CHAPTER 7: GROUND CONDITIONS AND CONTAMINATION

Introduction

7.1 This Chapter of the Environmental Statement considers the ground conditions and historic contamination with respect to human health and the wider environment that may impact upon proposed development plans. The following sections provide a brief introduction to the scheme.

7.2 The site is located in Barnsley town centre and currently comprises the Land between Cheapside/May Day Green/Kendray Street/Lambra Road east of railway line ('the Barnsley Market site') and land west of railway line ('the former CEAG site') between Kendray Street and the Harborough Hill Road. The site is divided by a railway line which crosses the site orientated north to south.

7.3 The current development proposals include the demolition of a significant part of Barnsley town centre for the construction of a mixed-use redevelopment, comprising retail and leisure, including new market, multi-storey car park, new pedestrian routes, means of access and open space.

7.4 Planning permission for a similar scheme was sought and achieved in 2006 but these plans have since been deemed no longer economically viable. Consequently, the planned scheme has now been scaled down and a revised planning application submitted.

7.5 It should be noted that the overall footprint of the development has not changed since the original (2006) redevelopment proposals.

Methodology

7.6 The methodology applied to the assessment of ground contamination follows an iterative process starting with an initial desk based study, which appraises all publicly available information and data pertaining to the site. The desk study report is subsequently used to inform the design of subsequent phases of intrusive site investigation. The site investigation is also undertaken on an iterative basis with

each subsequent phase used to further develop and refine the site conceptual model which identifies potential contaminant sources, viable pathways and environmental receptors. The assessment process examines the possible pollutant linkages and thereby produces a technical basis for the assessment of risk within the context of the proposed commercial development. Where environmental risks are perceived to be unacceptably high, an appropriate process of remediation and/or risk management is identified in order to reduce the risk and thereby minimise the impact of the development accordingly. The following sections provide a summary of the key steps in the assessment process.

7.7 An initial desk study and subsequent investigation and assessment reports on the site was previously developed by Wardell Armstrong (WA) LLP, and already been submitted to the regulators. These reports are entitled:

- Barnsley Markets and Adjacent CEAG Sites, Preliminary Stage 1 (Pre-demolition) Site Investigation Report. Wardell Armstrong, 2007. (Report Number SD07-00120) (REF1).
- Barnsley Markets and Adjacent CEAG Sites, Stage 2 (Pre-demolition) Site Investigation Report. Wardell Armstrong, 2008. Report Number SD08-0061. (REF2).

7.8 The Stage 2 report is presented as Appendix 7.1 and also includes the information from the Stage 1 report and these reports are summarised below in the following sections.

Desk Study and Stage 1 Site Investigation

7.9 The findings from the initial desk study and phase of site investigation undertaken by WA are presented in Preliminary Stage 1 (Pre-demolition) Site Investigation Report dated July 2007 (see Appendix 7.1). This document provides as full assessment of the surrounding land uses and site history as well as presenting summarised information from previous site investigations, which are not reiterated here.

7.10 In summary, the existing site is known to have been constructed over an area historically occupied by a variety of industrial land uses including: a gas works, a

number of foundries, a lamp works, malt houses and an electrical works. The railway line and sidings bisecting the site from north to south were also in place.

7.11 The initial Stage 1 investigation consisted of:

- 3 cable percussive boreholes,
- 11 cable percussive boreholes with rotary follow-on (open-hole and rotary cored),
- 15 window samples borehole to target the shallow strata,
- 49 soil chemical tests for a broad suite of determinants,
- 14 groundwater chemical tests for a broad suite of determinants,
- 2 surface water samples from the Sough Dyke.

7.12 The findings from this phase of investigation indicate ground conditions beneath the site generally consist of cohesive Made Ground with a typical thickness of 2-3m, over glacial deposits which were noted to be stiff clays and sandy gravels over a bedrock of weathered Coal Measures. The bedrock consisted of weak to moderately strong, grey mudstone inter-bedded with siltstone and sandstone and underlain by Kent's Rock Sandstone.

7.13 The Sough Dyke is the closest water course to the site, and is currently culverted beneath the site.

7.14 The initial Stage 1 investigation and assessment indicated that the majority of soils encountered beneath the site were likely to be suitable for retention and re-use within the context of the proposed commercial end-use scenario. However, the investigation also highlighted the presence of potentially elevated levels of contamination in three discrete areas of the site, which were subsequently termed contaminant 'Hotspots'. These areas were identified as:

- May Day Green Hotspot,
- Markets Basement Hotspot and

- Southern CEAG Hotspot

7.15 These potential Hotspots were in turn subjected to further and more detailed investigation during the Stage 2 site investigation (see Appendix 7.1), which is described below.

Stage 2 Site Investigation

7.16 The Stage 2 investigation comprised:

- 13 Cable percussive boreholes (8 with land gas and groundwater monitoring well installations)
- 6 rotary open hole boreholes
- 8 rotary cored boreholes (for geotechnical purposes)
- 59 Windowless sampler boreholes
- 2 Surface water samples from the Sough Dyke
- Ground gas and groundwater level monitoring

7.17 The previously identified contamination hotspots were thoroughly investigated and delineated during this process as well as further investigation of the general ground conditions. Drawing reference SH03582/16 in Appendix 7.1 shows the site investigation layout plan for both phases of investigation including the location where specific contaminants are shown to exceed the adopted environmental screening values.

Planning Policy Context

7.18 The redevelopment scheme previously achieved planning consent in 2006. However, the current submission is intended to support a revised application that envisages a slightly amended development scope, although the footprint remains essentially unchanged. From an environmental planning perspective, consent was granted on the work submitted by Wardell Armstrong LLP (WA), who was responsible for

assessing environmental risk and developing suitable management strategies up to the point where the scheme designs were revised.

7.19 The following section outlines the planning policies relating to ground conditions and contamination at the local, regional and national levels. These policies guide the planning process and as such the context of this development. Comments are provided to describe the ways in which the scheme and its proposed mitigation provisions comply with these policies.

National Policy

7.20 National Policy on ground instability and contamination is set out in Planning Policy Guidance Note 14, Planning Policy Statement 23 and the Environmental Protection Act 1990 Part IIA.

Planning Policy Guidance PPG14 – Development on Unstable Land (1990)

7.21 National Policy on the impact of ground instability is effectively encompassed within PPG14. The Guidance contains a main statement and two annexes.

7.22 Annex 1 relates to landslides and unstable slopes, which owing to the nature of the development site and known land use history requires no further consideration in this assessment. Annex 2 (revised 2002) is entitled 'Subsidence and Planning' with a focus on mined ground, subsidence potential and mitigation and is of significant relevance to the proposals.

7.23 Annex 2 **"....advises local planning authorities, landowners, and developers on the exercise of planning controls over land use and development on land liable to subsidence".** The Government looks to all parties to the development process to:

- recognise the occurrence and potential for subsidence at the earliest possible stage in preparing development plans and in considering proposals for development;

- take appropriate action in accordance with good practice to assess the risks of subsidence and, where practicable, to deal with them by ground treatment or by designing new buildings and structures to withstand the subsidence expected;

- take due account of the constraints imposed by ground subsidence at all stages of the development process; and

- ensure that new development is suitable for the ground conditions at its location and will not be threatened by subsidence in the future.

7.24 PPG14, the aim of which **"....is not to prevent the development of such (unstable) land....",** introduces the concept by stating that **"...difficulties have been experienced in developing land in areas of past and present mining and in other areas where land is unstable or potentially unstable....Given proper safeguards, however, land which has been damaged by mining or other industrial activities or which is naturally unstable can often be put to appropriate use".**

7.25 The application site, as described later, is located within a district of past mining. The existing use and other nearby developments that are already in place or under construction demonstrate the potential for the current proposals to be an appropriate use of the land.

7.26 Clause 17 of PPG14 (Responsibilities…) states: **"Where there are reasons for suspecting instability, the developer should determine by appropriate site investigations and geotechnical appraisal whether:-**

- **the land is capable of supporting the loads to be imposed;**

- **the development will be threatened by unstable slopes on or adjacent to the site;**

- **the development will initiate slope instability which may threaten its neighbours;**

- **the site could be affected by ground movements due to natural cavities; and**

- **the site could be affected by ground movements due to past, present or foreseeable future mining activities".**

7.27 The preceding clause is relevant as the applicant accepts responsibility for providing more detailed investigations and assessments at the appropriate stage – in this instance before the commencement of development.

7.28 Clause 20 of PPG14 states: **"The stability of the ground in so far as it affects land use is a material consideration which should be taken into account when deciding a planning application".**

7.29 This Chapter of the Environmental Statement addresses the elements which are most likely to be encountered on the site, in this instance mainly load bearing materials and the potential of shallow abandoned mine workings and hence potential surface instability.

7.30 Clause 40 of PPG14 Development control……The decision and the use of conditions states: **"Circumstances may arise in which the information available to the local planning authority is insufficient to fully resolve any questions of ground stability. For example, the developer may be unwilling or unable to commit investment to the necessary specialist investigation and assessment until he has the benefit of planning permission".**

7.31 Clause 41 of PPG14 Development control……The decision and the use of conditions states: **"In some cases, the information available will be sufficient to resolve the main issues regarding stability from a planning point of view but insufficient to resolve specific details. It may then be appropriate to grant planning permission subject to conditions that the development will not be permitted to start until an adequate site investigation and assessment has been carried out and that the development will need to incorporate all the measures shown in that assessment to be necessary".**

7.32 The two preceding clauses can be applied, as the applicant is not averse to providing more detailed investigations and assessments at the appropriate stage – in this instance before the commencement of development.

7.33 Clause 39 of Annex 2 of PPG14 Development on land liable to subsidence states: **"Where development proposed in an area of potential subsidence is subject to an environmental assessment under the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999, that assessment should have regard to the potential for subsidence, its effects and the effects of any proposed mitigation measures".**

7.34 This Chapter has been prepared in recognition of the above clause.

Planning Policy Statement PPS23 (2004) Planning and Pollution Control

7.35 The policies and the advice contained within PPS23, including the accompanying Annexes (Annex 1: Pollution Control, Air and Water Quality and Annex 2: Development on Land Affected by Contamination) are material to decisions on individual planning applications. The following clauses are particularly pertinent to the development proposals.

7.36 PPS23 (2004) Clause 24 states that: **"LPAs should pay particular attention to development proposals for sites where there is a reason to suspect contamination, such as the existence of former industrial uses, or other indications of potential contamination, and to those for particularly sensitive use such as a day nursery or housing likely to be used by families with children. In such cases, it should normally require at least a desk study of the readily-available records assessing the previous uses of the site and their potential for contamination in relation to the proposed development. If the potential for contamination is confirmed, further studies by the intending developer to assess the risks and identify and appraise the options for remediation should be required".**

7.37 This Chapter of the Environmental Statement satisfies the requirement stated above, with a view to the applicant carrying out further assessments at a later date if appropriate.

7.38 PPS23 (2004) Annex 1 Clause 37 Outline Planning Permission states: **"In circumstances (such as for relatively low-risk developments) where LPAs consider it appropriate to grant outline permission for development that could generate pollution, they should ensure that the development permitted cannot take place in a form which would lead to significantly different environmental effects from those considered at the outline planning application stage. In cases where, based on adequate information, the environmental effects, possible pollution and public health risks are not of sufficient significance to affect the principle of whether the development should be permitted, LPAs should attach conditions to the outline planning permission requiring particular environmental matters and/or health impact assessment to be considered in more detail at a later stage, before detailed permission is given".**

7.39 PPS23 (2004) Annex 2 Clause 2.55 Outline Planning Permission states: **"Outline permissions should not be granted until the LPA is satisfied that it understands the contaminated condition of the site and that the proposed development is appropriate as a means of remediating it. If the LPA is satisfied about this, further investigations and the detailed design of remediation might still be needed. Identifying these issues as reserved matters will enable detailed approval at an appropriate stage and give the developer greater certainty before incurring the costs involved."**

7.40 The Environmental Statement is intended to demonstrate that contamination is unlikely to be of sufficient significance to prevent the grant of outline permission. The two preceding clauses can be applied, as the applicant is not averse to providing further assessments at the appropriate stage – in this instance before the commencement of development.

Environmental Protection Act 1990 Part IIA

7.41 The significance of the Environmental Protection Act 1990 Part IIA is summarised in Annex 2 of PPS23, which states: **"Part IIA was introduced into the EPA by the Environment Act 1995 to help deal with the substantial legacy of contaminated land. Part IIA, its accompanying regulations and Statutory**

Guidance contained in DETR Circular 02/2000 Contaminated Land came into force in England on 1 April 2000. Part IIA included the first statutory definition of "contaminated land" and conferred new responsibilities and powers on local authorities and the Environment Agency to identify contaminated land and ensure that it is dealt with"*.*

7.42 'For the purposes of Part IIA, contaminated land is defined as: "**any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on, or under the land that:**

- **(a) significant harm is being caused or there is a significant possibility of such harm being caused; or**
- **(b) pollution of controlled waters is being, or is likely to be caused".**

7.43 Part IIA addresses "unacceptable risk". The approach is based upon the principles of risk assessment, including the concept of a contaminant, a receptor and a pathway, which, if combined, form a pollutant linkage. These and other key terms are defined in Part IIA and in the statutory guidance (DETR Circular 02/2000). A significant pollutant linkage forms the basis of a formal determination that land is contaminated land.

7.44 'For each receptor, a description of the harm that is to be regarded as significant harm for the purposes of the regime is contained in the statutory guidance. Receptors include human beings, ecological systems in certain protected locations (e.g. sites of special scientific interest), property such as crops, livestock, domesticated animals, animals maintained for sporting purposes and buildings and their services. Significant harm includes in appropriate cases death, disease, serious injury, specified ecological system effects, substantial diminution of crop yield and structural building failure. Pollution of controlled waters arising from the contaminated condition of land is also included in the regime.'

7.45 The above definitions have been taken into account during this assessment.

Local Policy

Barnsley Metropolitan Borough Council – Barnsley Unitary Development Plan (2000)

7.46 The following policies, taken from the current Barnsley UDP, define local policy in the context of ground instability and control of pollution:

7.47 Policy ES1 (Pollution) states:- **"The Council will refuse proposals for development which are likely to result in harm to the environment through excessive levels of pollution arising either within the site to be developed or occasioned elsewhere by the proposed development. The Council will in particular resist development which is likely to result in housing, schools, hospitals or other sensitive land uses being subjected to excessive levels of air, noise or other pollution. Where development is permitted the Council will seek to ensure that resulting pollution is avoided or minimised".**

7.48 Policy ES3 (Water Pollution) states:- **"The Council will, in conjunction with the Environment Agency, use all its available powers and influence to prevent the pollution of all surface and underground water and seek to improve their quality consistent with European Union water quality objectives".**

7.49 Policy ES6 (Unstable Land) states: - **"Where the Council considers it necessary it will insist on development proposals being accompanied by reports on site stability and appropriate remedial measures."**

7.50 This Chapter of the Environmental Statement aims to show that appropriate steps have been taken to assess ground instability and pollution issues, appropriate to the nature of subsurface features, the scale of proposed development and to a level sufficient for the purposes of an application for outline planning permission.

7.51 Policy ES7 (Contaminated Land) states:- **"Where development is proposed on land which the Council knows or strongly suspects is contaminated to an extent which would affect the proposed development or infringe statutory requirements, the Council will require to be satisfied that the applicant has:**

- **undertaken investigations to establish the nature and extent of contamination and its potential impact on the development proposed, and**

- **where appropriate, provided details of measures to be taken to remove and/or treat the contamination or to protect the development and the environment from its effects to the satisfaction of the Council. Such measures must be implemented prior to the commencement of the development or in accordance with a timescale to be agreed by the Council".**

7.52 Policy ES8 (Contaminated Land) states:- **"Where development is proposed on land which the council has only a suspicion that it might be contaminated, or there is evidence that it might be only slightly contaminated, planning permission may be granted subject to conditions requiring that development should not start until an investigation to establish the nature and extent of any contamination and an assessment of the measures necessary to remove or treat the contamination has been carried out and to ensure that any remedial measures are undertaken".**

7.53 Policy ES9 (Landfill Gas) states:- **"Where new development is proposed close to a closed or operational landfill site the Council will require to be satisfied that adequate measures have been taken to protect health and safety".**

7.54 Policy ES10 (Landfill Gas) states: - **'On sites where gas is generated or likely to be generated the Council will seek to ensure that a positive use of the gas can be achieved'.**

7.55 This Chapter of The Environmental Statement addresses soil and water contamination impacts and appropriate mitigation where required. In line with policy ES8, it is anticipated that any further investigations or measures could be accommodated within relevant planning conditions, should permission be granted for the development.

Barnsley MBC Environmental Health Services – Contaminated Land Strategy (2002)

7.56 BMBC produced their Contaminated Land Strategy to comply with the requirements of Part IIA of the Environmental Protection Act 1990. It gives details about how BMBC will implement the requirements for dealing with contaminated land in the Borough. This includes risk assessment, site investigation, remediation and entries on the public register. Although there was no information specific to the site, it detailed the measures to be taken within the Borough to deal with contaminated land.

7.57 The Strategy contains procedures for site prioritisation by modelling to calculate risk scores. Sites with highest scores will be prioritised for detailed investigation and assessment. The Strategy also expresses a clear preference for voluntary remediation wherever possible.

7.58 The report indicates that, owing to the extensive coal mining and industrial history, much of the Borough's derelict and redeveloped land is likely to be contaminated.

7.59 The report also highlights the problems already created in the Borough by the emissions of mine gas and how these situations might become exacerbated as the water tables return to their natural levels after the cessation of mine dewatering.

7.60 The Enviros baseline report confirmed that the application site has not been listed within the top 50 "priority" sites within the Borough, nor scheduled for classification as contaminated land by the EA or fast track remediation.

Existing Situation

Summary of Conclusions of Ground Contamination Investigation and Assessment

7.61 The Barnsley Markets and former CEAG sites historically accommodated a variety of industrial land uses including a gas works, electrical works, lamp works and a number of foundries. Despite of the potential for significant ground contamination to exist beneath the site, the extent of any significant or gross contamination has been shown to be limited to relatively small and discrete areas. This may be attributed to previous remedial works undertaken to accommodate the existing buildings, or possibly due to cutting of historic ground profile to accommodate the extensive

basement areas of the existing structures. In either case, the identified contamination remaining on the site must be considered as residual (e.g. locally impacted soil rather than identifiable sources such as tanks or industrial plant etc).

7.62 The key environmental issues on the site, as identified by Wardell Armstrong are summarised below.

- The majority of soils on the site may be considered as suitable for retention and re-use within the context of a commercial development on the basis that human interaction with sub-surface materials will be prevented by the development itself through the use of almost exclusive hard-cover surfacing.

- The ability of the majority of residual soils to generate significant leachate and impact significantly and groundwater and/or sensitive surface water resources is also considered to be relatively low and further managed by the development itself through managed surface water drainage and limited infiltration potential.

- Certain discrete areas of soil are considered to be significantly/grossly contaminated and therefore represent a theoretical risk to the wider environment (specifically due to the relative proximity of the Sough Dyke to impacted soils and groundwater).

- The groundwater quality beneath the site is locally poor, particularly in association with areas of local soil contamination, but is generally considered not to represent an ongoing contaminant source that needs be addressed by remedial activities.

- To date, the ground conditions beneath the site are not known to have impacted the wider environment in the form a pollution incident, and the chemical testing of the Sough Dyke (on-site culverted watercourse) has not revealed any significant contamination that could be linked to local ground conditions.

- Gas monitoring has identified slightly elevated concentrations of methane and carbon dioxide beneath the site. A Characteristic Situation 1 (very low risk) is considered appropriate to the Site east of the railway based on a proposed low sensitivity end us and only one recorded elevated methane concentration. It is considered that a Characteristic Situation 2 is appropriate for the Site west of the

railway due to consistently elevated carbon dioxide concentrations, elaveted methane concentrations and the proposed form of the development. The elevated carbon dioxide and methane may potentially originate from underlying coal seams.

- Basic protection against radon for residential dwelling or new structures of similar form of construction on the site.

7.63 The key areas identified as potentially requiring further assessment and/or remediation are summarised in Table 7.1 below together with the associated contaminant types:

Table 7.1 – Identified Ground Contamination

Contaminant Hotspot	Identified Contamination	
May Day Green	Benzo(a)pyrene	
Markets Basement	Cyanide Naphthalene Phenol BTEX	Toluene Xylene Short chained aromatic hydrocarbons (C8-C10)
Southern CEAG	Medium length aromatic hydrocarbons (C12-C21)	

7.64 It should be noted that the soils from beneath May Day Green were only assessed to represent a theoretical risk to human health and not to the wider environment. These soils are scheduled to be removed to accommodate the proposed development (i.e. in an area of cut). Consequently, removal of soils from the May Day Green part of the site is not classed as remediation but will be dealt with under a site-wide materials management plan that will be developed in due course.

7.65 Soils within the remaining two areas; Markets Basement and Southern CEAG hotspots, are considered to be grossly contaminated and therefore represent ongoing source potential that should be dealt with during any future development works on the site. Hence, the primary objective of remedial activity on the site is the removal of grossly contaminated soil from discrete areas below the Markets Basement and the Southern CEAG site.

Risk Management and Remediation

7.66 Following various phases of investigation and assessment, two discrete areas of potentially significant or gross soil contamination have been identified as representing ongoing source potential. Consequently it is recommended that such materials are removed from the site as part of future development works in order to minimise the risk of impact to the local environment and specifically to the Sough Dyke which passes in a deep culvert (5-6m below ground level) beneath the site.

7.67 In order to address these risks, the following documents will be developed and issued to the relevant statutory consultees:

- Detailed Remediation Strategy – to deal with known contamination
- Reactive Materials Management Strategy – to deal with unexpected contamination

7.68 All materials on site will be controlled under an over-arching Materials Management Plan (MMP) which will be developed and maintained by the contractor.

Mining and Stability

7.69 A review of the geological and mining setting at the site has previously been undertaken by Wardell Armstrong LLP based on the findings of two phases of site investigation (Phase 1 and Phase 2 Site Investigation consisting of a total of seven rotary open hole and twenty-two rotary cored boreholes) and using information from historical data and assessment presented by SYMAS (report references May Day Green and Kendray Street, Barnsley 10/10/2002 (ref. FW/SML/M4364) and Market Redevelopment, Barnsley Centre 10/10/2003 (ref. MAL/SML/M4364/2). Additional data have been obtained from the following sources.

- The published British Geological Survey (BGS) 1:10,000 Geological Mapping for the site, (sheet SE30NW, Barnsley), published in 2005;
- The Coal Authority report dated 16 January 2006;
- Geological Survey Memoir; Geology of the country around Barnsley; and

- Discussions with SYMAS about its data and previous site investigations.

7.70 The main observations and recommendations are as follows.

7.71 The window sampling, rotary open-hole and rotary core boreholes have identified the presence of four coal seams at depths between 0.30m and 35.55m beneath the Site. It is conjectured that the seams encountered are the Winter/Abdy, Top Beamshaw, Low Beamshaw and the Kent's Thin coals. The thicknesses of the leaves (combined where multiple) range from 0.25m to 1.23m.

7.72 Consideration is given to possible workings in two coal seams during the investigation.

7.73 The Winter/Abdy coal records possible backfill material at a depth between 9.1m to 10m bgl in addition to total loss of drilling flush at borehole location BH213. No other boreholes recorded potential working within the Winter/Abdy coal. Research records indicate that underground workings took place in the Winter/Abdy coal approximately 200m to the north-east from Mottram Wood Colliery prior to 1920.

7.74 These activities encountered old unrecorded workings some 600m to the northeast of the Site in the vicinity of Dryden Road. Previous investigations by SYMAS at the Alhambra centre and railway station concluded that the Beamshaw and Winter/Abdy coals in the locality have poor sections and would be incapable of economic working.

7.75 The Winter/Abdy coal varies widely in thickness where it occurs across the Site, however, it is present at potentially workable thickness in some boreholes. It is considered that the likelihood of shallow unrecorded abandoned workings being extensive beneath the Site is very low and even if present would likely be of a very limited nature. The subsequent risk of potential surface subsidence is low. However, given the sensitive nature of the development precautionary measures are recommended where the Winter/Abdy coal is present beneath the development area.

7.76 From the information gathered as part of the investigation the Winter/Abdy coal is identified as being present beneath the Zero Ice and CEAG site areas. As such

precautionary measures may be required beneath the south eastern sections of the proposed department store and multi-storey car park.

7.77 The Beamshaw Coals are recorded in the geological memoir (No. 87, Barnsley) as: **"Around Barnsley the Beamshaw Coals are usually two but sometimes three in number, and are thin seams much mixed with shale and of little value; they are sometimes exposed in the streets of Barnsley near the railway stations".**

7.78 The Low Beamshaw coal in borehole BH117 records an anomalous zone at 21.34m to 21.59m bgl. Situated above this a zone of no core recovery is present from 20.78m to 21.34m. No such anomaly or any evidence of workings within the Low Beamshaw coal was found in any other borehole during the investigations and drilling undertaken as part of the Stage 2 investigation within the vicinity of BH117. Those other boreholes record the Low Beamshaw coal to be intact. As discussed earlier the Beamshaw coals are not known or suspected as having been worked in this vicinity, where they are generally variable, thin and unproductive.

7.79 It is considered that though some very limited anomalous areas have been recorded (BH117) these are either not considered to be old workings or that they are possible old workings of such limited extent to not be of significance. Therefore, no further investigation or precautionary measures are required with regard to the Low Beamshaw coal. However, given that Borehole BH117 did identify some anomalous ground and that pile depths may encroach to within the potential influencing zone of this horizon it is considered that over design of piles may be prudent on a very local basis.

7.80 Remaining areas of Beamshaw coals if visible in excavations should be blinded with limestone / concrete and clay to prevent spontaneous combustion.

7.81 Borehole records are included as part of the Wardell Armstrong report entitled 'Stage 2 (pre-demolition) Site Investigation Report in Appendix 7.1.

Deep Mining

7.82 Some information was given on deep workings in the Barnsley and Top Fenton seams, similar to that outlined in the Coal Authority report (see section 7.183), but with an implied last date of working of 1953.

Mine Gas

7.83 SYMAS has no records of any specific mine gas migration in the vicinity of the site.

Future Development

7.84 If any coal is encountered during any future development works it should be blinded off using a lean mix concrete or other suitable inert material to prevent spontaneous combustion from occurring.

7.85 Model specification documents advise that coal and other unsuitable material associated with coal found to exist at formation level is to be excavated for a depth of at least 300mm and replaced with suitable material.

7.86 Considering the coal seam outcrops and potentially fissured sandstone bedrock lying beneath the surface of the site area, all the usual safety precautions should be employed regarding the possible presence of fugitive gases in any excavations taking place during site investigations and subsequent development works.

Impact of Development

7.87 In terms of the ground conditions and contamination identified during the previous phases of investigation outlined above, the impact of the proposed development, and thereby any sensitive receptors, is assessed below:

- Slight - site considered suitable for use and environmental setting. Contaminants may be present but unlikely to have an unacceptable impact on key targets. Action unlikely to be needed;

- Moderate - site may not be suitable for use and environmental setting. Contaminants probably or certainly present and likely to have an unacceptable impact on key targets. Action may be needed in the medium term; and

- Significant / Major - site probably or certainly not suitable for use and environmental setting. Contaminants probably or certainly present and very likely to have an unacceptable impact on key targets. Urgent action needed in short term.

7.88 Consideration is also given to the geographical importance of any impact (i.e. local, county, regional, national or international impacts) and whether the impact is likely to be beneficial neutral or adverse. Consideration is also given to the likely duration of the impact (i.e. short term, long term or irreversible).

7.89 As part of the proposed development plan, it is anticipated that remedial works will be required as outlined in the following sections (paragraphs 7.92 to 7.103) to treat the areas of contamination in the Markets basement and southern CEAG hotspots. The assessment of the impact of the development is cognisant of this assumption.

7.90 The impact of the development in terms of changes to ground contamination and ground stability are presented in Table 7.2 below.

Table 7.2 – Assessment of the Impact of Development with respect to Ground Stability and Contamination

Impact of Development	**Level of Importance**					**Likely Significance**	**Likely Impact**	**Nature of Impact**	**Mitigation Measures**	**Magnitude of impact post mitigation**
	L	**C**	**R**	**N**	**I**					
Removal of areas of gross contamination in line with proposed remediation scheme	x					Moderate	Neutral to slight beneficial	Long Term	No mitigation required beyond proposed remediation and reactive strategies.	Neutral to slight beneficial
Mobilisation of previously unidentified contamination in soils/groundwater during construction phase	x					Moderate	Slight Adverse	Medium Term	Implementation of reactive strategy during ground works and environmental monitoring programme	Neutral to slight beneficial

Relocation of Sough Dyke during construction phase (including decommissioning of former structure)	x					Slight to Moderate	Neutral to Slight Beneficial	Long Term	No mitigation measure required.	Neutral to slight beneficial
Leakages/spillage of oils, fuels or other chemicals	x					Moderate to Significant	Slight to moderate adverse	Short Term	Accident response plan to be put in place. Spill kits to be maintained on site	Neutral to slight adverse
Creation of preferential pathways and mobilisation of mine gas into development and surrounding properties	x					Moderate to Significant	Moderate Adverse	Long Term	Protection measures proposed for buildings to west of Railway. Ground gas monitoring during construction works	Neutral to slight adverse
Destabilisation of former mine workings	X					Moderate to Significant	Moderate to Major Adverse	Long Term	Recording and removal of any workings identified during excavation of basements. Remaining coal should be blinded with limestone / concrete and clay. In areas of piled foundations no mitigation measures are required as piles will be driven to depths below likely influence of mining.	Neutral to slight adverse
Terminology *Level of importance*: Local (L), County (C), Regional (R), National (N), International (I), *Likely Significance*: Slight, Moderate, Significant *Likely Impact*: Major/Moderate/Slight Beneficial, Neutral, Slight/Moderate/Major Adverse *Nature of impact*: Short term, Medium Term, Long Term, Reversible, Irreversible.										

7.91 The post development risks to human health will be adequately managed and the long-term source potential represented by sub-surface materials will be significantly reduced. Providing that the Remediation Strategy and Reactive Materials Management Strategy are fully implemented, the likely impact of the proposed

development on the local environmental conditions will represent a **neutral** or **slight beneficial** impact.

Mitigation Measures

Ground Contamination

7.92 Building on the Stage 1 and 2 Investigation and Assessment reports outlined in the sections above, WA also produced a Remediation Strategy Report, which has been previously submitted to the regulatory bodies in pursuit of Planning Consent for the previous (2008) development proposals. The report is entitled: Wardell Armstrong LLP -Outline Remediation Strategy Report (SD08-0052) (REF 3). In essence, the outline remediation strategy presented within this report comprised the removal of significant/grossly contaminated soil at specific 'Hotspot' locations, with remedial target values developed through quantitative risk assessment to validate the process. A copy of this report is presented in Appendix 7.1.

7.93 This overarching strategy objective is considered to be an appropriate response to the potential risk within the context of current development plans as well as the relevant environmental legislation and guidance. However, it is acknowledged that further detailed assessment work may be required in due course to update the QRA model and develop revised validation/verification criteria (i.e. remedial clean-up targets) which are derived on a risk basis through robust scientific method and are practically attainable.

7.94 Once the contaminated soil(s) have been removed, there are a number of potential options for treatment, retention and re-use, and/or off-site disposal. In due course a remediation options appraisal will be undertaken and presented to discuss viable ways to manage and minimise waste generation within the context of site specific remedial target values derived through dQRA.

Remediation Objectives

7.95 The objective of remedial activities on the site is essentially to remove any localised sources/zones of gross soil contamination from the site. On the basis of the investigation and assessment undertaken to date the affected areas are confined to the Markets Basement Hotspot and the Southern CEAG Hotspot.

Outline remediation strategy statement

7.96 The overarching principle on this site is to maximise sustainability through the retention or re-use of materials on the site wherever it is practical and/or economic to do so, whilst also minimising the potential for known contamination to impact on human health and/or the wider environment.

7.97 There two key areas on the site where remediation in the form of soil removal and/or treatment is deemed necessary to be protective of the wider environment (specifically the Sough Dyke) and these are:

- Markets Basement Hotspot, and
- Southern CEAG Hotspot

7.98 Significant soil removal from both of these areas is not strictly necessary to facilitate development of the site. However, in both areas, it is proposed that soil will be excavated to a level where impacted soils have been previously encountered and any significant or gross contamination will be removed (i.e. any soils representing ongoing source potential).

7.99 The soil descriptions presented by WA indicate the presence of visually identifiable hydrocarbon contamination beneath the Markets Basement and Southern CEAG areas of the site. It is therefore anticipated that the target materials for removal/remediation will also be readily identifiable on a visual basis with the potential for some free-product to be present. Wherever practically possible, areas/pockets of soil contamination will be targeted on a visual and olfactory basis and chased out to ensure that residual source potential is reduced to a level which is as low as is reasonably possible. It is anticipated that the excavation in the Markets Basement area will need to be 5-6m below current ground level and the lower parts of the excavation may well be lower than the local shallow groundwater level. In this instance, it is proposed that the excavation is temporarily de-watered to allow any significant or grossly impacted materials to be removed. Groundwater removed from the excavation will be passed through an appropriate treatment system prior to disposal subject to relevant licenses and permits being in place.

7.100 Full time specialist supervision of all excavations related to remedial processes will be provided and responsibility for validation/verification in due course will be assumed.

7.101 The exact volume of material affected by remedial activities beneath both Hotpots can be roughly delineated by the extensive site investigation coverage in these areas. However, in a practical sense the actual volume of soil identified as requiring removal will necessarily be undertaken on a reactive visual and olfactory basis. Further details will be supplied in due course within the Detailed Remediation Strategy Document.

7.102 Once the contaminated soil is removed, there are a number of potential management options available, however, if materials are to be retained and re-used on-site as fill materials, they will be subject to meeting minimum chemical (and geotechnical) quality criteria, which will be developed and presented in due course by development of site specific Remedial Target Values derived through a process of dQRA.

7.103 A reactive strategy will be required to manage unexpected areas of ground contamination if/when encountered during future development activities but in essence, the overarching objective of the strategy will remain unchanged. In due course, it is proposed to submit a formal Reactive Materials Management Strategy document which will describe protocols for the chosen Contractor to follow if unexpected ground contamination is encountered during future earthworks. This document will also be based on and intrinsically linked to site specific Remedial Target Values derived through a process of dQRA in due course.

Phasing of Development

7.104 Due to constraints associated with the city centre location of the site, it is anticipated that the development will be undertaken in a number of discrete phases. As such it is anticipated that the remediation will also be undertaken under a phased approach. The two areas of contamination (Markets Basement and Southern CEAG hotspots) will therefore be undertaken in two phases of remediation. It is therefore anticipated that any chosen on site treatment systems may require remobilisation prior to a second phase of remediation.

7.105 Validation of each phase will be undertaken during the remedial works. The remedial strategy will outline the full details of the objectives for the validation process will be outlined in the remediation strategy and agreed with the regulators prior to the start of the remediation works.

Mining Stability

7.106 In view of the identified ground conditions with respect to potential mine workings in the site, it is anticipated that extensive basement excavation in parts of the site will effectively remove some coal seam areas. During this exercise any evidence of old workings (whilst unlikely) should be recorded and removed by extra over excavation. Remaining areas of coal if visible in the excavations should be blinded with limestone / concrete and clay to prevent spontaneous combustion. The remaining areas will be subject to piling operations beneath the base of the Winter and any significant risk of associated potential surface subsidence is effectively negated by this operation. It is not considered that any grouting is necessary to give lateral support to the piling, however, if any anomalies are recorded during piling they should be reported and considered for whether localised remedial action is necessary.

Monitoring Programme

7.107 At this stage a framework of remedial targets is not being proposed but it is acknowledged that once planning consent is achieved further regulatory liaison and negotiation will be required, to develop and agree a technically based and practical set of values to define parameters for the retention and re-use of any materials on site.

7.108 Whilst the previous Remediation Strategy submitted for this scheme by WA in 2008 suggested a set of remedial target values, we consider that the technical basis upon which these values were derived (i.e. dQRA model) is overly conservative. If applied, this would possibly lead to the unnecessary removal of materials within the context of a strategy focused primarily on removing/minimising significant or grossly soil that represents ongoing source potential.

7.109 During all planned remedial activities on the site specialist instruction and supervision will be provided and responsibility assumed for providing suitable

validation/verification to the process. The resultant report will include the following key elements:

- a description and photographic record of the works and the extent of the excavations;
- validation of soil and groundwater quality in the vicinity of the hotspots;
- results of any in-situ and laboratory chemical analysis for soil and groundwater
- waste disposal documentation to demonstrate 'duty of care';

7.110 The validation will be submitted to the regulatory authorities to confirm that the agreed remediation strategy has been implemented.

Alternative Scenarios

7.111 As explained previously, the development location is prescribed by policy. The scoping opinion agreed with the Council, which has identified the site for redevelopment, does not require alternatives to be examined.

Robustness of Analysis

7.112 In general, the process of ground and contamination investigation and assessment has been undertaken in a comprehensive 'Tiered' basis with each successive tier bring further refinement to the understanding of the issues on the site. This process is considered to be compliant with the UK Contaminated Land Regulations up to the point of detailed remediation and risk management design, which will be undertaken in due course.

7.113 The Remedial Target Values derived by WA through dQRA are overly conservative and should be updated and refined in order to avoid unnecessary removal of soil from the site. A detailed review of the dQRA model will be undertaken in due course and will include consideration of the following key issues:

- The principal receptor considered during the initial dQRA is considered to be the Sough Dyke, a culverted water course which is located beneath the site. As part of the current development plans, a section of the water course will be realigned

along the boundary of the site. This is considered to be significant for two reasons.

a. The new section of culvert will be located such that the pathway from the contaminants in the Markets Basement hotspot to the Sough Dyke will increase and this is likely to have a significant impact on the resulting RTVs.

b. It is anticipated that the integrity of the new culvert will be significantly improved from the current water course, providing further protection from the contamination. As part of the realignment the former structure will be removed, thereby removing the former pathway.

- A number of water quality standards have been reviewed since the original assessment was undertaken; it is therefore recommended that the assessment is updated in line with the most current guidelines.

- The remedial target values derived for cyanide are below laboratory detection limits and are therefore not workable as validation criteria. In addition, the occurrence of cyanide on the site is highly localised and likely to be in 'complex' form, which is significantly less mobile than the 'free' form that the model conservatively assumes.

- The existing dQRA model uses chemical concentrations in 'soil' rather than relying on direct measurements of soil derived leachate.

- It remains to be seen if the model upon which the dQRA is based can be reasonably calibrated with reality. If the model cannot be reasonably calibrated then the suitability of this model to develop remedial target values should also be challenged, (for example if the predicted contaminant concentrations at a given compliance point are one or more orders of magnitude greater than is actually measured in groundwater).

Summary and Conclusions

7.114 Significant historical land uses on the site with potential sources of contamination include foundries, gas works, electric works, lamp works, railway and malt houses. In many instances, it is likely that most of those sources will have been removed or covered by more recent construction activity, particularly on the main markets site.

Adjacent or nearby historical land uses include timber yards, saw mill, foundries, colliery, metal works and 'inert' landfill.

7.115 Ground conditions on the site have been adequately characterised following various phases of site investigation and assessment, three discrete areas of potentially significant or gross soil contamination have been identified as representing an on site contaminant source. These have been identified as the May Day Green, Markets Basement and Southern CEAG hotspots. Soils from the May Day Green hotspot are considered to represent a theoretical risk to human health only and are scheduled to be removed to facilitate the proposed development. As such the removal of materials will be dealt with under site wide materials management plan.

7.116 The ground contamination represented by the Markets Basement and Southern CEAG hotspots is considered to represent gross or significant contamination for which soil removal is deemed necessary to be protective of the wider environment, specifically the Sough Dyke.

7.117 The development of the subject site will necessarily seek to remove or remediate any localised areas of ground contamination to a level where the risks to human health and the wider environment are judged to be acceptably low. Consequently the impact of the proposed development will be at worst neutral but more likely to be slightly beneficial by a reduction in the volume and longevity of residual contaminant sources.

7.118 It is anticipated that extensive basement excavation in parts of the Site will effectively remove some coal seam areas. During this exercise any evidence of old workings (whilst unlikely) should be recorded and removed by extra over excavation. Remaining areas of coal if visible in the excavations should be blinded with limestone / concrete and clay to prevent spontaneous combustion. The remaining areas will be subject to piling operations beneath the base of the Winter and any significant risk of associated potential surface subsidence is effectively negated by this operation. It is not considered that any grouting is necessary to give lateral support to the piling, however, if any anomalies are recorded during piling they should be reported and considered for whether localised remedial action is necessary.

7.119 Appropriate land gas protection measures to be incorporated into all buildings situated to west of railway.