8. Ground Conditions and Contamination

Introduction

8.1 This Chapter, which was prepared by Waterman, presents an assessment of the likely significant impacts of the Development with respect to ground conditions and contamination at the Site. It provides an overview of relevant legislation and policy, together with a description of the methodology used for the assessment. This is followed by a description of baseline conditions, the potential direct and indirect impacts of the Development. Where necessary, mitigation measures required to prevent, reduce or offset any adverse impacts are described.

Legislation and Planning Policy Context

Legislation

Environmental Protection Act: Part 2A 1990 and Contaminated Land (England) Regulations, 2006

8.2 UK legislation on contaminated land is principally contained in Part 2A of the Environmental Protection Act (EPA) 1990, which came into force in April 2000 through enaction of Section 57 of the Environment Act 1995. Part 2A is implemented by the Contaminated Land (England) Regulations 2006 which was brought into force on 4 August 2006. Statutory guidance issued by the Secretary of State is contained in Department for Environment, Food and Rural Affairs (DEFRA) Circular 01/2006, which provides an outline of the contaminated land regime and how it should be implemented.

8.3 The Part 2A regime supports a systematic approach to the identification and remediation of land affected by historical contamination. The legislation endorses the principle of a 'suitable for use' approach to contaminated land, using a risk assessment methodology to assess the need for remedial action. Such action is only required if unacceptable risks to human health or the environment are demonstrated, taking into account the end use of the land and its environmental setting. Within the legislation, contaminated land is defined as:

"...*any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that:*

(i) significant harm is being caused or there is a significant possibility of such harm being caused; or

(ii) pollution of controlled waters is being, or is likely to be, caused."

8.4 For actual harm to occur, a significant pollutant linkage must be demonstrated using a site-specific source-pathway-receptor conceptual model. The presence of all three elements must be established to accord with the definition of contaminated land. The elements of the conceptual model are as follows:

(i) source – the key pollutant hazards associated with the site;

(ii) receptor – the key targets at risk from the hazards identified e.g. people, environmental assets, surface or groundwater; and

(iii) pathway – the means by which the contaminant can reach and impact the receptor.

Water Resources Act 1991 (Amendment) (England and Wales), 2009

8.5 The Water Resources Act 2009 protects the quality of groundwater and surface water, collectively defined as 'controlled waters'.

8.6 The Act is of specific relevance to soil contamination in those cases where the nature, extent and mobility of contamination present a risk of pollution of controlled waters. In such cases, the landowner is committing an offence if the pollution of controlled waters is not prevented once the Site has been identified as being a source of contamination.

8.7 Under Section 161 of the Water Resources Act, the Environment Agency can serve a Works Order on a person or persons who cause or knowingly permit pollution of controlled waters.

The Environmental Protection (Duty of Care) Regulations, 1991 (as amended)

8.8 The Environmental Protection Regulations, 1991 relate to the requirements on waste producers to prevent the escape of waste, environmental pollution or harm to human health during the transfer, treatment or disposal of waste.

National Planning Policy

8.9 Planning Policy Statement 23: '*Planning and Pollution Control*' 2004 (PPS23) is designed to protect the environment from potential harm caused by development and operations. Consequently opportunities should be taken wherever possible, to assist and encourage the remediation of contaminated land that will be redeveloped.

Local Planning Policy

8.10 The adopted '*Cherwell Local Plan*', 1996 contains policies relating to contaminated land and water quality. Policy EN12 '*Contaminated Land*' stipulates that where land is known, or is suspected to be contaminated, adequate measures should be taken to remove the risk of contamination to future site users. Development would only be permitted where it is not likely to result in the contamination of surface or underground water resources. This is supported by Policy EN7 '*Water Quality*' which states that developments which would adversely affect the quality of surface waters and groundwater would not be permitted. Both these policies are reiterated in the '*Non Statutory Cherwell Local Plan 2011*'.

8.11 In addition, the '*Non Statutory Cherwell Local Plan 2011*' contains policies specific to developing the Site. Policy UH2 (iii) stipulates proposals for the onsite treatment of contaminated liquids and materials including soil where that would accord with the good environmental practice and have no detrimental environmental impacts arising.

Assessment Methodology and Significance Criteria

Establishing the Baseline Conditions

8.12 The baseline conditions of the Site, in respect of the potential for contamination, were established through a desk-based study, which included a review of the following information sources:

- Landmark Information, EnviroCheck Report dated July 2010;
- Enviros Consulting Ltd (2009) '*Supplementary Information to the Environmental Statement, Heyford Park*';
- Roger Evans Ltd (September 2007) '*Heyford Park Environment Statement*';

- Aspinwall & Company Limited (June 1997) '*RAF Upper Heyford Land Quality Assessment, Phase Two: Intrusive Survey Factual Report*'; and
- DLS South (1995) '*Explosives Ordnance Disposal of RAF Upper Heyford*';

8.13 A desk-based qualitative risk assessment for the Site and Flying Field area was undertaken by Arup and reported in the 2007 Environmental Statement. Supplementary information relating to Environmental Statement was prepared by Enviros Consulting in 2009. These documents present a site-specific conceptual model to establish significant potential pollutant linkages. Although the Site boundary has changed since the time of writing these documents, the sources of information consulted in undertaking the assessment and determining the significance criteria remain relevant where they relate to the current Site.

Method of Assessment

8.14 The assessment of ground contamination was undertaken in general accordance with current UK guidance on the assessment of contaminated land, including DEFRA Contaminated Land Reports (CLR) 11 '*Model Procedures for the Management of Contaminated Land*' (DEFRA & Environment Agency, 2004).

8.15 Current guidance on the assessment of contamination risk advocates the use of a conceptual risk assessment model to establish the links between a contamination source and a sensitive receptor via an exposure pathway. In order to evaluate the potential environmental and health risks associated with any potential contamination, sensitive receptors and potential pathways relevant to the Site and the Development were identified through the baseline research. This was followed by an appraisal of the means (i.e. the pathways) by which sources might affect receptors.

8.16 Since the time of the Roger Evans (2007) report, the Environment Agency and DEFRA announced the withdrawal of the Contaminated Land Reports CLR7 – 10, CLEA UK (beta). Consequently Soil Guideline Values (SGV) and Soil Assessment Criteria (Generic Assessment Criteria (GAC) and Site Assessment Criteria (SAC)) have altered. As such the screening values used within the Evans (2007) report to assess the chemical results of soil samples (collected from the Site as reported in Aspinwall (1997)) have changed since its production.

8.17 New risk assessment tools (CLEA model version v1.04, v1.05 and currently v1.06) have been published which allow environmental practitioners to derive generic and site specific GAC and SAC. For the purposes of the assessment reported in this Chapter, the results obtained from the Aspinwall (1997) report were reassessed using the updated SAC. The following hierarchy for the generic assessment of soils was also used to evaluate the risk to human health:

- published Soil Guideline Values (SGV's), or in their absence;
- GAC prepared in accordance with the CLEA v1.04 / v1.06 model by authoritative bodies (e.g. Chartered Institute of Environmental Health (CIEH), Land Quality Management (LQM) and Contaminated Land Applications in Real Environments (CL:AIRE), or in their absence; and
- Waterman in-house GAC prepared in accordance with the CLEA V1.04 model or associated documents.

Significance Criteria

8.18 There is no specific methodology or guidance for the assessment of impacts on ground conditions and contamination for the purposes of EIA. Significance criteria were therefore developed based on professional judgement and relevant experience. The criteria are based on the potential magnitude and duration of the impact, the sensitivity of the receiving receptor and the likelihood of the impact occurring. An explanation of the significance criteria used in this Chapter is provided in **Table 8.1**.

Table 8.1: Significance Criteria for Ground Conditions and Contamination Assessment

Significance Criteria	Description
Adverse Impact of Substantial Significance	Acute or severe chronic impacts on human health and/or animal/ plant populations predicted. Impact on a potable groundwater or surface water resource of regional importance e.g. Principal Aquifer, public water reservoir or inner protection zone of a public supply borehole.
Adverse Impact of Moderate Significance	Proven (or likely significant) pollutant linkages with human health and/or animal/plant populations, with harm from long-term exposure. Impact on a potable groundwater or surface water resource at a local level e.g. impact on an outer groundwater source protection zone. Temporary alteration to the regional hydrological or hydrogeological regime or permanent alteration to the local regime.
Adverse Impact of Minor Significance	Potential pollutant linkages with human health and / or animal / plant populations identified. Reversible, localised reduction in the quality of groundwater or surface water resources used for commercial or industrial abstractions, Secondary Aquifer etc.
Insignificant	No appreciable impact on human, animal or plant health, groundwater or surface water resources.
Beneficial Impact of Minor Significance	Risks to human, animal or plant health are reduced to acceptable levels. Local scale improvement to the quality of groundwater or surface water resources used for commercial or industrial abstraction.
Beneficial Impact of Moderate Significance	Significant local improvement to the quality of potable groundwater or surface water resources. Significant improvement to the quality of groundwater or surface water resources used for public water supply.
Beneficial Impact of Substantial Significance	Major reduction in risks to human, animal or plant health. Significant regional scale improvement to the quality of potable groundwater or surface water resources.

Assumptions and Limitations

8.19 In the absence of detailed construction methodologies it was assumed for the purposes of the assessment that surplus soil arising would be reused on the Site, where possible.

8.20 It was assumed that all recommended mitigation measures including the undertaking of a Ground Investigation and remediation work (if required) would be completed to a suitable standard and to the satisfaction of the responsible Statutory Authority, for the purposes of the assessment of residual impacts.

Baseline Conditions

Current Site Conditions

8.21 The Site to the north of Camp Road is largely occupied by offices, warehouses, access roads, and areas of hard-standing and landscaping. The area south of Camp Road is occupied by the residential area of the former Airbase.

8.22 Many of the warehouses and buildings to the north of Camp Road are leased out for various purposes including a storage and maintenance depot for new cars. The car storage company currently have an active fuel storage facility, which was previously part of the fuel handling and storage system of the Airbase, although this is not connected to the ring main fuel supply pipeline. They also occupy a number of other buildings for use as workshops and also operate a carwash facility.

8.23 Although some occupied semi-detached housing is present to the north of Camp Road, the majority of housing, which range from dormitories to semi-detached units, is located to the south of Camp Road. The majority of housing across the Site remains in occupation but the former barracks dormitories are unoccupied.

8.24 The former Airbase fuel pumps are also present to the south of Camp road, whilst two former vehicle filling points are present on the Site to the north of Camp Road. The fuel pumps and vehicle filling points are no longer in use.

8.25 A number of other above and below ground fuel storage facilities are known to be present on-Site including, but not limited to, two separate clusters of tanks associated with the on-Site district heating system and a network of tanks associated with the incinerator of the former hospital on-Site. Above and below ground heating fuel tanks are also associated with the housing.

8.26 The small land parcel to the east of the main part of the Site is undeveloped, although a petrol interceptor is known to be present. A small stream flows north to south through this part of the Site.

Surrounding Land Uses

8.27 Land to the north of the Site is occupied by the Flying Field area of the former Airbase. The Flying Field area comprises the runway and associated taxi ways, hardened aircraft shelters, fuel storage tanks, maintenance areas, offices, warehouses and undeveloped grassed areas. Some of buildings present on the Flying Field are leased out for a range of purposes. The Flying Field also contains a Petrol Oil Lubrication (POL) storage and delivery system. The POL system consists of approximately 13km of buried pipeline connected to numerous above and below ground tanks with ancillary infrastructure such as maintenance, valve and pump chambers located across the Flying Field.

8.28 Land to the south and east of the Site is in agricultural use, whereas land to the west of the Site comprises the former playing fields and sports facilities of the Airbase. Land to the south of Camp Road immediately east of the main part of the Site is occupied by a Mobile Home Park. A sewage treatment plant is located approximately 100m south-east of the Site.

Historical Land Uses

8.29 Historical maps are presented in the EnviroCheck Report (2010) provided in **Appendix 8.1**. A brief summary of the historical uses of the Site is set out below.

8.30 The 1884 Ordnance Survey (OS) map shows the Site to be largely undeveloped, and presumably in agricultural use. A tower and pumps were situated adjacent to south western corner of the Grouse Covert area. The OS map also shows that Camp Road was in place at this time. A field barn is also shown to be present adjacent to the southern boundary of the Site. A farm referred to as 'North Leys Farm' was present adjacent to the north western corner of the Site, whilst a farm referred to as 'Leys Farm' was present close to the eastern boundary. Remaining land surrounding the Site at this time was in agricultural use. A quarry was located approximately 130m east of the small area of land that is included as part of the Site.

8.31 The 1900 OS map shows that no significant changes had taken place across the Site since the 1884 map was published. A quarry, the bulk of which is shown as being present to the west, encroaches across the south-western tip of the Site.

8.32 The 1923 OS map again shows no significant changes had occurred in the intervening period. The Airbase is not marked on the 1923 map. However, it is known that construction of the Airbase began in 1916 when it was occupied by the Canadian Air Force prior to its closure in 1920. The Airbase reopened in 1927 and in 1951 control of the Airbase was passed to the United States Air force (USAF).

8.33 The 1955 OS map shows that no significant changes had taken place. The quarry previously identified on the western part of the Site appears to have been back-filled. No signs of the Airbase are marked on the map.

8.34 The 1966 OS map shows significant changes had taken place across the Site with the construction of warehouses and residential buildings. By this time, the Site generally resembled the current layout, particularly to the north of Camp Road. The runway and taxiing infrastructure is shown to the north of the Site, although similar infrastructure is also shown to the west of the Site. A sewage works is shown approximately 100m to the south-east of the Site in the location of the current facility.

8.35 OS maps of 1979 to 1982 show that continued development had taken place across the Site with the construction of a significant number of houses as well as shops, a hospital, a recreational park, car parks, a school and additional warehouses and building associated with the Flying Field. Development associated with the Airbase had also taken place adjacent to the west of the Site in the area previously occupied by the taxiing infrastructure. The quarry previously shown to the west of the Site appears to have been in filled by this time. Continued development of the land to the north of the Site had also taken place in the intervening period. The sewage works to the south-east of the Site had been extended by this time. A Mobile Home Park associated with the former grounds of Leys Farm had been developed immediately to the east of the main part of the Site.

8.36 The 1993 OS map showed that no significant changes had taken place since the 1982 map was published. In 1994 the Airbase closed and is now under the control of the applicant. The 2006 and 2010 OS maps show that no significant changes had occurred on the Site or surrounding areas since its closure.

Geology

8.37 The British Geological Survey (BGS) map (Sheet 218, scale 1:50,000) shows that the solid geology underlying the Site comprises the Great Oolite Limestone, which is part of the Jurassic Great Oolite Series and consists of limestones, marl, sandstones, siltstones and mudstones. The maximum thickness of the Great Oolite Limestone is expected to be approximately 25m. The BGS map shows the Great Oolite Limestone to be underlain by the Inferior Oolite Series, which comprises the Lower Estuarine Series consisting of sandstone, and thin mudstone and the underlying Northampton Sand which consists of the sandy, shelly limestones and sandstones. The Inferior Oolite Series is underlain by the Lias Series comprising mudstones, siltstones and thin limestones.

Hydrogeology

8.38 The Great Oolite Limestone is classified by the Environment Agency as a Principal Aquifer and is subject to extensive abstraction for local water supply. Limestone has a low primary permeability such that little groundwater movement takes place through the rock matrix itself. However significant movement of groundwater can take place through secondary features such as joints, fissures and bedding planes, especially where these have been enlarged by the solution process. In such instances the movement of groundwater can be rapid with little filtration. The Great Oolite Limestone also comprises bands of mudstone, which could act as effective low permeability strata giving rise to a layered aquifer system. Connectivity between the groundwater layers would depend on the thickness, lateral continuity and permeability of any intervening low permeability strata. This conceptual layered aquifer system, if present, could rapidly move contaminants in a lateral direction especially following periods of heavy rain when flushing could occur.

8.39 Although there are no boreholes on the Site from the seven boreholes that have been advanced on the Flying Field area there is evidence to suggest that a layered aquifer system does exist, although given the limited coverage provided by seven boreholes it is unknown whether the layered system is extensive across the Site itself.

Hydrology

8.40 Groundwater from the Site is discharged at a number of springs located at or close to the southern and eastern boundary of the Site and to the west of the Site. Some of these coincide with oil water separators leading to storm water outfall points. On-Site surface water drainage is discharged via the drainage system into a number of drainage ditches/watercourses along the southern and eastern boundaries of the Site.

8.41 Springs to the west of the Site drain to the River Cherwell which itself lies approximately 1km to the west of the Site, whilst springs located to the south of the Site flow to the River Ray, which in turn drains to the River Cherwell further downstream. The Oxford Canal is also present approximately 1km west of the Site and broadly runs parallel to the River Cherwell.

8.42 An unnamed tributary of Gallos Brook flows through the small parcel of land to the east of the main part of the Site. Gallos Brook flows to the south of the Site into the River ray, which in turn flows into the River Cherwell.

Previous Investigations

8.43 A previous Ground Investigation pertaining to the Site and Flying Field was undertaken in 1997, by others, and is reported by Aspinwall (1997). As part of the Ground Investigation 44No. trial pits were excavated on the Site across the existing commercial and disused areas of the Site to a maximum depth of 2.7m below ground surface.

8.44 A review of the relevant trial pit logs indicated that the underlying drift consisted of a clayey, sandy, silty deposit with varying quantities of limestone gravels and cobbles. Made ground encountered on the Site predominantly consisted of reworked natural material with various quantities of clinker and ash; and in some cases glass metal, wood and burnt timber. Buried horizons of concrete and tarmac were also encountered on the Site. Visual and olfactory evidence of hydrocarbon contamination was present in one trial pit, which was located approximately 200m north Camp Road, in an area currently in commercial use.

8.45 A number of soil samples were submitted for chemical analysis as part of the investigation. The results of the analysis were compared with SAC to investigate their significance in terms of the current commercial use of that part of the Site. The updated assessment criteria are present in **Table 8.2**. This includes tabulated ranges of concentrations detected in samples subject to testing, values of the GACs for a commercial land use, for the corresponding compounds analysed as part of the investigation as reported in Aspinwall (1997), together with the reference sources.

Table 8.2: Updated GACs for Corresponding Compounds as Reported in Aspinwall (1997)

Compound	Unit	Range of concentrations	Screening Value Commercial	Source
Arsenic	mg/kg	<1 – 72	640	CLEA SGV 2009
Boron (Water soluble)	mg/kg	<1 – 4	19200	LQM / CIEH
Cadmium	mg/kg	<1 – 2	230	CLEA SGV 2009
Chromium	mg/kg	4 – 60	30400	LQM / CIEH
Copper	mg/kg	2 – 65	71700	LQM / CIEH
Mercury	mg/kg	<1	26	CLEA SGV 2009
Nickel	mg/kg	2 – 46	1800	CLEA SGV 2009
Lead	mg/kg	<1 – 767	750	CLEA SGV 2002 (Withdrawn in 2008)
Selenium	mg/kg	<1 – 2	13000	CLEA SGV 2009
Zinc	mg/kg	9 – 271	665000	LQM / CIEH

8.46 Comparison of the results of the analysis of soil samples collected as part of the previous Ground Investigation in 1997 with the updated screening assessment in **Table 8.2,** showed one exceedance for lead in a soil sample collected from a trial pit advanced to the north of Camp Road, close to the northern boundary of the Site.

8.47 As part of the 1997 Ground Investigation, samples were also submitted for a range of organic analysis including Dichlorin Methanol, Solvent Extractable Matter, Mineral Oil, Total Non Volatile Aromatics, Non Specific Organics/Resins, Diesel Range Organics, Total Solvent Extract and Total Volatiles. These methodologies are predominately generic types of organic analysis and include the combined concentrations of many different organic compounds. More recent risk characterisation has been undertaken to define the hazardous associated with individual Poly-aromatic Hydrocarbons and Total Petroleum Hydrocarbon fractions. Consequently, the results of the previously completed analysis cannot be compared to the current GACs.

8.48 Ongoing groundwater sampling has been taking place from a number of off Site boreholes since 1997. All but one of the boreholes are located to the north of the Site on the Flying Field area. Borehole BH6 is located approximately 50m to the west of the Site. The results of the groundwater quality analysis of samples collected from these boreholes indicated that since December 1997 diesel range organic contamination was present in many of the boreholes. However, since December 2001 Diesel Range Organic contamination has been primarily associated with groundwater collected from BH7. Boreholes BH9, BH10 and BH11 were subsequently drilled to delineate the hydrocarbons identified within BH7 and have also identified Diesel Range Organic contamination. The area covered by these boreholes is located approximately 800m to the north of the Site.

8.49 Ongoing surface water sampling has been taking place from springs adjacent to the Site boundary and to the north of the Site. The result of the analysis of the surface water samples indicates that the springs adjacent to the Site are not significantly impacted.

Potential Sources of Contamination

8.50 A number of potential on and off Site current and historic sources of contamination have been identified. Current and historical sources of contamination include, but are not necessarily limited to the following:

- the storage of fuel in both above ground and underground storage tanks by the car storage company and other companies storing fuel as part of their operations, for example, as heating fuel, emergency power generation and for powering oil fired equipment. Contamination can arise from the storage and handling of fuel as result of leaks in tanks and/or ancillary pipe work, spillage during tank refuelling or equipment maintenance, and poor housekeeping practices;
- the storage of heating fuel oil for domestic purposes. It is known that some housing on the Site was previously connected to a heating oil delivery system, which included day tanks at each supplied property. Contamination could arise as a result of this activity due to leaks in tanks and ancillary pipe work, spillage during tank refilling and/or during boiler maintenance;
- three separate clusters of large underground storage tanks are present on the Site to the south of Camp Road; one is associated with the hospital incinerator and the other two being associated with the on-Site district heating system. Contamination could arise from this activity due to leaks from tanks and ancillary pipe work, accidental spillages during refilling and/or maintenance and poor housekeeping practices;
- fuel pumps and refuelling points. Contamination could have arisen due to the possibility of leaks from tanks and ancillary pipe work, accidental spillages during refilling and/or during maintenance and poor housekeeping practices;
- numerous electrical substations are present on the Site, which contain transformers and various quantities of mineral oil, some of which could contain Polychlorinated Biphenyls (PCBs). Contamination can arise as a result of leakage from the substations during servicing or as a result of vandalism. Two substation transformers are known to have leaked as a result of vandalism causing transformer oil to be discharged to ground surface in the immediate vicinity, and subsequently treated in conjunction with the Environment Agency;
- the presence of workshops and maintenance facilities associated with the commercial activities on Site, particularly to the north of Camp Road, for example those operated by Paragon with respect to the maintenance of vehicles. Contamination can arise as a result of these activities due to spillage and leaks of maintenance and lubricating oils, chemicals and poor housekeeping practices;

- runoff of washing water and/or rainwater from contaminated surfaces and/or activities, for example, from the car storage company's carwash or rainwater runoff from maintenance areas;
- the presence of made ground across the Site containing varying quantities of foreign material including concrete, brick, glass wire and timber. The results of chemical analysis carried out on samples collected from trial pits excavated during the Ground Investigation carried out by Aspinwall in 1997, indicated that at two locations arsenic concentrations exceeded the Waterman GAC, whilst at one location lead concentrations exceeded the Waterman GAC. Olfactory and visual evidence of hydrocarbon contamination was also encountered in one trial pit. Buried organic matter could also have the capability to generate ground gas including carbon dioxide, methane and hydrogen sulphide;
- the presence to the north of the Site of the POL storage and delivery system associated with the Airbase. Several leaks are known to have occurred from the POL system during its lifetime. In particular, POL 21 located close to the western boundary of the Site, which was the former fuel entry compound from the National Fuel Pipe Line. POL 21 is known to have leaked in 1990. POL19 and POL 23 also known to have leaked historically. It is possible that contamination from the POL has migrated on to the Site;
- the fuel entry pipe leading from the National Fuel Pipe Line passes close to the west of the Site boundary. Any leaks from this pipe or spillages as a result of maintenance could have caused contamination in this area;
- a number of in filled locations are also known to be present on the Site, including backfilled quarries and backfilled interceptor chambers. The consistency of the material used as backfill is unknown. Buried organic material has the potential to generate substantial amounts of landfill gases including carbon dioxide, methane and hydrogen sulphide. Decaying organic matter and or buried contaminated material also has the potential to leach contaminants to groundwater and surface water bodies; and
- asbestos is known to be present in the fabric of buildings on the Site and could also be associated with buried pipes and tanks. Given the unknown consistency of made ground on the Site, including materials used to backfill quarries, asbestos could also be present in made ground.

8.51 According to the Landmark Envirocheck Report (**Appendix 8.1**) there are no recorded landfill sites, registered waste treatment/transfer sites or Contaminated Land Register Entries and Notices within 1km of the Site.

Potential Receptors

8.52 Relevant potential receptors, that could be affected by contamination, identified for the Site as required by Part 2A of the Environmental Protection Act 1990, are set out below:

- human health (future users of the Site including visitors, construction and maintenance workers, residents and off Site land users including residential occupants);
- controlled waters including underlying groundwater, tributaries springs that drain the Site, including Gallos Brook, the River Cherwell, and The Oxford Canal; and
- property (building structures including foundations and buried services).

8.53 Although flora is not defined as a receptor under Part 2A of the Environmental Protection Act 1990, flora is identified as a potential receptor for this Site as the Development would include large areas of green infrastructure and tree planting.

Potential Pathways

8.54 Potential pathways, which could exist on-Site, or could be established during and/or once the proposed Development is completed, are as follows:

- potential pathways relating to human health impacts include: ingestion of home grown produce (in private garden areas); ingestion of, or dermal contact with contaminated soils, dust, surface water and groundwater; and inhalation of dust, indoor gases and vapours;
- potential pathways via which contamination could cause pollution of controlled waters include downward and lateral migration through soils and shallow rock head into groundwater, downward and lateral migration along foundation paths/service trenches, surface runoff, flowing through leaking and damaged drains, flow via smaller tributaries and direct spills and soakaways; and
- potential pathways relating building structures include: direct contact with contaminated soils and groundwater; and ingress of ground gases in confined spaces.

Impact Assessment

8.55 The elements of the Development that could potentially mobilise contamination sources and affect sensitive receptors are described in this section. For an impact to occur there needs to be a pathway (i.e. direct contact, ingestion, inhalation, and migration through soils) from the source of the contamination to the identified receptors. The key elements of the Development that would result in disturbance of the ground and the consequent impacts are described in the following paragraphs.

Demolition and Construction Phase

Risk to Human Health from Ground Contamination

8.56 Earthworks and excavations necessary for the installation of services, building foundations and the planned surface water attenuation tanks of the Development could disturb and expose localised areas of made ground and perched or shallow groundwater. Given the previous Site history, some material excavated may be classified as hazardous waste. Under the new Environmental Permitting (England and Wales) Regulations 2007, both hazardous and non-hazardous waste would require pre-treatment either on-Site or off Site, if disposed at a licensed landfill site, and prior consent from the Environment Agency would be required.

8.57 The potential for contaminant exposure is therefore considered greatest for construction workers, who could be exposed to any contaminated soils and perched or shallow groundwater through dermal contact, ingestion and inhalation of fugitive dusts. Construction workers could also be exposed to ground gases through the inhalation of gases and vapours, if required to work in confined spaces such as trenches. Hydrocarbon contaminated soil could be present on the Site in the vicinity of fuel tanks or fuel delivery pipelines.

8.58 Construction workers would be the subject to mandatory health and safety requirements under the Construction (Design and Management) Regulations 2007 and the Control of Substances Hazardous to Health (COSHH) Regulations (2002). Construction workers and Site visitors would therefore be required to use appropriate personal protective equipment, thereby minimising the risk of dermal contact, ingestion and inhalation of contaminated soils, dust, groundwater or contaminated surface water run-off.

8.59 In areas of earthworks and stockpiled material, dust could be generated during dry and windy conditions. Under these conditions, the general public using footpaths around the Site, together with local residents living on the Site could be exposed to contaminated dust.

8.60 Demolition of buildings without removing asbestos and/or asbestos containing material could result in the release of asbestos fibre to the surrounding environment. Construction workers therefore could be exposed to asbestos fibres by inhalation.

8.61 Adherence to the legislative requirements described above would significantly reduce the potential health risk posed to construction workers and the public from ground contamination. However, since there is the potential for construction workers and the general public, including Site occupants, to be exposed to ground gases and contaminated dust respectively, the impact is considered to be **temporary**, **adverse** and of **moderate significance**.

Contamination of Controlled Waters

8.62 The Great Oolite Limestone is classified by the Environment Agency as a Principal Aquifer and is subject to extensive abstraction for local water supply. Pollution of the underlying groundwater and deterioration of the quality of springs draining the Site and the subsequent potential impact on the River Cherwell and Oxford Canal could occur though the following activities:

- introduction of potential new sources of contamination to the Site such as fuel, oils, chemicals, cement. Accidental spillages or uncontrolled releases (e.g. drips, leaks and spills) could occur during construction activities;
- creation of new migration pathways such as underground service routes or via building foundations or during the excavating for the attenuation tanks into the limestone, which could introduce potential contaminants to greater depths;
- re-levelling and infilling areas, and
- disturbance of sub-surface soils (e.g. made ground) could remobilise or release any contamination currently present in a stable or contained form in the soil or groundwater.

8.63 Where construction works are carried out close to drains that discharge to springs and the stream in the eastern part of the Site, there is the potential for contaminants to enter the surface watercourses through direct spills and contaminated runoff.

8.64 Migration of any soluble mobile contaminants, for example from any contamination that has entered the Site from the POL system could be remobilised as a result of ground disturbance. Owing to the Site's shallow rock head and the fissured nature of Great Oolite, this could result in contamination travelling quickly and easily to underlying groundwater and also travelling a significant distance from the Site.

8.65 The Oxford Canal is likely to be lined such that groundwater is unlikely to be in direct hydraulic continuity with the canal. The lining would also inhibit the migration of contaminants into the canal through lateral pathways. Contamination of the canal via contaminated runoff or the spillage/leakage of a contaminative liquid entering the canal directly is considered unlikely because the canal is located approximately 1km to the west of the Site.

8.66 Water ingress into excavated areas such as trenches would be likely to occur and therefore dewatering would be required. If dewatering is not managed appropriately, the resulting runoff could, if carried out in proximity to the on-Site surface water drains, springs that drain the Site or the stream, cause the deterioration in surface water quality.

8.67 The greatest risk of contamination to controlled waters is likely to arise from new sources of contamination being introduced to the Site, together with the mobilisation of subsurface contamination currently on the Site. In the absence of appropriate mitigation, there could be a **temporary** and **local adverse impact** of **minor significance** in relation to the quality of controlled waters. However, the adverse impact would be reduced or avoided through the adoption of appropriate mitigation measures.

Completed Development

Impact on Human Health from Ground Contamination

8.68 There is the potential for exposure of future occupants and Site visitors to localised ground contamination within the near surface soils, surface water and shallow groundwater through ingestion, inhalation and dermal contact pathways. Any exposure would likely be limited to areas of soft landscaping and garden areas. The results of chemical analysis from the previous Ground Investigation carried out at the Site in 1997 indicated that arsenic and lead concentrations exceeded the respective residential and commercial screening criteria in soil samples from areas intended to be developed for residential and commercial use respectively. Visual and olfactory evidence of hydrocarbon contaminant was also encountered in one trial pit located in an area intended to be developed as open space. Moreover many potential sources of contamination are known to have been and are present on or close to the Site with the potential to cause significant ground contamination.

8.69 There is a potential for the generation of ground gas and vapours associated with made ground, infilled areas and/or contaminated soil. For this reason, there is the potential for ground gases to accumulate in poorly ventilated areas of buildings and rooms. However, it is anticipated that some of the made ground, that is a potential source of ground gas, would be removed during the construction works.

8.70 Without the adoption and implementation of appropriate mitigation measures future occupants and Site users could be exposed to contaminated soil in gardens and soft landscaped areas. There is also the potential for ground gas to accumulate in poorly vented confined spaces, posing a risk to future occupants. In the absence of appropriate mitigation future occupants and Site users could come into contact with ground contamination which would represent a likely **long-term adverse impact** of **moderate significance.**

Contamination of Controlled Waters

8.71 The Development does not include land uses that are likely to result in significant contamination of soil, underlying groundwater and surface waters. However, fuel and oil leakages cannot be discounted in car parks or from any of the intended future commercial activities on the Site.

8.72 Contamination is known to be present on the Site, along with many current and previous potential sources of contamination. Runoff attenuation features which are proposed principally in the south-western part of the Site, together with building foundations, could act as a pathway for contamination to reach the groundwater. A number of springs are also present adjacent to the Site boundaries. Therefore without the adoption of adequate mitigation measures, the likely impact of the Development on controlled waters would be **long-term, adverse** and of **moderate significance**.

Chemical Degradation of Underground Structures and Services

8.73 Buried concrete structures can be susceptible to chemical attack from ground contaminants, particularly sulphates. If present at significant concentrations, the structural integrity of below ground building structures could be compromised. In addition, if significant phenol, hydrocarbon, acids and metals contamination are present in the Site soils, there is the potential for contaminants to corrode and permeate plastic water mains and adversely affect drinking water. Without appropriate mitigation measures, the likely impact of contamination on underground building structures and services would be **long-term**, **adverse** and of **minor significance**.

Impact on Flora

8.74 The Development includes large areas of soft landscaping. Therefore there is the potential for flora to come into direct contact with localised areas of contamination. Without appropriate mitigation measures, plant uptake of phytotoxic compounds present in the soil could affect plant growth and for this reason, the likely impact of ground contamination on flora is assessed as **long-term, adverse** and of **minor significance**.

Mitigation Measures and Residual Impacts

Demolition and Construction Phase

Risk to Human Health from Ground Contamination

8.75 This assessment has shown that there is the potential for parts of the Site to have localised contamination. Whilst parts of the Site were subject to a preliminary Ground Investigation in 1997 (Aspinwall 1997), a supplementary Ground Investigation should be carried out to fully ascertain the location, nature and levels of ground contamination across the Site. Following this, a detailed Quantitative Environmental Risk Assessment should be undertaken in accordance with CLR11. Should any unacceptable environmental risks be identified, a Remediation Strategy should be developed and agreed with the statutory authorities and implemented prior to works commencing on the Site. This should ensure that the Site is suitable for use. A validation report should be produced to document the completed works and to update the final environmental conceptual model.

8.76 To lower the risk of the inhalation of potentially contaminated dusts by on and off Site users, including the public, a dust suppression regime of damping down exposed soils and wheel washing facilities for vehicles leaving the Site should be adopted. Areas of the Site should be secured from the public, where possible and stockpiled materials should be covered to reduce airborne dust.

8.77 Adequate ventilation should be maintained in confined spaces, such as trenches, to reduce the likelihood of ground gas accumulating. Entering confined spaces should be minimised and only undertaken by suitably trained and equipped workers. Excavations should also be monitored for ground gas and vapours during works, if they are to be entered.

8.78 The development and implementation of an agreed Remediation Strategy, if necessary, would reduce any ground contamination and its associated risk to workers to acceptable levels. The adoption of a dust suppression regime would also lower the potential for public exposure to contaminated dusts. With the adoption of the measures described above, the likely residual impact would be **beneficial** and of **minor significance**.

Contamination of Controlled Waters

8.79 A supplementary Ground Investigation should be carried out to ascertain the nature and levels of ground contamination. This should include groundwater testing to ascertain groundwater flows and levels, together with the quality of the groundwater and surface watercourses on the Site. If the findings of the investigation identify any unacceptable risks, a Remediation Strategy, should be developed, agreed with the statutory authorities and implemented. The removal of the sources of contamination, where necessary, would significantly reduce the risk of pollution to any controlled water.

8.80 A Construction Environmental Management Plan (CEMP) should be adopted during the construction phase and should include, but not be limited to, the following:

- procedures for the storage and management of materials, spillage and spill clean-up, use of best practice construction methods and monitoring;
- measures to avoid surface water ponding and the collection, testing (and treatment if necessary) and disposal of all Site runoff; and
- refuelling of vehicles in designated hard surfaced areas.

8.81 Water pumped from excavations should be tested and released, where appropriate, in accordance with environmental legislation and in agreement with the Environment Agency, Water Company or CDC.

8.82 To reduce the risk of potential groundwater contamination during any foundation works, an appropriate methodology should be selected and implemented in accordance with best practice guidelines produced by the Environment Agency. This should be developed at a detailed stage in the form of a Foundation Works Risk Assessment and in consultation with the Environment Agency.

8.83 Providing the above measures are developed and implemented, where necessary, the likely residual impact on controlled waters would be **insignificant**.

Completed Development

Impact on Human Health from Ground Contamination

8.84 As mentioned above, it is recommended that a supplementary Ground Investigation should be undertaken at the Site, and a Remediation Strategy developed and implemented if required. This would ensure that the Site is suitable for use and that there would be no unacceptable risk posed to future human receptors using the Site.

8.85 It is recommended that as part of the Ground Investigation, the ground gas regime on the Site is assessed. Gas protection measures should be implemented (if required) in accordance with guidance contained in '*Assessing Risks Posed by Hazardous Ground Gases to Buildings (revised) (C665)*' (Construction Industry Research and Information Association, 2007) and '*Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present*' (National House-Building Council, 2007).

8.86 Providing remediation of the Site is carried out, where necessary, and that gas protection measures are incorporated into the design of the buildings if necessary, the likely residual impact with respect to future Site users would be **beneficial** and of **minor significance**.

Contamination of Controlled Waters

8.87 Areas of hard-standing should be designed to prevent uncontrolled discharges to drains and surface watercourses. Surface water drainage systems for the Site should be designed to incorporate suitable interceptors, filters and silt traps to avoid the discharge of any fuels or oils that have entered the system, into the underlying groundwaters and nearby watercourses. The interceptor system should be regularly maintained to ensure it remains functional. Providing these measures are carried out the likely residual impact on controlled waters would be **long-term beneficial** and of **minor significance**.

Chemical Degradation of Underground Structures and Services

8.88 Concrete foundations should be designed using the results of the Ground Investigation and in accordance with guidance provided in British Research Establishment (BRE) Special Digest 1 (BRE, 2005) to ensure that the appropriate grade of concrete is used.

8.89 In addition, the water supply pipework should be selected in accordance with '*The Selection of Materials for Water Supply Pipes to be Laid in Contaminated Land*' (Water Regulations Advisor Scheme, 2002) to ensure that the pipeworks are resistant to chemical attack. The pipe and service routes should be protected from any residual contamination in the soils through the use of clean backfill.

8.90 Providing the above is implemented and taken into account during the design stage, the likely residual impact on underground structures and services would be **insignificant**.

Impact on Flora

8.91 It is recommended that as part of a supplementary Ground Investigation, phytotoxic metals should be tested for in areas where soft landscaping and gardens are proposed. Should remediation of the Site be required, this process would remediate the soils and contaminant concentrations to acceptable levels. A suitable thickness of clean inert topsoil should be placed in areas where residual contamination coincides with areas of proposed soft landscaping to reduce the likelihood of plants coming into direct contact with contaminated soil and groundwater. Providing these measures are implemented, where necessary, the likely residual impact on flora would be **insignificant**.

Conclusions

8.92 Localised contamination has been identified within the soils underlying parts of the Site. Contamination has also been found in groundwater to the north of the Site. Owing to the historical and current activities on, and adjacent to the Site, there is the potential for further contamination to exist within the soils and underlying groundwater.

8.93 During demolition and construction operations, construction workers and Site occupants could be exposed to ground contamination. Pollution of the underlying groundwater and springs draining the Site could also occur as a result of new sources of contamination introduced to the Site, together with the mobilisation of existing contamination in the subsurface soils. However, mitigation measures should be implemented, where necessary, to reduce the environmental risks to Site users, surface water courses and underlying groundwater to an acceptable level.

8.94 The proposed Development does not include land uses that would be likely to result in significant contamination of soil, underlying groundwater and surface waters. However, future Site users could be exposed to historical contamination in soft landscaped areas and ground gases accumulating in buildings. Runoff attenuation features and building foundations could provide new contamination pathways, introducing contamination to the underlying groundwater. Prior to developing the Site, a Ground Investigation should be carried out to ascertain the nature and extent of contamination across the Site. Where necessary, the Site should be remediated so that ground contamination is reduced to an acceptable level.