminated land sources comprise the landfill Site 593m east and former coal mines on the Site.

13.45 The Building Control Officer at Broxtowe Borough Council (Iain Gorton) was contacted via telephone and email on 22nd September 2011. He provided the following information:

- The 1990's built housing opposite the Site in the Mornington Crescent area were predominantly built on rafts; flat shallow, flat deep and toe rafts depending on
which the house builder preferred. This was due to sandstone/clay ground with fissures in the sandstone and local mine workings. To his knowledge, there has been no movement to the houses;

- When the ground has been exposed on rear and side extensions the sandstone strata begins as low as 300mm from the surface to 1.2m from the surface; and,
- The preferred foundation option of strip footings would need to be justified due to the ground conditions, it was a NHBC requirement that the houses went on a raft foundation.

Geoenvironmental Setting

**Hydrology**

**Surface Water Features**

13.46 Local surface water features within influence of the Site are listed below.

<table>
<thead>
<tr>
<th>Surface Water Feature</th>
<th>Distance</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnamed Drain</td>
<td>100m</td>
<td>South-east</td>
</tr>
<tr>
<td>Hempshill Brook</td>
<td>121m</td>
<td>North-east</td>
</tr>
<tr>
<td>“The Lake”</td>
<td>215m</td>
<td>North-west</td>
</tr>
</tbody>
</table>

13.47 The unnamed drain originates from ‘Issues’ within Chilwell Dam Plantation located adjacent to the A6002 Woodhouse Way to the south-east of the Site. The drain flows east then north-east through Broxtowe Country Park, before entering a culvert and into Hempshill Brook approximately 1.7km to the east of the Site. Hempshill Brook flows west to east and is culverted prior to its confluence with the unnamed drain. The brook also appears to be culverted until its confluence with the River Leen some 3.7km to the east of the Site.

**Surface Water Discharge Consents and Abstractions**

13.48 The Landmark Envirocheck Report (Ref.13.30) indicates that no active surface discharge consents or surface water abstractions are listed within 500m of the Site.
Geology

Published Geology

13.49 Published British Geological Survey (BGS) mapping (Ref. 13.33) indicates the Site is underlain by Cadeby Formation described as Dolostone: grey to buff grey, commonly oolitic or granular, with subordinate mudstone, dolomitic siltstone and sandstone. The Cadeby Formation has a proven maximum thickness of 37m. Middle Coal Measures are shown underlying The Cadeby Formation with worked seams of coal known to underlie the Site. The BGS 1:10,000 map (Ref. 13.34) indicates that the Site is underlain by a red brown clay loam at surface.

13.50 A north-west to south-east trending surface fault is shown crossing the very northern tip of the Site. The fault is downthrown to the south. No other faulting is present on the Site but additional surface faults are shown to the north of the Site and a subsurface fault in the Deep Soft Coal is shown just to the south of the Site.

13.51 Given the lack of substantial development at the subject Site indicated on the available mapping, it is considered that Made Ground, if present, may be limited in its extent and depth. However, the presence of mineshafts on the Site may indicate that colliery spoil may be present beneath the Site. The use of much of the Site for arable farming likely indicates that any colliery spoil may be limited to Area A (open grassland), where some Made Ground is also present on the surface associated with the previous use of the Site by travellers.

13.52 A number of BGS borehole logs (Ref.13.35) were obtained for boreholes located within close proximity to the Site. The logs and a location plan are presented in Appendix 13.1. Borehole SK548W503 was located to the west of the Site resulting from the ground investigation works undertaken prior to the construction of the M1. The log indicates limestone from a depth of 2.44m below ground level (bgl) with no coring occurring above this level. Shale was encountered at 18.59m with coal encountered at 23.22m. Borehole SK548W4 located to the east of the Site was for the former Engine Wood colliery shaft. Coal was encountered at 30.23m bgl with no geology recorded above this level.

Coal Mining

13.53 The Envirocheck Report (Ref. 13.30) lists eight inactive BGS recorded mineral Site within 1km of the subject Site for the abstraction of coal by deep mining methods and limestone by opencast methods.
A Coal Authority Report dated March 2011 (Ref. 13.36) presented in Appendix 13.1 indicates the following:

- The Site is in the likely zone of influence from workings in four seams of coal at 100m to 280m depth, last worked in 1965. Any ground movement from these coal workings should have stopped by now;
- The Site is not in the zone of influence of any present mining activities;
- The Site is not in an area that is likely to be affected at the surface from any planned future workings. However reserves of coal exist in the local area which could be worked at some time in the future;
- The Authority is not aware of any evidence of damage arising due to geological faults or other lines of weakness that have been affected by coal mining; and,
- The Site does not lie within 200m of a geographical boundary of an opencast Site within which coal is being extracted by opencast methods, or within 800m of an opencast Site for which a license to extract coal by opencast methods is awaiting determination or has been granted.

The Coal Authority state that there are twenty two mine entries within, or within 20m of, the boundary of the Site. The approximate positions of the shafts are shown on Figure 5 in Appendix 13.1. Coal Authority records and a summary of the information is presented in Table C1 in Appendix 13.1. The four shafts located off the Site beneath Woodhouse Road (451343-002 to 004 and 040) were located, treated and capped prior to construction of the road and adjacent housing development. The remainder of the shafts have not been located and no treatment details are available.

The BGS 1:10,000 scale mapping (Ref. 13.34) for the area indicates that a number of coal seams are present within the Middle Coal Measures within the vicinity of the Site. These are listed in Table C2 in Appendix 13.1.

BGS borehole records for Nuthall Wood Engine pumping shaft located just off the eastern boundary of the Site; and Chilwell Dam Farm located approximately 20m to the south of the Site are presented in Appendix 13.1. Summaries of the coal seams recorded in the boreholes are presented as Tables C3 and C4 respectively in Appendix 13.1. The records indicate a drop in gradient to the north/north-east of circa 1:11.7 for the Cinderhill Coal and 1:11.1 for the Top Hard Coal.

Mine abandonment plans held by the Coal Authority indicate that the Site was part of Cossall Pit, Nuthall Engine Pit, and Pay For All Pit. Broxtowe Pit, Nuthall Engine Wood...
Pit and Burdett’s Pit lay just off the eastern boundary; Cinderhill Colliery was present to the south of the Site; and Kimberley Colliery was present to the west beyond the M1. The plans show buffers were left between Cossall Pit workings and Kimberley and Broxtowe workings. The buffer between Cossall Pit and Broxtowe Pit is such that Broxtowe Pit may just have encroached beneath the very south-eastern corner of the Site (see Figure 5 in Appendix 13.1). A summary of the pits beneath or potentially beneath the Site and those seams thought to be worked is presented below:

**Table 13.4: Coal Mine and Worked Seams Summary**

<table>
<thead>
<tr>
<th>Pit Name</th>
<th>Location</th>
<th>Seams Mined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cossall Pit</td>
<td>On Site</td>
<td>Deep Soft (&gt;125m bgl) and connections shown to Piper Coal below. Mined during the 1960’s, the seam thickness was generally between 0.89m to 1.01m. The coal seam dipped to the north at a gradient of circa 1:8.5.</td>
</tr>
<tr>
<td>Nuthall Engine Pit</td>
<td>On Site</td>
<td>Suspected Top Hard at circa 76.81m bgl. Multiple shafts and buildings shown within the woodland on Site. Mining took place circa 1787.</td>
</tr>
<tr>
<td>Pay For All Pit</td>
<td>On Site</td>
<td>Unknown as abandonment plans unclear, but mineshaft (451343-006) indicated to be circa 53m deep which suggests Low Bright Coal and High Hazles Coal.</td>
</tr>
<tr>
<td>Broxtowe Pit</td>
<td>East (adjacent to 100m).</td>
<td>Deep Hard (mined 1906-09 adjacent to the Site), Deep Soft and Piper.</td>
</tr>
<tr>
<td>Burdett’s Pit</td>
<td>Adjacent (mineshaft 451343-004 marks location.)</td>
<td>Unknown.</td>
</tr>
<tr>
<td>Nuthall Engine Wood Pit</td>
<td>East (adjacent to 200m).</td>
<td>Unknown but pumping shaft sunk to Top Hard at circa 131m bgl.</td>
</tr>
</tbody>
</table>

* - From evidence supplied by the Coal Authority mine abandonment plans and other mapping; more seams may have been mined than are indicated.
Mineral Extraction

13.59 Four mineral extraction pits have been recorded within 1km of the site in the Envirocheck Report (Ref. 13.30). The records are all for opencast quarrying of Dolomite material from the Cadeby Formation. The quarry locations are as follows:

<table>
<thead>
<tr>
<th>Quarry Name</th>
<th>Distance</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Farm</td>
<td>528m</td>
<td>South-east</td>
</tr>
<tr>
<td>Kimberley Road</td>
<td>787m</td>
<td>West</td>
</tr>
<tr>
<td>Stonepit Plantation</td>
<td>946m</td>
<td>South</td>
</tr>
</tbody>
</table>

Radon

13.60 The Envirocheck Report (Ref. 13.30) indicates that the site is in an intermediate probability radon area with between 3% and 5% of homes above the action level. As such, basic radon protection measures are necessary in the construction of new dwellings or extensions. The BRE document ‘Radon: Guidance on Protective Measures for New Buildings’ (BR211) (Ref. 13.37) indicates that the site lies in an area that would require basic radon protection if the site is underlain directly by the Cadeby Formation.

13.61 As part of Reserved Matters applications, a BGS radon report and consultation with Building Control will be required to confirm the requirements for radon protection measures.

Hydrogeology

13.62 The EA has designated the underlying Cadeby Formation as a Principal Aquifer with the Coal Measures designated as a Secondary ‘A’ aquifer. It is anticipated that the groundwater flow direction will be towards the River Leen to the east.

13.63 Publicly available information held by the Envirocheck database (Ref. 13.30) indicates that there are two groundwater abstractions within 2km of the site. These are held by Fernwood Fuels Limited from a borehole 1.7km to the north-west of the site; and Hardy and Hanson Ltd from a spring 1.9km to the north-west of the site (both up hydraulic gradient of the site). The site is not located within a groundwater Source Protection Zone. Based on the anticipated groundwater flow direction, it is
considered that groundwater quality beneath the subject Site will not impact the above groundwater abstractions.

**Preliminary Risk Assessment (Preliminary Conceptual Site Model)**

13.64 The Preliminary Risk Assessment set out in the Geoenvironmental Desk Study and Terrain Assessment *(Appendix 13.1)* is summarised below.

13.65 Potential contamination sources comprise:

**Table 13.6: Potential Sources of Contamination**

<table>
<thead>
<tr>
<th>Likely Contamination Source</th>
<th>Potential Contaminated Issue and Justification</th>
</tr>
</thead>
</table>
| On-Site contamination sources | The Site has remained largely undeveloped throughout its documented history; therefore, significant widespread contamination is unlikely to have occurred due to on-site sources. Localised areas of contamination may exist associated with former mine workings (e.g. presence of colliery spoil, localised fuel spillages).

An area of organic clay material is likely to be present in the north of the Site in the former Ox watering area. This may present a potential ground gas risk in addition to the underlying Coal Measures. There is also a risk posed by Radon.

Localised areas of contamination may exist associated with the current and former agricultural use. These include: the use of fuel/oil; potential fired residues (i.e. ash) to have been spread on the Site; and the use of pesticides and insecticides. |
| Off-Site contamination sources | A former mineral way lies to the south of the Site and a fuel station lies 53m east of the Site. A tank and shaft related to former mine workings lie 35m to the east of the Site within the current grounds of a public house. No other major off-site sources of contamination have been identified as the landfill is considered to be too far from the Site to be a significant potential risk.

The M1 is located adjacent to the west of the Site; there is the potential for contamination from fuel spills. |
Potential receptors to contamination and exposure routes comprise:

**Table 13.7: Receptors and Exposure Pathways**

<table>
<thead>
<tr>
<th>Exposure Pathway</th>
<th>Active Receptor Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingestion and inhalation of contaminated soils, dusts, volatile vapours, ground gas and groundwater; dermal contact with contaminated soils or groundwater.</td>
<td><strong>Human Health:</strong> Construction workers, future Site users, future maintenance workers and neighbouring Site users.</td>
</tr>
<tr>
<td>Leaching of contaminants from mining activities, surface run-off, migration under gravity to groundwater or via subsurface flow into drainage ditches or surface water features.</td>
<td><strong>Controlled Waters:</strong> Principal Aquifer beneath the Site and local surface water features.</td>
</tr>
<tr>
<td>Ground gas may migrate into structures; contaminant permeation of water supply pipes could occur and aggressive ground conditions could impact buried concrete.</td>
<td><strong>Buildings and Structures:</strong> New buildings on the Site.</td>
</tr>
<tr>
<td>Contaminant migration via leaching and/or drainage.</td>
<td><strong>Third Party Land:</strong> Residential area to east and hotel/industrial area to south.</td>
</tr>
<tr>
<td>Uptake of contaminants by plants/vegetation on ecologically sensitive Sites.</td>
<td><strong>Ecology:</strong> Broxtowe Country Park and the on-site Site of Important Nature Conservation</td>
</tr>
</tbody>
</table>
With reference to the information above, the Preliminary Risk Assessment is as follows:

### Table 13.8: Preliminary Risk Assessment

<table>
<thead>
<tr>
<th>Receptor Group</th>
<th>Likely Significance of Risk</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human health</td>
<td>Low to Moderate</td>
<td>Localised sources of contamination may represent a low to moderate risk to human health during any construction and/or enabling works. Post development, potential risks are considered to be low given the likely management of any contamination present on the Site during construction works.</td>
</tr>
<tr>
<td>Controlled waters</td>
<td>Low to Moderate</td>
<td>Localised contamination sources (i.e. mining waste, fuel/oil spillage or localised waste burial from agricultural use) may have resulted in impacts to soils which may represent a limited risk to controlled waters.</td>
</tr>
<tr>
<td>Buildings and services</td>
<td>Low to Moderate</td>
<td>The underlying Cadeby Formation is likely to be water bearing at depth and is classified as a Principal Aquifer. The nature of this unit means it is likely to provide a pathway for contamination. In areas of the Site where groundwater is absent, it may allow the migration of contamination towards a groundwater body present off-site.</td>
</tr>
<tr>
<td>Third party land</td>
<td>Low to Moderate</td>
<td>It is considered that there is a low to moderate potential for aggressive ground conditions to exist at the Site. Localised Made Ground may contain pyrites and/or elevated sulphate concentrations resulting from coal mining legacy at the Site. These elevated concentrations could pose a risk to concrete foundations and structures.</td>
</tr>
<tr>
<td>Ecology</td>
<td>Low</td>
<td>It is considered unlikely that current Site derived contamination will result in significant impacts to third party land. However, there is the potential for residual contamination from historical localised sources to migrate off-site within the permeable strata underlying the Site.</td>
</tr>
</tbody>
</table>
Ground Stability Risk Appraisal

13.68 A summary of the ground stability risks set out in the Geoenvironmental Desk Study and Terrain Assessment (Appendix 13.1) is summarised below.

Table 13.9: Ground Stability Risks

<table>
<thead>
<tr>
<th>Issue</th>
<th>Likely Significance of Risk</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential for variable depth of Made Ground</td>
<td>Low to Moderate</td>
<td>Deep Made Ground is not expected on the Site but may be present locally associated with former coal mining activities.</td>
</tr>
<tr>
<td>Coal combustion</td>
<td>Low</td>
<td>Coal within the colliery spoil may be susceptible to combustion; however, the extent and depth of colliery spoil is expected to be limited.</td>
</tr>
<tr>
<td>Potential of residual foundations/buried structures/buried obstructions</td>
<td>Low</td>
<td>Residual foundations are unlikely to be present on the Site. No buildings or structures were known to be located on the Site other than around mineshafts located within the wooded area which is not scheduled for development.</td>
</tr>
<tr>
<td>Spoil mounds</td>
<td>Low to Moderate</td>
<td>A suspected colliery spoil mound is present on the Site. It is likely that it will need to be removed as part of the cut/fill earthworks for the scheme. The chemical and geotechnical properties of the spoil will need to be established before the material can be used as fill on the Site.</td>
</tr>
<tr>
<td>Issue</td>
<td>Likely Significance of Risk</td>
<td>Justification</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Future Coal Reserves</td>
<td>Low</td>
<td>It is considered that there may be reserves of coal beneath the Site that may be considered an economic resource. However, opencast methods are unlikely to be suitable on the Site due to the proximity of the M1 and housing. As such, deep mining is the only reasonable option for coal extraction. Given the history of mining beneath the Site, deep mining is likely to be considered too hazardous to consider as an option.</td>
</tr>
<tr>
<td>Mineshafts (recorded and unrecorded)</td>
<td>Moderate to High</td>
<td>There are twenty two known mineshafts located on or within 20m of Site. Only those beneath the A6002 Woodhouse Way to the east have been found and treated.</td>
</tr>
</tbody>
</table>

**Terrain Assessment (Preliminary Ground Investigation)**

**Assessment Aims**

13.69 The main aim of the assessment was to provide a broad understanding of the Site geology, hydrogeology, physical soil properties, and a preliminary assessment of likely soil contamination. The assessment was designed to provide the applicant and other interested parties with preliminary information on potential geoenvironmental constraints to any proposed development on the Site. The assessment was not sufficient to allow the discharge of planning conditions relating to contaminated land.

**Fieldwork**

13.70 A Terrain Assessment comprising a preliminary intrusive ground investigation was carried out 8th September 2011. The investigation was limited to the areas accessible at the time of the investigation, namely the arable field in the north of the Site and the area of grassland in the north and running along the western boundary of the Site (referenced as Areas C and A respectively in the Desk Study and Terrain Assessment Appendix 13.1). Full details of the investigation undertaken including the locations of
exploratory holes are presented in **Appendix 13.1**. A summary of the works undertaken is presented below.

13.71 Six exploratory trial pits (TP1-6) were excavated to depths of between 1.2m and 1.5m below ground level (bgl) using a mechanical excavator. Soakaway tests were performed in trial pits TP1-3.

13.72 Seven windowless sampler boreholes (WS1-7) were sunk to depths of between 1.25m and 4.0m bgl. Five boreholes were installed with dedicated gas and groundwater monitoring installations.

13.73 Gas concentrations and groundwater elevations were monitored on two occasions following completion of the ground investigation works.

13.74 A total of fifteen soil samples were tested for a standard suite of potential contaminants including metals, polycyclic aromatic hydrocarbons and petroleum hydrocarbons.

**Ground and Groundwater Conditions**

13.75 Ground conditions were generally found to comprise either Made Ground or topsoil overlying Sand or Gravel of The Cadeby Formation. Alluvium was recorded at one location in the north of the Site.

13.76 Granular topsoil was encountered within all of exploratory locations across the investigated areas of the Site (with the exception of in trial pit TP1 and window sampler borehole WS7), from ground level to depths of up to 0.3m bgl. Topsoil in TP1 was found to be cohesive and topsoil was absent in WS7.

13.77 Made Ground was only encountered in two locations. Reworked topsoil containing small quantities of coal was recorded in trial pit TP5 to a maximum thickness of 0.3m bgl. Window sampler borehole WS7 was located on a spoil mound and recorded 3.0m of colliery spoil overlying natural ground.

13.78 Alluvium was encountered in trial pit TP1 located on the former “Ox Watering” area known to have been flooded historically. Alluvium comprised sand, interbedded sand and silt, and clay.

13.79 The Cadeby Formation was found to comprise weathered sandstone at all locations except trial pit TP1, where limestone (possibly dolostone) was recorded.
13.80 Groundwater was not recorded during the ground investigation or subsequent monitoring period.

13.81 With the exception of rare coal in the tospoil in TP5 and coal within the colliery spoil in WS7, no visual or olfactory evidence of contamination was recorded.

13.82 Soakaway tests indicated infiltration rates of between $2.1 \times 10^{-5}$ and $2.9 \times 10^{-5}$ m/s within the weathered sandstone, and $1.6 \times 10^{-5}$ m/s within the alluvium/limestone (interbedded sand and silt, clay, with limestone at the base of the pit).

13.83 Preliminary ground gas monitoring did not record the presence of methane, but low concentrations of carbon dioxide were recorded in the range 0.4% to 1.2% by volume (WS4 and WS6 respectively). No positive gas flow rates were recorded.

**Generic Quantitative Risk Assessment (GQRA)**

13.84 The GQRA set out in the Desk Study and Terrain Assessment (Appendix 13.1) provides a preliminary assessment of the potential risks from contamination only. Further ground investigation and ground gas monitoring will be required to fully assess the risks posed in relation to the Proposed Development.

13.85 The results of the chemical analysis were compared to appropriate Soil Guideline Values (SGV) and WSP in-house Risk Based Generic Assessment Criteria (GAC) for a residential with gardens end-use.

13.86 None of the recorded contaminant concentrations for metals and inorganics, Polycyclic Aromatic Hydrocarbons (PAH), phenols, volatile or semi-volatile organic compounds and Petroleum Hydrocarbons exceeded the applied screening criteria, with the exception of arsenic in TP5 at 0.1m (38.4mg/kg recorded; SGV is 32.0mg/kg). The sample tested was from reworked topsoil containing coal fragments.

13.87 The preliminary ground gas assessment set out in the Desk Study and Terrain Assessment (Appendix 13.1) based on only two monitoring visits, concluded that the Site may be classified as ‘Green’ or ‘Characteristic Situation 1’ under the NHBC and CIRIA C665 methods, meaning no gas protection measures would be necessary. However, it is noted that further ground gas monitoring will be required, including from deeper boreholes sunk into the underlying Cadeby Formation.
Revised Conceptual Understanding

13.88 No significant sources of contamination have been recorded on the Site as part of the preliminary ground investigation. It is noted that approximately half of the Site is yet to be investigated but is in agricultural use as arable farmland and, as such, is unlikely to present a significant risk to human health or groundwater. However, further ground investigation will be required to confirm this, and potential contaminants associated with agricultural use (e.g. fuel spills, pesticide use etc.) and former mining activities (including ground/mine gas, elevated metal concentrations in colliery spoil etc.) must therefore remain as part of the Conceptual Site Model (CSM).

13.89 Based on the Preliminary CSM presented in the Desk Study and Terrain Assessment (Appendix 13.1), a revised risk assessment is presented below.

Table 13.10: Revised Conceptual Site Model

<table>
<thead>
<tr>
<th>Receptor Group</th>
<th>Likely Significance of Risk</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human health</td>
<td>Low to Moderate</td>
<td>Localised sources of contamination may represent a low to moderate risk to human health during any construction and/or enabling works. Although significant contamination has not been recorded during the terrain assessment, approximately half the Site is yet to be investigated. Post development, potential risks are considered to be low given the likely management of any contamination present on the Site during construction works.</td>
</tr>
<tr>
<td>Controlled waters</td>
<td>Low to Moderate</td>
<td>Localised contamination sources (i.e. fuel/oil spillage or localised waste burial from agricultural use etc.) may have resulted in impacts to soils which may represent a limited risk to controlled waters. Groundwater was not encountered at shallow depth during the terrain assessment, but deeper boreholes are likely to be required to reach the groundwater table. The underlying Cadeby Formation/Middle Coal Measures are likely to be water bearing at depth and are classified as a Principal Aquifer and Secondary ‘A’ aquifer respectively. The physical nature of these units means they are likely to provide a pathway for contamination. In areas of the Site where groundwater is absent, it may allow the migration of</td>
</tr>
<tr>
<td>Receptor Group</td>
<td>Likely Significance of Risk</td>
<td>Justification</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Buildings and services</td>
<td>Low to Moderate</td>
<td>It is considered that there is a low to moderate potential for aggressive ground conditions to exist at the Site. Localised Made Ground may contain pyrites and/or elevated sulphate concentrations resulting from coal mining legacy at the Site. These elevated concentrations could pose a risk to concrete foundations and structures. Where the weathered sandstone or dolostone are present, the risk is likely to be low.</td>
</tr>
<tr>
<td>Third party land</td>
<td>Low to Moderate</td>
<td>It is considered unlikely that current Site derived contamination will result in significant impact to third party land. However, there is the potential for residual contamination from historical localised sources to migrate off-Site within the permeable strata underlying the Site.</td>
</tr>
<tr>
<td>Ecology</td>
<td>Low</td>
<td>No significant risks to Site ecology or the ecology of the surrounding area have been identified. If any residual contamination on the Site was polluting local watercourse, it is likely that the effects of any such contamination would have been identified by now.</td>
</tr>
<tr>
<td>Overall Classification</td>
<td>Low to Moderate</td>
<td></td>
</tr>
</tbody>
</table>

13.90 The ground investigation undertaken was not specifically designed to address the ground stability hazards set out in Table 13.9 above, and additional ground investigation including deeper rotary boreholes into the Cadeby Formation will be required. The ground investigation has confirmed that deep Made Ground is not widespread across the areas of the Site investigated. However, the risk presented from mineshafts located on the Site remains moderate to high. A full appraisal of information obtained as part of the Desk Study and Terrain Assessment regarding the known mineshafts on the Site is not presented in full within this Chapter, but is presented in Section 9.4 of Appendix 13.1.
13.91 Development stand-off zones will be required around all known mineshafts. Smaller development stand-off zones will be applicable to mineshafts that have been located, drilled and grouted, and capped. A geophysical survey (Appendix 7.2) has been undertaken as part of the archaeological works and preliminary indications are that a limited number of the mineshaft locations may be indicated by the survey. However, detailed interpretation of the results is awaited. If not indicated by the geophysical survey, rotary percussion probing will be required to locate the known shafts on the Site to enable treatment prior to development on Site. A full mineshaft risk assessment will be required to inform the Proposed Development as part of the detailed design stage.

13.92 It should be possible to construct roads/maintenance routes across mineshafts, providing that no permanent structures are placed across the shaft and the stand-off zones. Some form of structural geogrid/geotextile may be required across the roads to limit the effects of total and differential settlement should a shaft collapse. Approval will be required by the appropriate Highways department and Building Control to facilitate adoption.

13.93 Foundations should be placed on weathered sandstone or competent sandstone/limestone bedrock. This is likely to be present at shallow depth across the Site.

13.94 The Building Control officer at BBC indicated that the houses built adjacent to the east of the Site were built on “flat shallow, flat deep and toe rafts”. Rafts were required by the NHBC due to the presence of shallow mine workings (depth not defined) and fissures within the underlying sandstone bedrock. Although conventional spread foundations should be possible on the Site, the requirements of Building Control and the NHBC may result in raft foundations being necessary on the Site.

**Further Work Required**

13.95 In order to facilitate residential development at the Site, it will be necessary to undertake additional intrusive ground investigation works prior to reserved matters applications to provide detailed information on ground conditions across the areas of the Site not previously investigated. This will inform foundation, pavement and earthworks design, and quantify the potential risk posed by the migration of ground gas to the Site. Investigations should focus on:

- The location of the proposed buildings to determine a ground model for foundation design and earthworks;
• A general consideration of the presence of potential contaminants, particularly in shallow soils and topsoil;
• A general spread of exploratory holes across the remainder of the Site to map the presence or absence of Made Ground;
• Deep rotary boreholes to establish the presence of mine workings and location of mineshafts;
• Installation of gas and groundwater monitoring wells to determine the presence or absence of groundwater and ground gas in the Cadeby Formation and/or Middle Coal Measures underlying the Site; and,
• Ground gas monitoring over a period of six months.

13.96 A detailed remediation strategy is not likely to be required unless significant contamination is encountered during the ground investigation; however, it will be necessary to ensure that any areas of contamination identified during either additional ground investigation works or future construction works are appropriately managed.

13.97 Mineshafts on the Site should to be located, drilled and grouted, and capped. If this is not undertaken, increased development stand-off zones will be required.

**Predicted Effects**

**Site Preparation and Construction Phase**

*Potential exposure to contamination associated with agricultural and mining historical land uses and effects on human health (e.g. ground workers, earthworks contractors, construction workers and third parties)*

13.98 No significantly elevated concentrations of contamination have been recorded as part of the Desk Study and Terrain Assessment ( Appendix 13.1 ). However, localised sources of contamination associated with current and former use of the Site may be present across areas of the Site not yet investigated. As such, it is considered that a potential risk to human health may exist during the site preparation and construction phase.

13.99 Disturbance of any contaminated ground during site preparation or construction works may release or increase the mobility of any localised contamination present. This may present a potential risk to earthworks and construction workers, but this will be dependent on the type and nature of any contamination present. The length of
exposure will depend on the amount of time each earthworks and construction worker spends on the Site, but it could extend to the full assumed extent of the site preparation and construction phase of the Proposed Development, assumed to be seven years.

13.100 It is anticipated that any contamination at the Site will be localised and no significant sources of contamination are currently located on the Site. As such, it is considered unlikely that any in-combination effects will exist with any of the surrounding committed developments.

13.101 The sensitivity of earthworks and construction workers is high and the magnitude of change, prior to mitigation, is minor to moderate. Therefore, there is likely to be a direct, temporary and / or permanent, medium-term effect on earthworks and construction workers of minor to moderate negative significance prior to the implementation of mitigation measures.

**Potential exposure of ground workers to hazardous ground gases generated from potential sources both on-site and off-site (e.g. Made Ground where present, Coal Measures and Alluvium)**

13.102 The underlying coal measures strata and the alluvial deposits in the north of the Site have the potential to generate hazardous ground gases within confined spaces, such as earthworks excavations. Where granular deposits are present, these could facilitate the migration of ground gas into site excavations. Preliminary ground gas monitoring has not recorded any significant concentrations of ground gas, but a full monitoring survey and risk assessment is required to confirm the ground gas regime beneath the Site. As most of the Site is underlain by granular deposits and the risk of ground gas accumulation in shallow excavations is considered to be low to moderate based on the information available.

13.103 The Desk Study and Terrain Assessment (**Appendix 13.1**) identified that the Site is located within an area where 3-5% of homes are affected by levels of radon gas above the Radon Action Level. As such, radon protection measures are likely to be required in new buildings on the Site. However, a site specific assessment by BGS, and discussions with the NHBC and Building Control will be needed to confirm this.

13.104 The length of exposure will depend on the amount of time each individual earthworks and construction worker spends on the Site, but it could extend to the full proposed extent of the site preparation and construction phase, assumed to be seven years.
13.105 It is possible that ground gas release from the Site or generated during the site preparation and construction phase could act in-combination with ground gas released from surrounding committed developments. This would only relate to gas generated by drilling or other works undertaken within the underlying Coal Measures stratum, that may push mine gas towards other sites. However, the Coal Authority needs to be consulted before any such works are undertaken, and it has measures in place to prevent such occurrences (e.g. the use of water flush techniques during drilling and grouting works to stabilise mine workings as part of site preparation works), and the actual risks of in-combination effects is therefore considered to be negligible.

13.106 The sensitivity of earthworks and construction workers is high and the magnitude of change, prior to mitigation, is minor to moderate. Therefore, there is likely to be a direct, temporary and / or permanent, medium-term effect on earthworks and construction workers of minor to moderate negative significance prior to the implementation of mitigation measures.

Potential release/migration of contamination associated with historical land uses and potential spills and leakages during construction to controlled waters (surface water features and underlying Secondary and Principal Aquifers)

13.107 The controlled waters receptors being considered as part of this assessment are the underlying Secondary (A) and Principal Aquifers and surface water features in the vicinity of the Site. The Principal Aquifer is considered to have a medium to high sensitivity as it is present near surface, but does not lie up hydraulic gradient of a groundwater abstraction or within a groundwater Source Protection Zone.

13.108 No significantly elevated concentrations of contamination have been recorded as part of the Desk Study and Terrain Assessment (Appendix 13.1). However, localised sources of contamination associated with current and former use of the Site may be present across areas of the Site not yet investigated.

13.109 The use of machinery and plant associated with site preparation and construction activities (including the development of a site construction compound) give rise to risk to soils, groundwater and surface water features from contaminants through accidental fuel/oil spills and leaks. In addition, disturbance of the ground where localised contamination may be present may release or increase the mobility of any contamination present.

13.110 Due to the likely localised nature of any contamination present on the Site, and the low likelihood of ad-hoc releases during the Proposed Development, contaminant...
releases are likely to be short-term and are unlikely to result in in-combination effects with the identified committed developments and effect interactions.

13.111 During this phase, there will be a greater risk of contaminated runoff, including hydrocarbon contamination and high-suspended solid loads, associated with the operation of vehicles. This has the potential to create overland migration pathways. The potential effects on surface water quality from an increase in physical contaminants are assessed in Chapter 9 - Hydrology and Water Resources.

13.112 The sensitivity of controlled water receptors (Secondary (A) and Principal Aquifers and surface water features) is medium to high and the magnitude of change, prior to mitigation, is minor to moderate. Therefore, there is likely to be a direct, temporary, short-term effect on controlled water receptors of minor to moderate negative significance prior to the implementation of mitigation measures.

Potential effects of ground stability hazards (e.g. mineshafts) on the development and ground workers during the site preparation and construction phase

13.113 The Site is underlain by the Cadeby Formation which in turn overlies the Middle Coal Measures. Coal subcrops and outcrops are not recorded beneath the Site.

13.114 A Coal Authority report presented within the Desk Study and Terrain Assessment (Appendix 13.1) for the Site indicates that the Site is in the likely zone of influence from workings in four seams of coal at 100m to 280m depth, last worked in 1965. Any ground movement from these coal workings should have stopped by now. In addition, there are twenty two mine entries within, or within 20m of, the boundary of the Site.

13.115 Alluvial deposits, infilled ground and Made Ground may be present to variable depths on the Site.

13.116 The risk to human health if an underground void or an area of unstable ground is encountered unexpectedly during this phase earthworks and construction activities is high. The likelihood is considered to be medium and therefore for the purposes of this assessment, magnitude has been considered to be medium to high. The reversibility of the effect is dependent on the nature and severity of the consequence of encountering underground voids or ground instability; therefore, the effect may be temporary or permanent.
13.117 Ground stability on the Site is considered unlikely to be affected by other committed developments.

13.118 The sensitivity of earthworks and construction workers is high and the magnitude of change, prior to mitigation, is moderate to major. Therefore, there is likely to be a direct, temporary and/or permanent, medium-term effect on earthworks and construction workers of moderate to major negative significance prior to the implementation of mitigation measures.

**Operational Phase**

_Potential exposure of future populations and third parties to contamination associated with mining and agricultural historical land uses_

13.119 It is assumed that as part of the site preparation and construction phases, any known contamination, or contamination encountered as part of the works, will have been remediated in line with the proposed residential end use. This includes any contamination deemed, after appropriate risk assessment, suitable for retention on Site beneath a clean cover layer in landscaped areas and residential gardens. It is assumed that as part of the site preparation and construction phase, any clean cover layers installed will have been validated for depth and chemical quality prior to occupation. It is has also been assumed that the same measures will have been applied to surrounding committed development.

13.120 The sensitivity of future populations and third parties is high and the magnitude of change, prior to mitigation, negligible. Therefore, there is likely to be a direct or indirect, temporary and / or permanent, long-term effect on future populations and third parties of negligible significance prior to the implementation of mitigation measures.

_Potential release/migration of contamination associated with historical land uses and potential future spills and leakages to controlled waters (surface water features and underlying Secondary and Principal Aquifers)_

13.121 A supplementary ground investigation will be undertaken prior to the commencement of the Proposed Development to confirm the ground and groundwater conditions. If sources of gross contamination are identified that are considered to represent a risk to controlled waters these will have been remediated / mitigated appropriately as part of the Proposed Development prior to the operational
phase. These measures will remove either the source of contamination or the exposure pathway in accordance with CLR11 (Ref. 13.1).

13.122 Although the risk to controlled waters from surrounding committed development sites remains outside the applicant’s control, it is assumed that the committed developments will adhere to similar mitigation measures to protect controlled waters as required and enforced by planning conditions and legal agreements which will limit the potential for in-combination effects and effect interactions.

13.123 It is assumed that any material used for backfilling during the earthworks phase to appropriate ground levels will have been certified clean and will therefore not present a risk to controlled waters. It has also been assumed that the material re-used as part of the earthworks cut and fill exercise (if required) will have been subject to chemical testing and geotechnical suitability.

13.124 Following the completion of the Proposed Development, there is the potential for localised spillage of fuel, surface water runoff / overland flow to contain elevated concentrations of contaminants, particularly from car parking areas, which may be carried to the on-site ponds, watercourses, underlying aquifers and drainage system. Any release of contamination of this sort is likely to be a short-term event.

13.125 There will be a reduction in impermeable areas during the operational phase as there is minimal hard standing present at the Site currently. The introduction of hard standing will allow a level of protection to the underlying aquifers from accidental spills and leaks, as will the inclusion of drainage systems associated with roadways. In addition, the frequency and severity of any leaks or spillages is likely to be minimal and therefore the magnitude of change is likely to be low.

13.126 The potential effects on surface water quality from an increase in physical contaminants are assessed in Chapter 9 - Hydrology and Water Resources.

13.127 The sensitivity of controlled water receptors (Secondary (A) and Principal Aquifers and surface water features) is medium to high and the magnitude of change, prior to mitigation, is minor. Therefore, there is likely to be a direct, temporary, short-term effect on controlled water receptors of minor negative significance prior to the implementation of mitigation measures.
Potential effect on groundwater from reduced recharge rates associated with an increased impermeable area due to the Proposed Development

13.128 The Site is currently classified as Greenfield and overlies Principal and Secondary A Aquifers. Ground conditions largely comprise weathered sandstone that will permit the migration of surface water to the underlying aquifers, providing a degree of recharge to the aquifers.

13.129 The Proposed Development comprises up to 555 dwellings, a neighbourhood centre, a retirement village and a one-form entry primary school, alongside supporting infrastructure works. These areas will largely intercept rainfall and reduce the infiltration of surface water into the underlying aquifers (with the exception of a proportion of residential gardens and Public Open Space). The existing woodland on the western boundary will be retained with a play area and a strip of informal open space located along the western boundary. In addition, a village park and attenuation ponds will be located on the northern area of the Site. These areas will continue to allow the infiltration of surface water.

13.130 The proportion of the Site likely to be covered by hard standing is approximately 40-50%. The use of standard piped drainage systems will reduce the amount of surface water infiltration.

13.131 The two largest committed developments (Land south west at Junction 26 of the M1; and Mellors Way) appear to be located on open undeveloped land. The proposed sports/recreational development south west at Junction 26 of the M1 will incorporate minimal hard cover with most of the site remaining open ground. As such, it is unlikely that an in-combination effect could arise relating to this committed development. The outstanding Mellors Way development will be predominantly buildings and hard standing which could impact groundwater recharge and result in in-combination effects with the Proposed Development. The remaining two sites are either too far away or too small to be considered significant to effects relating to groundwater recharge.

13.132 The sensitivity of the underlying aquifers is medium to high and the magnitude of change, prior to mitigation, is minor to moderate. Therefore, there is likely to be a direct, permanent, long-term effect on the underlying groundwater aquifers of minor to moderate negative significance prior to the implementation of mitigation measures.
Potential effect of hazardous ground gas ingress into properties and associated effects on human health of future populations and third parties

13.133 Potential sources and risks are as set out in Paragraphs 13.101 and 13.102 above, with the exception that the principal risks will be to the occupiers of new dwellings and workers and visitors to amenity buildings on the Site.

13.134 If ground gas accumulates within buildings this could lead to asphyxiation or explosion, or exposure to radon gas.

13.135 There will be no in-combination effects with the identified committed developments relating to ground gas during the operational phase.

13.136 The sensitivity of future populations and third parties is high and the magnitude of change, prior to mitigation, is moderate. Therefore, there is likely to be a direct, temporary and/or permanent, long-term effect on future properties and future end Site users of moderate negative significance prior to the implementation of mitigation measures.

Potential effects of ground stability hazards on future Site occupants and third parties

13.137 A set out in Paragraphs 13.112 to 13.114, the presence of underlying coal measures strata and potential shallow coal workings, infilled ground, deep Made Ground and alluvium could result in ground stability risks to the Proposed Development.

13.138 Ground stability on the Site is considered unlikely to be affected by other committed developments.

13.139 The sensitivity of the future Site occupants and third parties is high, and the magnitude of change, prior to mitigation, is moderate to major. Therefore, there is likely to be a direct, permanent, long-term effect on new buildings and occupants future populations and third parties of moderate to major negative significance prior to the implementation of mitigation measures.
Mitigation and Enhancement Measures

Site Preparation and Construction Phase

Potential exposure to contamination associated with agricultural and mining historical land uses and effects on human health (e.g. ground workers, earthworks contractors, construction workers and third parties)

13.140 A supplementary ground investigation will be undertaken at the Site to confirm the Site's contaminant profile. This will, as a minimum, consider the items summarised in Paragraph 13.94. Should it be required, remedial measures will be undertaken to enable development of the Site prior to site preparation and construction works being undertaken. As such, any risks during the site preparation and construction phases will be minimised.

13.141 All persons engaged in site preparation and construction activities will be made aware of the findings of the intrusive ground investigation and the potential for localised residual contamination hotspots to be present. The associated hazards of handling potentially contaminated materials will be conveyed to all site workers and all works will be conducted in accordance with the HSE publication entitled ‘Protection of Workers and the General Public during the Development of Contaminated Land’, 1991 (Ref. 13.28).

Potential exposure of ground workers to hazardous ground gases generated from potential sources both on- Site and off- Site (e.g. Made Ground where present, Coal Measures and Alluvium)

13.142 Installation of additional ground gas monitoring wells during supplementary ground investigation works will be undertaken in order to define the ground gas regime at the Site. This will include wells installed into the deeper Cadeby Formation. In the event that elevated concentrations of hazardous ground gases are identified, where entry into confined spaces and/or excavations is required by site preparation and construction contractors, a combination of appropriate full Personal Protective Equipment (PPE) and/or Respiratory Protective Equipment (RPE), monitoring equipment and safe entry procedures will be utilised to mitigate any potential risk of exposure to hazardous gases/vapours.

13.143 The presence of Radon will be considered as part of the site preparation and construction phase, and mitigation may include on-site radon measuring prior to Site
works to confirm that Radon levels will not affect effect construction workers on-site for the duration of this phase of the Proposed Development.

13.144 All works will be conducted in accordance with the HSE publication entitled ‘Safe Work in Confined Spaces’, INDG 258, 2006 (Ref. 13.29).

Potential release/migration of contamination associated with historical land uses and potential spills and leakages during construction to controlled waters (surface water features and underlying Secondary and Principal Aquifers)

13.145 A ground investigation will be undertaken prior to commencement of the site preparation and construction phase to confirm the ground and groundwater conditions. If sources of gross contamination are identified that are considered to represent a risk to controlled waters these will be remediated / mitigated appropriately as part of the Proposed Development.

13.146 If any further unexpected gross contamination is encountered during excavation and earthworks, expert advice will be sought prior to the removal of any affected material.

13.147 All ground works will be undertaken in accordance with CIRIA guidance ‘C532 – Control of Pollution from Construction Sites’ (Ref. 13.23) and the Considerate Contractors Scheme to help ensure a well-managed operation which minimises environmental risks.

13.148 All Site works will be undertaken in accordance with the EA’s Pollution Prevention Guidelines, in particular:

- PPG1 ‘General Guide to the Prevention of Water Pollution’ (Ref. 13.15) (please note that this document is currently being withdrawn but has been used for reference in lieu of the publication of an amended version);
- PPG2 ‘Above Ground Oil Storage Tanks’ (Ref. 13.16);
- PPG6 ‘Working at Construction and Demolition Sites’ (Ref. 13.17);
- PPG8 ‘Safe storage and disposal of used oils’ (Ref. 13.18); and,
- PPG21 ‘Pollution Incident Response Planning’ (Ref. 13.19).

13.149 The contractor’s method statement should detail how the temporary facilities will be provided and should demonstrate how construction related silts and potential contaminants will be prevented from entering the off-site drainage infrastructure.
These method statements should demonstrate compliance with the relevant EA Pollution Prevention Guidelines.

13.150 Mitigation measures may include, but are not limited to:

- Remediation of contamination hotspots;
- Segregation of contaminated waste types for appropriate off-site disposal;
- Use of wheel washes and covered wagons to reduce the potential for migration of contaminants off-site;
- Working areas clearly defined to ensure minimal disturbance of soils. The contractor shall appraise the suitability of such working areas in this respect as part of working method statements;
- Haul routes and accesses clearly defined to minimise the risk of accidents;
- Site preparation, construction and remediation vehicles will be regularly maintained to reduce the risk of hydrocarbon contamination associated with leaks and spillage and will only be active when required;
- Designated areas for the storage of hazardous materials, fuels and chemicals. All designated areas will be of hard-standing within bunds (110% the volume of the vessel) and all filler points/valves will be located within the extent of said bund or appropriate drip trays will be provided;
- Controlled, and covered, waste storage areas;
- Provision of fuel emergency spill kits, located at strategic points; and,
- Provision of environmental awareness training for Site workers.

13.151 In addition, all persons engaged in site preparation and construction activities will be made aware of the findings of the intrusive ground investigation and the potential for localised contamination hotspots to be present. The associated hazards of handling potentially contaminated materials will be conveyed to all Site workers and all works will be conducted in accordance with the HSE publication entitled ‘Protection of Workers and the General Public during the Development of Contaminated Land’, 1991 (Ref. 13.28).

**Potential effects of ground stability hazards (e.g. mineshafts) on the development and ground workers during the construction phase**

13.152 Ground investigation works will be completed across the Site prior to the start of site preparation works to characterise any Made Ground on the Site, and to produce a
ground model to inform foundation design and earthworks. This will include rotary drilling to 40m below ground level to confirm the depth of The Cadeby Formation beneath the Site and the presence or absence of coal seams and workings within influence of the Site surface. In addition, an attempt to locate the accessible mineshafts on the Site will be made. It is noted that some of the mineshafts are located in the SINC woodland and it is unlikely that these will be located. Any located shafts will be drilled and grouted, and capped near surface at the top of the underlying bedrock where possible.

13.153 Appropriate development stand-off zones will be applied around mineshafts whether treated or not, and this will also be protective of human health during the construction phase. As earthworks during site preparation and construction may cross the locations of mineshafts and stand-off zones, the location and treatment of mineshafts should occur prior to earthworks, and mineshaft caps should be placed in accordance with proposed levels post-earthworks. The suspected locations of any mineshafts not located will need to be appropriately managed during earthworks to ensure the health and safety of the workforce.

**Operational Phase**

**Potential exposure of future populations and third parties to contamination associated with mining and agricultural historical land uses**

13.154 No mitigation measures will be necessary, as it is assumed this will have been completed as part of the site preparation and construction phase.

**Potential release/migration of contamination associated with historical land uses and potential future spills and leakages to controlled waters (surface water features and underlying Secondary and Principal Aquifers)**

13.155 It is anticipated that proposed pollution control measures as part of the Proposed Development will include trapped road and car park gullies, silt traps and oil interceptors which will provide attenuation of contamination before discharge. It is assumed that these facilities will be subject to routine maintenance.

13.156 The Proposed Development, as shown on Parameters Plans attached as **Figure 4.1**, includes limited re-grading and the construction of swales and basins which will provide attenuation of contamination before discharge.
Potential effect on groundwater from reduced recharge rates associated with an increased impermeable area due to the Proposed Development

13.157 The drainage strategy developed for the Site includes the use of Sustainable Urban Drainage Systems (SuDS), that will return a proportion of the surface water intercepted by hard standing back to the ground. Although some piped drainage will occur off Site, this will be minimised and is considered unlikely to significantly impact recharge of the underlying aquifers.

Potential effect of hazardous ground gas ingress into properties and associated effects on human health of future populations and third parties

13.158 Installation of gas monitoring wells during ground investigation will be undertaken prior to construction to confirm the ground gas regime. This data will be in accordance the guidance document CIRIA C665 ‘Assessing risks posed by hazardous ground gases to buildings’ (Ref. 13.2) which includes the NHBC assessment approach (Ref. 13.3). In the event that elevated concentrations of hazardous ground gases are identified, data from the intrusive ground investigation and associated monitoring will be utilised to ensure appropriate gas protection measures are installed during construction in accordance with CIRIA C665 (Ref. 13.2) and the NHBC approach (Ref. 13.3).

13.159 Basic radon protection measures are likely to be required under Building Regulations as part of the Proposed Development. This is subject to confirmation by provision of a site specific Radon assessment and consultation with the NHBC and Building Control.

13.160 The assessment and mitigation measures are subject to the agreement of both BBC and the NHBC at detailed design stage and following supplementary ground investigation works.

Potential effects of ground stability hazards on future site occupants and third parties

13.161 Ground investigation (as set out in Paragraph 13.94) will be undertaken across the Site prior to the commencement of the operational phase to investigate the potential for shallow coal workings and confirm ground conditions. In addition, an attempt will be made to locate and treat all known mineshafts in accessible areas. This information will inform appropriate foundation design for new buildings and structures on the Site.

13.162 Whether located and treated or not, an appropriate development stand-off will be applied around each mineshaft. The exact size of the stand-off will depend if the shaft has been located and treated or remains unlocated, the depth of the overlying
drift deposits and on the diameter of the actual mineshaft. Stand-off zones will need to be agreed with the NHBC and Building Control.

13.163 Where roads cross unlocated mineshafts or mineshaft development stand-off zones, the mineshafts must have been located and treated, or it may be necessary to place a geogrid or geotextile as part of the road construction to limit the effects of total or differential settlement should a shaft collapse.

13.164 Public access to the SINC woodland will need to be considered in terms of risk to the public from mineshaft collapse. It is possible that access may need to be prevented to this area of the Site post-construction.

**Residual Effects**

**Site Preparation and Construction Phase**

*Potential exposure to contamination associated with agricultural and mining historical land uses and effects on human health (e.g. ground workers, earthworks contractors, construction workers and third parties)*

13.165 The sensitivity of earthworks and construction workers is high and the magnitude of change following mitigation is negligible. Therefore, there is likely to be a direct, temporary and/or permanent, medium-term residual effect on earthworks and construction workers of negligible significance following the implementation of mitigation measures.

13.166 No negative residual effects have been identified that could impact on common receptors, or result in in-combination effects with the surrounding committed development.

*Potential exposure of ground workers to hazardous ground gases generated from potential sources both on-Site and off-Site (e.g. Made Ground where present, Coal Measures and Alluvium)*

13.167 The sensitivity of earthworks and construction workers is high and the magnitude of change following mitigation is negligible. Therefore, there is likely to be a direct, temporary and/or permanent, medium-term residual effect on earthworks and construction workers of negligible significance following the implementation of mitigation measures.
13.168 No negative residual effects have been identified that could impact on common receptors, or result in in-combination effects with the surrounding committed development.

**Potential release/migration of contamination associated with historical land uses and potential spills and leakages during construction to controlled waters (surface water features and underlying Secondary and Principal Aquifers)**

13.169 The sensitivity of the controlled waters receptors (Secondary (A) and Principal Aquifers and surface water features) is medium to high and the magnitude of change, following mitigation, is negligible. Therefore, there is likely to be a direct, temporary, short-term residual effect on controlled waters receptors of **negligible** significance following the implementation of mitigation measures.

13.170 No negative residual effects have been identified that could impact on common receptors, or result in in-combination effects with the surrounding committed development.

**Potential effects of ground stability hazards (e.g. mineshafts) on the development and ground workers during the construction phase**

13.171 The sensitivity of earthworks and construction workers and earthworks contractors is high and the magnitude of change following mitigation is negligible. Therefore, there is likely to be a direct, temporary and / or permanent, medium-term residual effect on earthworks and construction workers of **negligible** significance following the implementation of mitigation measures.

13.172 No negative residual effects have been identified that could impact on common receptors, or result in in-combination effects with the surrounding committed development.

**Cumulative Effects and/or Predicted Interaction of Factors**

13.173 The mitigation measures described above will minimise the potential for contamination, ground gas or ground stability hazards from impacting potential receptors on and off-site. It is assumed that the developers and appointed contractors for each of the committed developments will also follow current best practice and employ good housekeeping measures at each Site.

13.174 As such, it is considered unlikely that any in-combination effects will exist with any of the surrounding committed developments.
Operation

Potential exposure of future populations and third parties to contamination associated with mining and agricultural historical land uses

13.175 The sensitivity of future populations and third parties is high and the magnitude of change, prior to mitigation, negligible. Therefore, there is likely to be a direct or indirect, temporary and / or permanent, long-term effect on future populations and third parties of negligible significance prior to the implementation of mitigation measures.

13.176 No negative residual effects have been identified that could impact on common receptors, or result in in-combination effects with the surrounding committed development.

Potential release/migration of contamination associated with historical land uses and potential future spills and leakages to controlled waters (surface water features and underlying Secondary and Principal Aquifers)

13.177 The sensitivity of the controlled waters receptors (Secondary (A) and Principal Aquifers and surface water features) is medium to high and the magnitude of change, following mitigation, is negligible. Therefore, there is likely to be a direct, temporary, short-term residual effect on controlled waters receptors of negligible significance following the implementation of mitigation measures.

13.178 No negative residual effects have been identified that could impact on common receptors, or result in in-combination effects with the surrounding committed development.

Potential effect on groundwater from reduced recharge rates associated with an increased impermeable area due to the Proposed Development

13.179 The sensitivity of the underlying aquifers is medium and the magnitude of change prior to mitigation will be negligible. Therefore, there is likely to be a direct, permanent, long-term effect on the underlying groundwater aquifers of negligible significance prior to the implementation of mitigation measures.

13.180 No negative residual effects have been identified that could impact on common receptors, or result in in-combination effects with the surrounding committed development.
Potential effect of hazardous ground gas ingress into properties and associated effects on human health of future populations and third parties

13.181 The sensitivity of future populations and third parties is high and the magnitude of change, following mitigation, is negligible. Therefore, there is likely to be a direct, temporary and / or permanent, long-term residual effect on future populations and third parties of negligible significance following the implementation of mitigation measures.

13.182 No negative residual effects have been identified that could impact on common receptors, or result in in-combination effects with the surrounding committed development.

Potential effects of ground stability hazards on future Site occupants and third parties

13.183 The sensitivity of future Site occupants and third parties is high and the magnitude of change following mitigation is negligible. Therefore, there is likely to be a direct, permanent, long-term residual effect on future Site occupants and third parties of negligible significance following the implementation of mitigation measures.

13.184 No negative residual effects have been identified that could impact on common receptors, or result in in-combination effects with the surrounding committed development.

Cumulative Effects and/or Predicted Interaction of Factors

13.185 The mitigation measures described above will minimise the potential for contamination, ground gas or ground stability hazards from impacting potential receptors on and off-site. It is assumed that the developers and appointed contractors for each of the committed developments will also follow current best practice and employ good housekeeping measures at each Site.

13.186 As such, it is considered unlikely that any in-combination effects will exist with any of the surrounding committed developments.

Limitations

13.187 The scope of this assessment is based on the findings of the Desk Study and Terrain Assessment (Appendix 13.1) and does not account for the findings of any future ground investigation on those parts of the Site not yet investigated, including deeper bedrock. Additional ground investigation and an assessment of the known mineshafts
on-site will be required on the Site as set out in Paragraph 13.94 above. The additional information due in the future will provide further details to that already obtained. However, it is not anticipated that the strategies and mitigation recommended above will significantly change as a result of future information.

Summary and Statement of Significance

- The Site has historically been open / undeveloped land with some local coal mining development including several mineshafts. Preliminary ground investigation undertaken on the Site encountered topsoil and limited Made Ground overlying The Cadeby Formation (sandstone and limestone/dolostone). Published geology indicates that the Middle Coal measures underlie The Cadeby Formation. The Cadeby formation is classified as a Principal Aquifer, and the Middle Coal Measures as a Secondary (A) aquifer. The Coal Authority state that four coal seams have been mined beneath the Site between 100m and 280m below surface. A total of 22 mineshafts are recorded on-site or within 20m of the boundary. The Site sits within an area where Radon protection measures may be required in new buildings.

- No soil contamination or ground gas was recorded on the Site as part of the terrain assessment that is considered to present a risk to human health or controlled waters post development. Approximately half the Site is yet to be investigated. As such, significant effects relating to contamination remain associated with contamination arising from current agricultural use, and former mining related use. In addition, other significant effects are considered to be risks from ground gas (including mine gas), and ground stability related to historical mining activities.

- Proposed mitigation measures include the completion of supplementary ground investigation to include an extended period of ground gas monitoring (including from deeper boreholes into the underlying bedrock); location of known mineshafts and associated risk assessment to define development stand-off zones; deep rotary boreholes to determine the presence or absence of shallow mine workings; the protection of site preparation and construction workers from any contamination on the Site and ground gas in any Site excavations; if necessary, the installation of ground gas protections measures that may include protection from Radon gas; the use of foundation solutions appropriate for the ground stability hazards identified; and the use of
sustainable urban drainage systems to protect off-site surface water features from contamination, and to limit the effect of the Proposed Development on groundwater recharge to the underlying aquifers.

- Following mitigation, it is considered that all residual effects will be negligible during both the site preparation and construction, and operational phases.

- Completion of a ground investigation and any associated risk assessments and remedial works will be compliant with current legislation and planning guidance relating to contaminated land and groundwater (e.g. The Contaminated Land (England) Regulations (Ref 13.6), The Groundwater (England and Wales) Regulations (Ref 13.8), and CLR11 (Ref 13.1)) that require the risk from contamination to be assessed prior to development, and the prevention of hazardous substances from entering groundwater.

- During the site preparation and construction phase, best practice measures will be adopted to be protective of human health in line with the requirements of the Construction (Design & Management) Regulations (Ref 13.10).
References

- 13.15: EA (pre 2007) PPG 1 ‘General guidance to the prevention of Pollution’.


13.36: Coal Authority Coal and Brine Report dated 05/03/2010.