11. Ground Conditions

Introduction

11.1 This Chapter presents an assessment of the potential environmental impacts associated with ground conditions at the Blythe Business Park site, which comprises approximately 15.58 hectares of primarily agricultural land split into two development parcels (eastern and western). Specifically, it considers potential effects related to soil and water contamination, ground gas, and the effects of ground conditions on buried structures (including water supply pipes and underground concrete). This Chapter also considers risks to future site users associated with historical mining.

11.2 The purpose of this assessment is to ensure that the development incorporates appropriate mitigation such that it is compliant with the requirements of Part 2A of the Environmental Protection Act (EPA) 1990 and the UK planning regime. In order to achieve this, the development must be undertaken in such a manner that potential impacts on human health (e.g. via soil contamination, ground gas) and the wider environment (e.g. rivers, aquifers etc.) are adequately assessed and mitigated; at both the construction and operational stages of the development.

11.3 Based on consultations with Staffordshire Moorlands District Council (SMDC), this assessment has been undertaken on the basis of **reasonable 'worst case' conditions**. The rationale for this is to demonstrate the scope of effective mitigation measures that could be deployed in the unlikely event that these worst case conditions are present. Therefore, the impact assessment is highly conservative and it is likely that future detailed investigation (as would be expected under planning conditions) will demonstrate that the actual potential impacts are less than the worst case impacts identified in this report. The assessment undertaken within this report therefore represents a highly conservative approach, which is considered appropriate at the outline planning stage when detailed information on actual site conditions is limited.

11.4 The environmental impacts assessed relate directly to the chemical quality of soil, groundwater and surface water at the site, and this Chapter constitutes a Tier 1 Contaminated Land Risk Assessment. There are overlaps between the scope of this assessment and various other assessments within this Environmental Statement. The following points should be noted:

- The assessment of effects on ecological receptors within this Chapter is limited to direct effects from either soil or water contamination (e.g. risks to aquatic life by leaching of contamination into a watercourse). Assessments relevant to other potential effects on these receptors (e.g. loss of habitat) are provided in Chapter 14 Ecology.

- The assessment of the effects of the development on water resources provided in this Chapter is limited to those directly related to contamination / chemical quality. Wider effects relating to water resources are discussed in Chapter 10: Flood Risk and Drainage.

- Assessment of the effects of the development on agricultural land in this Chapter is related only to effects directly related to land contamination.

- This Chapter does not consider waste management issues or the potential waste classification of materials at the site. This will be addressed by appropriate Environmental Permitting, exemptions, waste management plans etc., at detailed design stage.

11.5 The following information sources have been consulted in the preparation of this Chapter:

- Landmark Envirocheck report dated 6 January 2014, including historical topographical mapping, environmental sensitivity database information and geological / hydrogeological data. A copy of this report is included as **Appendix 11.1**.

- Health Protection Agency "Indicative Atlas of Radon in England and Wales" (2007) and supplementary report "Radon in Homes in England and Wales" (2010).

- Wardell Armstrong report '*Validation Report on Construction Quality Assurance for remediation of Areas 1, 2 and 3 and associated site information*' (2010, NL07510/J01).

- Wardell Armstrong report '*Addendum to Validation Report on Construction Quality Assurance for Remediation of Areas 1, 2 and 3 and Associated Site Information: Collation of Monitoring Reports*' (2013, NL07510/001/V0.1). This report is included as **Appendix 11.2**.

- Various other historical data / plans held by Wardell Armstrong.

- Environmental Search Information provided by Staffordshire Moorlands District Council (SMDC). This includes Rogers Geotechnical Services Ltd report '*Factual Report on a Site Investigation at Blythe Park Power Station, Draycott on the Moors, Staffordshire*' (2010), associated scoping comments from SMDC, and local historical information from SMDC's records. This includes written evidence from former employees of Blythe Colours Works (adjacent to the site) and local residents, subsequently referred to in this Chapter as 'VVSM information'. The information provided by SMDC, including the VVSM information, is included in **Appendix 11.3**.

11.6 The primary site areas discussed in this Chapter are shown on Drawing ST13776-001 (**Figure 11.1**), and are as follows:

- Western Development Area.

- Eastern Development Area.

- Proposed emergency access from Sandon Road.

- Proposed internal access road (between Western and Eastern Development Areas).

11.7 This Environmental Statement is intended to support an outline planning application for up to 33,480 sq. m of employment use, up to 168 residential units and up to 250 sq. m of ancillary uses (to include a community centre and a small village shop). The illustrative masterplan provided in **Appendix 11.4** shows details of the current development proposals. Generally, these comprise residential development and a community centre in the Western Development Area and commercial development in the Eastern Development Area. The assessment methodology adopted has assumed the presence of development of the type defined in the standard conceptual site model (CSM) for a residential site with private gardens in Environment Agency publication "Updated Technical Background to the CLEA Model" (2009) in the Western Development Area, and development consistent with the standard commercial CSM in the Eastern Development Area. The proposed emergency access route from Sandon Road and between the two development parcels will include roads only.

Policy Framework

National Policy, Legislative Context and Guidance

11.8 Part 2A of the Environmental Protection Act (EPA) 1990 provides a regime for the identification and remediation of contaminated land. This is implemented by the Contaminated Land (England) Regulations 2006 (which consolidate the provisions of the Contaminated Land (England) Regulations 2000 and subsequent amendments), as amended by the Contaminated Land (England) (Amendment) Regulations 2012. This regime is designed to provide an effective statutory framework for the remediation of contaminated land and is based on a number of principles including the "suitable for use" approach and the assessment of contamination by a risk based approach.

11.9 Section 78A of Part 2A of the EPA defines contaminated land as land that is in such a condition that:

- Significant harm is being caused or there is a significant possibility of such harm being caused or
- Pollution of Controlled Waters is being or is likely to be caused.

11.10 The assessment of contamination risks is based on the source-pathway-receptor concept (referred to as a significant pollutant linkage). These terms are defined as follows:

- Source: A substance that is in, on, or under the land and that has the potential to cause harm or to cause pollution of Controlled Waters.
- Pathway: A route or means by which a receptor could be, or is, exposed to or affected by a contaminant.
- Receptor: In general terms, something that could be adversely affected by a contaminant, such as people, an ecological system, property or a water body.

11.11 The "pollutant linkage" describes the relationship between the source, the pathway and the receptor. Each component of the pollutant linkage has to be identified as being present before land can formally be considered "contaminated".

11.12 Additional statutory guidance has been issued on the interpretation and application of Part 2A; namely "Environmental Protection Act 1990: Part 2A Contaminated Land Guidance" (DEFRA, 2012), which introduces additional concepts to assist in the assessment of potentially contaminated land, including consideration of "normal" background contaminant levels and a scheme for categorising sites using a 4 tiered system when undertaking Part 2A assessments. It also defines relevant ecological receptors requiring consideration as part of Part 2A contaminated land assessments, which are restricted to sites with recognised ecological status (e.g. SSSIs, Ramsar sites, national nature reserves etc.).

11.13 Environment Agency (EA) publication "Groundwater Protection: Policy and Practice" (2012) (GP3) sets out a framework for the regulation and management of groundwater and summarises policy for the protection of groundwater resources. It also describes the requirements of the Water Framework Directive (2000/60/EC), which provides an overarching system for the protection of all inland and coastal waters.

11.14 The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010 transpose requirements of European legislation with regard to surface water and groundwater quality into English and Welsh law. These regulations provide assessment criteria relevant to Priority Substances (as defined in EC Directive 2008/105/EC).

11.15 The Water Supply (Water Quality) Regulations 2000 (amended by the Water Supply (Water Quality) Regulations 2010) detail legislative requirements for drinking water quality.

Planning Policy and Guidance

11.16 The National Planning Policy Framework (2012) (NPPF) sets out the Government's planning policies for England and how these are expected to be applied and provides a framework for local planning. Section 11 "Conserving the Natural Environment" provides policy context for the redevelopment of brownfield and contaminated land. The NPPF incorporates legislative requirements into the planning regime. It states that "as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990". It specifies that the effects of redevelopment on human health and the environment should be considered by appropriate risk assessment and site investigation to "prevent unacceptable risks from pollution".

11.17 The key difference between legislative requirements and the planning regime is that planning guidance aims to prevent future potentially significant pollutant linkages, and is thus sensitive to the proposed land use. Therefore, land developed in accordance with the planning regime (i.e. the NPPF) would often be expected to meet more stringent standards than would be required under legislative requirements alone. This Chapter has employed a methodology designed to be consistent with the requirements of the planning regime.

National Planning Practice Guidance (NPPG), 2014

11.18 The Department of Communities and Local Government (DCLG) provides guidance for applications for the development of land that could potentially be affected by contamination, which is referred to as the NPPG. This recommends, amongst other

things, that developers should provide a risk assessment to "identify potential sources, pathways and receptors ('pollutant linkages') and evaluate risks". To allow outline planning permission to be granted, this assessment must demonstrate that "the risk from contamination can be reduced to an acceptable level".

11.19 The NPPG recommends that, before granting outline planning permission, the local planning authority must be satisfied, on the basis of the information submitted, that:

- *"it understands the contaminated condition of the site;*
- *the proposed development is appropriate as a means of remediating it; and*
- *it has sufficient information to be confident that it will be able to grant permission in full at a later stage bearing in mind the need for the necessary remediation to be viable and practicable."*

11.20 The NPPG notes that the information submitted should be "*proportionate to the decision at outline stage*" and that "*an applicant may be required to provide at least the report of a desk study and walkover*". This is considered to a minimum requirement and, as noted by the NPPG, in some instances intrusive investigation may be necessary to accompany the desk study and walkover information.

11.21 In the case of this site, following consultation with Staffordshire Moorlands District Council's (SMDC) Environmental Protection team, it is considered that a comprehensive desk study and walkover may constitute an appropriate and proportionate scope of information for an outline planning determination, should this demonstrate that, even in a worst case scenario, the site will be suitable for its proposed use or can be made suitable via the planning process (i.e. potential pollutant linkages can be addressed by viable remediation techniques).

EA Guidance

11.22 The EA has published extensive guidance on the practical aspects of contaminated land risk assessment, to assist practitioners in meeting both legislative and planning requirements. Of particular relevance is "Model Procedures for the Management of Land Contamination (CLR11)" (2004), which provides the technical risk management framework for assessing and dealing with land affected by contamination. The assessment provided in this Chapter has been undertaken in accordance with CLR11 where relevant. The EA also provides guidance regarding practical measures to protect Controlled Waters from contamination during construction projects within "PPG1 – General guide to the prevention of pollution".

Local Planning Policy

11.23 The site lies within the jurisdiction of Staffordshire Moorlands District Council. The relevant local planning policy is 'A Local Plan for the future of Staffordshire Moorlands: Core Strategy Development Plan Document' (2014).

11.24 The Core Strategy Development Plan Document states that:

- Whilst redevelopment of previously developed sites is favoured on sustainability grounds, such development should ensure "*that any legacy from former land uses*

(such as coal mining) is appropriately addressed so that no future liability for future maintenance or public safety arises" (Policy SD1).

- Where sites have a history of contamination due to industrial legacy, developers may be required to submit pre-application evidence as to the presence of contamination before a planning application can be determined (Policy SD1).

- In accordance with the NPPF, any site proposed for redevelopment should not be capable of being described as contaminated land under Part IIA of the Environmental Protection Act 1990 (following remediation measures) (Policy SD1).

- Water pollution associated with a development site presents a relevant issue in relation to development proposals, and development proposals should only be approved where there will not be unacceptable pollution impacts (either individually from the development site, or cumulatively with adjacent sites) on water receptors (Policy SD4).

Assessment Approach

Methodology

11.25 The assessment of potential effects has been undertaken by the following process:

- Determination of baseline conditions. This has been achieved by means of a desk study and site walkover inspection. It considers the potential for pre-existing soil, water or ground gas contamination to be present at the site.

- Assessment of the potential effects from any baseline soil, water or ground gas contamination on possible receptors during both the construction and operational phases of the development. This has been achieved by the determination of a CSM based on the baseline conditions and details of the proposed development.

- Assessment of the potential effects of the development on the contamination status of soil and water at the site (i.e. potential for the development to introduce new contamination sources, pathways or receptors, during both the construction and operational phases).

- Discussion of mitigation measures to prevent or minimise any identified significant potential adverse effects.

- Assessment of the likely level of residual effects following mitigation.

11.26 The desk study and site walkover inspection undertaken constitutes a Tier 1 risk assessment as defined in Environment Agency "Model Procedures for the Management of Land Contamination (CLR11)" (2004). Whilst this is considered to represent an appropriate level of assessment for outline planning purposes, intrusive site investigation will be required prior to detailed development / approval. This will be used to validate and review the findings of the Tier 1 assessment where necessary and provide additional confirmation / confidence in the appropriateness of any mitigation measures.

11.27 The desk study and walkover information is used to inform a qualitative risk assessment, allowing significance criteria to be assigned to each potential effect (in relation to receptor sensitivity and magnitude of effect).

11.28 The significance of effects on a given receptor (e.g. future site users, a surface water course, an aquifer etc.) is a product of the sensitivity of that receptor and the potential magnitude of the effect.

11.29 Sensitivity criteria for the receptors have been determined with general consideration of CIRIA 552 "Contaminated Land Risk Assessment: A Guide to Good Practice" (2001). However, it should be noted that the evaluation of the sensitivity of surface water and ecological receptors in particular is subject to significant professional judgement, which has been applied in conjunction with the outline classification scheme provided in **Table 11.1**.

Table 11.1: Receptor Sensitivity Criteria

Receptor Sensitivity Criteria	
High	Human health, where receptor characteristics promote the likelihood of a significant contaminant linkage (e.g. due to high levels of exposure to soil / dust and / or prolonged exposure). For example, children using residential gardens or public recreation areas, construction workers routinely exposed to soils. Controlled Waters receptors of national and / or strategic importance for the purposes of potable water supplies and / or ecosystems (e.g. Principal Aquifers, Source Protection Zones). High sensitivity ecological receptors, where the sensitivity is directly related to soil, surface water or groundwater conditions e.g. Ramsar site.
Medium	Human health risk, where receptor characteristics provide limited potential for a significant contaminant linkage. For example, workers in commercial premises. Controlled Waters receptors of local importance for the purposes of potable water supplies and / or ecosystems (e.g. Secondary (A) Aquifer). Medium sensitivity ecological receptors (e.g. non statutory local designations, such as Sites of Biological Importance) and other fauna (e.g. livestock).
Low	Human health risk, where receptor characteristics significantly minimise the likelihood of a significant contaminant linkage. For example, users of car parks. Controlled Waters receptors of low importance for the purposes of potable water supplies and / or ecosystems. Buildings or structures prone to long term damage from the chemical ground conditions.

11.30 The potential magnitude of effects on receptors has been assessed by considering the potential contamination sources and exposure pathways, to determine a classification in accordance with **Table 11.2**.

Table 11.2: Criteria for Magnitude of Effects

Criteria for Magnitude of Effects	
Major	Contamination that results in a short term (acute) risk to human health. Examples include soil displaying highly elevated cyanide concentrations. Short term risk of significant gross pollution of a watercourse or aquifer e.g. major spillage of oil from activities associated with the development. Of particular relevance is the potential release of Priority Substances and Priority Hazardous Substances.
Moderate	Exposure to contamination (soil and / or Controlled Waters) that, by way of its characteristics and extent, may result in long term (chronic) risk to human health. Long term risk from leaching of contaminants to water resources or ecological receptors.
Minor	Exposure to contamination (soil and / or Controlled Waters) that, by way of its characteristics and extent, may result in pollution of low value water resources or ecological receptors. Soil contamination at concentrations above that which might be considered 'normal background' (e.g. presence of Made Ground, low risk historical industrial / commercial use). Concentrations are such that a potential risk to human health is unlikely. Damage / compromise to underground structures.
Negligible	No significant harm to sensitive receptors, including no significant potential for adverse long term human health effects to future site users. Any non-permanent human health risks to construction workers can be fully prevented by means of personal protective equipment. Easily repairable damage to buildings, structures and services. No observable effect on the use or function of water resources.

[1] Criteria are based on guidance provided in CIRIA 552 (2001).

11.31 The overall effect on each potential receptor has been evaluated as a function of receptor sensitivity and the potential magnitude of effects, as illustrated in **Table 11.3**.

Table 11.3: Impact Assessment Matrix

Magnitude of Effect	Receptor Sensitivity		
	High	Medium	Low
Major	Major	Major-moderate	Moderate-minor
Moderate	Moderate	Moderate-minor	Minor
Minor	Moderate-minor	Minor	Minor-negligible
Negligible	Negligible	Negligible	Negligible

11.32 Impacts identified as moderate - minor, moderate, moderate - major or major will be considered significant for Environmental Impact Assessment purposes (i.e. mitigation required). Impacts assessed as minor or minor-negligible will not necessarily be considered significant. Nevertheless, measures to reduce these to negligible should be considered where practically and economically feasible.

11.33 **Table 11.3** does not include for coincident beneficial effects that can occur as part of a development, such as the removal or alteration of an at-risk receptor. Where relevant, such effects have been identified separately and assigned a classification of 'beneficial'.

Scoping Criteria

11.34 Consultation has been undertaken by submission of a formal EIA Scoping Report to Staffordshire Moorlands District Council (SMDC). The Scoping Response from SMDC included comments from the Environment Agency (in relation to the assessment of risks to Controlled Waters) and SMDC's Environmental Protection department. The EA and SMDC did not raise any objections to the proposed content or method of risk assessment outlined in the Scoping Report. The Scoping Response also provided the following informative comments:

- The EA identified relevant Controlled Waters receptors to include the River Blithe, an un-named tributary of the river adjacent to the site, and groundwater underlying the site.
- SMDC highlighted the importance of a comprehensive assessment of the historical uses of the site and surrounding area.
- SMDC highlighted the requirement for the EIA to consider a 'worst case scenario' when addressing potential contaminated land risks.

11.35 The above comments have been taken into account in carrying out the subsequent assessment work.

Baseline Conditions

11.36 The baseline conditions currently present have been taken as reflective of those at the commencement of the development.

Site Description

11.37 The Eastern Development Area consists entirely of agricultural land. The boundaries of the Eastern Development Area are the River Blithe and Stoke-Derby railway to the north, field boundaries / a watercourse to the east and a watercourse and subsequently Blythe Park Industrial Estate to the west. The southern boundary is not physically demarcated and cuts across an agricultural field.

11.38 The Western Development Area consists primarily of agricultural fields, although contains built development in the north east (see description of walkover observations, below). Its boundaries are the River Blithe to the north, industrial land (Blythe Park Industrial Estate) to the east, residential development to the south and south west, and Sandon Road to the west.

11.39 The planning boundary also includes an existing access point from Sandon Road (to be retained as emergency access) and a proposed internal access road, as shown on Drawing ST13776-001 (**Figure 11.1**)). Development activities in these locations will be limited to minor surface works (conversion to emergency access, alterations to existing roads etc.). Currently, the proposed emergency access area generally comprises hard surfaced land associated with Blythe Park Industrial Estate. It includes a rectangular grass surfaced area to the north of the Western Development Area (bowling green). The proposed internal access road generally follows the route of an existing road within the industrial estate.

11.40 The most significant adjacent land use to the site is Blythe Business Park Industrial Estate. This consists of a complex of industrial buildings located in the areas both between, and to the north of, the two development areas. Blythe Park Industrial Estate is built on land previously occupied by Blythe Colour Works.

Walkover Inspection

11.41 A site walkover was undertaken by Wardell Armstrong on 16 January 2014, to identify the current land use, any potential ground constraints or visual evidence of areas of potential contamination.

Western Development Area

11.42 The Western Development Area is largely comprised of fields, which were not in active use (i.e. no crops or grazing) at the time of the walkover. However, the north east of this area is occupied by built development associated with the industrial estate. The boundary between the developed north eastern section and the remainder of the Western Development Area is marked by a ditch, which contains water in places.

11.43 The developed area contains one building (currently used as a dance studio) and rough grassland used as a cable detection training facility (this appears to have been recently disturbed, presumably to lay dummy cables for training purposes). To the south east of the dance studio is an area of hardstanding, occupied by storage containers and various discarded materials, including timber, bricks, tyres, machinery and lubricant containers.

11.44 Running parallel with the site boundary and River Blithe is a track that leads to Sandon Road; this is mainly overgrown. Evidence of underground gas infrastructure (marker posts) was identified running parallel to the River Blithe in the north of the Western Development Area.

11.45 Topographically, the Western Development Area is relatively flat in the north, but rises towards the southeast corner. Parts of the fields in the Western Development Area were noted to be marshy and to contain reeds, particularly in the south west corner and a small area to the south of the dance studio.

11.46 Along the southern boundary of the fields minor quantities of fly tipped material were noted, generally comprising soil, breeze blocks, a large blue container and general litter. No contamination emanating from the blue container was evident at the time of the site walkover.

Eastern Development Area

11.47 The eastern area is occupied by a single field. This is generally flat and predominantly in active arable use. The northern and western extents of the field are occupied by more hummocky terrain.

11.48 Adjoining the western boundary of the area is a stream that is a tributary of the River Blithe in the north; the confluence appeared to be a fast flowing inlet to the River Blithe. A further watercourse, which also feeds into the River Blithe, forms the eastern site boundary. The flow in this watercourse was significantly slower.

Existing / Emergency Access Area from Sandon Road and Internal Access Road

11.49 The proposed emergency access area from Sandon Road is currently occupied by tarmac roadway/pavements, areas of hardstanding, landscaping and a bowling green. The location of the proposed internal access road is occupied by existing roads and hard surfaced areas within Blythe Park Industrial Estate.

Land Use Adjacent / Near to the Site

11.50 The adjacent Blythe Park Industrial Estate contains a mixture of office and factory units. The business types noted include greenhouse manufacturers, engineering works, car repair/MOT centre, silo cleaning services, door manufacturers, radiator valve manufacturers, catalytic converter manufacturers, auto paint manufacturers, vehicle finishing, metal fabrications, industrial cladding and a motorcycle training centre.

11.51 Although Blythe Colour Works is no longer operational, continuing industrial processes associated with the colour industry are undertaken in the south of the industrial estate (Johnson Matthey and United Colours). These premises are located to the south of the River Blithe (whereas the majority of the industrial estate is to the north).

11.52 The easternmost part of the industrial estate is occupied by premises of unknown use. From external inspection, however, these were noted to include the use and storage of various chemicals including hydrochloric acid and 'lime'.

Site History

11.53 1:2,500 scale historical topographical mapping for the site and surrounding area dating from 1880 to 1994 has been assessed, together with 1:10,000 scale mapping dating from 1888 to 2013. The relevant findings of this assessment are summarised below.

Western Development Area

11.54 This area consisted entirely of agricultural fields from the first mapping edition (1880) until mapping from 1970. The 1880 map shows the north east of this area being crossed by an arm of the River Blithe. However, this was drained / diverted prior to 1924 (where it is marked as marshy ground). Drawing ST13776-002 (**Figure 11.2**) shows the recorded historical positions of the river.

11.55 The 1970 mapping shows a partitioned area with a circular structure (subsequently identified as a tank) in the south east of the Western Development Area. Further development is shown on the 1987 mapping, comprising a building of unspecified use in the north east of the Western Development Area (this is currently occupied by the dance studio).

11.56 The tank is shown to be absent on mapping from 1994 onwards.

11.57 Aside from the land use noted above in the eastern part of the Western Development Area, the Western Development Area is shown to have been agricultural land throughout its history.

Eastern Development Area

11.58 This area is recorded to contain agricultural fields on the 1880 mapping, crossed in a west to east direction by an arm of the River Blithe. This section of the river is shown to have been artificially drained prior to 1924, with the 1924 mapping showing marshy ground in its former location and the watercourse restarting at the eastern site boundary as a spring. No significant changes are shown on subsequent editions of mapping in the Eastern Development Area, which has remained agricultural land throughout its history.

Existing / Emergency Access From Sandon Road and Internal Access Road

11.59 The land underlying the proposed emergency access area falls within the footprint of the former Blythe Colour Works. This was constructed at some time between 1924 and 1937. The former colour works is now occupied by Blythe Park Industrial Estate.

11.60 Prior to the construction of the colour works, the area of proposed emergency access was crossed by a mill race (water channel associated with a nearby bone mill). This ceases to be shown on mapping from 1937 onwards (after the construction of the colour works). Additionally, it appears that the River Blithe was diverted to facilitate the construction of the colour works. Recorded alterations to the configuration of the river are shown on Drawing ST13776-002 (**Figure 11.2**).

11.61 The proposed emergency access area includes a bowling green. The VVSM information indicates that the bowling green occupies land historically used for waste disposal by the colour works. The emergency access area also includes an area designated in previous Wardell Armstrong reports (e.g. report NL07510/001/V0.1, provided in **Appendix 11.3**) as 'Area 3', which was identified to have historically received waste deposits with higher contaminant concentrations than the general former colour works site (discussed further in the 'Previous Site Investigation Section', below).

Area Surrounding the Site

11.62 Blythe Colour Works is likely to be the most significant historical land use in the area surrounding the site. This was originally located between the Eastern and Western Development Areas and to the north of the River Blithe, although from the 1950s to 1970s expanded to include land to the south of the river (also between the two development areas).

11.63 Blythe Colour Works manufactured a range of colour products for various purposes, primarily to supply the ceramics industry. Historically, many ceramic colours were derived from heavy / toxic metal compounds. In particular, arsenic, boron, cadmium, lead, antimony, chromium, nickel and cobalt compounds were commonly used. **Appendix 11.5** contains information historically provided to Wardell Armstrong by Cookson Matthey (former operators of the colour works), which corroborates the use of materials containing many of these elements. Additionally, there is anecdotal evidence that colour manufacturing at Blythe Colour Works included the use of uranium oxide (this was historically used to produce red, orange, yellow and black colour products).

11.64 The colour works may also have used organic chemicals as a 'base' for colour products. Other chemicals used in the colour production process may have included pH adjusters (acids, bases), flocculants and binders. In addition, fuel oils are likely to have been used to meet operational requirements, and fuel storage facilities may have been present.

11.65 Several areas of historical waste disposal are reported in the VVSM / SMDC information. Predominantly, these relate to the area directly to the south of the River Blithe, between the Eastern and Western Development Areas, which was previously used as a landfill by the colour works. Additional areas include the bowling green (as discussed above) and an area currently occupied by a motorcycle training centre (referred to in previous Wardell Armstrong reports (e.g. NL07510/001/V0.1) as Area 2, and also known as the 'Old Mill' tip). Consistent with the contaminants generally associated with colour manufacturing discussed above, the VVSM / SMDC information mentions waste deposits to include materials containing lead and cadmium (e.g. cadmium painted tiles) and potentially uranium oxide.

11.66 The VVSM information indicates that historical waste disposal processes at the colour works may have affected the surrounding agricultural land, with various reports of waste deposits being used to fill ponds / gullies and to form farm tracks. The precise location or chemical composition of any such deposits is difficult to ascertain from the available information. However, there is the potential that this unregulated deposition may have occurred within the boundaries of the Eastern and Western Development Areas, with the chemical composition of the waste likely to be consistent with the potential contaminants identified at Blythe Colours (i.e. elevated concentrations of metals, potential for uranium oxide etc.).

11.67 Part of the adjacent former colour works site was used as a US Army base during World War 2. From publically available aerial photography, it appears that this comprised a series of Nissen huts directly adjacent to the eastern boundary of the proposed emergency access area. SMDC report that the US army base used the colour works buildings for chemical impregnation of clothing (i.e. to provide protection against agents of chemical warfare). The primary chemical used for impregnation during World War 2 was chloramine, hence reagents associated with the production of this compound (e.g. ammonia, sodium hypochlorite) may have been present. SMDC report that the impregnation plant 'occupied more than 43,000 cubic feet'. In addition to chloramine, it is possible that dry cleaning chemicals and solvents were used at the army base. It is noted that the VVSM information refers to 'tetrachloride'. This may be a reference to such solvents, although it is not clear which specific compound(s) it relates to, as tetrachlorides comprise a range of compounds.

11.68 It is not known whether the Nissen huts had asbestos roofs, although this was a common construction method for these structures. Therefore, on demolition of the huts, it is possible that asbestos containing materials could have been deposited.

11.69 Other historical land use in the direct vicinity of the site includes:

- A railway line adjacent to the northern site boundary (from 1880 to present);

- A station and various associated infrastructure adjacent to the north of the site (this was Cresswell station, which was operational between 1848 and 1966, whereafter it was replaced by a level crossing);

- A bone mill approximately 60m north west of the site (from 1880 to pre-1937);

- A filter bed and circular structure (assumed to be a tank) adjacent to the west of the Western Development Area (shown on 1937 mapping only, being replaced by a pond on 1957 mapping and subsequently infilled).

- A pipeline with a NW-SE orientation, shown on land to the west of the Western Development Area, and recorded to terminate approximately 30m from the western site boundary (shown on mapping from 1957 to present). This is an above ground section of the Meir-Checkley sewage and foul water pipeline. It is not known whether this subsequently passes beneath the site;

- A sub-station directly adjacent to the west of the Western Development Area (shown on mapping from 1957 onwards, and associated with residential development in this area).

- Various unmarked buildings directly adjacent to the south of the Western Development Area, shown on 1:10,000 mapping from 1950-1971. These buildings are not shown on 1:2,500 scale mapping from this time, and their use is unknown. Their former location is currently occupied by a residential property and garden.

Geological and Environmental Setting

Geology

11.70 The published geological mapping indicates the majority of the former colour works to be underlain by Made Ground deposits. These generally do not encroach within the site boundary, with the exception of the north eastern corner of the Western Development Area and the proposed internal access road. This generally correlates with the site history. However, additional Made Ground deposits are anticipated to be present within the proposed emergency access area from Sandon Road (e.g. the bowling green and Wardell Armstrong Area 3, which are not shown to contain Made Ground on the mapping).

11.71 Natural superficial deposits are recorded to underlie the entire site. These are predominantly River Terrace Deposits (sand and gravel), although the west of the Western Development Area is recorded to be underlain by glacial till. An area of alluvium, associated with the route of the River Blithe, is recorded to be present adjacent to the north of the two development areas. This underlies part of the proposed emergency access from Sandon Road.

11.72 The solid geology at the site is recorded to be as follows:

- The Mercia Mudstone Group (mudstone) is recorded to underlie the southern half of the Western Development Area and the south western and south eastern corners of the Eastern Development Area.

- The Tarporley Siltstone Formation (sandstone and siltstone) is recorded to underlie the remainder of the Western and Eastern Development Areas, together with the area of proposed emergency access from Sandon Road.

- A west-east trending fault crosses the Western Development Area.

Coal Mining

11.73 After a review of the mapping made available by The Coal Authority, it is apparent that the site is not within a coal mining reporting area and is situated approximately 2.5km south of the nearest area deemed to be a "Development High Risk Area" by The Coal Authority. Consequently it can be reasonably assumed that no workings are present nearby and any risk associated with past coal mining activities can be classed as negligible in accordance with the Criteria for Magnitude of Effects (**Table 11.2**) and needs no further consideration.

Hydrogeology

11.74 The River Terrace Deposits that underlie the majority of the site are recorded to be a Secondary A Aquifer. These aquifers are defined by the Environment Agency as being capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

11.75 The Mercia Mudstone Group and Tarporley Siltstone Formation are both categorised as Secondary B Aquifers, which are defined by the Environment Agency as 'predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering'. A groundwater abstraction is present approximately 244m north west of the site, in an area underlain by the Tarporley Siltstone. This abstraction is licensed to Severn Trent Water for public drinking water supply.

11.76 The parts of the site underlain by the Tarporley Siltstone are generally recorded to lie within a groundwater Source Protection Zone 3 (this defines the source catchment for the groundwater abstraction to the north west). The north western corner of the Western Development Area and parts of the proposed emergency access from Sandon Road fall within a Source Protection Zone 2 (defined by a 400 day travel time to the abstraction point), whilst the extreme north western corner of the proposed emergency access from Sandon Road falls within a Source Protection Zone 1 (defined by a 50 day travel time to the abstraction point). The remainder of the site (i.e. parts underlain by the Mercia Mudstone) does not fall within a Source Protection Zone.

11.77 Public water supply boreholes are relatively uncommon on Secondary B Aquifers. It is noted that the Sherwood Sandstone Principal Aquifer underlies both the Mercia Mudstone and Tarporley Siltstone in the area. It is possible that the abstraction is from the Sherwood Sandstone, with the Source Protection Zone including areas underlain by the Tarporley Siltstone but not the Mercia Mudstone due to the difference in permeability between these two units (i.e. the Tarporley Siltstone is assumed to potentially be in hydraulic continuity with the underlying sandstone, whereas the Mercia Mudstone is not).

Hydrology and Environmental Sensitivity

11.78 The closest surface watercourse to the site is the River Blithe, which forms part of the northern site boundary and flows in a west to east direction. The Envirocheck report indicates that chemical quality in this river was Grade A (very good) under the Environment Agency's GQA scheme, as of 2009. Additionally, long term chemical monitoring has been undertaken in the River Blithe by Wardell Armstrong in association with the former colour works, between 2010 and 2013. The results of this monitoring generally indicate continued good chemical water quality throughout this period (i.e. no contaminant concentrations above relevant water quality standards, as detailed in Wardell Armstrong report NL07510/001/V0.1, included in **Appendix 11.2**).

11.79 The western boundary of the Eastern Development Area is formed by a surface water channel. This flows into the River Blithe at the north western corner of the Western Development Area. It is noted that this channel flows directly past the former colour works landfill. No chemical quality data is available from this channel.

11.80 Due to agricultural use in the area surrounding the site, it contains an extensive network of field drains and also numerous ponds. A culvert is recorded to cross the area of proposed emergency access from Sandon Road in the north west of the site. This connects surface drainage to the north of the site to the River Blithe. The depth, dimensions or condition of this culvert are not known.

11.81 The Envirocheck report indicates that Johnson Matthey and Cookson Matthey Ceramics are licensed to abstract water from the River Blithe as it passes the site. It also includes records of discharge consents for trade effluent to the river from these operators.

11.82 The Envirocheck report records one historical pollution incident to Controlled Waters in the vicinity of the site. This relates to the discharge of fire fighting foam to the River Blithe 8m north of the site in 1996. This was a Category 3 (minor) incident that occurred in 1996 and residual long term effects are considered very unlikely.

11.83 There are no recorded SSSI, Ramsar sites or nature reserves within 500m of the site.

Landfills and Waste

11.84 The area to the south of the River Blithe, directly adjacent to the east of the Western Development Area (outside the site boundary), was historically used as a landfill by Blythe Colours. This area is recorded as a historical landfill in the Envirocheck report, which indicates it to have been operational between 1948 and 1992 and to have accepted 'industrial, commercial and special waste, and liquid sludge'. Specifically, authorised waste included borates (frit and glazes), cadmium compounds, fluorides, fuel oil, hardcore and rubble, interceptor pit wastes, lead compounds and 'other toxic metal compounds'. The landfill license for the site (dated 1977) indicates that, amongst other things, the authorised waste types included 'waste colours', 'waste frits', 'waste glaze' and 'settler sludge'. Further to this information, this area is reported to have received significant quantities of material affected by elevated concentrations of toxic metals / metalloids (as discussed in the 'site history' section, above). It is understood that tipping was undertaken as a land raise. This area is currently approximately 3m higher than the adjacent land.

11.85 Wardell Armstrong has undertaken intrusive investigations within this landfill previously (1998). The laboratory data from these investigations confirmed the presence of waste deposits of the type indicated above, including deposits displaying significantly elevated concentrations of various metals. This data is discussed further in 'Previous Site Investigations', below.

11.86 A further area of historical landfilling is recorded in the Envirocheck report, located in the north west of the site within the proposed emergency access area from Sandon Road. This is identified as "The Paddock" landfill. However, the Envirocheck report also contains a conflicting record of the location of this landfill that positions it 93m west of the site. The Environment Agency's website correlates with the former record (i.e. positions the landfill within the proposed emergency access area from Sandon Road). Therefore, the precise location of this landfill (or whether there are actually two separate areas of landfilling) is unclear.

11.87 Details of the operator, operational dates or types of materials accepted at The Paddock landfill are not provided for the record located within the proposed emergency access from Sandon Road, whilst the record located 93m west of the site indicates the landfill to have accepted "saggers" (ceramic waste derived from the pottery industry).

11.88 The Envirocheck report also records historical landfill sites 173m and 361m north of the site. Details of the operators, operational dates or types of materials accepted at these are not known.

11.89 In addition to the recorded historical landfills in the vicinity of the site, there is also evidence of unlicensed waste disposal both within and in the surrounds of the former colour works, as discussed above (e.g. bowling green, Area 3 etc.).

Radon

11.90 The site is in a location where less than 1% of homes are recorded to display radon concentrations at or above the action level (200 Bq m^{-3}). Due to this, the British Geological Survey advises that no radon protection measures are necessary in new houses (see Envirocheck report in **Appendix 11.1**).

Other Environmental Information

11.91 The Envirocheck report provides an indication of potentially significant commercial / industrial activities within the area surrounding the site, via records of current and former Pollution Prevention and Control designations and details held within Landmark's Contemporary Trade Directory. A review of this information indicates the main processes of potential contaminative significance to be those associated with the former Blythe Colour Works, adjacent to the site. This was licensed under various Integrated Pollution Control / Integrated Pollution Prevention and Control (IPPC) authorisations and under the Control of Major Accident Hazards (COMAH) Regulations.

11.92 There is an active Local Authority Pollution Prevention and Control authorisation for the manufacture of 'coating materials' located 9m north of the site, within Blythe Park Industrial Estate. The Envirocheck Contemporary Trade Directories database records other current and historical land use at the industrial estate to include ironworking,

colour manufacturing, ceramics manufacturing / supply, road haulage, fuel dealers, exhaust system manufacturing, commercial cleaning services and a garage.

Previous Site Investigations

Western Development Area

11.93 Wardell Armstrong has previously undertaken site investigations across the adjacent Blythe Colour Works site. **Appendix 11.6** shows the site investigation locations. These generally fall outside the boundaries of the Western and Eastern Development Areas, with the exception of boreholes BH1, RB1, PH13 and PH14 (drilled in 1998). These lie in the north east of the Western Development Area, within the area currently segregated from the agricultural fields and occupied by built development and hard surfacing. This is also recorded to be the location of a former tank by historical mapping and it is therefore considered possible that the colour works may have encroached onto this part of the Western Development Area.

11.94 The logs from BH1, RB1, PH13 and PH14 indicate that only BH1 recorded Made Ground, indicated to consist of 'compacted soil stone clay and brick fill' at a depth of 0-0.8m. Otherwise, the boreholes recorded granular natural superficial deposits to a depth of between 3.9m and 5.2m, assumed to correlate with the River Terrace Deposits recorded on the published mapping. RB1 and BH1 penetrated the underlying solid geology. This was recorded to be mudstone and siltstone to a depth of at least 11.5m in RB1 and sandstone (2.5m thickness) overlying mudstone to a depth of 8.7m in BH1.

11.95 Chemical testing of soils was undertaken from BH1, PH13 and PH14 (5 samples in total). **Table 11.4** summarises the results of this testing.

Table 11.4: Soil Chemical Testing Results

Soil Chemical Testing Results from BH1, PH13 & PH14 (1998 Investigation)		
Analyte	Number of Samples	Range of Recorded Concentrations (mg/kg)
pH	5	6.4-9.1
Cyanide	5	Al results <1
Sulphide	5	All results <0.5
Total Sulphate	5	500-900
Arsenic	5	7-29
Boron (water soluble)	5	0.09-5.7
Cadmium	5	1.1-6.5
Chromium	5	15-40
Copper	5	10-25
Lead	5	20-140
Mercury	5	All results <0.1

Soil Chemical Testing Results from BH1, PH13 & PH14 (1998 Investigation)		
Analyte	Number of Samples	Range of Recorded Concentrations (mg/kg)
Nickel	5	20-45
Selenium	5	All results <1
Zinc	5	60-100
Phenol (monohydric)	5	All results <1
Toluene Extractable Matter	5	<100-1900

11.96 Additionally, groundwater testing was undertaken as part of the 1998 site investigation at BH1 (two monitoring rounds) and PH14 (one monitoring round). The results of this testing are summarised in **Table 11.5**.

Table 11.5: Groundwater Chemical Testing Results

Groundwater Chemical Testing Results from BH1 & PH14 (1998 Investigation)		
Analyte	BH1 (mg/l), 2 monitoring rounds unless otherwise stated	PH14 (mg/l), 1 monitoring round
pH	7.6-7.8	6.8
Cyanide	<0.05 (1 monitoring round only)	N/A
Sulphate	99-100	67
Sulphide	All results <0.05	<0.05
Arsenic	All results <0.01	<0.01
Boron	<0.01-186	4.8
Cadmium	All results <0.01	<0.005
Chromium	All results <0.01	<0.01
Copper	All results <0.01	<0.01
Lead	All results <0.01	<0.01
Mercury	<0.001 (1 monitoring round only)	N/A
Nickel	<0.01 (1 monitoring round only)	0.02
Selenium	All results <0.01	<0.01
Zinc	All results <0.01	<0.01
Cyclohexane Extractable Matter	2-8	<1
Volatile Organic Compounds (VOC)	All VOC concentrations below laboratory limit of detection (1 monitoring round only)	N/A

Eastern Development Area

11.97 SMDC have provided details of a ground investigation undertaken by Rogers Geotechnical in 2009 at the Eastern Development Area. This comprised three cable percussion boreholes to 6.86-7.55m and three trial pits to 1.90-2.80m. All investigation points were located at the western boundary of the Eastern Development Area.

11.98 The Rogers Geotechnical investigation recorded ground conditions to consist of topsoil (0.3-0.5m), overlying reworked natural gravels generally to a depth of 0.8-1.4m), which in turn overlie River Terrace Deposits (gravels) and Mercia Mudstone deposits (stiff to very stiff clay). However, this information is limited to three locations on the extreme western boundary of the Eastern Development Area, and therefore only provides a very incomplete representation of ground conditions across the Eastern Development Area. As discussed above, specific contamination sources (e.g. associated with the former route of the River Blithe, uncontrolled historical waste deposition from the adjacent colour works etc.) may be present within the Eastern Development Area. The Rogers investigation does not provide sufficient coverage to assess the presence / absence or nature of these possible sources.

11.99 No soil contamination testing was undertaken as part of the Rogers investigation. Groundwater sampling was undertaken from all three boreholes, although this appears to have been done contemporaneously with the drilling. This method deviates from current best practice, hence the results should be viewed with caution. Nevertheless, the results have been reviewed with regard to current published guidance values (e.g. Environmental Quality Standards for the protection of aquatic life in Controlled Waters). This indicates good groundwater quality, with results falling below guidance values (or within published ranges for contaminants where guidance values vary depending on the hardness value of the receiving watercourse).

Emergency Access Area from Sandon Road

11.100 The previous investigations included numerous boreholes and trial pits within / close to the proposed emergency access from Sandon Road and the proposed internal access road, as these lie within the footprint of the former colour works. This includes Area 3 of the former Blythe Colour Works (see **Appendix 11.2**). This was identified as an area of particularly elevated metals concentrations, particularly cadmium, lead and arsenic. Due to potential risks to human health (commercial end users) and the wider environment (e.g. Controlled Waters) associated with this contamination, remediation was undertaken as part of the redevelopment of the colour works as Blythe Park Industrial Estate.

11.101 The remediation work involved the installation of drainage control measures and capping with hard surfacing. This was accompanied by a programme of long term surface water monitoring in relation to potential risks to the River Blithe (discussed further below).

11.102 The remainder of the proposed emergency access area from Sandon Road falls with part of Blythe Colour Works previously defined as ‘Area 4’. Based on the assumption of a commercial end use, Wardell Armstrong report NL07510/001/V0.1 concluded that Area 4 ‘was not considered to pose any significant threat to the environment or potential site occupiers’. However, it is noted that the former bowling green was not investigated

in detail. This has been identified by the VVSM information as an area of potential landfilling, although it should be noted that there will be no ground disturbance in this area as part of the establishment of the emergency access.

Remainder of Previous Investigations

11.103 The remainder of the previous investigations relating to the former Blythe Colour Works site falls outside the site boundary. The findings of these investigations are briefly summarised as follows:

- Based on the assumption of future commercial land use, three areas of potentially significant contamination requiring remediation were identified (Areas 1-3; see **Appendix 11.2**). Area 3 falls within the proposed emergency access area from Sandon Road, as discussed above.

- Area 1 comprises the former colour works landfill. This is approximately 26,000m² in area and raised approximately 3m above the surrounding land. Elevated concentrations of various metals / metalloids, specifically As, Cd, Cr, Pb, Zn and B, were recorded in soils in this area. In particular, highly elevated concentrations of cadmium (up to 10,000 mg/kg), lead (93,000 mg/kg) and zinc (21,000 mg/kg) were identified. This correlates with the landfill records and anecdotal evidence previously discussed. Elevated concentrations of other contaminants (e.g. PAH, petroleum hydrocarbons) may also be present in the landfill, although available information in this regard is limited.

- The landfill in Area 1 has historically been reported to overlie natural deposits containing peaty clay. Limited historical gas monitoring has been undertaken, but this is considered insufficient, with regard to the current regulatory framework, to assess the associated ground gas risk.

- Area 2, similarly to Areas 3, contains made ground deposits that display highly elevated metals concentrations.

- Elevated leachable contamination and evidence of groundwater contamination was identified, primarily associated with Areas 1-3. Following risk assessment in relation to potential effects on the nearby River Blithe, a remediation strategy was developed in consultation with Staffordshire Moorlands District Council and the Environment Agency (both in relation to human health risks and risks to the river).

- The remediation strategy for Area 1 involved clay capping and drainage / leachate control measures. Drainage measures were installed in Area 2 and this area capped with hard surfacing (similarly to Area 3, as discussed above). This strategy was accompanied by a programme of long term surface water monitoring in relation to potential risks to the River Blithe. This programme was completed in 2013, as detailed in Wardell Armstrong report ref. NL07510/001/V0.1 '*Addendum to Validation Report on Construction Quality Assurance for Remediation of Areas 1, 2 and 3 and Associated Site Information: Collation of Monitoring Reports* (**Appendix 11.2**)'. That report concluded that "although some fluctuation in water chemistry has occurred no single determinant has exceeded the guidelines used for water quality".

- The remainder of the Blythe Colour site recorded lower contaminant concentrations and was designated as 'Area 4'. No remediation was undertaken in Area 4, which is now in use for a variety of commercial and industrial purposes. A localised area of chlorinated solvent contamination (both in soil and groundwater) was identified in Area 4, adjacent to the proposed emergency access from Sandon Road (outside the current site boundary). Following several phases of investigation and risk assessment, it was determined that the potential risks were sufficiently low that no remediation was necessary in relation to chlorinated solvents.

Predicted Significant Effects

11.104 An impact assessment is presented for both the construction and operational phases. For ease of assessment with regard to published guidance, the operational phase is assessed first, followed by consideration of any additional or different effects that may be present during the construction phase.

Operational Phase – Conceptual Site Model

Sources

On Site

11.105 The identified baseline conditions are considered to provide the following potential contamination sources within the boundaries of the Western and Eastern Development Areas:

- All parts of the site have historically been used for agricultural purposes, with this being the exclusive recorded historical land use in the Eastern Development Area. Although agricultural land presents a relatively low contamination risk, the potential for contamination associated with historical agricultural activities cannot be discounted. Potentially contaminative agricultural practices include the application of soil improvement agents (in some historical cases, these included sewage sludge and industrial by-products) and pesticides / herbicides. They can also include burning, with the resulting ash potentially containing elevated contaminant concentrations (e.g. heavy metals, polycyclic aromatic hydrocarbons (PAH)).

- As discussed above, the potential for uncontrolled, unrecorded, disposal of waste from the colour works at locations within the site boundary exists, and there is anecdotal evidence that this may have occurred. Based on the processes undertaken at the colour works, the VVSM information, and data available on the chemical composition of the waste at the adjacent landfill, any such deposits may display elevated concentrations of toxic / heavy metals, asbestos, the presence of organic contaminants and potentially present a risk via radioactivity (i.e. from uranium oxide). Additionally, the disposal of chemicals associated with the former army base (e.g. chlorinated solvents, chloramine, ammonium solutions etc.) cannot be discounted.

- Current land use in the north east of the Western Development Area includes an area that has been used to discard various materials, including tyres, lubricant

containers etc. Associated soil contamination may include hydrocarbons and potentially asbestos (this is a general risk associated with tipping; no specific evidence of asbestos was noted during the walkover).

- Historical industrial land use in the eastern part of the Western Development Area, including a former tank in the north east of this area (as shown on historical mapping from the 1970s). As this appears on topographical mapping, it is assumed to have been an above ground structure. Depending on its contents (e.g. fuel, water etc.), which is currently unknown, residual contamination may be present associated with this structure. Although the history of this area suggests that it may be a potential contamination source, the limited available data from the 1998 site investigation in this area did not identify any significant evidence of contamination.

- The potential for infilled former watercourses in the north east of the Western Development Area and across the centre of the Eastern Development Area, as identified from the historical mapping. Additionally, the area of proposed emergency access from Sandon Road was historically crossed by a watercourse (Mill Race) that may have been infilled. Depending on the nature of any infill materials used, these features may present a contamination source. Additionally, marshy ground previously associated with the route of the watercourses (shown on historical mapping) may indicate the presence of deposits with a high organic content that may provide a ground gas source.

11.106 Additional sources of contamination may be present within the proposed emergency access area from Sandon Road and the proposed internal access road, which fall within areas previously occupied by Blythe Colour Works. Whilst these lie within the previously defined Area 4 of the Blythe Colours site (identified to be the lowest contamination risk) and development work in these areas will not involve significant ground disturbance, based on the previous investigation data the presence of Made Ground with elevated concentrations of various contaminants (particularly metals / metalloids) should be anticipated. In particular, the bowling green area is recorded to have historically received waste deposits.

11.107 The emergency access area may also be underlain by a landfill ("The Paddock") although the precise location of this is unknown. The available information suggests that this landfill may have accepted waste from the pottery industry. Contaminants associated with such waste often include metals / metalloids, derived from pottery glazes and colours.

Off Site

11.108 Potential contamination sources in the vicinity of the site are relevant in relation to mobile contaminants (e.g. groundwater contamination, ground gas). The primary significant historical land use in the vicinity of the site is Blythe Colour Works (this was generally located outside the site boundary, although as previously discussed appears to have encroached into the Western Development Area and also occupied the proposed emergency access and internal access road).

11.109 As identified by previous investigations, both soil and groundwater contamination are present in the location of the former colour works (metals / metalloids and chlorinated

solvents), particularly in Areas 1-3. Following the remediation previously undertaken, the potential risks of ongoing contaminant migration onto the site should be significantly reduced. However, the potential for the site to have been affected by historical migration of contamination from Blythe Colour Works exists. Available groundwater monitoring data from within the Western Development Area generally indicates that water quality in this area does not appear to have been affected by such migration (i.e. the results listed in **Table 11.5** generally fall below laboratory limits of detection and / or Environmental Quality Standards and UK Drinking Water Standards). However, the level of data available is insufficient to allow any meaningful certainty that this is the case across the site. It is also noted that the results include a single highly elevated boron result from BH1 (186 mg/l), although this was not replicated in the only other monitoring round from this borehole (result of <0.01 mg/l boron).

11.110 The former army base represents a potential source of groundwater contamination. The primary impregnation chemical likely to have been used is chloramine. In itself, the presence of chloramine is not directly regulated in groundwater or drinking water in the UK. However, it does contribute towards assessments of river quality when considering free chlorine levels and hence represents a relevant contaminant of concern. Other contaminants potentially associated with the army base may include ammoniacal nitrogen and chlorinated solvents. No significant contamination by these substances was identified when the location of the former base (i.e. the former colour works) was previously investigated. However, this does not necessarily preclude the presence of historical contamination derived from the base in groundwater in the area. It is also noted that, although ultimately determined to not present a risk, a localised area of chlorinated solvent contamination was recorded within the adjacent Blythe Colours site by previous investigations.

11.111 Other potential off-site sources of contamination include:

- Blythe Park Industrial Estate. This is / has been occupied by a wide variety of industrial and commercial operators and thus represents a potential source of a variety of contaminants.
- Historical railway land adjacent to the north of the site.
- A former filter bed and tank adjacent to the west of the site. This may be indicative of sewage processing in this area.
- Historical landfills located 173m and 361m north of the site. The type of waste deposited at these is unknown. If it contained a significant degradable content then they may represent a potential ground gas source.
- Materials within the natural superficial deposits that display a high organic content. In the area of the former colour works landfill (Area 1), these include thin deposits of ‘silty sandy peaty clay’. These deposits may present a gas generation source, although based on the currently available information, the risk of significant generation rates appears to be low.

- The foul sewer to the west of the site. It is not known whether this subsequently runs beneath the site. Depending on its route and condition, this may represent a source of contamination.

Receptors

11.112 The relevant critical receptors during the operational phase in relation to human health risks from soil contamination are:

- Female child aged 0-6, in the Western Development Area.
- Female worker aged 16-65, in the Eastern Development Area.

11.113 The proposed emergency access area from Sandon Road is considered to have no receptor during the operational phase (i.e. area occupied by roads), although sources of contamination in this area may still remain relevant in relation to migratory contaminants (e.g. groundwater and gas).

11.114 The primary sensitive Controlled Waters receptors present at or near to the site are:

- The River Blithe and associated un-named tributaries adjacent to the site.
- The Secondary B Aquifers that underlie the site, particularly the Tarporley Siltstone as this falls within part of the Source Protection Zone for a drinking water abstraction located 244m north west of the site.

11.115 Aside from aquatic life within the River Blithe / tributaries (defined as Controlled Waters receptors), no ecological receptors have been identified (i.e. no sites / designations listed as relevant ecological receptors in Part IIA guidance).

11.116 The primary receptor in relation to ground gas is considered to be human health, via accumulation of gas in enclosed spaces (e.g. within buildings) leading to explosion or asphyxiation.

11.117 Other potential receptors at the operational stage include buried concrete and below ground water supply pipes, both of which have the potential to be affected by the surrounding soil and groundwater chemistry.

Pathways

11.118 Whilst potential sources and receptors of contamination have been identified in relation to the operational phase, in order for a potential contamination risk to be identified, it is essential that a viable pathway for contamination from the source to reach the receptor exists.

11.119 The following potential exposure pathways exist in relation to human health risk from chemical soil contamination during the operational phase within the Western and Eastern Development Areas: direct soil and indoor dust ingestion, consumption of homegrown produce (Western Development Area only), consumption of soil adhering to homegrown produce (Western Development Area only), skin contact with soils and indoor dust, inhalation of indoor and outdoor dust and vapours.

11.120 Due to the radioactive decay mechanism of uranium (alpha decay with long half-lives), the primary relevant exposure pathway associated with any deposits that contain uranium oxide would be direct ingestion or contact with open wounds.

11.121 The potential pathways associated with risks to Controlled Waters are:

- Leaching of contamination to the underlying aquifers and subsequent groundwater flow to the drinking water abstraction.
- Migration of contaminated groundwater onto the site from identified off-site potentially contaminative land uses. This may include shallow migration within the superficial gravels or deeper migration within the solid strata (particularly in areas underlain by the Tarporley Siltstone).
- Groundwater flow into the River Blithe (from the superficial and / or solid aquifers).
- Surface run off to the River Blithe.

11.122 The potential pathways associated with ground gas are lateral migration through high permeability deposits (e.g. gravels, sandstone) and vertical migration into buildings.

11.123 Whilst the above describes the general nature of the pathways that may be present, it should be noted that the nature of the pathways is not uniform across the site. Specific preferential migration pathways may exist that lead to increased risks in certain areas. Conversely, other areas of the site may display characteristics that reduce the potential for a significant pathway. Examples of these circumstances include:

- Preferential migration of ground gas and / or groundwater contamination within the routes of former watercourses.
- Preferential migration of contaminants into groundwater in any locations where the operational phase involves the use of piled foundations.
- Localised direct hydraulic continuity between the former bowling green landfill (within the proposed emergency access area from Sandon Road) and the River Blithe. The landfill is recorded to overlie a local area of alluvial deposits that are assumed to be in hydraulic continuity with the River Blithe, hence a direct shallow groundwater migration pathway may be present.
- Reduced potential for groundwater contamination migration pathways in the south of the Western Development Area, as this is underlain by deposits of glacial till and Mercia Mudstone.

11.124 The potential pathways associated with risks to buried concrete and water supply pipes are the generation of contaminated leachate within the unsaturated zone and direct contact with these structures.

Operational Phase Effects

11.125 The potential operational phase impacts have been assessed by considering a reasonable 'worst case' scenario, in accordance with the Scoping Response.

Human Health

11.126 The 'receptor sensitivity' criterion for human health impacts in the Western Development Area has been assessed as 'high' and the sensitivity in the Eastern Development area as 'medium', in accordance with **Table 11.1**.

11.127 The identified potential 'worst case' sources include the potential for the presence of highly elevated concentrations of toxic metals / metalloids, asbestos, radioactive waste deposits, soils affected by organic contamination (e.g. solvents, PAH) etc. These sources provide the potential for acute health risks to future site users and potentially also for significant long term chronic health risks. Therefore, in this worst case scenario, the 'magnitude of effects' criterion would be 'major'. In accordance with Table 11.3, this provides an overall potential impact of **major** for the Western Development Area and **major-moderate** for the Eastern Development Area.

11.128 As there is no operational phase receptor in the emergency access area, the overall potential impact has been assessed as **negligible**.

Controlled Waters

Groundwater

11.129 The receptor sensitivity in relation to groundwater has been assessed as 'high', as parts of the site are within a Source Protection Zone for a potable groundwater abstraction. Due to the remediation work undertaken in relation to the adjacent Areas 1-3 of the Blythe Colour Works site (which will significantly limit future contaminant leaching) and the limited on-site groundwater data available from the 1998 site investigation (which generally indicates low contaminant concentrations), an appropriate classification for the potential 'magnitude of effects' may be 'moderate'. However, whilst realistic given the currently available data, this classification does not account for the potential worst case conditions. These are considered to be:

- The presence of significantly elevated levels of toxic metals / metalloids in groundwater, derived from any historical uncontrolled waste disposal at the site.
- The presence of organic contamination in groundwater, potentially including light non-aqueous phase liquids (LNAPL) derived from waste disposal, fuel storage etc.
- Elevated levels of radioactivity in groundwater.
- General poor groundwater quality (PAHs, pesticides / herbicides, inorganic contaminants etc.) associated with historical agricultural practices and the presence of backfill materials in the former river channel.

11.130 Based on this worst case scenario, the 'potential magnitude of effects' has been classified as 'major'. In accordance with **Table 11.3**, this provides an overall potential impact of **major**.

Surface Water

11.131 In accordance with **Table 11.1**, the receptor sensitivity in relation to the River Blithe would be classified as 'medium'. However, given the good pre-existing chemical water quality in the river (as recorded by historical Environment Agency GQA records and long term monitoring undertaken by Wardell Armstrong between 2010 and 2013), professional judgment has been used to classify the sensitivity of this receptor as 'high'.

11.132 With regard to the worst case scenario discussed above, the 'magnitude of effects' criterion would be classified as high. However, there is evidence from the baseline conditions assessment that there is no ongoing significant effect on the river (i.e. the 2010-2013 monitoring results), indicating that these potential worst case effects are not being observed in reality. Therefore, the 'magnitude of effects' criterion has been decreased to 'moderate'. In combination with the high receptor sensitivity, this provides an overall potential impact of **moderate**.

Ground Gas

11.133 The receptor sensitivity in relation to ground gas has been classified as 'high'. The 'magnitude of effects' criterion has been classified as 'major', as the potential effects of ground gas include acute risks to human health (i.e. explosions in occupied buildings or asphyxiation). This would provide an overall potential impact of major. However, although the impact would be major if an adverse effect did occur, the probability of such an effect occurring is considered to be relatively low. This is due to the nature of the identified potential gas sources, which include:

- Any deposits of degradable material associated with the backfilled river channel (given the age of this, the potential for significant ongoing gas generation is limited).
- Organic-rich soils associated with the former river channel.
- The Paddock landfill. The available records do not suggest that this accepted household waste, indicating a low-moderate potential for gas generation.
- Vapour generation from any organic contamination of soil and groundwater.

11.134 As the nature of the potential gas sources indicates a relatively low probability of the identified possible adverse effects being realised, professional judgement has been used to decrease the overall potential impact assessment to **moderate**.

Water Supply Pipes

11.135 The receptor sensitivity in relation to water supply pipes has been classified as 'high' due to the direct relevance of water quality in supply pipes to human health. The identified potential sources indicate that the presence of soil contamination that may pose a risk significant risk of contaminant leaching into water supply pipes is possible. Therefore, the 'magnitude of effects' criterion has been classified as 'major'. This provides an overall potential impact of **major**.

Underground Concrete Structures

11.136 The receptor sensitivity in relation to underground concrete structures has been classified as “low”, in accordance with **Table 11.1**. As defined in **Table 11.2**, the ‘magnitude of effects’ criterion for effects on underground concrete is classified as minor. This provides an overall potential impact of **minor-negligible**. Nevertheless, as a matter of construction quality, structures should be designed to be appropriate for the ground conditions throughout their design life (i.e. a concrete specification appropriate for the ground conditions should be used).

Construction Phase Effects

11.137 The potential construction phase impacts have been assessed by considering a reasonable ‘worst case’ scenario, in accordance with the Scoping Response.

Human Health

11.138 The critical human health receptor in relation to construction phase impacts is construction workers. In accordance with **Table 11.1**, the receptor sensitivity has been classified as ‘high’. Although the potential exposure duration for construction workers is limited, the nature of their activities (i.e. close contact with soil, dust etc.) promotes the likelihood of a source-pathway-receptor linkage.

11.139 The worst case potential sources of contamination include those with the potential to present a direct acute risk to construction workers. As discussed, these may include highly elevated concentrations of toxic metals / metalloids, deposits displaying radioactivity, and asbestos. Due to this, the ‘magnitude of effects’ criterion has been classified as ‘major’. This provides an overall potential impact of **major**.

Controlled Waters

11.140 The receptor sensitivities for groundwater and surface water (River Blithe) are classified as ‘high’ in both instances, as discussed in the Operational Phase assessment above.

11.141 Ground disturbance during development activities provides an increased potential for the leaching of contamination to surface water and groundwater. The extent of this risk will depend on the nature of the development activities, with operations involving bulk earthworks or piling the most likely to cause a potential impact. The ‘magnitude of effects’ criterion has been assessed as ‘major’, to allow for the full range of likely development operations, and also account for the worst case potential contamination sources discussed. This provides an overall potential impact of **major** for both surface water and groundwater.

Ground Gas

11.142 The receptor in relation to ground gas is human health, which is classified as a ‘high’ sensitivity receptor.

11.143 It is assumed that any construction compounds will be lightweight modular buildings with solid metal floors. The potential for gas ingress into such buildings is low. However, in the unlikely event of significant gas accumulation, the potential effect (asphyxiation / explosion) is severe, hence the ‘magnitude of effects’ criterion has been assessed as ‘major’. Together with the high receptor sensitivity, this would provide an overall potential impact of major. However, the potential for an adverse effect (asphyxiation /

explosion) occurring is considered to be low, given the nature of the potential gas sources identified and the low possibility of significant gas ingress into modular compound buildings. To account for this, professional judgement has been applied to provide an overall potential impact assessment of **minor**.

11.144 Construction workers also present a potential receptor for ground gas, due to the possibility of gas accumulation within excavations / trenches. However, it is anticipated that this can be addressed by the use of appropriate Confined Spaces working procedures and PPE, so does not affect the overall potential impact assessment provided above.

Potential Impacts Associated With Construction Activities

11.145 The assessment of potential construction phase impacts provided above is based on pre-existing potential contamination sources at / around the site (i.e. information identified from the baseline conditions assessment). However, the potential for construction activities to introduce new sources of contamination also exists.

11.146 This can occur due to the storage and / or spillage of fuels and other chemicals used during the construction process. Incorrect fuel storage / use can present a significant risk to the environment and potential risk classifications associated with these sources are as follows:

- Human health (skin contact, ingestion, inhalation): **Major** (high receptor sensitivity and major magnitude of effects).
- Controlled Waters (leaching to groundwater etc.): **Major** (high receptor sensitivity and major magnitude of effects).
- Controlled Waters (River Blithe): **Major** (high receptor sensitivity and major magnitude of effects).

11.147 Mitigation measures will be required with respect to fuels and other potentially hazardous chemicals to ensure that the construction phase does not introduce new contamination sources that lead to the potential effects on receptors indicated above. This would include the preparation of a construction phase Environmental Management Plan.

Cumulative Effects

11.148 SMDC requested that the EIA consider one development for potential cumulative effects. The site is located at the former Indesit Work, Grindley Lane. Blythe Bridge (reference 09/11860/FUL) and the application, now permitted, was to alter conditions allowing the change of use on existing factory buildings. The reason for assessing for potential cumulative effects relates to highways and traffic flows. It is judged that there is no potential for significant cumulative Ground Condition effects given the physical separation between the sites.

11.149 The only other potential cumulative effects are those that relate to mobile contaminants i.e. ground gas and groundwater / surface water contamination. The only potentially significant cumulative impact identified is the potential for increased contaminant

leaching during the construction phase. This could provide an additive effect with contamination from the adjacent former colour works, increasing the risk to Controlled Waters. The potential cumulative impact is assessed as **moderate-major**.

Summary of Conceptual Site Model and Impact Assessment

11.150 The potential pollutant linkages discussed above are summarised in the 'worst case' conceptual site model in **Table 11.6**.

Table 11.6: Worst Case Conceptual Site Model

Worst Case Conceptual Site Model Operational Phase Source	Contaminants*	Pathway	Receptor	Impact Assessment
Human Health (Items in red relate to the Western Development Area only, items in blue relate to the Eastern Development Area only, items in black potentially relate to both areas)				
1) Made Ground and / or contaminated natural soils associated with agricultural land use.	Metals / metalloids, pesticides / herbicides / insecticides, PAH, petroleum / diesel hydrocarbons.	**Chemical contamination** • Ingestion of soil; • Ingestion of indoor dust; • Dermal contact with soil; • Dermal contact with indoor dust; • Inhalation of fugitive soil dust; • Inhalation of fugitive indoor dust; • Inhalation of vapours outside; • Inhalation of vapours inside; • Ingestion of homegrown produce; • Ingestion of soil attached to homegrown produce. **Radiological Contamination** • Ingestion of soil; • Ingestion of soil attached to homegrown produce; • Inhalation of fugitive soil dust; • Inhalation of fugitive indoor dust; • Soil contact with open wounds.	Western Development Area: Human health (critical receptor female child aged 0-6) Eastern Development Area: Female worker aged 16-65	Major Major-moderate
2) Former tank in the east of the Western Development Area.	Hydrocarbons e.g. fuel oils.			
3) Infilled former watercourses.	Nature of any backfill materials unknown. Potential for a wide range of contaminants (e.g. metals, PAH, inorganics etc.)			
4) Made Ground and / or contaminated soils associated with area of tipping in the north east of the Western Development Area.	Potential for a range of contaminants, which may include hydrocarbons (lubricants, oils, greases) and asbestos.			
5) Unrecorded waste deposits derived from the former colour works.	Elevated concentrations of metals / metalloids, other inorganics (including significantly acidic or alkaline waste), organic contaminants. Radioactivity (colour products containing uranium oxide).			
6) Sewage pipeline (unproven) i.e. potential for historical sewage leaks.	Metals / metalloids, pathogens.			
7) Made Ground and / or soil contamination derived from the adjacent former army base.	Chlorinated solvents, chloramine, caustic or acidic pH, asbestos.			

Worst Case Conceptual Site Model Operational Phase Source	Contaminants*	Pathway	Receptor	Impact Assessment
Controlled Waters (N.B. As Controlled Waters risk has been assessed on a 'site-wide' basis, this section has not been colour coded in relation to specific site areas)				
1) Made Ground and / or contaminated natural soils associated with agricultural land use.	Metals / metalloids, pesticides / herbicides / insecticides, PAH, petroleum / diesel hydrocarbons.	• Leaching / direct infiltration of contamination to superficial deposits and underlying solid aquifers. • Preferential vertical migration of contamination via piled foundations. • Lateral groundwater flow from off-site sources into the site. (See 'Pathways' section above for discussion of possible preferential pathways).	Underlying Secondary Aquifers, particularly the Tarporley Siltstone. Associated drinking water abstraction 244m north west of the site.	Major
2) Former tank in the east of the Western Development Area.	Hydrocarbons e.g. fuel oils.			
3) Infilled former watercourses.	Nature of any backfill materials unknown. Potential for a wide range of contaminants (e.g. metals, PAH, inorganics etc.)			
4) Made ground / soil contamination associated with Blythe Colour Works in the area of the proposed emergency access, particularly in the location of the bowling green (recorded area of former tipping).	Elevated concentrations of metals / metalloids. Potential for organic contamination.			
5) Made Ground and / or contaminated soils associated with area of tipping in the north east of the Western Development Area.	Potential for a range of contaminants, which may include hydrocarbons (lubricants, oils, greases).			
6) Unrecorded waste deposits derived from the former colour works.	Elevated concentrations of metals / metalloids, other inorganics (e.g. significantly acidic or alkaline waste), organic contaminants. Radioactivity (colour products containing uranium oxide).			
7) Pottery waste landfill deposits ('The Paddock' landfill).	Most likely contaminants are metals / metalloids and PAH.			
8) Sewage pipeline (unproven) i.e. potential for historical sewage leaks.	Metals / metalloids, pathogens.			
9) Made Ground and / or soil contamination associated with the adjacent former army base.	Chlorinated solvents, chloramine (potential liberation of free chlorine) and adverse pH.			

Worst Case Conceptual Site Model Operational Phase Source	Contaminants*	Pathway	Receptor	Impact Assessment
10) Off-site sources of groundwater contamination, potentially derived from a variety of historical off-site activities. These include Blythe Colour Works, Blythe Park Industrial Estate, the former army base, railway and possibly sewage processing.	Wide range of possible contaminants, including metals / metalloids, other inorganics, and organic contaminants. Contamination derived from the army base may include chlorinated solvents, chloramine (potential liberation of free chlorine) and adverse pH.			
Sources 1-10, as above.	Contaminants associated with sources 1-10, as above.	• Lateral groundwater flow within the superficial and solid aquifers. • Surface run-off. (See 'Pathways' section above for discussion of possible preferential pathways).	River Blithe and associated un-named tributaries.	Moderate
Water Supply Pipes (N.B. As risks to water supply pipes have been assessed on a 'site-wide' basis, this section has not been colour coded in relation to specific site areas)				
Sources 1-10, as above.	Contaminants with the potential to permeate supply pipes (primarily hydrocarbons)	Generation of leachate and subsequent permeation into water supply pipes and / or damage to pipe construction materials.	Human health (drinking water supply)	Major

Worst Case Conceptual Site Model Operational Phase Source	Contaminants*	Pathway	Receptor	Impact Assessment
Ground Gas (N.B. As ground gas risk has been assessed on a 'site-wide' basis, this section has not been colour coded in relation to specific site areas)				
1) Made Ground and / or contaminated natural soils associated with agricultural land use.	Carbon dioxide and / or methane.	• Direct vertical migration of site-generated gas into buildings. • Lateral migration of off-site generated gas onto the site. (See 'Pathways' section above for discussion of potential preferential pathways).	Human health and buildings (asphyxiation and / or explosion).	Moderate
2) Former tank in the east of the Western Development Area.	Residual hydrocarbon contamination (risk of vapour generation).			
3) Infilled watercourses, together with associated areas of historically marshy ground (potential for soils with high organic content).	Gas generating material, including organic matter in any Made Ground.			
4) Made ground / soil contamination associated with Blythe Colour Works in the area of the proposed infrastructure improvements.	Carbon dioxide and / or methane. Vapours associated with industrial waste deposits (e.g. volatile organic compounds).			
5) Made Ground associated with area of tipping in the north east of the Western Development Area.	Carbon dioxide and / or methane.			
6) Unrecorded waste deposits derived from the former colour works.	Carbon dioxide and / or methane. Vapours associated with industrial waste deposits (e.g. volatile organic compounds).			
7) Pottery waste landfill deposits ('The Paddock' landfill).	Carbon dioxide and / or methane.			
8) Sewage pipeline (unproven) i.e. potential for historical sewage leaks.	Carbon dioxide, methane, hydrogen sulphide.			
9) Organic matter within natural superficial deposits at / around the site (e.g. recorded presence of minor quantities of peaty clay beneath adjacent Blythe Colour Works landfill).	Carbon dioxide and / or methane.			
10) Off-site gas sources e.g. historical sewage processing, historical landfills located 173m and 361m from the site.	Carbon dioxide, methane, other landfill gas constituents (e.g. sulphur compounds).			

Worst Case Conceptual Site Model Operational Phase Source	Contaminants*	Pathway	Receptor	Impact Assessment
Construction Phase				
Human Health (Items in red relate to the Western Development Area only, items in black potentially relate to both areas)				
1) Made Ground and / or contaminated natural soils associated with agricultural land use.	Metals / metalloids, pesticides / herbicides / insecticides, PAH, petroleum / diesel hydrocarbons.	***Chemical contamination*** • Ingestion of soil; • Dermal contact with soil; • Inhalation of fugitive soil dust; • Inhalation of vapours outside. • Radiological Contamination • Ingestion of soil; • Ingestion of soil attached to homegrown produce; • Inhalation of fugitive soil dust; • Inhalation of fugitive indoor dust; • Soil contact with open wounds.	Construction Workers	Major
2) Former tank in the east of the Western Development Area.	Hydrocarbons e.g. fuel oils.			
3) Infilled former watercourses.	Nature of any backfill materials unknown. Potential for a wide range of contaminants (e.g. metals, PAH, inorganics etc.)			
4) Made Ground and / or contaminated soils associated with area of tipping in the north east of the Western Development Area.	Potential for a range of contaminants, which may include hydrocarbons (lubricants, oils, greases) and asbestos.			
5) Unrecorded waste deposits derived from the former colour works.	Elevated concentrations of metals / metalloids, other inorganics (e.g. significantly acidic or alkaline waste), organic contaminants. Radioactivity (colour products containing uranium oxide).			
6) Sewage pipeline (unproven) i.e. potential for historical sewage leaks.	Metals / metalloids, pathogens.			
7) Made Ground and / or soil contamination associated with the adjacent former army base.	Chlorinated solvents, chloramine, caustic or acidic pH, asbestos.			

Worst Case Conceptual Site Model Operational Phase Source	Contaminants*	Pathway	Receptor	Impact Assessment
Controlled Waters (N.B. As risks to Controlled Waters have been assessed on a 'site-wide' basis, this section has not been colour coded in relation to specific site areas)				
1) Made Ground and / or contaminated natural soils associated with agricultural land use.	Metals / metalloids, pesticides / herbicides / insecticides, PAH, petroleum / diesel hydrocarbons.	• Leaching / direct infiltration of contamination to superficial deposits and underlying solid aquifers. The leaching potential may be increased by ground disturbance associated with construction activities (e.g. piling). • Lateral migration from off-site sources. The migration potential may be increased by development activities (e.g. if any dewatering is required in areas underlain by shallow sand and gravel). (See 'Pathways' section, above, for discussion of potential preferential pathways).	Underlying Secondary Aquifers, particularly the Tarporley Siltstone. Associated drinking water abstraction 244m north west of the site.	Major
2) Former tank in the east of the Western Development Area.	Hydrocarbons e.g. fuel oils.			
3) Infilled former watercourses.	Nature of any backfill materials unknown. Potential for a wide range of contaminants (e.g. metals, PAH, inorganics etc.)			
4) Made ground / soil contamination associated with Blythe Colour Works in the area of the proposed emergency access and internal access road, including the recorded area of former tipping). Note that this potential source will not be disturbed during the construction phase, minimising the potential for contaminant mobilisation.	Elevated concentrations of metals / metalloids. Potential for organic contamination.			
5) Made Ground and / or contaminated soils associated with area of tipping in the north east of the Western Development Area.	Potential for a range of contaminants, which may include hydrocarbons (lubricants, oils, greases).			
6) Unrecorded waste deposits derived from the former colour works.	Elevated concentrations of metals / metalloids, other inorganics (e.g. significantly acidic or alkaline waste), organic contaminants. Radioactivity (colour products containing uranium oxide).			
7) Pottery waste landfill deposits ('The Paddock' landfill). Note that this potential source will not be disturbed during the construction phase, minimising the potential for contaminant mobilisation.	Most likely contaminants are metals / metalloids and PAH.			
8) Sewage pipeline (unproven) i.e. potential for historical sewage leaks.	Metals / metalloids, pathogens.			

Worst Case Conceptual Site Model Operational Phase Source	Contaminants*	Pathway	Receptor	Impact Assessment
9) Made Ground and / or soil contamination associated with the adjacent former army base.	Chlorinated solvents, chloramine (potential liberation of free chlorine) and adverse pH.			
10) Off-site sources of groundwater contamination, potentially derived from a variety of historical off-site activities. These include Blythe Colour Works, Blythe Park Industrial Estate, the former army base, railway and possibly sewage processing.	Wide range of possible contaminants, including metals / metalloids, other inorganics, and organic contaminants. Contamination derived from the army base may include chlorinated solvents, chloramine (potential liberation of free chlorine) and adverse pH.			
Sources 1-10, as above.	Contaminants associated with sources 1-10, as above.	Lateral groundwater flow within the superficial and solid aquifers. Surface run-off. The potential for the generation of contaminated leachate and surface run-off may be increased by ground disturbance associated with construction activities. (See 'Pathways' section, above, for discussion of potential preferential pathways).	River Blithe and associated un-named tributaries.	Major

Worst Case Conceptual Site Model Operational Phase Source	Contaminants*	Pathway	Receptor	Impact Assessment
Ground Gas (N.B. As risks from ground gas have been assessed on a 'site-wide' basis, this section has not been colour coded in relation to specific site areas)				
1) Made Ground and / or contaminated natural soils associated with agricultural land use.	Metals / metalloids, pesticides / herbicides / insecticides, PAH, petroleum / diesel hydrocarbons.	• Gas migration into temporary buildings (e.g. construction compound) and / or trenches and other enclosed spaces. (See 'Pathways' section, above, for discussion of potential preferential pathways).	Human health (construction workers)	Minor
2) Former tank in the east of the Western Development Area.	Hydrocarbons e.g. fuel oils.			
3) Infilled watercourses, together with associated areas of historically marshy ground (potential for soils with high organic content).	Nature of any backfill materials unknown. Potential for a wide range of contaminants (e.g. metals, PAH, inorganics etc.)			
4) Made ground / soil contamination associated with Blythe Colour Works in the area of the proposed infrastructure improvements.	Elevated concentrations of metals / metalloids. Potential for organic contamination.			
5) Made Ground and / or contaminated soils associated with area of tipping in the north east of the Western Development Area.	Potential for a range of contaminants, which may include hydrocarbons (lubricants, oils, greases) and asbestos.			
6) Unrecorded waste deposits derived from the former colour works.	Elevated concentrations of metals / metalloids, other inorganics (e.g. significantly acidic or alkaline waste), organic contaminants. Radioactivity (colour products containing uranium oxide).			
7) Pottery waste landfill deposits ('The Paddock' landfill).	Most likely contaminants are metals / metalloids and PAH.			
8) Sewage pipeline (unproven) i.e. potential for historical sewage leaks.	Metals / metalloids, pathogens.			

Worst Case Conceptual Site Model Operational Phase Source	Contaminants*	Pathway	Receptor	Impact Assessment
9) Organic matter within natural superficial deposits at / around the site (e.g. recorded presence of minor quantities of peaty clay beneath adjacent Blythe Colour Works landfill ().	Carbon dioxide and / or methane.			
10) Off-site gas sources e.g. historical sewage processing, historical landfills located 173m and 361m from the site.	Carbon dioxide, methane, other landfill gas constituents (e.g. sulphur compounds).			

* The contaminants listed are intended to give an indication of the most likely / significant contaminants associated with each source, rather than to provide an exhaustive list of all possible contaminants.

Notes

For brevity, potential risks to underground concrete are not shown, as these have been assessed as minor-negligible.

Potential impacts associated with construction activities are not shown. As discussed previously, these comprise potential 'major' impacts in relation to human health (construction workers) and Controlled Waters.

Mitigation, Enhancement and Residual Effects

Operational Phase Mitigation – Human Health (Worst Case Conceptual Site Model)

11.151 The potential worst case human health effects during the operational phase have been assessed as major for the Western Development Area, major-moderate for the Eastern Development Area and negligible in the proposed access areas. Mitigation measures in relation to human health are discussed below on a source-by-source basis, to allow for the variability in potential risk within the site.

Made Ground and / or contaminated natural soils associated with agricultural land use

11.152 Generally, agricultural land use presents a relatively low contamination risk. Human health risks associated with elevated metals / metalloids concentrations caused by the use of agricultural improvement agents would often be expected to be able to be adequately mitigated by the use of clean cover in areas not covered by hard surfacing (e.g. gardens in the Western Development Area), although at higher concentrations this may need to be coupled with lime stabilisation. Hydrocarbon contamination associated with agricultural activities would generally be expected to be restricted to localised areas of fuel storage / spillage or burning. Mitigation measures for such contamination may involve clean cover or off-site disposal. Given UK legislation in relation to pesticides, herbicides and insecticides, the presence of a significant source of these contaminants is considered unlikely. The majority of pesticides, herbicides and insecticides that present human health risks display low environmental mobility, such that in the unlikely event that significant soil contamination is present, the volume of affected soil would be expected to be limited. In these circumstances, off-site disposal is often a viable mitigation strategy.

Former tank in the east of the Western Development Area

11.153 The contents of the former tank are unknown. As a worst case assumption, the tank could be considered to have contained hydrocarbon fuels that, due to leaks or spills, had contaminated the surrounding ground. In this instance, human health risks could be mitigated by the identification, delineation and excavation of the affected soils. Depending on the volume and nature of the soil affected, excavation arisings would either be subjected to treatment (e.g. bioremediation) and re-used, or removed from the site (e.g. to a soil treatment facility or landfill). The presence of the former tank within a proposed residential area (Western Development Area) will necessitate the use of stringent remediation criteria for any contamination present.

Infilled watercourses

11.154 Given the age of the backfilling of the River Blithe and the Mill Race, it is considered that a reasonable worst case scenario would be the presence of a localised area of pre-1960s waste. Such material commonly contains elevated concentrations of metals / metalloids and PAH (e.g. ashy deposits). Mitigation of localised contamination could involve clean cover (depending on concentrations). Alternatively, if higher concentrations are present and / or the material is also geotechnically unsuitable, mitigation measures may include chemical or physical solidification or stabilisation (followed by clean cover in high risk areas such as residential gardens, if necessary).

11.155 The potential human health mitigation associated with the former watercourses would be expected to be confined to their previous routes, as shown on Drawing ST13776-002 (**Figure 11.2**). Only sections of the former watercourses that traverse the Eastern and Western Development areas would be expected to require mitigation in relation to human health risks, given that there will be no human health receptor during the operational phase in the remainder of the site.

Made Ground and / or contaminated soils associated with the area of tipping in the north east of the Western Development Area

11.156 Following the clearance of tipped materials, the underlying soils should be assessed for the presence of contamination. It is likely that any contamination would be limited to near surface soils affected by hydrocarbons and, in the worst case, asbestos. In this instance, the most appropriate mitigation would be the removal of gross contamination and clean cover of any lower risk, residual, contamination.

Unrecorded waste deposits associated with the former colour works

11.157 Chemical contamination associated with unrecorded waste deposits may include highly elevated concentrations of metals / metalloids and potentially also adverse pH. Such waste deposits, if present, are likely to be localised and contained (i.e. defined areas of landfilling). If small volumes and / or very high concentrations are present, then off-site disposal would likely be the most appropriate mitigation. If larger volumes and lower concentrations are present, then chemical or physical stabilisation of the waste may be viable, followed by clean cover.

11.158 Should organic contamination be associated with the waste deposits, then this would necessitate more complex mitigation design for any retention of soils on-site. Various treatment techniques exist for remediating soils affected by organic contamination, ranging from bioremediation to thermal desorption. The specific remediation method required would be dictated by the properties and volume of the soil affected, the nature and concentrations of contaminants present, and any requirement to co-treat inorganic contamination.

11.159 Similarly to chemical contamination, any radiological risks associated with unrecorded waste deposits would be expected to be localised to specific disposal sites, particularly as the primary radiation risk associated with uranium oxide is alpha decay. It is likely that off-site disposal would form the mitigation for dealing with any affected materials.

Sewage Pipeline

11.160 If the pipeline passes beneath the site, then it is assumed that it will be necessary to either allow a development stand-off or divert it to outside the site boundary. If the pipeline is present and is retained, then the development stand-off would likely be suitable to mitigate human health risks, together with clean capping of the stand-off area if this is not hard-surfaced. If the pipeline is diverted, then this would provide the opportunity for the excavation of any contaminated soils for either re-use within the scheme (after treatment if necessary) or off-site disposal, depending on the nature and concentrations of contaminants present.

Made Ground and / or soil contamination associated with the adjacent former army base

11.161 Contamination associated with the adjacent former army base may include the localised unrecorded disposal of waste materials (chemical drums etc.) and asbestos. Such materials would be dealt with by appropriate off-site disposal (together with any associated contaminated soils not suitable for retention on site). Any soils affected by the presence of solvents or other organic chemicals could be treated by a variety of chemical remediation methods, depending on economic viability and the specific contaminants present. Techniques commonly used for remediating solvents and volatile compounds in soil include soil vapour extraction, chemical oxidation (either *in situ* or *ex situ*) and thermal desorption. Alternatively, if concentrations are relatively low then clean cover may be employed (notwithstanding Controlled Waters risk).

Operational Phase Mitigation – Controlled Waters (Worst Case Conceptual Site Model)

11.162 Potential risks to Controlled Waters from existing contamination sources have the potential to occur over a prolonged timescale and therefore these impacts are considered relevant to the operational phase (although obviously unrelated to operational activities). However, it should be noted that the mitigation measures discussed below to address any potential long term risks would typically be undertaken prior to the operational phase (i.e. groundwater remediation as part of the construction phase).

11.163 Based on the worst case CSM, the most significant Controlled Waters contamination that may be present is considered to be:

- The presence of widespread elevated concentrations of metals / metalloids and other inorganics (e.g. sulphide, sulphate, chloride) in groundwater with the potential to have a significant adverse effect on the identified surface water receptors and / or groundwater quality.
- The presence of hydrocarbon contamination in groundwater, potentially including the presence of non-aqueous phase liquids.
- Elevated levels of radioactivity in groundwater.

11.164 A range of conventional remediation measures are available to treat metals in groundwater. Selection of an appropriate technique would be controlled by detailed assessment of the site characteristics, following intrusive investigation. It is envisaged that intrusive investigations, detailed risk assessments, remediation options appraisals and identification of detailed remediation requirements would be undertaken as part of the planning process (i.e. under conditions). Nevertheless, in principle the remediation of metals in groundwater commonly involves either *in situ* or *ex situ* chemical treatment e.g. 'pump and treat', or the installation of reactive barriers.

11.165 Mitigation of hydrocarbon contamination in groundwater would focus initially on the removal of any non-aqueous phase liquid. Light non-aqueous phase liquids (e.g. fuels oils) can be removed by the deployment of skimmer pumps. Dissolved phase hydrocarbon contamination can be remediated by a range of techniques, depending on the specific contaminant. Given the nature of the aquifer units at the site and the

possible contaminants identified by the baseline conditions assessment, mitigation techniques that may be relevant include: *in situ* / *ex situ* chemical oxidation (e.g. for petrol / diesel hydrocarbons chlorinated solvents), dual / multi-phase vacuum extraction (best suited to high volatility contaminants), reductive dehalogenation (used for chlorinated solvents), permeable reactive barriers.

11.166 Any groundwater mitigation would be directly supplemented by the treatment of shallow (accessible) residual contamination sources. This may include soil treatment (by thermal desorption, soil washing, stabilisation etc.) or the removal of soils from site. This treatment may be required before, or instead of, the placement of any clean cover (as discussed in the human health mitigation section, above), hence it will be important for the Controlled Waters and human health mitigation measured to be designed in a complimentary manner.

11.167 Due to the potential contaminants identified, the possibility that dense non-aqueous phase liquids (DNAPL) may be present in groundwater cannot be discounted. The presence of DNAPL contamination can significantly reduce the cost-effectiveness of groundwater remediation, particularly if the DNAPL is at a depth where source removal / treatment is impractical. However, mitigation measures such as *in situ* chemical oxidation or reductive dehalogenation can still be applied to the dissolved phase (likely over a prolonged period) to achieve groundwater quality improvement.

11.168 Elevated levels of alpha radiation in groundwater would be likely to require *ex situ* treatment (i.e. 'pump and treat'). Treatment generally involves either ion exchange or reverse osmosis, to remove radionuclides.

11.169 The mitigation measures above primarily relate to the mitigation of groundwater risks. As groundwater flow forms a potentially significant pathway to surface water adjacent to the site, these mitigation measures would also be appropriate for mitigating risks to surface water from groundwater flow. The only other pathway relevant to surface water identified by the CSM is surface run-off. Site drainage will be designed with regard to contaminant leachability (which will be determined based on intrusive investigation data, as discussed below), in order to mitigate this potential impact.

Operational Phase Mitigation – Ground Gas (Worst Case Conceptual Site Model)

11.170 It is anticipated that the worst case situation in relation to gas generation within the Eastern and Western Development Areas is the presence of carbon dioxide / methane fluxes that necessitate the installation of passive protection measures in new buildings. There is the potential that minor quantities of material with a high gas generation capacity may be present associated with the former watercourse. Any such material would also be likely to be geotechnically unsuitable for development, so mitigation measures would be likely to comprise either use in landscaping areas with free ventilation to the atmosphere or off-site disposal. Similarly to the groundwater and human health (soil contamination) mitigation measures discussed above, these mitigation measures would be undertaken prior to the operational phase (i.e. during the construction phase), but relate to mitigation of potential impacts that may occur during the operational phase.

11.171 Several potential ground gas sources have been identified external to the development areas, including the Paddock landfill. The potential for gas migration from these sources that would require additional gas mitigation beyond passive protection is considered to be low. Should such migration be occurring, then mitigation would comprise the installation of a perimeter gas barrier (e.g. vent trench).

11.172 The potential soil and groundwater contamination sources may include sources of volatile organic compounds (VOCs). Mitigation measures in relation to VOCs may be required to address potential risks to human health and Controlled Waters (as discussed above). Should a residual risk of vapour ingress into buildings be present after the completion of this mitigation, then additional protection could be achieved by the installation of vapour resistant membranes within new development.

Operational Phase Mitigation – Water Supply Pipes (Worst Case Conceptual Site Model)

11.173 Water supply pipes may be affected by the presence of contaminants with the potential to permeate through standard pipe materials. Any such contaminants in soil or groundwater may be addressed by the mitigation measures required in relation to Controlled Waters and human health. Nevertheless, should a residual risk of contaminant ingress into water supply pipes be present after the completion of this mitigation, then additional mitigation would be required comprising the use of specialist chemical-resistant pipe materials (e.g. PE-Al-PE barrier pipe) and / or clean low permeability service trenches. In this instance the precise pipe specification should be determined via chemical testing in accordance with the recommendations of UKWIR publication 'Guidance for the Selection of Water Supply Pipes to be Used in Brownfield Sites', and approved by the service provider prior to installation.

Construction Phase Mitigation

Construction Phase Mitigation - Human Health Risk (Worst Case Conceptual Site Model)

11.174 The worst case scenario in relation to risks to construction workers would be the presence of gross contamination with the potential to present an acute health risk. Based on the worst case CSM, this may include the presence of asbestos, gross soil contamination with organic contaminants, highly elevated levels of metals / metalloids, and radioactivity. Mitigation measures should be designed based on a thorough understanding of the materials present and the nature of the risks. As such, a detailed intrusive investigation is crucial to the determination of mitigation requirements. Site investigation recommendations are discussed further below. Based on the site investigation findings, mitigation should involve the determination of specific safe working practices / equipment by occupational health and safety professionals. For example, this may include the adoption of full asbestos resistant PPE or the use of Licensed Asbestos Contractors should asbestos be identified. Important components of this mitigation would be the formal recording of mitigation measures in site health and safety documentation and the appropriate training of site operatives.

11.175 Although construction workers represent the primary sensitive receptor during the construction phase, mitigation measures also need to consider potential risks to residents / workers on adjacent land. In particular, where deposits are excavated that

present a potential risk via dust generation, the mitigation measures for construction workers (use of respiratory equipment etc.) would not provide protection to adjacent land users and additional mitigation would be required. This would comprise dust suppression measures (e.g. use of sheeting, water etc.). Details of the required mitigation measures should be defined in the Environmental Management Plan (EMP) for the construction phase, which should include compliance monitoring requirements.

Construction Phase Mitigation – Controlled Waters (Worst Case Conceptual Site Model)

11.176 As discussed, the worst case CSM includes the presence of contaminated groundwater potentially including non-aqueous phase liquids. Should de-watering be required during the construction phase (e.g. to suppress high groundwater levels), then groundwater generated should be managed and treated / discharged in a manner appropriate to its chemical composition. Treatment (mitigation) measures may include on-site treatment involving oil separators and precipitation of inorganic contamination etc. to generate effluent suitable for discharge either to surface water or sewer. The discharge of water would need to be undertaken under appropriate permits (e.g. discharge consents). Alternatively, depending on the volume of water and the contamination levels, off-site disposal may be adopted as a mitigation procedure.

11.177 The worst case CSM includes the potential for the site to generate contaminated leachate. Construction activities are likely to increase contaminant mobilisation / leachate generation due to the disturbance of near surface soils. Additionally, should any piling be undertaken, this may introduce a preferential pathway for vertical contaminant migration to groundwater. Mitigation will be via the construction phase EMP and, if necessary, a Piling Risk Assessment. Depending on the nature and extent of any contamination present, mitigation measures contained within the EMP and Piling Risk Assessment may include:

- Segregation of any material identified to present a specific risk of contaminated leachate generation onto impermeable sheeting, for future selective re-use, on-site treatment, or off-site disposal.
- Topsoil stripping to directly precede any excavations, to minimise the time that ground surfaces are exposed for.
- Good practice during earthworks / excavations to minimise leaching, including the compaction of exposed surfaces.
- Managed temporary surface drainage (ditches, temporary impoundment ponds) to control surface run-off / leachate. This can assist in managing both the chemical quality of construction water and the suspended solids load. Following any necessary treatment within impoundment facilities, options for re-use or discharge of construction water may include dust suppression or release to the River Blithe. The protection of water quality in the River Blithe is likely to be a relevant concern during the construction phase and monitoring may be required throughout this phase.

- The control of any earthworks or material movements under appropriate Environmental Permits, exemptions, or CL:AIRE "The Definition of Waste: Development Industry Code of Practice" (2011).

- Selection of appropriate piling methods (e.g. continuous flight augering).

- QA/QC procedures during piling.

Construction Phase Mitigation – Ground Gas (Worst Case Conceptual Site Model)

11.178 Given the nature of the potential gas sources and common construction details of construction compound buildings (i.e. temporary modular buildings), the potential construction phase impact associated with ground gas has been assessed as minor and it is therefore considered that no mitigation measures are required. However, this should be confirmed by intrusive investigation and ground gas monitoring prior to the construction phase. It will also be necessary for the construction contractor to implement any occupational health & safety measures necessary to protect construction workers from gas accumulation in excavations / trenches (i.e. adoption of Enclosed Spaces working procedures, where required).

Construction Phase Mitigation – Use and Storage of Fuels and Chemicals

11.179 Construction activities provide a risk of introducing additional contamination sources, with the potential to affect human health and Controlled Waters via the spillage or inappropriate storage of chemicals (e.g. fuels). These risks are not abnormal for a construction project and can be mitigated by good construction health and safety / management procedures. The specific details of these should be determined by occupational health and safety specialists and will be specified in site health and safety documentation prior to the construction phase (e.g. a Pollution Incident Control Plan). For the purposes of this assessment, an overview of the likely requirements is considered sufficient.

11.180 The scope of the protective / mitigation measures is likely to include:

- Appropriate training of site personnel in the handling and use of potentially dangerous substances, and associated risk.

- Preparation of method statements for the handling and use of chemicals / fuel.

- Use of adequate PPE.

- Appropriate environmental management at fuel storage locations (e.g. in accordance with *The Control of Pollution (Oil Storage) Regulations 2001* and Environment Agency PPG2 "*Above Ground Oil Storage Tanks*") and,

- Identification of contingency / emergency measures to minimise / negate effects in the event of spillages.

11.181 Mitigation measures will ensure that the development complies with the requirements of Environment Agency PPG1 "General Guide to the Prevention of Water Pollution". This

provides a significant degree of overlap with the construction phase Controlled Waters mitigation measures discussed above.

Potential Risks from Unexpected Contamination

11.182 The possibility for unexpected contamination to be identified during the construction phase exists, although this will be minimised by appropriate pre-construction site investigation. As unexpected contamination only becomes apparent once construction work has commenced, it is anticipated that this matter will be dealt with as a post-commencement condition. However, the general principles for dealing with unexpected contamination will be as follows:

- Identification of any suspicious materials by site management.
- Isolation of affected area and assessment by a suitably qualified environmental professional, including the laboratory analysis of soil and / or water samples.
- Determination of the potential level of risk and identification of an appropriate mitigation strategy, to be approved by the relevant regulatory authorities (e.g. Local Authority). Mitigation measures should be developed in accordance with the 'waste hierarchy', with treatment and retention of material on-site favoured over off-site disposal. The construction phase Environmental Management Plan would be reviewed and updated at this stage, to account for the material encountered.
- Validation of any mitigation (remediation) work, to confirm that the unexpected contamination has been adequately mitigated (remediated). Validation data should be reported to the Local Authority.

Site Investigation

11.183 The mitigation measures discussed above are based on the worst case CSM. It is highly unlikely that, in reality, all of these worst case conditions will exist together at the site (this is of note when considering the overall practicality and viability of mitigation). Prior to the detailed design of any mitigation measures, an intrusive site investigation should be undertaken to investigate the identified potential source-pathway-receptor linkages. This should be used to revise the worst case CSM, based on actual site conditions. Where the investigation indicates that the actual conditions present a lower risk than the worst case CSM, the impact assessment should be refined. This may remove the requirement for mitigation measures in some instances. Where it confirms that mitigation is required, it will provide the necessary detail to allow the general scope of possible mitigation measures discussed above to be developed into a detailed site specific remediation strategy. This may include refining the CSM by further zoning the site, with different mitigation measures applied in different zones, based on the site investigation results. In addition to considering the technical suitability of different mitigation options, the detailed remediation strategy will also consider environmental, economic and sustainability issues associated with the mitigation measures. For example, on sustainability grounds, off-site disposal would generally be minimised to instances where retention on site is impractical or uneconomic.

11.184 It is envisaged that this process will be undertaken as a requirement of planning conditions attached to any outline approval. Such conditions are commonly applied to applications for development on sites that may be affected by contamination and specific wording / requirements can vary between Local Authorities. However, in general, it is anticipated that the conditions may require:

- Intrusive site investigations and detailed risk assessments in relation to the potential source-pathway-receptor linkages present.

- Remediation options appraisal and the determination, implementation and verification of a detailed remediation (mitigation) scheme. It is anticipated that the detailed remediation scheme will fall within the general scope of potential mitigation measures discussed in this report.

11.185 It is likely that the site investigation will need to be undertaken across several phases, particularly where the presence of viable source-pathway-receptor linkages is confirmed by initial investigation and detailed investigation (e.g. Detailed Quantitative Risk Assessment) is required for remediation design. The scope of the site investigation(s) should be discussed and agreed with the relevant statutory regulators (SMDC and the EA) in advance. However, the initial investigation is anticipated to generally comprise the following:

- Chemical testing of soils from across the site. This should provide adequate spatial coverage from across the site, but is also likely to include targeted investigation on specific potential contamination sources (e.g. location of the former tank, infilled former watercourses etc.) and a greater density of investigation in locations of proposed high sensitivity end use (i.e. the Western Development Area). Testing depths should be determined with regard to development proposals (e.g. any re-grading) and should aim to prioritise testing of materials that will be within the top 1m of the finished ground profile. However, deeper soils should also be tested, at a lower frequency unless specific visual / olfactory evidence of contamination is present. Testing suites should be designed based on the potential contaminants identified by the worst case CSM.

- Soil leachability testing (particularly of Made Ground deposits), groundwater testing and surface water testing. This should be designed based on the locations of identified potential contamination sources (both on-site and off-site), the hydrogeological baseline conditions (i.e. locations and depths of aquifer units, groundwater abstractions etc.) and observations made during the site investigation (e.g. presence of any unrecorded Made Ground deposits etc.). Depending on initial findings, more detailed investigation (permeability testing etc.) may be required to undertake a Detailed Quantitative Risk Assessment.

- The installation and monitoring of ground gas monitoring standpipes. The number and locations of boreholes should be designed in accordance with the identified potential gas sources and the recommendations of relevant guidance (e.g. CIRIA 665 ‘Assessing risks posed by hazardous ground gases to buildings’ and BS8576:2013 ‘Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds (VOCs)’). In accordance with this guidance, it should include boreholes targeted on specific potential gas sources identified from the

baseline conditions assessment (e.g. infilled former watercourses) and perimeter monitoring boreholes where potential off-site gas sources have been identified.

- Investigation and testing along the route of any proposed water supply pipes in accordance with UKWIR publication 'Guidance for the Selection of Water Supply Pipes to be Used in Brownfield Sites'.

Residual Effects

11.186 It is considered that any mitigation necessary to address the source-pathway-receptor linkages associated with the worst case CSM would fall within the capabilities of established conventional mitigation (remediation) techniques. In accordance with current contaminated land guidance, the standard of remediation achieved by these techniques would need to be such that the site did not present a residual risk to human health or the wider environment. Therefore, no significant residual effects have been identified in relation to the operational phase. However, a slight level of residual risk exists in relation to the use / storage of fuels during the construction phase. This is because the risk of accidental spillage of fuels / chemicals cannot be completely removed. However, the mitigation measures will reduce the potential for this as far as reasonably practical, in accordance with current guidance and best practice. Therefore, the residual effect, which is assessed as **minor-negligible**, is considered acceptable.

Conclusions

11.187 A Tier 1 contaminated land risk assessment (desk study and walkover) has been undertaken to identify baseline conditions and determine a preliminary worst case conceptual site model.

11.188 Based on this, an assessment of the worst case potential impacts has been undertaken for both the construction and operational phases. Impacts potentially requiring mitigation have been identified at both phases in relation to human health risks, risks to Controlled Waters, and ground gas. Additionally, an impact potentially requiring mitigation has been identified in relation to water supply pipes at the operational phase.

11.189 Potential mitigation options have been considered that would reduce the identified potential impacts to acceptable (i.e. negligible) levels. It is concluded that the worst case CSM does not include any potential source-pathway-receptor linkages that could not be feasibly addressed by established and available mitigation technologies. Although the development and implementation of these mitigation measures may have significant cost implications, the scale of the site and development proposals is appropriate to accommodate significant remediation (mitigation) work if necessary.

11.190 In order to develop a detailed remediation (mitigation) strategy, it is recommended that a comprehensive intrusive ground investigation is undertaken. The data from this should be used to refine the worst-case CSM, by identifying whether the worst case conditions actually exist and, if not, to revise the CSM accordingly. This process accords with current DEFRA / EA guidance (e.g. CLR 11). In some instances, the investigation may allow potential source-pathway-receptor linkages to be discounted, meaning that mitigation measures may not be required.

11.191 Following the implementation of the detailed remediation strategy, residual impacts would be expected to be negligible or minor-negligible during the construction phase and negligible during the operational phase.

11.192 **Table 11.7** summarises the findings of the impact assessment.

Table 11.7: Summary of Effects

Description of Likely significant Effects	Significance of impacts: Major, Moderate, Minor Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Summary of Mitigation / Enhancement Measures	Significance of Residual Effects: Major, Moderate, Minor, Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Relevant Policy	Relevant Legislation
Demolition and Construction Phase													
Human health risk (construction workers and the general public)	Major	Negative	P	D	ST, MT & LT	Mitigation requirements and details to be reviewed following intrusive site investigation, to determine appropriate occupational health & safety measures. Mitigation will also include the production and implementation of a construction phase Environmental Management Plan (EMP), to include details of measures to protect the public / nearby site users (e.g. dust suppression).	Negligible[1]	N/A	N/A	N/A	N/A	National Planning Policy Framework (2012) National Planning Practice Guidance (NPPG), 2014 SMDC 'A Local Plan for the future of Staffordshire Moorlands: Core Strategy Development Plan Document', 2014; specifically Policy SD1.	Part 2A of the Environmental Protection Act (EPA) 1990. Contaminated Land (England) Regulations 2006, as amended by the Contaminated Land (England) (Amendment) Regulations 2012. Extensive legislation relevant to occupational health & safety (e.g. Control of Asbestos Regulations, 2012).

Significance of impacts							Significance of Residual Effects							
Description of Likely significant Effects	Major, Moderate, Minor Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Summary of Mitigation / Enhancement Measures	Major, Moderate, Minor, Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Relevant Policy	Relevant Legislation
Groundwater	Major	Negative	P	D/I	ST, MT & LT	Mitigation requirements and details to be reviewed following intrusive site investigation. Mitigation will be controlled and implemented via a construction phase EMP, which specify requirements relating to drainage / water control, selection of appropriate piling techniques, materials handling / management procedures, and any necessary chemical and physical water treatment prior to discharge.	Negligible[1]	N/A	N/A	N/A	N/A	National Planning Policy Framework (2012) National Planning Practice Guidance (NPPG), 2014 Groundwater Protection: Policy and Practice" (2012) (GP3) SMDC 'A Local Plan for the future of Staffordshire Moorlands: Core Strategy Development Plan Document', 2014; specifically Policy SD4.	Part 2A of the Environmental Protection Act (EPA) 1990. Contaminated Land (England) Regulations 2006, as amended by the Contaminated Land (England) (Amendment) Regulations 2012. The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010. The Water Supply (Water Quality) Regulations 2000 (amended by the Water Supply (Water Quality) Regulations 2010).

Significance of impacts							Significance of Residual Effects						
Description of Likely significant Effects	Major, Moderate, Minor Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Summary of Mitigation / Enhancement Measures	Major, Moderate, Minor, Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Relevant Policy	Relevant Legislation
Surface water	Major	Negative	P	D/I	ST, MT & LT	Mitigation requirements and details to be reviewed following intrusive site investigation. Mitigation will be controlled and implemented via a construction phase EMP, which specify requirements relating to drainage / water control, selection of appropriate piling techniques, materials handling / management procedures, and any necessary chemical and physical water treatment prior to discharge.	Negligible[1]	N/A	N/A	N/A	N/A	National Planning Policy Framework (2012) National Planning Practice Guidance (NPPG), 2014 Groundwater Protection: Policy and Practice" (2012) (GP3) SMDC 'A Local Plan for the future of Staffordshire Moorlands: Core Strategy Development Plan Document', 2014; specifically Policy SD4.	Part 2A of the Environmental Protection Act (EPA) 1990. Contaminated Land (England) Regulations 2006, as amended by the Contaminated Land (England) (Amendment) Regulations 2012. The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010. The Water Supply (Water Quality) Regulations 2000 (amended by the Water Supply (Water Quality) Regulations 2010).

Description of Likely significant Effects	Significance of impacts					Summary of Mitigation / Enhancement Measures	Significance of Residual Effects					Relevant Policy	Relevant Legislation
	Major, Moderate, Minor Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT		Major, Moderate, Minor, Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT		
Operational Phase													
Ground gas	Minor	Negative	P	D	ST	None required. To be confirmed based on site investigation findings.	Negligible[1]	N/A	N/A	N/A	N/A	National Planning Policy Framework (2012) National Planning Practice Guidance (NPPG), 2014 SMDC 'A Local Plan for the future of Staffordshire Moorlands: Core Strategy Development Plan Document', 2014; specifically Policy SD1.	Part 2A of the Environmental Protection Act (EPA) 1990. Contaminated Land (England) Regulations 2006, as amended by the Contaminated Land (England) (Amendment) Regulations 2012.
Human health risk (residential users)	Major (Western Development Area), major-moderate (Eastern Development Area), negligible (area of emergency access and internal access road)	Negative	P	N/A	ST, MT & LT	Mitigation requirements and details to be reviewed following intrusive site investigation, via production of detailed remediation strategy. Based on the worst case CSM, mitigation requirements may include: clean cover, stabilisation / solidification, bioremediation, thermal desorption, soil vapour extraction, chemical oxidation, off-site disposal.	Negligible[1]	N/A	N/A	N/A	N/A	National Planning Policy Framework (2012) National Planning Practice Guidance (NPPG), 2014 SMDC 'A Local Plan for the future of Staffordshire Moorlands: Core Strategy Development Plan Document', 2014; specifically Policy SD1.	Part 2A of the Environmental Protection Act (EPA) 1990. Contaminated Land (England) Regulations 2006, as amended by the Contaminated Land (England) (Amendment) Regulations 2012.

Significance of impacts							Significance of Residual Effects						
Description of Likely significant Effects	Major, Moderate, Minor Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Summary of Mitigation / Enhancement Measures	Major, Moderate, Minor, Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Relevant Policy	Relevant Legislation
Contamination of groundwater	Major	Negative	P	N/A	ST, MT & LT	Mitigation requirements and details to be reviewed following intrusive site investigation, via production of detailed remediation strategy. Based on the worst case CSM, these may include: in situ or ex situ chemical treatment (e.g. oxidation, reductive dehalogenation, LNAPL removal, multi-phase vacuum extraction, source treatment (e.g. soil stabilisation), radioactivity reduction techniques (e.g. ion exchange, reverse osmosis).	Negligible[1]	N/A	N/A	N/A	N/A	National Planning Policy Framework (2012) National Planning Practice Guidance (NPPG), 2014 Groundwater Protection: Policy and Practice" (2012) (GP3) SMDC 'A Local Plan for the future of Staffordshire Moorlands: Core Strategy Development Plan Document', 2014; specifically Policy SD4.	Part 2A of the Environmental Protection Act (EPA) 1990. Contaminated Land (England) Regulations 2006, as amended by the Contaminated Land (England) (Amendment) Regulations 2012. The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010. The Water Supply (Water Quality) Regulations 2000 (amended by the Water Supply (Water Quality) Regulations 2010).

Significance of impacts							Significance of Residual Effects						
Description of Likely significant Effects	Major, Moderate, Minor Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Summary of Mitigation / Enhancement Measures	Major, Moderate, Minor, Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Relevant Policy	Relevant Legislation
Contamination of surface water (risk to aquatic ecosystems)	Moderate	Negative	P	N/A	ST, MT & LT	Mitigation requirements and details to be reviewed following intrusive site investigation, via production of detailed remediation strategy. Based on the worst case CSM, these may include groundwater and soil remediation (as discussed above) and use of permeable reactive barriers.	Negligible[1]	N/A	N/A	N/A	N/A	National Planning Policy Framework (2012) National Planning Practice Guidance (NPPG), 2014 Groundwater Protection: Policy and Practice" (2012) (GP3) SMDC 'A Local Plan for the future of Staffordshire Moorlands: Core Strategy Development Plan Document', 2014; specifically Policy SD4.	Part 2A of the Environmental Protection Act (EPA) 1990. Contaminated Land (England) Regulations 2006, as amended by the Contaminated Land (England) (Amendment) Regulations 2012. The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2010. The Water Supply (Water Quality) Regulations 2000 (amended by the Water Supply (Water Quality) Regulations 2010).

Significance of impacts							Significance of Residual Effects						
Description of Likely significant Effects	Major, Moderate, Minor Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Summary of Mitigation / Enhancement Measures	Major, Moderate, Minor, Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Relevant Policy	Relevant Legislation
Explosion / asphyxiation due to ground gas	Moderate	Negative	P	D	N/A	Mitigation requirements and details to be reviewed following intrusive site investigation, via production of detailed remediation strategy. Based on the worst case CSM, mitigation requirements may include the installation of passive gas protection in new buildings, and the construction of a perimeter vent trench.	Negligible[1]	N/A	N/A	N/A	N/A	National Planning Policy Framework (2012) National Planning Practice Guidance (NPPG), 2014 SMDC 'A Local Plan for the future of Staffordshire Moorlands: Core Strategy Development Plan Document', 2014; specifically Policy SD1.	Part 2A of the Environmental Protection Act (EPA) 1990. Contaminated Land (England) Regulations 2006, as amended by the Contaminated Land (England) (Amendment) Regulations 2012.
Contamination of drinking water within supply pipes.	Major	Negative	P	D	ST, MT & LT	Mitigation requirements and details to be reviewed following intrusive site investigation, via completion of a water supply risk assessment report based on UKWIR guidance. Based on the worst case CSM, mitigation may involve the use of barrier pipe and clean service trenches.	Negligible[1]	N/A	N/A	N/A	N/A	National Planning Policy Framework (2012) National Planning Practice Guidance (NPPG), 2014 SMDC 'A Local Plan for the future of Staffordshire Moorlands: Core Strategy Development Plan Document', 2014; specifically Policy SD1.	Part 2A of the Environmental Protection Act (EPA) 1990. Contaminated Land (England) Regulations 2006, as amended by the Contaminated Land (England) (Amendment) Regulations 2012. The Water Supply (Water Quality) Regulations 2000 (amended by the Water Supply (Water Quality) Regulations 2010).

Significance of impacts							Significance of Residual Effects						
Description of Likely significant Effects	Major, Moderate, Minor Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Summary of Mitigation / Enhancement Measures	Major, Moderate, Minor, Negligible	Positive / Negative	P/T	D/I	ST/ MT/ LT	Relevant Policy	Relevant Legislation
Damage to below ground concrete due to chemical attack	Minor-negligible	Negative	P	D	MT / LT	None required. However, as a matter of construction quality, structures will be designed to be appropriate for the ground conditions throughout their design life (i.e. concrete specification appropriate for the ground conditions)	Negligible	N/A	N/A	N/A	N/A	National Planning Policy Framework (2012) National Planning Practice Guidance (NPPG), 2014 SMDC 'A Local Plan for the future of Staffordshire Moorlands: Core Strategy Development Plan Document', 2014; specifically Policy SD1.	Part 2A of the Environmental Protection Act (EPA) 1990. Contaminated Land (England) Regulations 2006, as amended by the Contaminated Land (England) (Amendment) Regulations 2012.

1 In accordance with Part 2A of the Environmental Protection Act (EPA) 1990 and "Model Procedures for the Management of Land Contamination (CLR11)" 2004, the minimum requirement of any remediation strategy is that the resulting site does not present a significant risk of significant harm to future site users, Controlled Waters or the wider environment.

P/T = Permanent or Temporary, D/I = Direct or Indirect, ST/MT/LT – short Term, Medium Term or Long Term, N/A = Not Applicable