11 GROUND CONDITIONS

11.1 INTRODUCTION AND KEY ISSUES

11.1.1 This chapter describes the likely ground condition effects of the proposed Richmond Education and Enterprise Campus (REEC) development at Richmond upon Thames College (RuTC) in Twickenham, within the London Borough of Richmond upon Thames (LBRuT).

11.1.2 Land contamination in the context of this assessment is defined as the presence of substances in, on or under the land, that have the potential to cause harm, whether this is to the environment (i.e. groundwater or controlled waters) or to human health. Potential geo-environmental impacts with respect to development construction, operation and waste management are also considered.

11.1.3 The key issues considered are:

- Location and nature of any potentially contaminated land within the Site and other areas in close proximity to the Site;
- Identification of potential sources of contaminant migration into the Site, including migration of ground gases;
- Impacts of potential contamination arising during clearance, demolition, excavation and construction;
- Impacts of potential contamination left in-situ;
- Management of potentially contaminating materials arising from clearance, demolition and construction; and
- Management of potential unexploded ordnance within the study area.

11.1.4 The study area for the contaminated land assessment is the land within the site boundary for the proposed REEC development together with a surrounding area extending approximately 500 m from the redevelopment site boundary.

11.2 CONSULTATION

11.2.1 The scope of assessment of contaminated land issues and the methodology to be used were set out in the EIA Scoping Report (**Appendix 2.1** in Chapter 2). Of those responses to the Scoping Report received, only that of the Environment Agency refers specifically to contaminated land, and in particular the assessment of impacts on groundwater and other controlled waters. The scope of the assessment reflects all of the comments and requirements of the Environment Agency.

11.2.2 The assessment focuses on the impacts of contaminated land during demolition, excavation and construction as there are not expected to be any contaminated land

impacts during the operational phase of the proposed development. This is because there will be no new sources of contaminants nor any significant changes to the site that would affect the potential impacts of residual contaminants on site, and all mitigation measures will be complete by the end of the construction phase or will have been incorporated into the design of the development.

11.3 LEGISLATION AND PLANNING POLICY

International

EU Directive (2004/35)

11.3.1 The only significant European legislation which has been transposed into UK law on contaminated land is the EU Directive (2004/35) in respect of environmental liability and remedying environmental damage. This introduced obligations to ensure that the polluter pays for damage caused which strengthened the pre-existing 'Polluter Pays Principle' in UK Common Law.

National

11.3.2 Land contamination in the UK is regulated under several regimes, including environmental protection, pollution prevention and control, waste management, planning and development control, and health and safety. There are a number of key legislative drivers for dealing with risks to human health and the risk of pollution of the environment from land contamination, including:

- Part 2A of the Environmental Protection Act (EPA) 1990 (the Contaminated Land Regime);
- Contaminated Land (England) Regulations 2006;
- Contaminated Land (England) (Amendment) Regulations, 2012;
- The Water Act 2003;
- The Water Resources Act, 1991 (as amended);
- The Environmental Damage (Prevention and Remediation) Regulations 2009;
- The Town and Country Planning Act, 1990 (as amended); and
- The National Planning Policy Framework (NPPF) 2012.

Environmental Protection Act (1990)

11.3.3 Under Part 2A of the EPA 1990 sites are identified as 'contaminated land' if they are causing harm or if there is a significant possibility of significant harm or if the site is causing, or could cause, significant pollution of controlled waters. Part 2A mostly applies to the existing use of the site and its enforcement is the responsibility of the Local Planning Authority. As a minimum, newly developed sites should not be able to be classed as contaminated land as defined by Part 2A of the EPA 1990.

11.3.4 The EPA 1990 endorses the principle of a 'suitable for use' approach for contaminated land, where remedial action is only required if there is an unacceptable risk to human health or risk of pollution of the environment, taking into account the use of the land and its environmental setting. Statutory Guidance on contaminated land guidance describes a risk-based approach based on a 'source-pathway-receptor' model of the site. For the land to be determined as contaminated in a regulatory sense, and thereby require remediation, all three elements (a source of contamination, a receptor and a pathway by which the receptor could be exposed to the contamination) must be present.

The Contaminated Land (England) Regulations (2006)

11.3.5 The Contaminated Land (England) Regulations 2006 elaborate on various details of the Part 2A regime, such as dealing with 'special sites'; public registers; remediation notices; and the rules for appeals and are amended by the Contaminated Land (England) (Amendment) Regulations 2012.

Water Act (2003)

11.3.6 The Water Act 2003 amended the Water Resources Act 1991 and makes numerous provisions, including those related to contaminated land. The Water Act 2003 (and various commencement orders) brings into effect changes to the definition of contaminated land in the EPA 1990 so that, in relation to the pollution of controlled waters, for land to be determined as contaminated land it must cause significant pollution or there must be a significant possibility of such pollution of controlled waters.

11.3.7 The Water Resources Act 1991 (as amended) seeks to protect the quality of water by setting out the functions of the Environment Agency and describing offences relating to water and discharges to it.

Environmental Damage (Prevention and Remediation) Regulations (2009)

11.3.8 The Environmental Damage (Prevention and Remediation) Regulations 2009 implement the European Union Directive (2004/35) in respect of environmental liability and remedying environmental damage. They introduced obligations to ensure that the polluter pays for damage caused, supplementing existing legislation. Various enforcing authorities include the Environment Agency in relation to damage to water, Natural England in relation to biodiversity and LPAs in relation to land damage.

National Planning Policy Framework (NPPF) (2012)

11.3.9 The National Planning Policy Framework (NPPF) states in Section 11, paragraph 120 'Conserving and Enhancing the Natural Environment' that '*…where a site is affected by contamination, responsibility for securing a safe development rests with the developer and/or landowner*'.

11.3.10 The NPPF states in paragraph 121 that local planning policies and decisions should also ensure that '*…the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation'.*

11.3.11 This is consistent with the requirement that a development site granted planning consent should not be able to be classed as contaminated land under Part 2A of the EPA 1990 when the site is occupied and in use (paragraph 121 of the NPPF).

11.3.12 It is also stated in paragraph 17 of the NPPF that within the overarching roles that the planning system ought to play, a set of core land-use planning principles should underpin both plan-making and decision-taking. These include contributing to the conservation and enhancement of the natural environment and to the reduction of pollution.

11.3.13 Section 11, paragraph 109 of the NPPF states that: *'the planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, or water pollution and remediating and mitigating despoiled, degraded, derelict and contaminated land, where appropriate*'.

11.3.14 Planning Practice Guidance was published in March 2014 to reflect the requirements of the NPPF in respect of land affected by contamination[1]. The guidance deals primarily with matters of concern for local planning authorities and the role of planning in dealing with land contamination. It confirms that a contaminated land risk assessment is required to inform an EIA where this is a planning requirement and that the minimum requirement is the report of a desk study and walkover and a conceptual model. The Planning Practice Guidance also indicates that local planning authorities may use planning conditions to secure the submission of remediation schemes for approval and the validation of remedial works when they are complete. Planning conditions may also specify a system for notifying the planning authority of

[1] http://planningguidance.planningportal.gov.uk/blog/guidance/land-affected-by-contamination/land-affected-by-contamination-guidance/ (accessed 02-04-2014)

key stages in the process and reporting of unexpected contamination and responses to it.

Local

The London Plan – The Spatial Development Strategy for London Consolidated with Alterations since 2011 (2015)

11.3.15 The adopted London Plan is the overall strategic plan for London and sets out a fully integrated economic, environmental, transport and social framework for the development of the capital to 2031.

11.3.16 Policy 5.21 'Contaminated Land' of the London Plan states that:

- *'The Mayor supports the remediation of contaminated sites and will work with strategic partners to ensure that the development of brownfield land does not result in significant harm to human health or the environment and to bring contaminated land to beneficial use;*
- *Appropriate measures should be taken to ensure that development on previously contaminated land does not activate or spread contamination; and*
- *Local development frameworks (LDF) should encourage the remediation of contaminated sites and set out policy to deal with contamination'.*

11.3.17 Paragraph 5.95A of Policy 5.21 states where potentially contaminating activities are proposed, development should include appropriate measures to mitigate any potential harmful effects.

11.3.18 The London Plan also addresses Geological Conservation. Policy 7.20 states that

- *'The Mayor will work with partners to ensure the protection and promotion of geodiversity. Boroughs should:*
- *Accord the highest protection to nationally designated sites (SSSIs) in accordance with Government guidance*
- *Give strong protection in their DPDs (Development Plan Documents) to Regionally Important Geological Sites (RIGS) which, in addition to nationally designated sites, includes sites of strategic importance for geodiversity across London'.*

11.3.19 Neither the Further Alterations to the London Plan (FALP) published in March 2015 nor the Minor Alterations to the London Plan published for public consultation in May 2015 contains any new or revised policies specifically relating to contaminated land.

11.3.20 Core Policy CP1 on Sustainable Development in the London Borough of Richmond

upon Thames Core Strategy published in 2009 states that '*local environmental impacts of development with respect to factors such as … contamination should be minimised*'.

11.3.21 Policy DM SD 9 Protecting Water Resources and Infrastructure in the 2011 Development Management Document states that '*the borough's water resources and supplies will be protected by resisting development proposals that would pose an unacceptable threat to surface water and groundwater quantity and quality*'.

11.4 ASSESSMENT METHODOLOGY

Evaluation of Effects

11.4.1 The principal guidance document on managing contaminated land is Contaminated Land Report 11 (CLR11), published by the Environment Agency[2]. This provides a technical framework for identifying and remediating contaminated land through the application of a risk management process. CLR11 also sets out the approach to remediation of contaminated land.

11.4.2 The question of whether risk is unacceptable in any particular case involves not only scientific and technical assessments, but also appropriate criteria to judge the risk and conclude on exactly what risk would be unacceptable.

11.4.3 The process of risk assessment is summarised as follows:

- Develop a Conceptual Site Model – carry out a desk study review of available documentary information and identify the potential sources, pathways and receptors relevant to the site, and the potential pollutant linkages.
- Gather site-specific information on the Conceptual Site Model – through site investigation, gather information on the nature and extent of contamination, details of pathways for migration of contamination, specific information on the receptors to update the model.
- Risk assessment – apply criteria that will enable a judgement as to whether the concentrations of contaminants in soil represent an unacceptable risk. These criteria must be relevant to each pollutant linkage, and can be generic (conservative) criteria, or can be site-specific (less conservative). Generic assessment criteria (GAC) are concentrations of a contaminant in soil below which the risk is acceptable. Site-specific assessment criteria are concentrations of a contaminant in soil above which there is likely to be an unacceptable risk.

11.4.4 If a site passes based on the application of GAC, then it is likely that no remedial

[2] Environment Agency (2004) *Model Procedures for the Management of Land Contamination. Contaminated Land Report 11.* Bristol: Environment Agency

action is required. If a site fails, then there may be a benefit in gathering further information and deriving site specific assessment criteria. If a site also fails on the application of site specific criteria, then remedial action will be required. Alternatively, a decision to remediate can be based on generic criteria as these are likely to be more conservative than site-specific criteria. In general, this is the approach taken in this assessment.

11.4.5 The Environment Agency has published extensive guidance on the technical aspects of risk assessment, which forms the recognised basis of the UK approach to identifying whether land affected by contamination presents an unacceptable risk. Derivation of relevant assessment criteria is done using the Contaminated Land Exposure Assessment (CLEA) model. The Environment Agency has published a number of GAC in the form of Soil Guideline Values for a number of contaminants, while a wide range of generic values have been published independently by various agencies using CLEA. The principal sources of generic criteria used in the assessment are EIC/AGS/CL:AIRE[3] and the Chartered Institute of Environmental Health[4].

11.4.6 Risks arising from gas in the ground would be assessed and managed in accordance with the guidance in Construction Industry Research and Information Association (CIRIA) report C665[5].

11.4.7 CIRIA defines Gas Screening Values which are calculated by multiplying the maximum concentration of the gas detected in borehole sampling by the measured flow rate to give a value expressed in litres per hour. Threshold values are given for a range of six risk classifications (termed Characteristic Situations) ranging from very low (<0.07 l/h) to very high (>70 l/h).

Significance of Effects

11.4.8 For the purposes of the EIA, the assessment of likely significant effects and likely residual effects will be based on significance criteria derived in line with the good practice provided in the CIRIA Report C552. The criteria consider controlled waters, human health, ecological and property receptors listed in the contaminated land statutory guidance and Environment Agency Model Procedures (CLR11).

11.4.9 The significance criteria are shown in **Table 11.1**.

[3] Environmental Industries Commission, The Association of Geotechnical and Geoenvironmental Specialists and Contaminated Land: Applications in Real Environments (2010) *Soil Generic Assessment Criteria for Human Health Risk Assessment*. London: CL:AIRE.

[4] The Chartered Institute of Environmental Health (2009) *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment* (2nd Ed.). Land Quality Management Ltd.

[5] S Wilson, S Oliver, H Mallett, H Hutchings and G Card (2007) *Assessing Risks posed by Hazardous Ground Gases to Buildings. Report C665*. London: CIRIA.

Table 11.1: Significance Criteria for Contaminated Land

Effect	Description
Major adverse	Severe or irreversible detrimental effect to human health. Severe temporary or irreversible reduction in the quality of a potable groundwater or surface water resource of local, regional or national importance. Irreversible or severe temporary detrimental effect on animal or plant populations. Irreversible detrimental effect to nationally important geological feature. Irreversible detrimental effect to building structure resulting in collapse or demolition.
Moderate adverse	Long-term minor or short-term moderate detrimental effect to human health. A minor or moderate, local-scale reduction in the quality of potable groundwater or surface water resources of local, regional or national importance, reversible with time. Reversible widespread reduction in the quality of groundwater or surface water resources used for commercial or industrial abstractions. Medium-term, reversible detrimental effect on animal or plant populations. Medium-term, reversible detrimental effect to nationally important geological feature. Detrimental effect to building structure requiring remedial engineering works.
Minor adverse	Short-term minor detrimental effect to human health. A minor or moderate temporary detrimental effect in the quality of groundwater or surface water resources that are used for, or have the potential to be used for, commercial or industrial abstractions. Short-term reversible detrimental effect on animal or plant populations. Short-term reversible detrimental effect to nationally important geological feature. Detrimental effect to building structures not requiring remedial engineering works.
Negligible	No appreciable effect on human, animal or plant health, potable groundwater or surface water resources or geological features of importance.
Minor beneficial	Minor reduction in risk to human, animal or plant health. Minor local-scale improvement to the quality of potable groundwater or surface water resources. Moderate local-scale improvement to groundwater or surface water resources that are used for, or have potential to be used for industrial or commercial abstractions.
Moderate beneficial	Moderate reduction in risk to human, animal or plant health. Moderate local-scale improvement to the quality of potable groundwater or surface water resources. Major local-scale, or moderate wide-scale, improvement to the quality of groundwater or surface water resources used for commercial or industrial abstraction only.
Major beneficial	Major reduction in risk to human, animal or plant health. Major local-scale/moderate to major improvement in the quality of a potable groundwater or surface water resource of local, regional or national importance.

Limitations of Assessment

11.4.10 Contaminated land assessments on operational sites in general are necessarily limited by constraints on access. Intrusive investigations cannot be undertaken within building footprints and even in open areas such as car parks or sports fields, investigations can only be undertaken if such areas are taken out of commission. Where contamination is suspected in such areas, further investigations may be required during clearance and demolition. It is expected that reports of these further

investigations and accompanying risk assessments will be required under planning conditions.

11.4.11 Since different assessment criteria (soil guideline values or GAC) apply to different land uses, the Site Development Zones Parameter Plan PL-03 (see **Appendix 5.1**) and the Illustrative Masterplan (**Figure 5.1** in Chapter 5) have been used to determine the development zones within which identified areas of contamination lie.

11.4.12 Where there is a risk that materials excavated during construction may be contaminated, these will be subject to chemical testing (Waste Acceptance Criteria testing) to establish whether they are hazardous and to identify potential treatment and disposal sites that would be licensed/permitted to accept them as wastes.

11.5 BASELINE

Introduction

11.5.1 The study area covers both the site of the REEC development and a surrounding area of search for baseline data up to 500m from the redevelopment site boundary. A buffer zone of 500m is considered sufficient to identify any potential sources of contamination outside the site boundary which could result in the migration of contaminants into the Site or any sensitive receptors that could be affected by contaminants migrating from the site.

11.5.2 The following description of the existing environment on and in the vicinity of the Site is based on a historical mapping and data report in the form of a Landmark Envirocheck report dated May 2014, a site walkover conducted in May 2014 and information supplied by the College Estates Office at the time of the survey. The historical mapping and data report is included as **Appendix 11.1**. The development site boundary shown was that under consideration at the time. The current proposed development site boundary differs somewhat, but the area within the former, as shown in **Appendix 11.1**, incorporates the whole of the latter as well as a considerable buffer zone outside it.

11.5.3 Additionally, reference has also been made to site investigations (including trial pits and boreholes) completed in 2008 by Soiltechnics, to determine data on contaminant levels. A copy of the Soiltechnics contamination data is provided in **Appendix 6.6**.

Current Baseline

11.5.4 The site is occupied by the buildings of existing college and its associated open spaces, including car parks and sports fields. Ground level across the site varies typically between about 9.5mAOD and 12.0mAOD.

11.5.5 A review of historical mapping indicates that the site was covered mainly by open fields in 1869. Buildings identified as 'Marsh Farm' stood in the southern part of the site near to the course of the River Crane. The north eastern part of the site was occupied by orchards which appear to be connected to a building beyond the northern site boundary on Whitton Road identified as 'Orchard Cottage'.

11.5.6 The situation within the main site was largely unchanged by 1896. However, an area adjacent to but outside the south western corner of the site is shown as being developed as a sewage works. The 1896 map appears to show some unidentified features of the works on both sides of the River Crane, whose original course ran through the site at that time. A tramline which ran across the site between the sewage works and Whitton Road is shown. London United Tramways operated commercial trams in south west London between 1894 and 1933. However, a map dating from that period shows that the tram line crossing the site was not part of the commercial network. It is considered likely that the tram line shown was operated privately and may have been connected with gravel workings (see below). Most tramways that were not electrified for commercial uses in that period were horse-drawn.

11.5.7 The 1896 map shows a gravel pit beyond the southern site boundary immediately south of the railway line.

11.5.8 The 1920 map shows that there were a number of filter beds at the sewage works, mostly lying outside the site. However, the edges of some of the filter beds were close to the river as it ran through the main site at that time. By 1920, the tramway across the site was no longer shown and the gravel pit to the south had been infilled and partly redeveloped.

11.5.9 By 1935 the sewage works had expanded, partly into the areas currently occupied by the Harlequins Stadium (Twickenham Stoop) but also partly into the eastern area of the site. On the later 1938 map, the extended areas are labelled as allotment gardens. Also, by 1938 the first of the current college buildings which presently occupy the main site had been built.

11.5.10 The 1960 - 1966 mapping shows the sewage works to have been replaced by a depot on the site of the current council depot. The River Crane had been realigned to its present course along the southern boundary of the site. Allotment gardens are still shown to the west and south west of the college buildings. However, the area to the south of the buildings is shown as a playing field.

11.5.11 The 1975 map shows further extensions to the college buildings. This situation appeared largely unchanged in 1992. By 2006, the full development of the college is shown. The most recent map, dated 2014, also shows the new housing areas to the

east of Twickenham Stoop.

11.5.12 The superficial geology of the sites and surrounding area consists of the sands and gravels of the Kempton Park Gravel formation which overlies the London Clay. Inspection of the geological map of the area (at 1:50,000 scale) published by the British Geological Survey indicates that the London Clay is 50m thick and that it overlies the sands and gravels of the Lambeth Group, which is also about 50m thick and which overlies the Upper Chalk.

11.5.13 The site is located in an area designated a major aquifer, defined by the Environment Agency highly productive and able to support large abstractions for public water supply and other purposes.

11.5.14 The groundwater vulnerability map shows the recording the soils as having high leaching potential. These soils have little ability to attenuate diffuse source pollutants. Non-absorbed diffuse source pollutants and liquid discharges will percolate rapidly through them. The groundwater vulnerability map also records a sub class of soil type U (undifferentiated). In such a case there is insufficient information to classify the soils accurately and generally a default class of H1 is adopted. A sub class of H1 is defined as a soil which readily transmits liquid discharges because they are either shallow or susceptible to rapid by-pass flow directly to rock, gravel or groundwater.

11.5.15 The nearest licensed groundwater abstraction is over 1.5 km from the site.

11.5.16 The potential for ground stability hazards due to collapsible ground, and running sand is very low, while there are no hazards from compressible ground or landslides. There is a moderate hazard of swelling or shrinking clay. The development is not in a radon-affected area. Soiltechnics undertook a comprehensive assessment of the potential effects of ground conditions on construction materials which is included in **Appendix 11.2**. This concluded that risks were generally low and would be mitigated through specification and design. These risks are therefore not considered further here.

11.5.17 Site investigations completed in 2008 encountered between 0.3-1.0m of topsoil or made ground, grading into orange brown clays becoming sand and gravel (considered to be Kempton Park Gravel) to depths of between 4.2m and 5.3m, and locally 9.3m. Stiff grey dark grey clay considered to be London Clay was encountered underlying the Kempton Park Gravel. Groundwater was encountered at depths between 1.1-3.5m in exploratory excavations and water levels at depths of between 1.33-2.54m were observed in standpipes installed across the site.

11.5.18 During the site walkover survey, no obvious features of the main site or its current or former uses suggested that there may be a significant risk of soil contamination. All

boilers for heating and hot water purposes are currently gas fired, so no solid or liquid fuel is stored on site. However, the potential for localised small scale contamination was recognised. There are some storage areas for small amounts of chemicals used in laboratories and one location was identified where solid or liquid fuel may have been used previously, although there were no obvious residues visible.

11.5.19 Although there were no obvious areas of infill on the sites, it is understood that there were bunkers in use during the Second World War and that these have since been backfilled.

11.5.20 During the 2008 site investigations, elevated concentrations of benzo[a]pyrene were measured in several locations and these were presumed to be associated with ash and clinker contained in the soil. Some hydrocarbon contamination was also identified in two locations in the near surface soils along the western boundary of the site, south of the Langhorn Drive entrance.

11.5.21 Based on gas monitoring undertaken, the site is classified as characteristic gas situation two, based on the definitions in CIRIA guidance document C665, which could require mitigation depending on the final location of the buildings.

Future Baseline

11.5.22 Baseline conditions are not expected to change significantly between those described above and the commencement of the redevelopment works because:

- The Site will continue in operation until the redevelopment works;
- The geology and ground conditions are stable;
- Most of any contamination present would be as a result of historical incidents; and
- There are no significant continuing sources of soil contamination at the Site or on nearby sites with a significant potential to cause future migration of contaminants into the Site.

Baseline Limitations

11.5.23 The same limitations apply to the identification of baseline conditions as those identified in Section 11.4, above, in respect of the whole assessment.

11.5.24 As with any assessment based on a finite number of samples taken from different locations across the Site there is a risk that unidentified contamination could be present. This possibility, together with appropriate management responses, is addressed in the section on mitigation, below.

11.6 SENSITIVE RECEPTORS

11.6.1 The sensitive receptors potentially at risk of exposure to contaminated land are listed in Section 11.7, below, as part of the initial conceptual model of the Site.

11.7 IMPACT ASSESSMENT

Site Enabling, Demolition and Construction

Initial Conceptual Model

11.7.1 On Site sources include*:*

- Fuel storage;
- Made ground and other potential infill; and
- Chemical storage.

11.7.2 Off Site sources include:

- Made ground;
- Former sewage works to the south west; and
- Depot to the south west (on former sewage works land) waste transfer station and treatment plant to south.

11.7.3 Contaminants associated with these sources were identified to include hydrocarbons, solid or liquid fuels (coal, coke or diesel oil) and polycyclic aromatic hydrocarbons (PAHs), specifically benzo[a]pyrene, and ground gases (methane and carbon dioxide).

11.7.4 Potential pathways include:

- Surface water run-off into surface water features;
- Migration of leachable contaminants from Made Ground into shallow aquifer;
- Migration of contaminants within groundwater in shallow aquifer into surface water features;
- Dermal contact / ingestion / inhalation of dust, soil or liquids;
- Inhalation of ground gases, vapours and dust;
- Migration of ground gases and vapours; and
- Dissolution of ground gases into groundwater.

11.7.5 Potential Receptors include:

Controlled waters:

- Shallow Principal Aquifer underlying site;

- River Crane; and
- Duke of Northumberland's River.

Human health:

- Construction workers;
- Future REEC staff, students and visitors; future residents; and
- Adjacent site users and residents.

Construction materials and structures:

- Buildings at risk from gas ingress.

Ecological Receptors:

- Aquatic ecology (see Controlled Waters, above).

Predicted Effects

Soil Contaminants

11.7.6 A Ground Investigation was undertaken for RuTC by Soiltechnics in 2008. The report is provided in **Appendix 11.2**, minus the Appendix that contains the Envirocheck report commissioned at that time, as this is superseded by the newer Envirocheck report in **Appendix 11.1**.

11.7.7 Ground conditions are not expected to have changed significantly since 2008 for the reasons set out in paragraph 11.5.22, above.

11.7.8 Where contaminants in soil samples have been detected at levels above the analytical detection limit of the methods used for testing, their concentrations have been screened against relevant assessment criteria. The criteria used were Environment Agency Soil Guideline Values and GAC published by CL:AIRE/EIC/AGS and LQM/CIEH. These criteria were all derived using the latest version of the CLEA software and they therefore supersede those used by Soiltechnics in their report. For each contaminant there are a range of published criteria which relate to different end uses of the land. The criteria used in this assessment are those which correspond to a commercial end use for the development, i.e. the college, schools and tech hub development zones, and those which correspond with a residential end use which apply to the residential development zone. Where the relevant criterion for a particular contaminant varies according to the soil organic matter concentration, initial screening has been against the most stringent value (generally a soil organic matter concentration of 1%).

11.7.9 The analytical detection limits reported by the testing laboratory are generally lower than the relevant Soil Guideline Values or GAC so that where contaminant

concentrations in soil fall below the analytical detection limit they would also fall below the relevant criteria.

11.7.10 The relevant guideline values or assessment criteria are used both for the assessment of risks to construction workers and future site users in the longer term, i.e. they apply for both construction and operational phases of the proposed development.

11.7.11 A summary of the principal guideline values used and the maximum concentrations of contaminants found in soil samples within the college, schools and tech hub development zones, noting any exceedances, is shown in **Table 11.2**. The relevant guideline values, maximum concentrations and exceedances for the residential development zone are shown in **Table 11.3.**

11.7.12 **Figure 11.1** shows the locations of trial pits and boreholes where exceedances of the relevant guideline values were identified.

11.7.13 None of the relevant criteria for commercial end use were exceeded in the college, schools or tech hub development zones. The sole instance of exceedance of a criterion for commercial end use shown in **Table 11.2** is within the residential development zone.

11.7.14 The significance of the potential effects on human health of the elevated contamination is considered to be **negligible** within the college, schools and tech hub development zones.

Legend

Contamination Hotspot

N

0 100m

CASCADE

Note: All locations are approximate

Drawing Source: HoK Number PL-17

Project Title:
Richmond Education and Enterprise Campus Development

Figure Title:
Locations of Contamination Hotspots

For Information Only

Figure Number:	Date:
Figure 11.1	June 2015

Table 11.2: Summary of Soil Testing Data and Comparison with Risk Assessment Criteria for Commercial End Use

Determinand	Maxi-mum value (mg/kg)	Guideline Value (mg/kg)	Source	Exceedances
Total cyanide	3.0	34	SSV, 1% SOM	
As	43	640	EA SGV	
Cd	1.4	230	EA SGV	
Cr	42	330	SSV assuming 100% Cr (VI)	
Pb	1,100	6,490	SSV, 1% SOM	
Hg	1.9	4.3	SGV, worst case	
Ni	65	1,800	CIEH/LQM GAC	
Se	<2.5	13,000	EA SGV	
TPH	720	8,300	CL:AIRE/EIC/AGS GAC	
Acenaphthene	23	57	CL:AIRE/EIC/AGS GAC	
Acenapthylene	16	86	CL:AIRE/EIC/AGS GAC	
Anthracene	52	530,000	CL:AIRE/EIC/AGS GAC	
Benzo[a]anthracene	68	90	CL:AIRE/EIC/AGS GAC	
Benzo[a]pyrene	58	14	CIEH/LQM GAC	DTS05, 0.2 m
Benzo[b]fluoranthene	74	100	CL:AIRE/EIC/AGS GAC	
Benzo[ghi]perylene	26	650	CL:AIRE/EIC/AGS GAC	
Benzo[k]fluoranthene	28	140	CL:AIRE/EIC/AGS GAC	
Chrysene	64	140	CL:AIRE/EIC/AGS GAC	
Dibenzo[a,h]anthracene	6.4	13	CL:AIRE/EIC/AGS GAC	
Fluoranthene	200	23,000	CL:AIRE/EIC/AGS GAC	
Fluorene	24	31	CL:AIRE/EIC/AGS GAC	
Indeno[1,2,3 -cd]pyrene	26	60	CL:AIRE/EIC/AGS GAC	
Naphthalene	2.2	200	CL:AIRE/EIC/AGS GAC	
Phenanthrene	130	22,000	CL:AIRE/EIC/AGS GAC	
Pyrene	150	54,000	CL:AIRE/EIC/AGS GAC	

Table 11.3: Summary of Soil Testing Data and Comparison with Risk Assessment Criteria for Residential End Use

Determinand	Maxi-mum value (mg/kg)	Guideline Value (mg/kg)	Source	Exceedances
Total cyanide	3.0	34	SSV, 1% SOM	
As	24	32	EA SGV	
Cd	1.4	10	EA SGV	
Cr	34	45	GAC	
Pb	400	166	SSV, 1% SOM	DTs03, DTS12, DTS13,
Hg	1.9	1	SGV, worst case	DTS13
Ni	65	130	EA SGV	
Se	<2.5	350	EA SGV	
TPH	720	N/A (See Table 11.4)		
Acenaphthene	23	210	LQM	
Acenapthylene	16	170	LQM	
Anthracene	52	2,300	LQM	
Benzo[a]anthracene	68	3	LQM	
Benzo[a]pyrene	58	0.6	LQM	DTS03, DTS05, DTS12,
Benzo[b]fluoranthene	74	6	LQM	DTS05
Benzo[ghi]perylene	26	44	LQM	
Benzo[k]fluoranthene	28	9	LQM	DTS05
Chrysene	64	6	LQM	DTS05
Dibenzo[a,h]anthracene	6.4	0.8	LQM	DTS05
Fluoranthene	200	260	LQM	
Fluorene	24	160	LQM	
Indeno[1,2,3 -cd]pyrene	26	3.2	LQM	DTS05
Naphthalene	2.2	1.5	LQM	DTS05
Phenanthrene	130	92	LQM	DTS05
Pyrene	150	560	LQM	

11.7.15 Within the residential development zone, there were elevated PAH concentrations in excess of the relevant criteria in samples from DTS03, DTS05 and DTS 12, although these exceedances occurred only in DTS05 for PAHs other than benzo[a]pyrene. However, the level of benzo[a]pyrene contamination in DTS05 exceeded criteria for both residential end use and commercial end use of the site.

11.7.16 In addition, there were exceedances of the criterion for lead in three locations and mercury in one location within the residential development zone.

11.7.17 The significance of the potential effects on human health of the elevated soil contamination is considered to be **minor to moderate adverse** without mitigation within the residential development zone.

11.7.18 There are no criteria for total petroleum hydrocarbons (TPH) against which an assessment of the risks of hydrocarbon contamination in TP9 and TP14 can be made. However, criteria can be derived for individual hydrocarbon fractions and these are shown in **Table 11.4**, together with maximum measured concentrations of those fractions. The GAC are those published by LQM/CIEH. The highest concentrations of the individual hydrocarbon fractions were found in TP09, which is located within the residential development zone. Accordingly, the generic criteria used were those for residential development.

Table 11.4: Summary of Soil Testing Data for Hydrocarbons and Comparison with Risk Assessment Criteria for Residential End Use

Fraction	GAC (mg/kg)	Maximum Measured Concentration (mg/kg)
Aliphatic		
EC 5-6	30	0.02
EC>6-8	73	0.02
EC>8-10	19	0.02
EC>10-12	93	0.09
EC>12-16	740	28
EC>16-35	45,000	92
EC>35-44	45,000	-
Aromatic		
EC5-7 (benzene)	65	<0.01
EC>7-8 (toluene)	120	<0.01
EC>8-10	27	0.07
EC>10-12	69	0.2
EC>12-16	**140**	**140**
EC>16-21	**250**	**240**
EC>21-35	890	220
EC>35-44	890	-

11.7.19 Although none of the measured concentrations exceed the relevant criterion, two of the aromatic fractions are close to or equal to the criterion (these are shown in bold). These therefore have the potential to pose a small risk to human health within a residential development. On this basis, the effects of the higher concentrations of hydrocarbons would potentially be **minor adverse** without mitigation in the residential development zone. The location of TP09 where these elevated hydrocarbon concentrations were found is shown in **Figure 11.1.**

11.7.20 The concentrations of hydrocarbons in TP14 are lower than those in TP09 and since the former is in the college development zone, there would be no exceedances of the relevant assessment criteria for commercial development and therefore the effects of hydrocarbons in the college, schools and tech hub development zones would be **negligible** and therefore no mitigation would be required.

Ground Gases

11.7.21 Monitoring of gas in the ground was undertaken during the 2008 investigations. Six standpipes were installed at the site to depths between 4m and 6m. Ideally, the risk assessment should be based on a total of six monitoring rounds over a three month period. However, the Soiltechnics report is based on only two monitoring rounds.

11.7.22 Measurements of landfill type gases were made under atmospheric conditions in the range *of* 1003 to 1013mb and temperatures in the range of 16°C to 18°C. Essentially, no methane was detected but concentrations of carbon dioxide were measured in the range of 0.1 to 6.1%. Two out of a total of 12 readings showed carbon dioxide levels at above 5%, while seven were above the short term (1.5%v/v) Occupational Exposure Limit specified by the HSE (HSE EH40).

11.7.23 The risk of fire or explosion due to flammable mixtures of methane with air is rated as insignificant.

11.7.24 Based on the available ground gas monitoring results, a risk to the health of construction workers is considered to exist at the Site, which would require the adoption of appropriate mitigation measures during the construction phase of the proposed development. Based on this risk, the effects would be considered **moderate adverse** in the absence of any mitigation for all development zones.

Groundwater

11.7.25 Concentrations of contaminants in groundwater samples taken from the Site investigation boreholes are provided in the Soiltechnics report in **Appendix 11.2**, together with a detailed assessment of their effects against appropriate criteria.

11.7.26 There are no directly relevant standards for perched groundwater on potentially contaminated sites where the groundwater itself is not abstracted for sensitive uses, such as for potable supply or crop irrigation. The shallow or perched groundwater in and around the Site is not abstracted locally for any uses near the Site. Therefore the only waters potentially at risk from contaminants dissolved in perched or shallow groundwater at the Site are the River Crane to the south and the Duke of Northumberland's River to the west. The deep chalk aquifer beneath the site is not considered to be at risk because it is overlain by approximately 50 m of London Clay, which acts as an aquiclude.

11.7.27 In order to provide context for the levels of contaminants recorded in groundwater samples, the Environment Agency Environmental Quality Standards (EQS) for Inland Surface Waters[6] have been used.

11.7.28 The EQS values for freshwater are dictated by the hardness of the receiving watercourse. The Environment Agency have advised that the average hardness in the River Crane downstream of the proposed development is 280mg/l at Duke of Northumberland's River (downstream of the subject site). Based on this water hardness value, the measured concentrations of inorganic contaminants in six water samples taken across the college campus fell below the EQS values for the hardness of the receiving watercourse.

11.7.29 With respect to PAH, EQS values have only been published for naphthalene. All measured concentrations of naphthalene fell well below the EQS value for this contaminant.

11.7.30 For other PAHs, the test results have been compared against maximum allowable concentrations in the Water Supply (Water Quality) Regulations 2000 (the UK Drinking Water Standards). Again, the total PAH values did not exceed the drinking water standard.

11.7.31 While there was some hydrocarbon contamination in soils in trial pits TP09 and TP14 (albeit not exceeding the relevant assessment criteria), no significant hydrocarbon contamination was found in any of the water samples.

11.7.32 It is therefore concluded that the potential effects of groundwater contamination on sensitive receivers are **negligible**.

Ground Stability

11.7.33 As indicated in paragraph 11.5.16, hazards due to ground stability are generally low, and therefore would have **a negligible** to **minor adverse** effect within all development zones.

Mitigation Measures

Soil Chemical Contamination

11.7.34 The preferred mitigation measure for excavated contaminated material is treatment off site prior to the return of the recovered material for reuse on site. Contaminated material is defined as that which contains contaminants at levels above the appropriate assessment criteria. Such material is classified as waste by virtue of its contamination. It therefore cannot be re-deposited on site, nor used in construction

[6] Environment Agency (2011) *H4 Annex D - Basic Surface Water Discharges*. Bristol: Environment Agency.

on site or elsewhere (except under the provisions of the Environmental Permitting (England and Wales) Regulations 2010). The suitability of landfills to accept such material will be based on its classification according to the Landfill Regulations and the Environment Agency Waste Acceptance Criteria. Preliminary analysis indicates that while some contaminated excavated material could be disposed of at landfill permitted to accept inert waste, some may require disposal at non-hazardous and hazardous waste sites. Further Waste Acceptance Criteria testing of materials designated for disposal off site will be undertaken once works commence on the Site.

11.7.35 Areas affected by soil chemical contamination at levels above the relevant guideline values for the type of end use will require remediation. However, in view of the contamination present at several locations within the residential component of the site, associated mainly with made ground, all garden areas within the residential area should be remediated as a precaution by removing the made ground to a depth of at least 0.75 m and replacing it with clean sub-soil and topsoil from certified sources.

11.7.36 Wherever possible, contaminated soil that must be removed from site will be sent to an off-site treatment centre rather than to landfill. The quantities of such material likely to arise on the Site are so small that on site treatment is not a practical or economic possibility.

11.7.37 Potential impacts of contaminants in soil on groundwater and surface waters during construction will be mitigated by use of containment and prevention of run-off from stockpiled excavated contaminated materials entering controlled waters.

11.7.38 A watching brief on contaminated land will be undertaken by members of the contractor's site team during site preparation and excavation in order to identify any unforeseen contamination that may arise during the works which was not identified as part of the site investigation work done to date. The Outline CEMP (**Appendix 5.1** in Chapter 5) sets out the arrangements for this in more detail.

11.7.39 The above mitigation is required only where there is an ongoing risk of direct exposure to contaminants. Where contaminated material is to remain undisturbed on site potential health impacts will be mitigated where required by containment beneath a capping layer. This situation would apply where potentially contaminated material is situated under roads or car parks.

11.7.40 Mitigation of health impacts of contaminants in soil on construction workers will be through a safe system of work and if required, the use of appropriate protection (Personal Protective Equipment). The principal risk from PAHs arises from direct skin contact, although there is also a risk of exposure via inhalation. Therefore protection will include face masks and gloves for any personnel coming into direct contact with the material. In addition, where ground works are to take place in areas

identified to be at risk of contamination there will be restrictions on access and measures will be taken to control dust during the works, thereby mitigating the inhalation risks.

11.7.41 The outline design of the development does not incorporate any piling for foundations as the ground conditions will support the use of shallow footings. However, should piling be introduced as part of the detailed design of the proposed development, it would be necessary to undertake a Foundation Works (Piling) Risk Assessment in accordance with Environment Agency guidance[7].

Ground Gases

11.7.42 Since the HSE Occupational Exposure limits for carbon dioxide may be exceeded, a safe system of work for any personnel entering enclosed spaces or deep excavations will be implemented. This will involve risk assessments, gas testing prior to entry and provision of breathing equipment where appropriate.

11.7.43 According to the CIRIA guidance in CIRIA report C665, the appropriate mitigation for office/commercial/industrial development in areas affected by gas levels equivalent to Characteristic Situation 2 would be provision of either a 1,200 g damp proof membrane (DPM) with a cast *in situ* reinforced concrete slab or a 2,000 g DPM with a beam and block or pre-cast concrete slab, with possible additional venting.

11.7.44 The equivalent mitigation for residential development will require either a reinforced concrete floor slab cast *in situ,* with at least a 1,200 g DPM and underfloor venting, or beam and block pre-cast concrete and a 2,000 DPM with underfloor venting.

11.7.45 All joints and penetrations will also be sealed against ingress of gas in both cases.

11.7.46 All of the above mitigation measures will be incorporated into the CEMP.

Ground Stability

11.7.47 As indicated in paragraph 11.5.17, mitigation for ground stability will be included through design and specification, including specification of resistant materials.

Residual Effects

11.7.48 After completion of mitigation, the effects of all chemical contaminants in the soil are rated **negligible** for the college, schools and tech hub development zones and **moderate beneficial** for the residential development zone since the development itself will result in the permanent mitigation or removal of contamination which

[7] F J Westcott, C M B Lean and M L Cunningham (2001*) Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention*. Solihull: Environment Agency National Groundwater & Contaminated Land Centre.

would otherwise have remained on site.

11.7.49 The effects of ground gases on the completed development would be **negligible**.

11.7.50 The effects of groundwater contamination would be **negligible** without mitigation and therefore no mitigation is required.

11.7.51 The effects of ground instability after mitigation would be **negligible.**

Monitoring

11.7.52 Further testing of soil contaminants for the purposes of selecting the most appropriate treatment/disposal site will be required. Some preliminary testing was undertaken by Soiltechnics and this is provided in **Appendix 11.2**. This will require updating.

11.7.53 The ground gas risk assessment is based on limited monitoring and will be updated based on further *in situ* gas monitoring.

Operation

11.7.54 There are not expected to be any significant effects of contaminated land or ground conditions during the operational phase of the REEC development. This is because there will be no new sources of contaminants nor any significant changes to the Site that would affect the potential impacts of residual contaminants on site, and all mitigation measures will be complete by the end of the construction phase or will have been incorporated into the design of the REEC development.

11.8 SUMMARY OF RESIDUAL EFFECTS

11.8.1 Residual effects are summarised in **Table 11.5**.

Table 11.5 Summary of Residual Effects

Issue	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Site Enabling, Demolition and Construction			
Soil chemical contamination health impacts on construction workers, occupiers and residents	Minor to moderate adverse effect of soil contamination and minor adverse effect of hydrocarbons in residential development zone. Negligible effects in college, schools and tech hub development zone	Excavation and removal for treatment and/or disposal	Negligible during construction and on completion of college, schools and tech hub development zones, minor to moderate beneficial at completion of residential development zone
Ground gases health impacts	Moderate adverse for all development zones	Protection of construction workers Foundation design incorporating measures to prevent gas ingress	Negligible
Ground instability impacts	Negligible – minor adverse for all development zones	Incorporated in Design and Specification, including specification of resistant materials	Negligible
Groundwater contamination	Negligible for all development zones	None	Negligible
Operation			
None	None	None	None

11.9 CUMULATIVE EFFECTS ASSESSMENT

11.9.1 There are no additional plans or projects which are likely to have cumulative effects with the contaminated land aspects of the REEC development. The contaminated land desk study and geo-environmental constraints reports searched for contaminated land data in a buffer zone of 500m from the Site and found nothing of significance that would have any cumulative effects.

11.10 SUMMARY AND CONCLUSION

11.10.1 A contaminated land risk assessment based on site investigation data from 2008, and a data search, desk study and site walkover undertaken in 2014 has concluded that the majority of the Site contains soil contaminants below screening criteria for commercial use of the Site. These criteria would apply to the college, schools and tech hub development zones. However, there is one exceedance of the relevant criterion for benzo[a]pyrene (a polyaromatic hydrocarbon). This could pose a risk to human

health and will require mitigation. Several contaminants, including some heavy metals and petroleum hydrocarbons were equal to or exceeded screening criteria for the residential development zone of the REEC development and could therefore pose a risk to future residents if not mitigated. These contaminants collectively would potentially have **minor to moderate adverse** effects in the absence of mitigation.

11.10.2 Mitigation will take the form of further site investigation and soil testing to characterise the nature and extent of contamination followed by excavation and removal of contaminated soil for treatment off-site. However, where there are contaminants in areas where there is to be no excavation for construction purposes, these would be left *in situ*. All garden areas within the residential development zone would be excavated and material replaced with clean sub-soil and topsoil. The potential impacts of soil contamination prior to any mitigation are rated minor to moderate adverse in the residential development zone, but with mitigation in place the residual effects would be **negligible**. When construction is completed, **minor** to **moderate beneficial** effects will ensue in the residential development zone because levels of contaminants or exposure to them will have been reduced as a result of the works.

11.10.3 There are **negligible** effects of groundwater contamination at the site.

11.10.4 There would be potentially **minor adverse** effects due to ground instability hazards, but these would be mitigated through design and the residual effects would be **negligible**.

11.10.5 The potential effects of ground gases (carbon dioxide) are rated **moderate adverse** across the site. However, after mitigation, which would involve incorporation of gas barriers into the floor slabs of any sensitive structures, the residual effects would be **negligible**.

12 WASTE

12.1 INTRODUCTION AND KEY ISSUES

12.1.1 This chapter describes the likely waste effects of the proposed Richmond Education and Enterprise Campus (REEC) development at Richmond upon Thames College (RuTC) in Twickenham, within the London Borough of Richmond upon Thames (LBRuT).

12.1.2 The key issues considered in this chapter are:

- Management and disposal of wastes arising from demolition, excavation and construction;
- Management and disposal of operational wastes arising from the completed development;
- Identifying opportunities for waste minimisation and reuse and recycling of materials and waste;
- Identifying opportunities for use of recycled materials in construction (e.g. the use of recycled aggregates); and
- Achieving compliance with waste legislation.

12.2 CONSULTATION

12.2.1 The scope of assessment of waste issues contaminated land issues and the methodology to be used were set out in the Scoping Report. No specific comments were made in relation to waste in the response to the Scoping report. However, it was noted that the assessment should take into account the West London Waste Plan (WLWP).

12.3 LEGISLATION AND PLANNING POLICY

International / European

12.3.1 Government policy on waste is driven by a number of European Union Directives of which the most significant are the Waste Framework Directives of 2006 and 2008. The 2006 Directive aims to protect human health and the environment against the negative effects of collection, treatment, storage and disposal of waste. It encourages European Union (EU) member states to apply the waste hierarchy in managing their waste.

12.3.2 The 2008 Directive re-affirms the basic concepts and definitions related to waste management, such as definitions of waste, recycling, recovery. It explains when waste ceases to be waste and becomes a secondary raw material (so called end-of-waste criteria), and how to distinguish between waste and by-products. The Directive

lays down some basic waste management principles: it requires that waste be managed without endangering human health and harming the environment, and in particular without risk to water, air, soil, plants or animals, without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest. Waste legislation and policy of the EU Member States shall apply as a priority order the following waste management hierarchy:

- Prevention;
- Preparing for reuse;
- Recycling;
- Recovery; and
- Disposal.

National

12.3.3 The reduced amount of landfill capacity has necessitated a rethink of how waste is dealt with throughout the UK. Waste must be dealt with in a more sustainable way, and in 2002 the Government re-introduced the 'Waste not, Want not' strategy which put forward the waste hierarchy. The waste hierarchy prioritises:

- Reduction of waste;
- Reuse of waste;
- Recycling of waste;
- Recovery of energy from waste; and
- Waste disposal.

12.3.4 The Waste (England and Wales) Regulations 2011 implement the revised Waste Framework Directive 2008 and in summary:

- Require businesses to confirm that they have applied the waste management hierarchy when transferring waste and to include a declaration on their waste transfer note or consignment note;
- Require a new waste hierarchy permit condition and where appropriate a condition relating to mixing of hazardous waste;
- Introduce a two-tier system for waste carrier and broker registration, which includes those who carry their own waste, and introduces a new concept of a waste dealer;
- Make amendments to hazardous waste controls and definition; and
- Exclude some categories of waste from waste controls, notably animal by-products whilst include (sic.) a small number of radioactive waste materials.

12.3.5 The NPPF was published and became immediately effective on 27 March 2012. It sets out the Government's economic, environmental and social planning policies for

England.

12.3.6 The NPPF effectively consolidates previous national planning policy advice and does not introduce new technical guidance. It does not contain specific waste policies, since it was intended that national planning policy would be published alongside the National Waste Management Plan for England.

12.3.7 The National Waste Strategy for England describes the Government's vision for managing waste and resources in accordance with the Waste Framework Directive. The strategy recognises the waste hierarchy and that the demolition and construction sector have the potential to significantly reduce the quantity of waste sent to landfill. The waste strategy established a target of reducing by half the quantity of demolition, excavation and construction waste sent to landfill by 2012 in partnership with the industry.

12.3.8 National targets were set for recycling and composting of household waste of at least 40% by 2010, 45% by 2015 and 50% by 2020. Similarly recovery targets for municipal waste were set at 53% by 2010, 67% by 2015 and 75% by 2020.

12.3.9 The Government completed a Waste Review in June 2011 and published an Action Plan which includes various waste-related targets.

12.3.10 The Waste Management Plan for England was published in December 2013. This is a high level document which is non–site specific. It provides an analysis of the current waste management situation in England, and evaluates how it will support implementation of the objectives and provisions of the revised 2008 Waste Framework Directive. National planning policy on waste is currently set out in Planning Policy Statement 10 'Planning for Sustainable Waste Management'. It provides the planning framework to enable local authorities to put forward, through local waste management plans, strategies that identify sites and areas suitable for new or enhanced facilities to meet the waste management needs of their areas. This policy is currently being updated and has been subject to public consultation. Once it has been finalised, the updated policy will replace Planning Policy Statement 10 as the national planning policy for sustainable waste management.

12.3.11 According to the Waste Management Plan England and the UK are already achieving an estimated 93% recovery rate of construction and demolition waste. This already exceeds the 2020 target of recovering at least 70% by weight, of non-hazardous construction and demolition waste.

12.3.12 The Site Waste Management Regulations 2008 required that all construction projects with a value over £300,000 had a Site Waste Management Plan (SWMP) in place. The Regulations were repealed in 2013 and SWMPs are no longer a statutory

requirement. However, they are still produced for many construction projects as they are seen to be the best way of keeping records of quantities and types of waste generated and how they were managed/disposed of during demolition and construction. A SWMP, or its equivalent, such as a construction resource management plan (CRMP) will be implemented for the proposed development.

Local

12.3.13 The London Plan[1] sets out policy on planning for waste as follows.

12.3.14 Policy 5.16 on Waste Self-Sufficiency states that The Mayor will work with London boroughs and waste authorities, the London Waste and Recycling Board (LWaRB), the Environment Agency, the private sector, voluntary and community sector groups, and neighbouring regions and authorities to:

- Manage as much of London's waste within London as practicable, working towards managing the equivalent of 100 per cent of London's waste within London by 2026;
- Create positive environmental and economic impacts from waste processing; and
- Work towards zero biodegradable or recyclable waste to landfill by 2026.

12.3.15 This will be achieved by:

- Minimising waste;
- Encouraging the reuse of and reduction in the use of materials;
- Exceeding recycling/composting levels in municipal solid waste (MSW) of 45 per cent by 2015, 50 per cent by 2020 and aspiring to achieve 60 per cent by 2031;
- Exceeding recycling/composting levels in commercial and industrial waste of 70 per cent by 2020;
- Exceeding recycling and reuse levels in construction, excavation and demolition (CE&D) waste of 95 per cent by 2020;
- Improving London's net self-sufficiency through reducing the proportion of waste exported from the capital over time;
- Working with neighbouring regional and district authorities to co-ordinate strategic waste management across the greater south-east of England.

12.3.16 Policy 15.8 on Construction, Excavation and Demolition Waste states that '*major development sites are required to recycle CE&D waste onsite, wherever practicable, supported through planning conditions*' and that '*Waste should be removed from construction sites, and materials brought to the site, by water or rail transport*

[1] *The London Plan Spatial Development Strategy for London Consolidated with Alterations since 2011* (2015)

wherever that is practicable'.

12.3.17 The supporting text notes that re-use and recycling rates for construction, excavation and demolition (CE&D) waste in London are already high with an estimated rate of 82% in 2008. The Mayor supports further improvement and Policy 5.20 sets a target of 95 per cent for recycling/reuse of CE&D waste by 2020.

12.3.18 Policy 5.20 on Aggregates sets out the following targets in relation to the use of recycled aggregates.

12.3.19 The Mayor will work with strategic partners to achieve targets of:

- 95 per cent recycling/re-use of construction, demolition and excavation waste by 2020
- 80 per cent recycling of that waste as aggregates by 2020.

12.3.20 The GLA's Supplementary Planning Guidance on Sustainable Design and Construction (SPG) of April 2014 outlines the Mayor's priorities and best practice for various aspects of development which provide further detail on the practical implementation of relevant policies in the 2011 London Plan. Table 1.1 of the Mayor's SPG on Sustainable Design and Construction summarises the priorities for waste which are relevant to the proposed development:

- Design of development should prioritise materials that have low embodied energy, are sustainably sourced, are durable and do not release toxins;
- Developers should maximise the use of existing resources and materials and minimise waste generated during the demolition and construction process through the implementation of the waste hierarchy.

12.3.21 The SPG identifies best practice as design of developments which maximises the potential to use pre-fabrication elements.

12.3.22 The WLWP is a product of a collaboration between six West London boroughs (Brent, Ealing, Harrow, Hounslow, Hillingdon and Richmond upon Thames) and when formally adopted it will be part of each borough's local plan.

12.3.23 The London Plan requires all London Boroughs to make sure that there are sufficient facilities for managing the waste produced by households and businesses in their area. The basis for this plan is 'net self sufficiency' which means that West London must plan to eventually manage an equivalent amount of the waste it produces within its boundaries.

12.3.24 The proposed submission plan was submitted to the Planning Inspectorate in 2014. The Inspector considered the representations made on the Main Modifications to the West London Waste Plan and issued a report on 16 March 2015. The report states

that, subject to the inclusion of certain modifications, the Plan is legally compliant and sound. The West London boroughs are currently considering whether to adopt the Plan and modifications.

12.3.25 LBRuT has published Supplementary Planning Guidance on Refuse and Recycling Storage Requirements, adopted in April 2015 under its Local Plan. This guidance has been used to estimate operational waste arisings, below.

12.4 ASSESSMENT METHODOLOGY

Evaluation of Effects

12.4.1 Compliance with relevant waste management legislation will serve to minimise many potential environmental impacts and the application of good practice will reduce any residual impacts. Key legislation includes the following:

- Duty of Care imposed by Section 34 of the Environmental Protection Act 1990;
- Environmental Permitting Regulations (England and Wales) Regulations 2010, as amended particularly provisions relating to registered exemptions from permitting; and
- Hazardous Waste Regulations 2005.

12.4.2 Current Department for Environment, Food and Rural Affairs (Defra) guidance in the Code of Construction Practice for the Sustainable Use of Soils on Construction Sites[2] and the CL:AIRE Definition of Waste guidance[3] relating to waste management on development sites will also be followed as a means to maximise reuse of excavation waste and minimise the quantities of soil requiring disposal off site. The protocols which will be followed to implement this guidance are set out in a series of documents. The Construction Environmental Management Plan provides high level information on waste management. This is supported by a SWMP to record waste data on a day to day basis. The SWMP will also contain all of the documentation required to demonstrate compliance with statutory requirements, including waste carriers' licences, waste transfer notes and details of permits for off-site waste transfer, treatment and disposal sites used. The SWMP is a live document subject to frequent amendment and updating.

12.4.3 It is intended to work in accordance with the CL:AIRE Code of Practice to handle excavation and demolition materials arisings as a resource so that these materials would not be classified as waste.

[2] Defra (2009) *Code of Construction Practice for the Sustainable Use of Soils on Construction Sites*. Accessed at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69308/pb13298-code-of-practice-090910.pdf

[3] Contaminated Land: Applications in Real Environments (2011) *The Definition of Waste: Development Industry Code of practice.* Version 2. London: CL:AIRE.

12.4.4 There is no established methodology for evaluating the direct environmental effects of waste because there is a legal requirement for all waste to be either treated or disposed of at licensed or permitted sites which are designed and operated in order to mitigate such effects, or recycled under the terms of similar licences or permits in order to produce recycled products no longer considered to be waste, or processed for reuse, in which case the reused material is no longer considered to be waste.

12.4.5 No waste treatment, disposal or processing of waste will take place on site and therefore there will be no direct environmental effects of these activities on site. The assessment of effects focusses mainly on ensuring that there is adequate provision for managing wastes on site and sufficient capacity within the current and future wider waste management infrastructure to accommodate waste arisings from the site.

12.4.6 There are potential indirect effects of waste, including noise from waste handling plant and equipment and waste transfer vehicles, dust from stockpiled waste such as excavated soils and potential contamination from excavated soils. However, these effects are considered as part of the assessments of transport, noise and air pollution and are covered in the relevant chapters of this ES.

Significance of Effects

12.4.7 There are no published or widely recognised criteria for assessing the significance of environmental effects of waste. In the absence of specific guidance, professional judgement has been used to assess the likely impact of waste against the baseline.

12.4.8 The significance of environmental effects has been determined by considering the magnitude of waste arisings within the context of the sensitivity of receptors likely to be affected and current baseline waste arisings on a local and regional scale.

Limitations of Assessment

12.4.9 The assessment is limited in that demolition, excavation and construction waste quantities are estimates based on an outline design only and would therefore be subject to change at detailed design stage.

12.4.10 Future residential waste arisings can be estimated based on the planning guidance for waste provision. Future arisings from other elements of the proposed development cannot be estimated with any precision because the nature of the operations and the floor area occupied by them or the number of people likely to be employed by them are not known at this stage. However, by using 'typical' arisings figures published by the Building Research Establishmentbased on gross floor areas, broad

12.4.11 Significant effects are more likely to arise where there are large changes in waste

arisings compared to the baseline or there are new sources of waste associated with the proposed development.

12.5 BASELINE

Introduction

12.5.1 The assessment of baseline waste arisings considers both wastes originating within the site and the wastes arising or managed by the West London Boroughs. Data relating to the latter are derived from the WLWP.

Current Baseline

12.5.2 There are no current significant existing demolition, excavation or construction waste arisings within the site.

12.5.3 There are no existing residential waste arisings within the site where collection is the responsibility of the local authority. Neither are there any arisings from a tech hub or its equivalent.

12.5.4 There are no baseline operational waste arisings figures available for the existing college. These wastes would be considered to be commercial wastes and are collected by private contractors.

12.5.5 Within the West London area, the West London Waste Authority (WLWA) deals with 657,000 tonnes per annum of municipal solid waste (largely household waste). About 45% is landfilled, the remainder being recycled, composted or sent to Energy from Waste plants.

12.5.6 About 1.3 million tonnes per annum of commercial and industrial waste are produced in West London, almost all of which is collected by private contractors.

12.5.7 Total arisings of 742,000 tonnes per annum of construction, demolition and excavation waste are produced in West London. Of this, 411,000 tonnes are exported outside the area, but 776,000 tonnes per annum are imported from other areas so that a total of 1,107,000 tonnes per annum is managed within the area. West London could therefore be more than self-sufficient in managing wastes of this type from within its area.

Future Baseline

12.5.8 The current baseline is not expected to change significantly in the period up to the commencement of development works.

Baseline Limitations

12.5.9 Although there are no baseline waste arisings figures available for the existing college, since the proposed development involves in effect a reprovisioning of the college within its current site and for similar numbers of staff and students, there are not expected to be significant changes in waste generation before and after development, so the lack of such data is not considered to be significant in the context of the assessment.

12.6 SENSITIVE RECEPTORS

12.6.1 Receptors for indirect effects of waste, such as noise, air pollution and contamination, are identified in the relevant chapters on those topics. Sensitive receptors for the direct effects of waste are considered to be those within the wider waste management infrastructure.

12.6.2 Landfill is considered to be a receptor with a high sensitivity to large volumes of waste, due to the finite nature of landfill capacity. Local and regional waste recycling and reprocessing is considered to be a low sensitivity receptor, on the basis that such activity has a generally beneficial environmental impact compared to the alternative of disposal of the waste and that demand for many recycled or recovered materials currently exceeds supply.

12.7 IMPACT ASSESSMENT

Site Enabling, Demolition and Construction

Introduction

12.7.2 This section considers waste arising from demolition and clearance of existing structures, excavation for foundation works or site formation and construction. It does not consider asbestos waste arisings from existing buildings. As indicated in Chapter 6 of the ES, all buildings would be surveyed following vacant possession to establish the location and quantity of asbestos containing material and any such material would be removed and sent for disposal in accordance with the Control of Asbestos Regulations 2012.

Predicted Effects

Demolition and Excavation Waste

12.7.3 It is envisaged that approximately 45,278m^3 of demolition material derived from existing buildings and hardstanding would require storage or removal from the Site following demolition. **Table 12.1** shows a breakdown of this figure.

12.7.4 A number of assumptions were made when calculating the total volume of demolition material. The main building types were identified using drawings of existing

buildings and site photos and using professional judgement, the approximate area, perimeter and height were estimated for each existing building on Site. The construction type and construction of individual elements of existing buildings was also assumed.

Table 12.1 Indicative Volumes of Demolition Materials

Demolition Material	Total Volume (m^3)
External walls	4,998
Internal walls	1,499
Ground floors	8,349
Intermediate floors	6,006
Roofs	4,241
Hardstanding areas	6,106
External foundations	1,815
Internal foundations	1,815
Total volume of material	**34,830**
Total factored volume of material (including 30% bulk factor)*	**45,279**

12.7.5 A number of assumptions were made when calculating the total volume of demolition material. The main building types were identified using drawings of existing buildings and site photos and using professional judgement, the approximate area, perimeter and height were estimated for each existing building on Site. The construction type and construction of individual elements of existing buildings was also assumed.

12.7.6 The following outlines the major types of materials likely to arise from demolition;

- Concrete (substructure, superstructures, floor slabs, walls and columns);
- Brick (external and internal walls);
- Glass and cladding (cladding);
- Metal components (windows, plant, superstructures, sub-assemblies);
- Timber and plasterboard (partitions and ceilings);
- Hard-standing / tarmac (internal pathways, car parks); and
- Asbestos

12.7.7 Soil would also be exported offsite to allow construction of levels for foundations and approximately 150 mm of topsoil would be removed from all landscaped areas. **Table 12.2** provides a breakdown of the approximate volume of soil to be removed from the Site.

12.7.8 Excavation for new foundations would be required to a depth of up to 1.5m. The proposed development will be supported on traditional shallow strip and pad foundations and piling at depth is not expected to be required.

Table 12.2 Approximate Volume of Soil to be Removed from Site

Soil Excavations	**Total Volume (m³)**
Foundations	4,431
Topsoil	10,316
Total volume	**14,747**
Total factored volume of soil (including 30% bulk factor)	**19,171**

12.7.9 Excavation of some additional material in the garden areas of the proposed residential development zone will be required in order to mitigate the effects of soil contamination (see Chapter 11). Although the volume of this soil will not be known until detailed designs are available, it is estimated to be an additional 700 m³ based on the Indicative Masterplan and is therefore only about 3.6% of the total volume of excavated material in **Table 12.2**.

12.7.10 Of the total demolition waste arisings of 45,279 m³, up to approximately 5,329 m³ (including brick and concrete from external walls and internal partitions) would be recycled, crushed, graded and re-used as a sub-base for new foundations. These demolition materials would be stockpiled on-site prior to re-use during the site enabling works.

12.7.11 Stockpile areas would be located as required by the demolition construction phase and to enable reuse of demolition material on Site.

12.7.12 The total quantity of demolition and excavation waste to be taken off site for reuse, recycling or disposal will be around 60,000 m³. Assuming a bulk density of 2, this would equate to 120,000 tonnes. Demolition works would be ongoing until the end of Phase 2 over a period of about 3.25 years. Therefore the annual average arisings would be about 34,000 tonnes. This equates to less than 3.5% of the annual total of 1.1 million tonnes of construction, demolition and excavation waste arisings managed in the West London area and is therefore considered to have a **negligible** effect on the waste management infrastructure.

Construction Waste

12.7.13 There is insufficient detail available at outline design stage to permit reliable estimates of construction waste arisings. These will be dependent on many factors, such as of the types of construction materials used, the extent of pre-fabrication off-site the amount of packaging associated with different products and the extent of control over quantities of materials ordered. These issues are all addressed as mitigation measures, below.

12.7.14 A broad estimate of arisings can be made based on typical figures published by the Building Research Establishment Smartwaste. These show typical volumes of

construction waste per 100 m² of floor area for construction projects in different sectors. The relevant figures for the proposed development are shown in **Table 12.3**. The figures are based on GEA, which is the only estimate of floor area available for the outline design, and therefore represent a worst case analysis, since net floor area will be lower.

12.7.15 Assuming a bulk density of 2, the total construction waste arisings will be about 23,706 tonnes. Over the construction period of just over 4 years, this equates to 5,926 tonnes per annum. This is about 17% of the demolition and excavation waste figure for the site, and about 0.5 % of the total construction demolition and excavation waste arisings in West London. The effect of this waste is therefore considered to be **negligible**.

Table 12.3 Estimates of Construction Waste Arisings

Development Component	Gross External Area (m²)	BRE Average Waste Generation (m³ per 100 m² floor space)[4]	Estimated Arisings (m³)
Replacement college	16,000	21.3	3,408
SEN School	4,000	21.3	852
Sports Centre	3,900	15.8	616
Residential	22,250	17.3	3,849
STEM	6,100	21.3	1,299
Secondary School	7,000	21.3	1,491
Tech Hub	1,700	19.9	338
Total			11,853

Mitigation Measures

12.7.16 Mitigation measures to minimise environmental impacts from the storage, transportation and disposal of wastes will include:

- Careful location of stockpiles and other storage areas;
- Segregation of waste streams to maximise opportunities for reuse and recycling;
- Use of on site recycling plant, such as concrete crushing;
- Use of good practice in the design of waste storage areas and the use of suitable waste containers;
- Use of sheeting, screening, damping and seeding of stockpiles where appropriate and practicable;
- Control and treatment of runoff from soil and waste soil stockpiles;
- Minimising storage periods;
- Minimising haulage distances; and
- Sheeting of vehicles.

[4] BRE (2010) *Measuring and benchmarking construction refurbishment and demolition waste.* http://www.smartwaste.co.uk/benchmarkingt.jsp

12.7.17 Such measures would help to mitigate the potential impacts remaining after waste minimisation, recycling and reuse have been optimised.

12.7.18 Details of the waste management and mitigation measures will be provided in the contractor's SWMP and their implementation will be monitored and enforced as part of the CEMP.

12.7.19 The SWMP will ensure compliance with the statutory waste management Duty of Care, which requires that waste is stored and handled in a manner that prevents its escape. Waste producer records will be kept which cover the transfer of waste to registered waste carriers and its management and disposal at a licensed or permitted facility.

12.7.20 The SWMP will be based on implementing the following waste hierarchy throughout all phases of the proposed development:

- Avoid the generation of waste;
- Minimise the generation of waste;
- Reuse and/or recycle materials within the proposed development;
- Reuse and/or recycle materials for beneficial use on other sites; and
- Dispose of material at permitted sites.

12.7.21 In accordance with this hierarchy the contractor aims to meet the following targets:

- Divert a total of 96% of waste from landfill through reuse and recycling of demolition waste, clean excavated 'waste' and construction waste; and
- Reuse and recycle at least 80% of mixed demolition and construction waste.

12.7.22 The following measures will be taken to minimise the production and avoid disposal of waste:

- 'Just-in-time' procurement to minimise the chance of damage to materials;
- Storage in an appropriately dedicated area to prevent spoilage, damage and contamination;
- Training of construction teams on the importance of correct ordering of materials so as to avoid excess materials;
- Use of standard materials where possible that can be used elsewhere if necessary;
- Ensuring that deliveries are correct before accepting them on site;
- Review of packaging requirements where possible to avoid, reduce and reuse;
- Maximising use of offsite manufacturing;
- Development of a materials inventory of construction material, equipment and plant for the purposes of identifying reuse options across the project; and

- General training of site personnel on waste issues.

12.7.23 The SWMP will identify key roles and responsibility within the project team, measures for minimising waste, waste storage, transport and disposal, measures for dealing with potentially hazardous waste, monitoring, reporting and record keeping, training and periodic review.

12.7.24 As a result of the above, limited additional mitigation is expected to be required.

Residual Effects

12.7.25 There are not expected to be any significant residual effects of demolition, excavation and construction wastes with the adoption of the SWMP, CEMP and specific mitigation measures described above, and therefore the residual effects are predicted to be **negligible**.

Monitoring

12.7.26 Monitoring of impacts associated with waste management on site, including dust and noise and vibration is described in the relevant chapters of the ES and set out in the CEMP. Quantities of waste leaving the site will be monitored and recorded under the SWMP.

Operation

Introduction

12.7.27 This section provides estimates of new waste arisings for new elements of the proposed development. It does not address arisings from the college element of the development or the sports centre, as these are essentially reprovisioning of existing facilities.

Predicted Effects

12.7.28 The waste and recycling storage capacities for new developments within LBRuT are set out in the Local Plan Supplementary Planning Document on Refuse and Recycling Storage Requirements, adopted in April 2105. This has been used to estimate worst case arisings based on weekly collections and GEA figures for floor area.

12.7.29 Residential waste storage requirements are 240 litres per household for units up to three bedrooms and 360 litres per household for units with more than three bedrooms. Alternatively, the provision should be 70 litres per bedroom. The former basis for the calculation gives the higher of the two figures based on the residential mix set out in **Table 5.5** in Chapter 5, equating to 2,359 m^3 per annum. This waste will have a bulk density of about one, so total residential waste is estimated at about

0.36% of total municipal waste handled by the WLWA.

12.7.30 The effects of this waste are therefore considered to be **negligible.**

12.7.31 Waste from the other new facilities are based on the Supplementary Planning Document guide value of 2.6 cubic metres per 1,000 m^2 of gross floor area. Again, GEA figures have been used as a worst case. Based on a GEA of 18,800 m^2 in total for the new schools, Tech Hub and STEM, the total storage capacity would be 49 m^3, equivalent to 2,548 m^3 per annum based on weekly collection. This is less than 0.2% of the annual commercial and industrial waste arisings within West London and the effects are therefore considered to be **negligible**.

Mitigation Measures

12.7.32 Operational waste servicing provisions will be in accordance with LBRuT Supplementary Planning Guidelines. Further details of waste servicing are not available at outline design stage and will be developed under Reserved Matters.

12.7.33 No additional mitigation over and above the planning requirements for waste servicing are considered necessary.

Residual Effects

12.7.34 Provided that planning guidance is adhered to, residual effects of waste during the operational phase of the development will be **negligible.**

Monitoring

12.7.35 No monitoring of operational phase waste servicing is proposed over and above that implicit in Supplementary Planning Guidance.

12.8 SUMMARY OF RESIDUAL EFFECTS

12.8.1 A summary of residual effects is provided in **Table 12.4.**

Table 12.4 Summary of Residual Effects of Waste

Issue	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Site Enabling, Demolition and Construction			
Demolition and Excavation waste effects on waste management infrastructure	Negligible	Measures set out in SWMP and CEMP	Negligible
Construction Waste effects on waste management infrastructure	Negligible		Negligible
Operation			
Residential waste effects on waste management infrastructure	Negligible	Measures set out in Supplementary Planning Guidance	Negligible
Commercial (including new educational facilities) waste effects on waste management infrastructure	Negligible		Negligible

12.9 CUMULATIVE EFFECTS ASSESSMENT

12.9.1 There are no other nearby developments involving waste generation on a similar scale to the proposed development that could lead to direct cumulative effects during either the construction or operational phases of the development. Indirect cumulative effects, for example on air quality and noise levels, are addressed in the relevant chapters of this ES.

12.10 SUMMARY AND CONCLUSION

12.10.1 The assessment of impacts of waste has focussed on estimating quantities of different types of waste for both construction and operational phases of the development and comparing their magnitude to the total quantities of such wastes managed within the West London Waste Authority area on an annual basis. This has shown that the likely direct effects of waste will be of negligible significance for all waste streams, i.e. demolition and excavation waste, construction waste, operational waste from the proposed residential development and operational waste from the new schools, STEM and Tech Hub. Waste arisings from the college and the sports centre are not

expected to change significantly because these are replacement facilities.

12.10.2 Wastes will be managed in accordance with the CEMP, SWMP and LBRuT Supplementary Planning Guidance, as appropriate.

13 WATER RESOURCES AND FLOOD RISK

13.1 INTRODUCTION AND KEY ISSUES

13.1.1 This chapter describes the likely water resources and flood risk effects of the proposed Richmond Education and Enterprise Campus (REEC) development at Richmond upon Thames College (RuTC) in Twickenham, within the London Borough of Richmond upon Thames (LBRuT).

13.1.2 The water resources and flood risk assessment has been undertaken for the likely affected watercourses located on site and off site.

13.1.3 An assessment of likely environmental effects in relation to groundwater quality is considered in Chapter 11 - Ground Conditions. The findings of the water resources assessment are used to inform other topic areas in the ES, notably the aquatic ecology assessment in Chapter 15 – Ecology.

13.1.4 The key issues for the assessment are considered to be:

- Changes to water quality and turbidity in surrounding water courses during construction;
- Changes to groundwater flow as a result of below ground works and structures;
- Changes to flood risk within the catchment of the River Crane from the new operational site;
- Changes to site drainage and run-off patterns from the new operational site and the requirement for Sustainable Drainage Systems (SuDS); and
- Changes in potable water supply and foul water drainage capacity.

13.2 CONSULTATION

13.2.1 Consultation has been undertaken with LBRuT, the Environment Agency and Thames Water. Preliminary consultation was undertaken with Thames Water on the local water and sewerage networks; further consultation will be undertaken at detailed design stage on the existing drainage network and water supply and wastewater treatment capacity for the REEC development.

13.2.2 In its EIA Scoping Opinion (**Appendix 2.2**), LBRuT confirmed the scope of the water resource and flood risk assessment as proposed in the Scoping Report (**Appendix 2.1**).

13.3 LEGISLATION AND PLANNING POLICY

International / European

13.3.1 There are two key European Directives – the Water Framework Directive (WFD)[1], and the Flood Directive (FD)[2] that are relevant to the REEC development.

13.3.2 The WFD (2000/60/EC) aims to protect and enhance the quality of the surface waters and groundwaters throughout Europe. Member states must aim to achieve good ecological and chemical status in inland and coastal waters. Three surface water bodies in the vicinity of REEC: River Crane, Duke of Northumberland's River and Longford Brook, currently fail to meet the water quality requirements of the WFD.

13.3.3 The FD (2007/60/EC) aims to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. The Directive will be carried out in coordination with the WFD. There are indications that parts of REEC is affected by the flood risk, highlighting the existing level of flood risk and the impact of development on flood risk at construction and operational phases should be properly assessed and appropriate mitigation is considered.

National

13.3.4 A number of statutory instruments are in place to ensure water resources comply with European legislation, as outlined above. In the UK, the Water Environment (WFD) (England and Wales) Regulations (2003) implement the WFD and the Flood Risk Regulations (2009) implement the FD.

13.3.5 Other relevant national legislation includes:

- Water Resources Act 1991 (as amended) provides legislation for the control of the pollution of water resources. The Water Act (2003) amended the Water Resources Act to improve long term water resource management.
- Flood and Water Management Act 2010 (as amended) addresses the threat of flooding and water scarcity, both of which are predicted to increase with climate change. It gives the EA a strategic overview of the management of flood and coastal erosion risk in England, and local authorities responsibility for preparing and putting in place strategies for managing flood risk from groundwater, surface water and ordinary watercourses within their areas.

[1] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

[2] Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.

- Water Act, 2014; one of the purposes of this act is to reform the water industry to make it more innovative and responsive to customers, and to increase the resilience of water supplies to natural hazards such as drought and floods.

National Planning Policy Framework (2012)

13.3.6 The National Planning Policy Framework (NPPF) outlines the government's economic, environmental and social planning policies for England. The NPPF sets out the government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations. The NPPF supersedes and replaces a number of planning policy documents that are applicable to the water environment including Planning Policy Statement 25 (PPS25) Development and Flood Risk and PPS23 Planning and Pollution Control. The NPPF sets out 12 core planning principles as guidance for local councils for the preparation of their local plan and in making planning decisions; the following principles are directly applicable to the water environment:

- Meeting the challenge of climate change, flooding and coastal change – support the transition to a low carbon future in a changing climate taking full account of (inter alia) flood risk and coastal change; and
- Conserving and enhancing the natural environment – development should minimise pollution and other adverse effects on the local and natural environment and should plan positively for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure.

National Planning Practice Guidance

13.3.7 The National Planning Practice Guidance (NPPG) was launched on 6 March 2014 and provides a web-based resource in support of the NPPF. Section 7 of the NPPG provides guidance and advises on how local planning authorities and developers should take account of the risks associated with flooding and coastal change in plan-making and determining planning applications.

13.3.8 One of the most important requirements from this guidance is that a site-specific Flood Risk Assessment (FRA) should be carried out by (or on behalf of) a developer to assess the flood risks to and from a development site. The FRA should demonstrate how flood risk will be managed now and over the development's lifetime by taking climate change into account, and with regard to the vulnerability of its users. A FRA should be proportionate to the degree of flood risk and make optimum use of information already available, including the local Strategic Flood Risk Assessment (SFRA), the Environment Agency's indicative flood maps and the

Defra/Environment Agency's Flood Risk Assessment Guidance (2015)[3]. The SFRA and Agency's maps and guidance aim to direct the requirements for a FRA according to the nature of the development and its location in relation to three flood zones based on the probability of river and sea flooding (without the presence of flood defences):

- Zone 1 - low probability: less than 1 in 1000 annual probability of river or sea flooding (<0.1%) in any year;
- Zone 2 - medium probability: between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year;
- Zone 3a - high probability: 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability flooding from the sea (>0.5%) in any year; and
- Zone 3b - the functional floodplain: where water has to flow or be stored in times of flood; identification should take account of local circumstances but would typically flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme 1 in 1000 (0.1%) flood.

13.3.9 The NPPG states that developers and Local Planning Authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of SuDS. It provides advice on taking climate change into account, setting out recommended contingency allowances for net sea level rise and peak rainfall intensities. The NPPG also includes advice on flood risk vulnerability and flood zone compatibility to guide development activities.

13.3.10 Flood risk vulnerability is split into five classifications (Table 2 of the NPPG), as follows, and the compatibility of these activities within each Flood Zone is set out in **Table 13.1** (reproduced from Table 3 of the NPPG).

- Essential utility and transport infrastructure (does not generally include sewage treatment works);
- Highly vulnerable, e.g. emergency services (those required to be operational during flooding), basement dwellings;
- More vulnerable, e.g. residential dwellings, hospitals, schools, hotels, drinking establishments;

[3]Department of Environment, Food and Rural Affairs and Environment Agency, Flood Risk Assessment: Local Planning Authorities, April 2015 (this document is a new replacement to Department of Environment, Food and Rural Affairs and Environment Agency, Flood Risk Standing Advice for Local Planning Authorities, March 2014).

- Less vulnerable, e.g. sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place), waste treatment (except landfill and hazardous waste facilities), retail, offices, storage and distribution; and
- Water compatible development, e.g. sewage transmission infrastructure and pumping stations, amenity open space, docks, marinas, and navigation facilities.

Table 13.1 Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Zones	**Flood Risk Vulnerability Classification**				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required†	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓*

Key:
✓ Development is appropriate
✗ Development should not be permitted.
† In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.
* In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to: (i) remain operational and safe for users in times of flood, (ii) result in no net loss of floodplain storage and (iii) not impede water flows and not increase flood risk elsewhere.

Draft National Standards and Specified Criteria for Sustainable Drainage Systems (2014)

13.3.11 Defra's Draft National Standards and Specified Criteria for Sustainable Drainage Systems outlines the requirements for design, construction, operation and maintenance of sustainable drainage systems.

13.3.12 The standards indicate the following hierarchy for discharging runoff from a site:

- Discharge to ground;
- Discharge to a surface water body;
- Discharge to a surface water sewer highway drain, or another drainage system; and
- Discharge to a combined sewer.

13.3.13 This hierarchy must be applied to all developments to ensure that the most sustainable method is used.

13.3.14 In addition to the above, Local Planning Authorities can set local planning permission requirements for developments which provide more stringent advice than that outlined in the National Standards.

Regional

The London Plan – The Spatial Development Strategy for London Consolidated with Alterations Since 2011 (2015)

13.3.15 The London Plan sets out an integrated economic, environmental, transport and social framework for the development of London over a 20-25 year period. The Plan also includes a number of key policies aimed to assist in the protection of the water environment during redevelopment and construction.

13.3.16 Policies of relevance to water resources and flood risk for the REEC development include:

- Policy 2.18: Promotes the protection and management of London's network of green infrastructure to secure benefits including mitigating and adapting to climate change and water management.
- Policy 5.3: Sustainable Design and Construction – Promotes the efficient use of natural resources (including water), including making the most of natural systems both within and around buildings and avoiding impacts from natural hazards (including flooding).
- Policy 5.11: Green roofs and development site environs - Promotes roof, wall and site planting, especially green roofs and walls where feasible, to deliver objectives including sustainable urban drainage by absorbing rainfall and thereby reduce flooding associated with surface water runoff.
- Policy 5.12: Flood risk management - Development proposals must comply with the flood risk assessment and management requirements set out in the NPPF and the associated technical Guidance on flood risk over the lifetime of the development.
- Policy 5.13: Sustainable drainage - Development should utilise SuDS unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible.
- Policy 5.14: Water quality and sewerage infrastructure - Development proposals must ensure that adequate wastewater infrastructure capacity is available in tandem with development.
- Policy 5.15: Water Use and Supplies – Development should minimise the use of mains water by incorporating water saving measures and equipment and

designing residential development so that mains water consumption would meet a target of 105 litres or less per head per day.

Supplementary Planning Guidance – Sustainable Design and Construction (2014)

13.3.17 The London Plan Supplementary Planning Guidance (SPG) on Sustainable Design and Construction sets out a list of 'Mayor's Priorities' and best practice approaches for sustainable design and construction. The guidance relevant to the REEC development includes the following:

- On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate, with a minimum requirement to achieve at least 50% attenuation of the site's (prior to re-development) surface water runoff at peak times.
- When designing their schemes developers should follow the drainage hierarchy set out in London Plan policy 5.13.
- Developers should design SuDS into their schemes that incorporate attenuation for surface water runoff as well as habitat, water quality and amenity benefits.

The Mayor's Water Strategy (2011)

13.3.18 The Mayor's Water Strategy details ways in which water resources could be used more effectively in order to tackle problems such as water supply, wastewater generation and flood risk across London. Actions of relevance to water resource and flood risk issues for the REEC development comprise:

- Action 5, which aims to make property more water efficient. The strategy aims to raise awareness of efficient commercial (non-domestic) water use and encourages commercial users to set internal targets and best practice benchmarks for reducing water usage.
- Action 18, which encourages the use of green roofs, rainwater harvesting, grey water recycling and sustainable drainage techniques to relieve the pressures on the drainage systems, thereby reducing flood risk and water demand.

Thames River Basin Management Plan (2009)

13.3.19 River Basin Management Plans (RBMPs) provide a framework for managing water. They set statutory objectives for river, lake, groundwater, estuarine and coastal water bodies, and summarise the programme of measures to achieve them. The current RBMPs are in the process of being updated by the Environment Agency.

13.3.20 Measures identified in the RBMP, Thames River Basin District (2009) for the lower River Crane, where RuTC is located, include improvements to the morphology and

ecology/naturalisation and restoration of the lower River Crane downstream of Mereway Road weir and implementation of various enhancement works to rehabilitate the lower River Crane between Mereway and the River Thames /Crane Tidal Gates.

Various actions identified by the Environment Agency for the lower River Crane are:

- Increase flow in the lower Crane particularly during low flow periods;
- Install fish pass at Mereway Road weir;
- Remove concrete channel to restore 330m of river in Craneford Playing Fields on the left bank and Old Shooting range site on the right bank;
- Remove concrete bed and bank and restore natural two-stage channel along 500m through Twickenham Rough;
- Remove concrete channel to restore 600m of river in Moor Mead Park;
- Remove concrete channel to restore 300m at Cole Park Island;
- Fish easement for 19 weirs between Mereway Road and the Thames (i.e. remove or modify weir); and
- In channel habitat enhancements to improve morphological diversity in reaches between Mereway road and the Thames that cannot be fully restored.

Thames Region Catchment Flood Management Plan (2008)

13.3.21 A Catchment Flood Management Plan (CFMP) is a high-level strategic plan prepared by the Environment Agency, which identifies long-term (50 to 100 year) policies for sustainable flood risk within a catchment.

13.3.22 The relevant key messages contained within the Thames Region CFMP are that:

- Climate change will be the major cause of increased flood risk in the future; in urban areas and areas of narrow floodplain, flooding from heavy rainfall will be more regular and more severe. Surface water, sewer and fluvial flooding can occur within minutes of a severe rainfall event. Flooding can therefore occur at any time of the year, and there is very little time to provide flood warnings.
- It is increasingly necessary to recognise the value of flood plain in reducing the effects of flooding. Technical, environmental and economic constraints mean there are likely to be very few flood defence schemes in areas of narrow floodplain in the foreseeable future.
- Development and urban regeneration provide a crucial opportunity to manage flood risk; the location, layout and design of development can all reduce flood risk. For example, the use of SuDS can help to control surface water (design).
- PPS25 (now NPPF) should be applied to ensure that flood risk is managed appropriately.

The London Regional Flood Risk Appraisal (2009)

13.3.23 The London Regional Flood Risk Appraisal (RFRA) aims to ensure that overall flood risk (probability x consequences) does not increase and that by addressing existing problems, overall risk is reduced. The RFRA contains 19 recommendations including the following:

- Recommendation 8: Organisations responsible for development with large roof areas should investigate providing additional surface water run-off storage.
- Recommendation 18: Operators of London's emergency services should ensure that emergency plans for flooding incidents are kept up to date and suitable cover arrangements are in place in the event of a flood effecting operational locations. The following recommendations were made in relation to schools:
    - *'Schools need to serve their local population. 385 of London's 3064 schools (13%) are either wholly or partially within flood zones, although for some of them it may only be to a minor extent, for example within playing fields. The majority of schools affected are in central/inner London part of the Thames tidal flood plain and as such have a high degree of flood protection. Clearly a flood would represent a direct risk to the pupils and staff at schools and would cause longer term disruption whilst any repairs are made. The analysis has examined both public sector and private schools including further education, six form colleges. It has not included pre-schools and nurseries'.*
    - *'Schools are also important in terms of managing civil emergencies as they are often used as emergency shelter, food and supply bases. If the emergency is a flood, then this may mean that the school cannot fulfil this function.'*

Local

The Crane Valley – A Water Framework Directive Catchment Plan

13.3.24 The Crane Valley Catchment Plan is co-ordinated by the Crane Valley Partnership with a vision for '*a well managed and high quality river corridor which is accessible to all in which wildlife can thrive and local people can take pride and ownership'.*

The Crane Valley Partnership Mission is to develop a co-ordinated strategic plan that will:

- Raise awareness and support action for conservation, restoration and new approaches to design and management of the River Valley;
- Help communities take a sustainable approach to managing and improving the River Crane and its tributaries;

- Improve and protect the biodiversity of the area;
- Maximise the use of the river corridor as a resource for healthier living and educational activities for local people; and
- Promote connectivity along the river corridor.

The London Borough of Richmond upon Thames Strategic Flood Risk Assessment (2008)

13.3.25 SFRAs should be carried out by the Local Planning Authorities to inform the preparation of Local Development Plan Documents and provide the information needed to apply the sequential approach in accordance with the NPPF. The sequential approach is a risk based approach to determine the suitability for development in flood risk areas. LBRuT has developed a Level 1 Strategic Flood Risk Assessment and accompanying flood maps which are publicly available.

13.3.26 The proposed site at that time (i.e. ID: T29-Richmond College, Egerton Road, Twickenham, (8.6 ha), 2008) was included in the assessment. The SFRA concluded the following with respect to the plan at that time:

The site lies adjacent to the River Crane, an area proposed for environmental improvements. The development of this site therefore presents an opportunity to enhance on-site landscaping and amenity space which would open up access to the river and thus deliver benefits to residents and wildlife.

13.3.27 Points most critical to satisfy the Exception Test for the Site include:

- The development of the site for residential development is a significant identified need in the borough.
- The development is located on developable, previously developed land.
- The development is safe from flood risk perspective as largely located in flood risk zone 1 and a reduction in site runoff should be sought, aiming to achieve Greenfield run-off rates, or reduce run-off rates by at least 50% over current levels.

Local Flood Risk Management Strategy for Richmond upon Thames

13.3.28 LBRuT is defined as a Lead Local Flood Authority (LLFA) under the Floods and Water Management Act, and such has new roles and responsibilities to coordinate and lead the management of local flood risk (i.e. flooding from surface water, groundwater and ordinary watercourse). LBRuT is required to develop a Local Flood Risk Management Strategy, which will explain how their new local flood risk roles and responsibilities are achieved. The Local Flood Risk Management Strategy will provide the opportunity to:

- Encourage direct involvement in decision making;
- Improve knowledge and understanding of the interactions between different sources of flooding;
- Encourage residents, businesses and local landowners to take action and contribute to reducing flood risk;
- Target resources where they have the greatest effect; and
- Contribute to wider social, economic and environmental outcomes.

13.3.29 The Local Flood Risk Management Strategy for LBRuT is yet to be completed.

13.3.30 It should be noted that flooding from main rivers, such as the River Thames, River Crane or Beverley Brook, comes under the responsibility of the Environment Agency.

The London Borough of Richmond upon Thames Preliminary Flood Risk Assessment (2011)

13.3.31 The Preliminary Flood Risk Assessment (PFRA) has been prepared by LBRuT primarily to deliver the first step of the Flood Risk Regulations (2009). LBRuT The first step of the Flood Risk Regulations is for LLFAs to produce a PFRA.

13.3.32 The LBRuT PFRA has provided an evidence base of previous flooding events and conducted an assessment of future flood risk across the Borough via surface flooding, groundwater flooding and flooding from ordinary water courses.

Surface Water Management Plan for the London Borough of Richmond upon Thames (2011)

13.3.33 The LBRuT Surface Water Management Plan (SWMP) outlines the preferred surface water management strategy for the Borough. In this context surface water flooding describes flooding from sewers, drains, groundwater and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall. When compared to adjacent Boroughs the extent and depths of future flood risk identified through pluvial modelling across the LBRuT is relatively small.

13.3.34 Within the LBRuT, seven Critical Drainage Areas (CDAs) have been identified. For each CDA identified within the Borough, site-specific options have been identified that could help alleviate surface water flooding. These measures were subsequently shortlisted to identify a potential preferred option for each CDA.

13.3.35 A long-term Action Plan for the LBRuT was finally established to assist in their role under the FWMA to lead in the management of surface water flood risk across the Borough. Key generic actions that have been specified include:

- Develop, maintain, apply and monitor a Strategy for local flood risk management of the area;
- Duty to maintain a local flood risk asset register;
- Investigate flood incidents and record in a consistent manner;
- Establish a SuDS Approval Body (SAB);
- Contribute towards achievement of sustainable development;
- On-going responsibility to co-operate with other authorities through sharing of data and expertise; and
- Preparation of flood risk management plans.

13.3.36 The LBRuT SWMP shows that:

- The proposed development is located in one of the CDAs (i.e. Group8_001);
- Open pitches at the site may experience limited surface water flooding during heavy rainfall events by a maximum depth of 250 mm;
- No sewer flooding occurs in and around the Site; and
- Suitability of infiltration SuDs is uncertain and further site investigation is required.

13.4 ASSESSMENT METHODOLOGY

Evaluation of Effects

13.4.1 The assessment considers all of the potential water resource receptors and consists of the following sequential elements:

- Receptor identification and description of the baseline;
- Evaluation of the likely effects on receptors during the demolition/ construction and operational phases;
- Identification of specific mitigation measures to protect water resources; and
- Evaluation of the likely residual effects on receptors after the implementation of specific mitigation measures.

13.4.2 An outline FRA has been prepared and is provided in **Appendix 13.1**. It identifies and assesses all forms of flooding to and from the proposed development and demonstrate how these flood risks will be managed so that the proposed development remains safe throughout its lifetime, taking into account the potential impact of climate change.

13.4.3 Changes to site drainage and run-off patterns from the new operational site and the requirement for SuDS have been discussed and provided in an outline Sustainable Drainage Assessment (**Appendix 13.2**).

Significance of Effects

Significance Criteria

13.4.4 The potential significance of effects has been assessed based on the criteria set out in **Tables 13.2** and **13.3**.

13.4.5 The significance criteria are based on the nature of the effect (in terms of magnitude, probability, reversibility, duration and direction) and the receptor (in terms of sensitivity and value/ importance). The closer the proximity of a receptor to the site the greater the likelihood of direct and indirect effects, this is captured by the 'probability' criterion in **Tables 13.2** and **13.3**. The time scale of effects are also considered as short (0-5 years), medium (5-25) and long (over 25 years) term.

13.4.6 It should be noted that these criteria form a starting point to guide decisions on significance of effects. Decisions are based on professional judgement and in some circumstances it may be judged necessary to deviate from the criteria. Any deviations have been clearly recorded and justified within the assessment presented in this ES.

Table 13.2 Criteria for Determining the Nature of Water Resources Effects

Risk Level	Magnitude	Probability	Reversibility	Duration
High	Large-scale (regional to waterbody) effects on flows, water levels and/or wetted areas, significantly influenced outside their normal operating envelope. Large-scale effects on the river channel, banks or sediment dynamics, which are likely to have a consequent effect on watercourse hydrodynamics and on water quality, which affects ability to support Good or High WFD status for river ecology. Loss of the special characteristics of a groundwater resource, pollution of a potable source. Pollution likely to occur within Groundwater Source Protection Zone 1 (Inner Source Protection Zone), in a groundwater protection zone of special interest or a Groundwater body that has Good WFD Status. Effects on groundwater providing a significant baseflow to a WFD surface waterbody with 'High' status for Chemical Elements.	High likelihood of direct effects on hydrology, water quality and geo-morphology. Severe harm to groundwater receptor likely.	Effects on hydrology, water quality, geo-morphology and groundwater are irreversible.	Long term effects on hydrology, water quality, geo-morphology and groundwater.
Medium	Medium-scale (local to waterbody) changes to flows, water levels and/or wetted areas, and on the river channel, banks or sediment dynamics, such as changes to erosional and depositional character that have a limited influence on channel function. Medium-scale effects on water quality, but not predicted to lead to deterioration in WFD status for river ecology. Impact on groundwater resource: any pollution that takes up to 400 days to travel to a groundwater abstraction borehole or constitutes 25% of the total groundwater catchment area for an abstraction (Groundwater Source Protection Zone 2, Outer Protection Zone). Effects on groundwater providing baseflow to a WFD surface waterbody with 'Good' status for Chemical Elements.	Medium likelihood of direct effects or high likelihood of indirect effects on hydrology, water quality, geo-morphology and groundwater.	Effects on hydrology, water quality, geo-morphology and groundwater are partially reversible.	Medium term effects on hydrology, water quality, geo-morphology and groundwater

Risk Level	Magnitude	Probability	Reversibility	Duration
Low	Small-scale (up to local) changes to flows, water levels and/or wetted areas, within their normal operating envelope. Small-scale (up to local) effects on the river channel, banks or sediment dynamics, with little or no consequent effects on watercourse hydrodynamics and on water quality, within the usual variability for the site. Minor impact to groundwater resources, insufficient to affect the use or character of the groundwater resource. Groundwater more than 400 days travel time away from Source Protection Zone 1 or 2 or unsuitable for abstraction (due to historic contamination or saline intrusion) Effects on groundwater providing baseflow to a WFD surface waterbody with a status for Chemical Elements below 'Good' status.	Low likelihood of direct effects or medium likelihood of indirect effects on hydrology, water quality, geo-morphology and groundwater.	Effects on hydrology, water quality, geo-morphology and groundwater are mostly reversible.	Short term effects on hydrology, water quality, geo-morphology and groundwater.
Negligible	Little or no changes to flows, water levels and/or wetted areas. Little or no effects on the river channel, banks or sediment dynamics or water quality. Little or no effect on groundwater resources, aquifer contains very small amount of groundwater. Groundwater provides no baseflow to WFD watercourses.	Low likelihood of direct or indirect effects on hydrology, water quality, geo-morphology and groundwater	Effects on hydrology, water quality and geo-morphology are fully reversible.	At most temporary effects on hydrology, water quality, geo-morphology and groundwater.

Table 13.3 Criteria for Determining the Nature of Flood Risk Effects

Risk Level	Magnitude	Probability	Reversibility	Duration
High	Severe detrimental effect to human activity or the fabric of the proposed development, or the surrounding environment. An example would be widespread flooding, threatening life, and causing major damage to property and key infrastructure.	High likelihood of direct effects on flood risk	Effects on flood risk are irreversible	Long term effects on flood risk
Medium	Major detrimental effect to human activity or the fabric of the proposed development, or the surrounding environment. An example would be widespread flooding, causing major damage to property and key infrastructure but not threatening life.	Medium likelihood of direct effects or high likelihood of indirect effects on flood risk	Effects on flood risk are partially reversible	Medium term effects on flood risk
Low	Minor detrimental effect to human activity or the fabric of the proposed development, or the surrounding environment. Results in measurable change of limited size and/or proportion. An example would be localised flooding temporarily affecting low lying amenity areas and possibly minor infrastructure, not causing damage to property or infrastructure and not threatening life.	Low likelihood of direct effects or medium likelihood of indirect effects on flood risk	Effects on flood risk are mostly reversible	Short term effects on flood risk
Negligible	Little or no changes to flood risk.	Low likelihood of direct or indirect effects on flood risk	Effects on flood risk are fully reversible	At most temporary effects on flood risk

13.4.7 Overall, the significance of the effect has been assessed in terms of the sensitivity and value of the receptor (**Table 13.4**) and the magnitude of effect (**Tables 13.2** and **13.3**). **Table 2.5** in Chapter 2 sets out the four categories of significance of the effects.

13.4.8 The level of significance set out in **Table 2.5** is defined as follows:

- Major – adverse or beneficial effects representing effects of considerable duration, magnitude or extent and therefore represent impacts that are of potential concern;
- Moderate – adverse or beneficial effects considered to have moderate importance to the immediate local; and
- Minor - adverse or beneficial effects that are likely to be either slight or very short term.

13.4.9 Negligible effects are not considered significant.

Limitations of Assessment

13.4.10 The assessment of potential likely effects on water resources has been informed by the Parameter Plans in **Appendix 5.1** and the construction phasing plans in **Appendix 6.4.** The Illustrative Masterplan (Chapter 5, **Figure 5.1**) was used as indication of potential permeable and impermeable areas for developing an outline sustainable drainage strategy (**Appendix 13.2**) and for potential location of SuDS features. This demonstrates that surface water runoff can be managed on site; if the layout at detailed design stage and associated impermeable areas change, the drainage strategy would need to be updated accordingly.

13.5 BASELINE

Introduction

13.5.1 This section presents the water resources, surface drainage, flood risk, water supply and foul water infrastructure baseline for the study area relevant to the potentially sensitive receptors. An overview of the Site and surroundings is provided in Chapter 3 – Site and Surroundings, and a detailed description of the redevelopment is provided in Chapter 5 – Proposed Development.

Table 13.4 Criteria for Determining the Value of Water Resources Receptors

	Sensitivity	Value/ Importance
High	Hydrology, water quality and geomorphology support Good or High WFD status. Groundwater has Good WFD status for quantitative and chemical quality. High vulnerability to temporary or permanent changes in hydrology, water quality, geomorphology or groundwater.	Surface water designated for relevant environmental features at national (SSSI, NNR or equivalent) or international level (SPA, SAC or Ramsar). This includes WFD protected areas (e.g. Drinking Water Protected Area DrWPA). Surface water frequently used by people e.g. for recreation, abstraction. Groundwater aquifer designated as a Principal Aquifer and support water supply and/or river base flow on a major scale. Aquifer located within a Source Protection Zone 1 (Inner Source Protection Zone).
Medium	Hydrology, water quality or geomorphology support Good or High WFD status or potential. Groundwater has Good WFD status for quantitative and qualitative quality. Medium vulnerability to temporary or permanent changes in hydrology, water quality, geomorphology or groundwater.	Surface water designated for relevant environmental features at regional (e.g. Sites of Metropolitan Importance) or district level (e.g. Local Nature Reserves). Surface water occasionally used by people e.g. for recreation, abstraction. Groundwater aquifer designated as Secondary A, 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. Aquifer located within a Source Protection Zone 2 (Outer Source Protection Zone) or travel time to a groundwater abstraction borehole within 400 days.
Low	Hydrology, water quality or geomorphology support Less than Good WFD status or potential. Groundwater has Less than Good WFD status for quantitative and qualitative quality. Low vulnerability to temporary or permanent changes in hydrology, water quality, geomorphology or groundwater.	Surface water not designated for relevant features, but may contain habitats or populations/assemblages of species that appreciably enrich the local habitat resource (e.g. species rich hedgerows, ponds). Surface water infrequently used by people e.g. for recreation, abstraction. Groundwater aquifer designated as Secondary B, 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. Aquifer located outside any Source Protection Zones and travel time to a groundwater abstraction borehole of more than 400 days.
Negligible	Hydrology, water quality and geomorphology support Less than Good WFD status or potential Groundwater has Less than Good WFD status for quantitative and qualitative quality. Not vulnerable to temporary or permanent changes in hydrology, water quality, geomorphology or groundwater.	Surface water not designated for relevant features. Not used by people e.g. for recreation, abstraction. Groundwater aquifer designated as unproductive strata.

Infrastructure

Local Abstractions and Discharges

13.5.2 An Envirocheck Report (2014) provided in Appendix 11.1 of Chapter 11 has identified that there is one abstraction within 1500m of the Site. A surface water abstraction from the Duke of Northumberland's River is located 859m to the north-west of the Site (NGR TQ15410 74860), and is recorded as water supply related, for general use at a Thames Water Sewage Treatment Works. The remaining four abstraction points are located in excess of 1,500m from the development site and are not considered further.

13.5.3 According to the Envirocheck Report, there are eight discharge consents within 1km of the Site, five of which are active, and three which have been revoked. The main active consent in close proximity is held by Thames Water (TQ 15400 73700), for storm sewage discharge to the River Crane. The other four active discharge consents are located between 251 – 1,000m from the Site. Out of these active discharge consents three are operated by Thames Water and relate to storm sewage discharges to the River Crane, Whitton Brook and the Thames Tideway. The Rugby Football Union at the Dene Estate Social Centre also has a consent to discharge final treated effluent (non-water company) to an irrigation area.

Water Supply

13.5.4 Thames Water's Water Resource Management Plan 2014 sets out forecasts for supply and demand and identifies the measures proposed to meet consumers' needs over a 25 year period. Demand from developments such as the REEC is accommodated through the plan process, which takes into account regional projected population growth. However, even though there is sufficient regional water resource, the capacity of the local supply network to deal with changes in demand is of concern to Thames Water as highlighted in consultation and documented in the Scoping Opinion. A net increase in potable water demand might necessitate water infrastructure extension, upgrade or reinforcement.

13.5.5 Thames Water has been consulted regarding the existing drainage and water supply network in the surrounding area, and has supplied asset location plans detailing the water supply network surrounding the Site (see Appendix D of Utility Statement - **Appendix 13.3**). The plans indicate that the existing site has potable water infrastructure along Egerton Road and Craneford Way. The Site is served by a connection that enters the Site between Craneford Way and Heathfield South. There is no potable water to the west side of the Site, and the water infrastructure along the A316 is located on the opposite side of the road.

Surface Water Drainage and Foul Water Drainage

13.5.6 As part of a previous study for the development, a mapping survey of the external drainage was commissioned by RuTC (2009), this is documented in the outline Sustainable Drainage Assessment presented in **Appendix 13.2**. At least fifteen soakaway systems/chambers were identified during the mapping of the surface water drainage system and an additional two possible soakaways/chambers. Surface water is mostly routed via gullies along roads and concreted areas to the soakaways. The current understanding presented in the outline Sustainable Drainage Assessment (**Appendix 13.2**) suggests most of the surface water is managed onsite in the current configuration through the soakaways. There also appears to be a gravity connection to a combined Thames Water manhole 5703, serving the eastern portion of the site. It should be noted that some of the existing pipes could not be surveyed, due to pipe blockages and the connection to manhole 5703 would need to be verified. There is no evidence of site runoff releases to the River Crane or any natural watercourses.

13.5.7 The site wide Utility Statement (**Appendix 13.3**) indicates that the existing College foul drainage discharges to the Thames Water public infrastructure system. The existing site survey indicates two existing pumping stations (presumed private) located towards the west of the Site area, which discharge to a combined Thames Water manhole 3601 on Craneford Way. There are also two discharges to the east of the Site to combined manholes 4802 and 5702 on Egerton Road. It is assumed that this area of the Site is drained by gravity. The layout of the sewers and drainage is presented in Appendix D of Utility Statement. A sewer also runs parallel to the River Crane on its north bank within the College playing fields.

Geology, Hydrogeology and Groundwater

13.5.8 Geological mapping of this site indicates that the bedrock geology underlying the site is the London Clay Formation which is not associated with groundwater flooding and has no aquifer designation. However, there are superficial deposits of Kempton Park Gravel Formation (sand and gravels) beneath the Site and these are classified as a principal aquifer, which means that they usually provide a high level of water storage that may support water supply and/or river base flow on a strategic scale due to their high intergranular and/or fracture permeability[4]. The FRA (**Appendix 13.1**) provides further information and references the British Geological Survey (BGS) susceptibility map as identifying the Site as having potential for groundwater

[4] *Groundwater Accessed*, Environment Agency,. January 2015, http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=518500.0&y=174500.0&topic=groundwater&ep=map&scale=9&location=Richmond,%20Richmond%20upon%20Thames&lang=_e&layerGroups=default&distance=&textonly=off#x=513303&y=173255&lg=4,3,&scale=7

flooding at surface.

13.5.9 The sand and gravels below the Site are most likely in hydraulic continuity with the River Thames. A ground investigation of the Site undertaken by Soiltechnics in 2008 (described in the outline Sustainable Drainage Assessment, **Appendix 13.2**) encountered groundwater at between 1.1-3.5 mbgl in exploratory excavations and water levels of 1.33-2.54 mbgl were observed in standpipes installed across the Site. Groundwater quality is covered in Chapter 11 – Ground Conditions.

Hydrology

13.5.10 The River Crane is a moderate sized watercourse and tributary of the tidal River Thames. It flows adjacent to the Craneford Way playing fields on the south side in a concrete channel from west to east, eventually joining the River Thames approximately 2km downstream of the site at Isleworth (**Plate 13.1**).

Plate 13.1 River Crane

13.5.11 The Duke of Northumberland's River is located west of the Site and flows from south to north towards the River Thames which is located approximately 2 km to the east of the Site. It branches off from the River Crane 500 m south west of the Site and flows in culvert under Chertsey Road further downstream. The Duke of Northumberland's River is artificial with a straight channel and (concrete) reinforced banks (**Plate 13.2**). The location of the rivers in relation to the Site is shown in **Figure 13.1**.

Plate 13.2 Duke of Northumberland River, South of the A316

13.5.12 The topography of the Site and surrounding areas suggests that the River Crane is the only water body that may directly receive surface water from the Site (from the College playing fields south of Craneford Way).

Surface Water Quality

13.5.13 The River Crane and Duke of Northumberland's River are typical urban watercourses. The River Crane to the south of the site was initially designated as a Heavily Modified Waterbody (HMWB) under the WFDas part of the first River Basin Management Plan (RBMP1), published by the Environment Agency in 20095. The reason for designation was urbanisation.

13.5.14 The River Crane forms part of the WFD waterbody 'Crane, including part of the Yeading Brook' (GB106039023030) (**Figure 13.1**). RBMP1 classified this waterbody as having overall poor ecological potential, with poor status for two biological elements (fish, phytobenthos) and one supporting element (phosphate). The waterbody was expected to achieve Good Ecological Potential by 2027.

13.5.15 As part of the RBMP2 consultation process, the Crane Valley Partnership, hosted by Green Corridor, made a successful application to the Environment Agency to remove the heavily modified designation for the Crane waterbody[6] on the grounds that

[5] Environment Agency (2009). *Water for life and livelihoods. River Basin Management Plan Thames River Basin District. Annex B: Water body status objectives*. 1047 pp.

[6] Accessed 6 June 2015 from: www.cranevalley.org.uk/documents/CraneCatchmentConsultationPack.pdf

urbanisation is not a designated use (like flood protection or abstraction); that most urbanised reaches of the RBMP1 water body have been assigned to other RBMP2 waterbodies; and that most of the RBMP2 Crane waterbody runs through open space where measures will not have an impact on buildings or infrastructure and are likely to result in good ecological status (**Figure 13.2**). As a result of losing its heavily modified designation the waterbody is now expected to achieve Good Ecological Status by 2021. It also means that a wider range of biological indicators, including fish, macrophytes and invertebrates should be accounted for as part of the WFD assessment methodology.

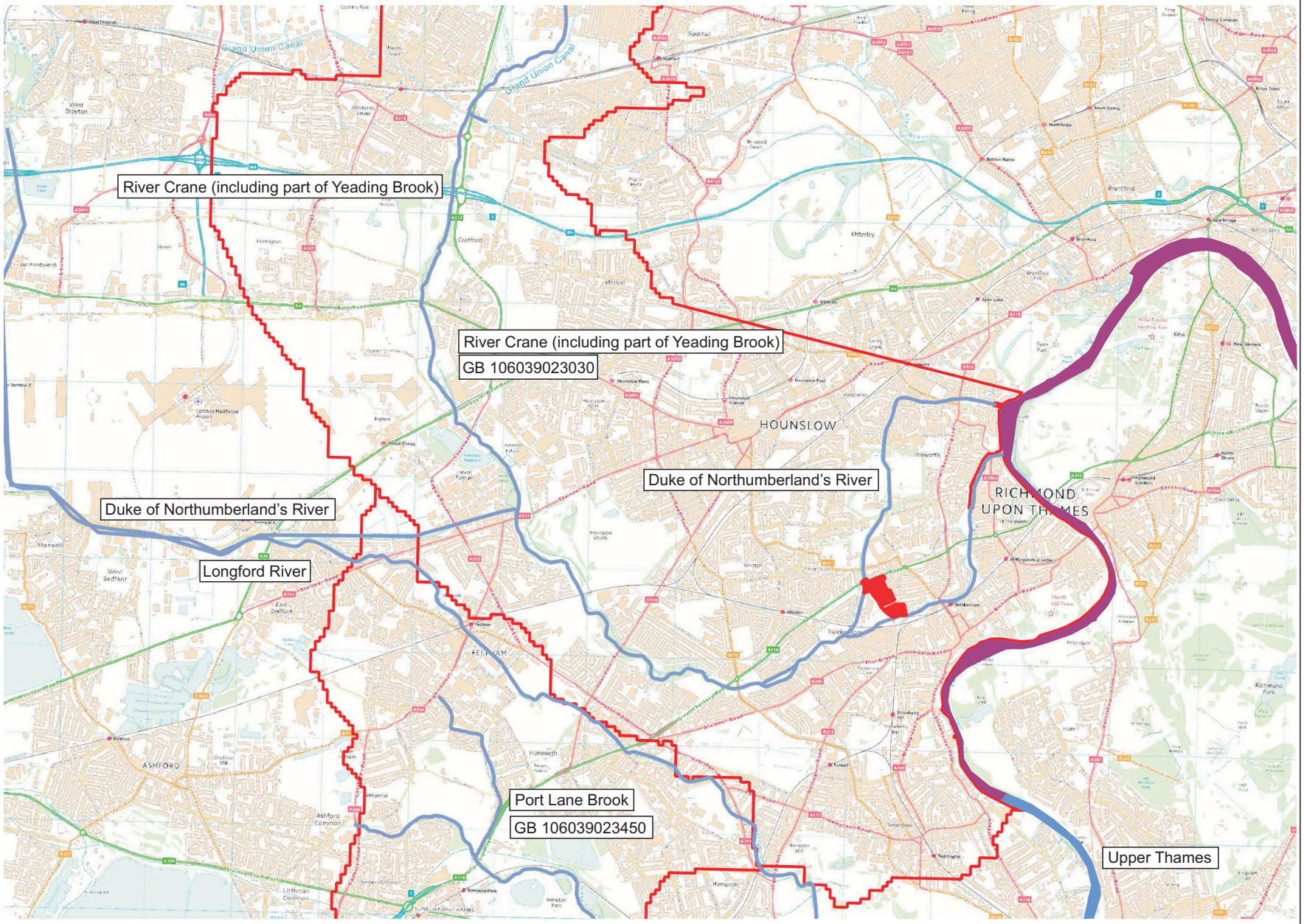
13.5.16 The RBMP2 update[7] classifies the Crane waterbody as having overall poor ecological potential, with poor ecological status (very certain) and failing good chemical status (very certain). Fish and phosphate remain at poor status. Macrophytes and phytobenthos are a combined class in RBMP2 and have combined moderate status for this waterbody. An official update to the RBMP2 WFD waterbody status is expected to be published in December 2015.

Flood Risk

13.5.17 Based on the Environment Agency's indicative flood maps, the majority of the Site (including the northern and central section) lies in Flood Zone 1 which has lower than a 1 in 1000 year annual probability of flooding. The southern half of the College playing fields south of Craneford Way is within Flood Zone 2 which has lower than a 1 in 100 year but higher than a 1 in 1000 year annual probability of flooding.

13.5.18 The SFRA (LBRuT, 2010) indicates that a large proportion of Twickenham, north of the railway line, is within Flood Zone 2 which has between a 1 in 100 and 1 in 1000 year probability of being affected by fluvial flooding from the River Crane and Duke of Northumberland's River. The extent to which the Site is affected by the fluvial flooding in SFRA is commensurate with the Environment Agency's indicative maps.

[7] Environment Agency (2015). WFD – Surface Water Classification Status and Objectives 2013-2014.Accessed June 2015 from: http://www.geostore.com/environment-agency/



Legend

- Richmond Education and Enterprise Campus College
- Tidal Thames - Upper GB 530603911403
- Freshwater River
- RBMP 1 Waterbody Boundary

N

CASCADE

Not to scale

Note: All locations are approximate

Project Title:

Richmond Education and Enterprise Campus Development

Figure Title:

RBMP 1 Water Framework Directive Waterbodies near RuTC

For Information Only

Figure Number:	Date:
Figure 13.1	June 2015